AGROCHEMICAL ABUSE: REASONS FOR PESTICIDE AND FERTILISER OVERUSE AMONG ARABLE FARMERS OF GUYANA

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LIST OF ACRONYMS ABBREVIATIONS

ACIAR	Australian Centre for International Agricultural Research
AITCC	Agriculture In-Service Training & Communication Centre
ADP	Agricultural Diversification Programme
AED	Audio English Dictionary
AOA	Agreement on Agriculture
AWI	Australian Wool Innovations Limited
BOG	Bank of Guyana
CARICOM	Caribbean Community
CARIFORUM	Caribbean Forum of African, Caribbean and Pacific States
CAQDAS	Computer-Assisted Qualitative Data Analysis Software
CDC	Centre for Disease Control and Prevention
CED	Collins English Dictionary
CET	Common External Tariff
CFA	Cane Farmers Association
CIMMYT	International Maize and Wheat Improvement Centre
CLSS	Crops and Livestock Support Services
CS	Commonwealth Secretariat
DFID	Department for International Development
EAB	Environmental Assessment Board
EC	European Commission
ECD	English Collins Dictionary
EDC	Entrepreneurial Development Centre
EEPSEA	Economy and Environment Program for South East Asia
EPA	Environmental Protection Agency
ERP	Economic Recovery Programme
ESRC	Economic and Social Research Council
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FEPA	Food and Environmental Protection Act
FFS	Farmer Field School
FFTC	Food & Fertiliser Technology Centre for the Asian &Pacific Centre
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FSC	Forest Stewardship Council
GAP	Good Agricultural Practice
GDP	Gross Domestic Product
GINA	Government Information Agency
GLSC	Guyana Lands and Surveys Commission
GNBS	Guyana National Bureau of Statistics
GOI	Guyana Office for Investment
GOG	Government of Guyana
GR	Green Revolution
GRDB	Guyana Rice Development Board
GRDC	Grains Research Development Corporation
Guysuco	Guyana Sugar Corporation
HYV	High Yielding Variety
IBRD	International Bank for Reconstruction and Development
ICZM	Integrated Coastal Zone Management

IDB	Inter-American Development Bank
IDRC	International Development Research Centre
IEEP	Institute for European Environmental Policy
IFA	International Fertilizer Industry Association
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IICA	Inter-American Agency for Cooperation on Agriculture
IMF	International Monetary Fund
IOMC	Inter-Organization Programme for Management of Chemicals
IPED	Institute of Private Enterprise Development
IPCS	International Programme on Chemical Safety
IPM	Integrated Pest Management
IWRAW	International Women's Rights Action Watch
JIFSAN	Joint Institute for Food Safety and Applied Nutrition
LDC	Least Developed Country
LSC	Lands and Survey Commission, Guyana
LWA	Land and Water Australia
MAFF	Ministry of Agriculture, Food and Fisheries
MFMTF	Michigan Farm Market Task Force
MLA	Meat and Livestock Australia
MOA	Ministry of Agriculture
MV	Modern Variety
NARI	National Agricultural Research Institute
NCSU	North Carolina State University
NDC	Neighbourhood Democratic Council
NDS	National Development Strategy
NES	No Early Insecticide Spraying
NGMC	New Guyana Marketing Corporation
NHE	New Household Economics
NMTPF	National Medium Term Priority Framework
NSA	Network for Sustainable Agriculture
NYSDL	New York State Department of Labour
OED	Oxford English Dictionary
ODI	Overseas Development Institute
PERC	Political Economy Research Centre
PNC	People's National Congress
POA	Partners of the Americas
PPP	People's Progressive Party
PSC	Private Sector Commission
PT	Practice Theory
PTCB	Pesticides and Toxic Chemicals Board
READ	Rural Enterprise and Agricultural Development
RCT	Rational Choice Theory
RDC	Regional Democratic Council
RPA	Rice Producers Association
RPE	Rational Peasant Economics
SANDEE	South Asian Network for Development and Environmental Economics
SAS	Statistical Analysis System
SED	School of Environment and Development
SPS	Sanitary and PhytoSanitary

SLA	Sustainable Livelihoods Approach
TFI	The Fertilizer Institute
TWN	Third World Network
UG	University of Guyana
UI	Unemployment Insurance
UNCCD	United Nations Convention to Combat Desertification
UOA	University of Arizona
USDA	United States Department of Agriculture
WB	World Bank
WAB	Women's Affairs Bureau
WOCAN	Women Organizing for Change in Agriculture
WRI	World Resources Institute
WTO	World Trade Organization

ABSTRACT

The overuse of agrochemicals by arable crop farmers in Guyana is of increasing concern. But the literature reveals a paucity of information concerning the reasons for farmers' persistence of this inappropriate practice. No previous study has been conducted using a structured format to reveal the scope or reasons for farmers' sustained overuse of these chemicals.

This research adopted an original structured-type approach, suitable for unearthing and explaining the reasons for this phenomenon. The study was theoretically and analytically guided by the theory of practices and critical realist theory respectively, to identify the prevalence, intensity and significant factors of farmer's pesticide and fertiliser overuse, but more importantly to elucidate reasons for overuse and formulate relevant recommendations.

This investigation utilised a mixed methods strategy of complementary quantitative and qualitative techniques; comprising analysis of data from 229 farm unit surveys and 38 farmer and 19 key informant interviews, respectively. Quantitative analysis, conducted via SPSS software using tables and regression, revealed widespread prevalence of both pesticide and fertiliser overuse among farmers. The overuse consisted of high frequencies and concentrations of the chemicals. The study notes the factors which were significantly associated with overuse including farmers' age, education level, area cultivated, land tenure status and the 'source-type' of information they accessed.

However, qualitative analysis, utilising a grounded-theory approach with the aid of NVivo software, demonstrated that unlike the suggestions by other studies, the reasons for farmers' overuse were not the single factors which showed statistical significance for overuse practices. On the contrary, this study revealed original findings, which indicated that the reasons for farmers' overuse practices were embedded within an intricate network of contingent, support and contextual factors. These explained both the instigation and continuance of agrochemical overuse by farmers. Overall the findings emphasise the need for policy redress, especially regarding the mandate and conduct of farmer-training regarding chemical use, and the regulatory enforcement of appropriate agrochemical use.

Understanding the reasons for farmers' inappropriate practices revealed new insight into the interpretation of these practices; as consequences of policy deficiency instead of farmer delinquency. Thus, the implications provided to address this problem of farmers' agrochemical overuse presented a new orientation to the type of suggestions previously suggested in other studies. The proposals indicated by this study for a targeted resolution of overuse in arable farmers of Guyana are more policy-oriented than farmer-targeted, since this study revealed that farmers' overuse behaviour is largely a response to policy-influenced support and contextual factors.

DECLARATION

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this thesis or any other university or other institute of learning.

COPYRIGHT STATEMENT

DEDICATION

This thesis is dedicated to my parents, Mr. and Mrs. Clifton David whose thorough interest in the residual effects of agrochemicals in food has been a source of inspiration to me throughout the period of this research.

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CHAPTER 1: THE SIGNIFICANCE OFAGROCHEMICAL USE: A TECHNICAL REVIEW

1.1 INTRODUCTION

The use of agrochemicals in agriculture is legendary; having its primary derivation within elements of the Green Revolution (GR). The GR is an expression used to describe a period of agricultural development, occurring from the mid to late 1960s to as late as 2000, which is characterised by the adoption of new or improved technology to increase yield from crop varieties, especially grain crops. Within the context of the GR, new technology comprised the use of improved plant varieties; commonly called High Yielding Varieties (HYVs) or Modern Varieties (MVs), increased use of inputs (particularly agrochemicals and special seed types) and regulated irrigation systems (Conway and Barbier, 1988; Evenson *et al*, 2003; IFPRI, 2002; Khush, 2001; Pearse, 1974; Ruttan, 2002; Wharton, 1969).

The combined use of these various recommended components (for example MVs, chemicals etc.) of this new technology was regarded as a package-type technology for achieving increased agricultural production (Pearse, 1980). While the GR introduced the use of these components for attaining increased agricultural yields, to satisfy the nutritional needs of a growing global population, debates surrounding the merits and demerits of this era soon emerged. Authors especially challenged whether this technology had spread to developing countries including the Caribbean (Feder *et al*, 1985; Pearse, 1980; Potter *et al*, 2004). Writers also highlighted the increased use of agrochemicals (Khush, 2001; Pearse, 1974); more specifically, their overuse [1] (Evenson *et al*, 2003; IFPRI, 2002).

It is debatable whether the effects of the GR were significant in developing countries, but the use improved technology including machinery and agricultural inputs (including agrochemicals), within Caribbean territories such as Jamaica and Guyana is recorded (Spence, 1999). Although the use of agrochemicals in Guyana is not widely documented, literature records instances of intensive and inappropriate

[1] Pesticide and fertiliser overuse for this study was defined as use of these chemicals above the manufacturer's stipulated dosage or frequency for use. The definition and basis for identifying overuse is discussed in more detail in Chapter 3 in the theoretical framework of the study.

agrochemical use, which includes the overuse of these chemicals (Bovell *et al*, 2002; Chandran, 2006; Lall, 2002; Spiller and Aleguas, 2007).

While instances of overuse are documented with corresponding concerns, the incident continues to be one that is extremely under-researched with paucity of specific empirical data. Baseline information on pesticide and fertiliser practices is lacking. Research into farmers' motivations for practices of agrochemical overuse is severely limited and attempts to garner and analyse farmers' perceptions are neglected. Previous studies generally lack a methodological and theoretical framework.

My interest in conducting this study was derived from the lack of appropriate investigations and interventions to combat the continuous problem of pesticide and fertiliser overuse in farmers of Guyana. The country contextual setting of my thesis and the evaluation of previous studies, conducted in chapters 2 and 3, respectively, highlight the dire need for investigations which could appropriately inform on the reasons for continuity of farmers' overuse of agrochemicals and provide substantial feedback for appropriate interventions. Section 1.2.2 of this chapter, presents various documented concerns of agrochemical overuse in Guyana. This discussion simultaneously highlights the paradox surrounding the continuity of this practice and emphasises the paucity of in-depth, structured research concerning the phenomenon. Subsequently, section 1.3 elucidates the rationale of this investigation.

My research utilised a mixed methods strategy, underpinned by the precepts of the theory of practices, to investigate agrochemical use in Guyana, and initially established foundational information concerning farmers' agrochemical use. More specifically, this study identified, analysed and conceptualised the causes/reasons which influenced pesticide and fertiliser overuse in some arable farmers of Guyana.

This chapter introduces the theme of agrochemical use with focus on its origin and expansion, first in a global setting and then within the context of Guyana. Elements of the GR are utilised as a foundation for understanding the context within which these chemicals were introduced and are currently utilised within agricultural production. Various debates concerning the merits and demerits of agrochemicals use are outlined, for a clearer understanding of the concerns surrounding their use and misuse, both in a general context and more specifically for Guyana. This chapter also specifies agrochemical overuse as the focus of this investigation and highlights the significance and originality of this study, for Guyana.

1.2 BACKGROUND

The origin and evolution of agricultural technology, especially its merits and demerits, are explained by the era of GR, which commenced in the 1960s and attracted wide debates concerning its effectiveness in providing increased agricultural production through the use of improved technology. Improved agricultural technology within the context of the GR included the intensive use of agricultural machinery and inputs such as high yielding varieties and chemical fertilisers and pesticides for achieving increased production.

The intensive use of agrochemicals raised widespread debates concerning the harmful effects produced when these chemicals were utilised in excess of recommended applications. It is within the context of this inappropriate use that the overuse of pesticides and fertilisers is examined in this study. This investigation acknowledges the use of agrochemicals for agricultural production both globally and in Guyana, but nonetheless adopts a position of concern for their overuse in Guyana. This study emphasises that establishing the reasons for farmers' overuse practices is the foundation for arriving at feasible solutions for this problem. In so doing, the significance of overuse behaviour is first discussed within the context of technology adoption.

1.2.1 Agricultural Technology adoption: Global Significance and Impact of Agrochemical Use and Abuse

Technology adoption refers to change in techniques through the application of new principles that result from research or experience (Hogg, 2000). Although the implementation of new agricultural technologies plays an important role in poverty reduction in developing countries, agricultural innovations are frequently adopted slowly because aspects of the adoption process are not clearly understood (Bandiera and Rasul, 2005). Understanding the factors which influence the adoption process is essential for the design of effective programmes to influence adoption (Rubas, 2004).

The history and evolution of technology adoption in agricultural production can be characterised by three main phases, according to the type and intensity of technology utilised. A first 'Pre-Green Revolution' phase utilised traditional crop varieties with small amounts of external inputs. Increased production was mainly achieved by increments of land and water resources. The second phase, commonly known as the GR was characterised by increased technological adoption where production increments were achieved through the use of high yielding or modern varieties (HYVs/MVs) and external inputs such as fertilizers, as opposed to land expansion in the traditional system. A third 'Post-Green Revolution' phase was characterised by increased use of inputs to improve production and input efficiency. Relevant information was utilised in conjunction with appropriate management skills to increase the efficiency of inputs while simultaneously contributing to the sustainable use of resources (Conway and Barbier, 1990; DFID, N.D.; Feder and Umali, 1993; Finan, 1998; Gollin *et al*, 2005; Gollin and Evenson, 2003).

The GR was initiated during the 1960s and is associated with significant changes in technology which are aimed at increasing agricultural production. However, the impact of this phenomenon is highly contested. The accounts of several authors laud its benefits and spread across several regions (Conway and Barbier, 1990; Feder and Umali, 1993; Finan, 1998; Golin *et al*, 2005). Authors attribute increased crop production to the use of technology packages comprising interrelated components of MVs, agricultural chemicals such as, fertilizers, herbicides, and relevant machinery (Feder and Umali, 1993; Finan, 1998; Golin *et al*, 2005). Examples of implementation of the GR in developing countries to solve food shortages and improve food security, include the adoption of modern varieties of rice by Latin American farmers (Finan, 1998; Golin *et al*, 2005) and the use of high yielding varieties, fertilisers and irrigation technology for rice and wheat cultivation in the third world (Conway and Barbier, 1990).

While some authors linked the GR to increased food production, others contested this view (Feder *et al*, 1985; Griffin, 1979; Potter *et al*, 2004). Griffin believes that no acceleration in agricultural output occurred in the major underdeveloped regions and concludes that 'there has been no breakthrough in overall agricultural output'. (Griffin, 1979: 5) He argues that developments of new high yielding varieties were mainly for two crops: rice and wheat and asserts that the GR was a 'modest phenomenon' when assessed in a global context; with 'big gains' in some areas and no evidence of a GR in others (Griffin, 197, p10).

Paarlberg and Pray (2007) point out that success of the GR in Asia in the 1970s was falsely interpreted as a solution to problems of farm productivity in all locations. Boucher (1999) believes that the increase of overall grain production in Central America was not due to adoption of the GR but rather the expansion of cultivated areas by poor farmers. Feder *et al*, (1985) observes that introduction of many new technologies in Less Developed Countries (LDCs) has only partial success, due to constraints such as appropriate knowledge, credit and tenure arrangements among others, which limit adoption. Potter *et al*, (2004, p99) argues that the GR 'barely touched' the Caribbean since crops of interest; wheat and rice, were not cultivated in substantial amounts at that time. He however notes that agricultural intensification may have occurred in developing countries through the use of imported inputs such as agrochemicals and machinery or technology transfer.

While it is debatable whether the GR actually reached the Caribbean, features of technology associated with the GR are present in Caribbean farming. Intensive farming[2] for both plantation and vegetable type crops, which includes the use of agrochemicals, is practised in various Caribbean territories; including Jamaica and Guyana (Spence, 1999). Adoption of technology in the Caribbean and LDCs is characterised by varying rates of implementation both across and within territories and farmer groups. Authors note several reasons such as risk aversion measures or constraints to adoption of entire technological packages (Feder and Umali, 1993; Feder *et al*, 1985; Gollin et al, 2005; Potter *et al*, 2004). These constraints exemplify typical impacts which accompany the implementation of any new system.

Much deliberation surrounds the impacts of technology adoption in agriculture (DFID, N.D.). Positive impacts cited include increased food supply; both nationally and globally, increased food security and profitability, modernisation of societies, substitution of scarce natural resources and enhancement of human welfare (Conway

[2] Intensive farming also includes increased mechanisation, decreased fallow period and adoption of permanent agriculture

and Barbier, 1990; Evenson and Gollin, 2003; Goklany, N.D.; Grainger *et al* 2003). Adoption of agricultural technology is recognised as a positive influence in increasing farm productivity, enhancing rural employment, lowering food prices and positively influencing global food security (DFID, N.D). Goklany (N. D.) explains that irrigation technologies have reduced hunger and significantly enhanced productivity. The author cites the importance of fertilisers and pesticides in doubling yields reducing crop loss respectively.

Conversely, several sources have recorded negative effects of technology adoption. Conway and Barbier (1990) note that levels of success in adoption of technologies have not been replicated on farms. Pretty (2002) explains that systems which utilise intense technology lead to land degradation, water pollution, increased costs due to address adverse effects such as pollution, compromised human health, and destruction of livelihoods and the social systems embedded in those livelihoods.

Among some of the more widely discussed impacts of agricultural technology adoption are the effects of fertiliser and pesticide use. More importantly, literature indicates that it is the inappropriate use of these inputs, rather that their mere use, which creates cause for concern. The benefits of fertilisers and pesticides are indicated in increased crop yields and reduced crop loss respectively, but their excess use is associated with pollution (Goklany N. D.). Excess use of both agrochemicals is associated with pollution of soil and water while excess fertiliser use is implicated in eutrophication[3] and support of invasive species (IEEP, 2003; Scott, 2003). Ghatak and Turner (1978) mention the benefits of pesticides in the destruction of plant pests and reducing crop loss but also acknowledge detrimental effects of residue formation and impacts on non-target organisms including humans and natural predators of pests. The constant use of similar pesticides is implicated in the development of pesticide-resistant strains of pests (Ghatak and Turner, 1978; Hogg, 2000). Weight and Kelly (1998) record negative side effects of inappropriate fertilizer use, which include decline in productivity, acidification and losses in soil organic matter. Excessive use

[3] Eutrophication is excessive growth of aquatic flora resulting from increased enrichment of water with plants nutrients above the levels required by plants. Excessive use of pesticides is associated with drift into natural habitats and destruction of plant and animal life (IEEP, 2003; Scott, 2003).

of fertiliser is also linked to contamination of water, health hazards of infants, various cancers and denitrification[4] (FFTC, 2009; Scott, 2005; Wipatayotin, 2007).

Agrochemical misuse (including overuse) is of worldwide concern. However, the developing world (which includes the Caribbean and Latin American regions) has been highlighted as one of the areas where this practice is continuous, thereby requiring necessary measures for its alleviation. Some of the main concerns of this practice are negative residual effects which include environmental pollution (CEO, N.D. a.; CEO, N.D.b.; CEP, N.D; Gilles and Franco, 2005; PRB, 2011). Literature relates environmental pollution based on principles of the Environmental Kuznets Curve (EKC), which hypothesises a relationship between per capita income and environmental degradation and pollution. This relation is expressed in the form of an inverted U-shape. The principle of the EKC posits that at low income levels of environmental degradation and pollution increase as income increases. Beyond a turning point, the reverse will occur where environmental degradation and pollution will decline with increased income. This principle therefore suggests that the impact of pollution on the environmental is a function of per capita income. The principle explained by the EKC may in some measure explain why agrochemical overuse and pollution seems to be a persistent problem with developing countries (Richmond and Zencey, 2007; Stern, 2004).

In Guyana, instances of agrochemical misuse, which includes overuse, have been recorded with related concerns (Chandran, 2006; Lall, 2002; Spiller and Aleguas, 2007). The history of the agricultural sector reveals evidence of technology adoption, which includes the use of agrochemicals from colonial times (Adamson, 1972; Baber and Jeffrey, 1986). Varying rates of technology adoption, including agrochemical use, are reflected across traditional and non-traditional[5] agricultural sub-sectors. Features of the previous and present status of Guyana's agricultural sector, discussed in the following section, provide an understanding of the impacts of technology adoption; particularly those of agrochemical use and misuse within Guyana's agricultural sector.

[4] Denitrification defines losses of excess nitrogen from intensely cultivated fields into the atmosphere

[5] 'Traditional-agriculture' includes major crops cultivated during and immediately after colonialism (sugar and rice), while the term "non-traditional agriculture" is used in Guyana to include all components of the agricultural sector with the exception of rice, sugar, forestry and fishing. Vegetables are included in the latter group (NDS, 2001: 12.I.1).

1.2.2 Agricultural Technology in Guyana: The National Significance and Impact of Agrochemical Use and Abuse

Adoption of intensive technology in Guyana's agricultural sector originated in the era of colonialism where the main crop, sugar cane, required intensive plantation-type production with high levels of inputs and skilled technology (Adamson, 1972). Subsequently, focus during the post colonial, nationalist/socialist era, 1953 to 1992 was directed towards agricultural diversification and increased production of non-traditional crops. This new focus promoted the use of increased technology, which mainly comprised agrochemical use and some forms of mechanisation (Griffin, 1979; Potter *et al*, 2004).

At present Guyana's agricultural sector has adopted a market oriented approach which requires intensified agricultural production. Diversification is one of the major initiatives, since the effects of globalisation; (described in more detail in the following chapter), threaten preferential marketing arrangements of Guyana's two major traditional export crops, rice and sugar. The pursuit of intensified agricultural production requires increased technology adoption. Due to a long history of extensive technology use in the cultivation of main traditional crops, technology adoption principles for these crops are well understood and applied. However, this is not the same for the cultivation of non-traditional crops. The use of increased inputs during their cultivation is accompanied by various impacts which are not new to the discourse of technological adoption in agricultural production, but nevertheless present new areas of concern and challenges to agricultural production in Guyana (Canterbury, 2007).

Production within the sugar and rice industries is controlled by the Government of Guyana through two agencies namely; the Guyana Sugar Corporation (Guysuco) and the Guyana Rice Development Board (GRDB) respectively. Technology development and transfer are 'self-contained' within the traditional sugar and rice industries. On the other hand, the Ministry of Agriculture (MOA), through its relevant agencies, collaborates with other organisations for the transfer of technology to farmers within the non-traditional sub-sector (FAO, 2006). Within this sub-sector, the Crops and Livestock Support Services (CLSS) division is responsible for aspects of production. The National Agricultural Research Institute (NARI) is concerned with research, while the New Guyana Marketing Corporation (NGMC) is responsible for monitoring exports of non-traditional crops (NDS, 2001).

Production of alternative or non-traditional crops was conducted at subsistence level since the colonial period (Adamson, 1972; Baber and Jeffrey, 1986; Canterbury, 2007), but concerns of agrochemical use have occurred more recently. Increased health consciousness, stipulated export standards and general intensified environmental concerns have promoted increased scrutiny concerning agrochemical misuse. Some non-traditional crops are exported from Guyana to various international and Caribbean territories in small amounts and this trade requires strict adherence to protocols which stipulate residual limits of agrochemicals in exported produce [6] (NGMC, N.D.a).

Authors have recorded instances of agrochemical misuse, indicating instances of their overuse by arable farmers in Guyana. Chandran (2006) noted limited knowledge of farmers with respect to choice of the correct types of pesticides and the rate, timing and method of application of these chemicals. Lall (2002) recorded the concerns of an agricultural official who believed that agricultural produce sold on Guyana's local market were not completely free of pesticides. Spiller and Aleguas (2007), in a study on agricultural chemical exposure in small vegetable farmers in Guyana reported common occurrences of morbidity from agricultural chemical exposure, among farmers in four regions of Guyana. For the purposes of this study, concerns surrounding the overuse of agrochemicals can be grouped into three categories, namely; health, environmental and economical.

While there is general paucity of information concerning all categories, health concerns surrounding agrochemical misuse in Guyana appear to be more scantily documented compared to the other categories. These concerns are two dimensional, and include the possible consumption of vegetables which contain chemical residue and the inappropriate exposure of agricultural workers to these chemicals

[6] This information was also derived from 4 key informants: 2 Ministry of Agriculture Officials and 2 other from IICA and NGMC respectively

(IICA[7]/JIFSAN, 2004; Spiller and Aleguas, 2007; Lall, 2002). The Ministry of Health (MOH) reports health concerns of agrochemical misuse within categories of deaths by suicidal poisoning and exposure to noxious substances. For the period 2003-2007, 946 suicidal deaths were reported (representing an average of 236 deaths per year for this period). Sixty percent (60%) of these deaths were due to pesticide poisoning **(GC, 2011).** Additional statistics provided by the MOH concerning deaths caused by exposure to noxious substances, including pesticides revealed negligible figures (ranging from one to two deaths per year, with an average one death per year for the period, 2006-2008 (see appendix 2).

However, reporting of deaths within this category is not sustained. It should be noted that interviews of farmers and key informants of this investigation revealed that cases where farmers felt ill after inappropriate agrochemical use was not generally reported to any relevant authority. This practice could affect the authenticity of this type of data. This finding was also substantiated by findings where farmers were generally not perturbed in revealing their overuse practices. Farmers, from their standpoints justified this behaviour for various reasons such as their need for a liveable source of income and their use of their experience, among other reasons. These are fully explained in chapter 7, section 7.2.

Some recorded evidences of pesticide overuse and corresponding effects in Guyana are documented as long past events. In 1987 widespread thallium poisoning was reported in Guyana (Singh, 1988). More recently, Spiller and Aleguas (2007), in their study concerning agricultural chemical exposure in small farmers in Guyana, recorded that relatively few farmers in their study sought medical assistance for symptoms caused by this exposure. Only 11% of these farmers reportedly visited a local doctor while 1% reported going to a hospital for treatment. The authors reported that exposure to agricultural chemicals was consistently frequent, with incidence of severe injury which required less frequent medical attention.

[7] IICA collaborates with the Ministry of Agriculture for instruction of arable farmers in Guyana concerning Good Agricultural Practices (GAPS).

Environmental concerns surrounding agrochemical misuse in Guyana include the pollution of waterways through the leaching of excess agro chemicals residues into streams. Agriculture is cited as one of the causes of environmental pressures with precise reference to the use of agro-chemicals as a cause of environmental pressure. Specific mention is made of contamination of coastal waters through unregulated and irresponsible use of pesticides and toxic chemicals within the agriculture sector (EC, 2006; NDS, 2001). Eutrophication, which is mentioned as common side effect of fertiliser misuse (IEEP, 2003; Scott, 2005), is implicated in fertiliser misuse in Guyana (EC, 2006; NDS, 2001) as one of the main causes of blocked waterways.

The mandate of the Environmental Protection Agency (EPA), Guyana encompasses environmental concerns regarding the inappropriate use of chemicals. However, enquiry from senior personnel of the Research and Development of the EPA revealed that this agency does not collect data concerning the pollution water by agrochemicals. This again reflects the lack of appropriate policy and policy enforcement concerning the use of agrochemicals. Notwithstanding this gap, a study conducted by Ansari and Waleema (2009) on the effect of agricultural chemicals on Guyana's aquatic ecosystem in revealed the presence of heavy metals such as lead nitrates, phosphates and arsenic iron, which were above their toxic limits in waterways and soils and contributed to toxicity. Further, this investigation revealed that toxicity varied linearly with crop activities and concluded that the aquatic organisms were contaminated by agricultural pollutants which include chemical fertilizers.

Economic concerns surrounding pesticide misuse in Guyana primarily concern compliance with WTO governed Sanitary and PhytoSanitary (SPS) regulations (Singh *et al*, 2005). Guyana is a member of World Trade Organisation (WTO). The country is therefore obligated to implement the WTO Sanitary and PhytoSanitary (SPS) Agreement which includes measures to enhance food safety and market access for Guyana's agricultural products (FAO, 2005). Agrochemical residue in crop exports has major implications for securing and maintaining export markets. Strict adherence to pesticide residual limits is required according to protocols established between Guyana and importing countries (NGMC, N.D.a). Guyana's non compliance with required guidelines can result in refusal or dumping of vegetable exports which are found to contain higher chemical residue limits than stipulated and subsequent loss of export markets (Lall, 2002).

The NGMC offers detailed guidelines of export protocols at its website (NGMC, N.D.a). The CLSS division of the MOA is mandated to ensure Guyana's compliance with protocol agreements. This is achieved through farm certification and is necessary to guarantee exports of agricultural commodities from Guyana to other CARICOM countries[8]. Isolated cases of rejection of consignments of vegetables from Guyana by importing countries, due to higher residual limits of pesticide than stipulated, have been reported; unsurprisingly, through informal information channels[9].

The MOA, through its CLSS division, reported farmers' persistent use of excessive agrochemicals despite efforts by the department to curb this practice and called for enforcement of the pesticide legislation (CLSS, 2005). Some initiatives were adopted by the MOA and its respective agencies to address this problem. Extension staff of the MOA monitors the production of agricultural produce for export, ensuring that these products come from certified farms where Good Agricultural Practices (GAPs) are in use. This ensures reduction of pest infestation and also avoids the excessive use of pesticides (CLSS, 2005).

However, there is heavy dependence on farmers to ensure the correct usage of agrochemicals, especially adherence to dose rates, since complete monitoring of farmers' application procedures is impossible. Inspection of agricultural produce sold to the domestic market is absent, as the local market is unregulated[10]. The Pesticides and Toxic Chemicals Laboratory (PTCL) was established in 2008 to conduct tests for required limits of agrochemicals in crops but this facility is not fully operational. Tests for residue limits in export products are conducted by the country of import. Hence these initiatives to address overuse have proved futile due to lack of appropriate identification of the causes of farmers' overuse problems.

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[8] CARICOM Countries are Antiuga & Barbuda, Barbados, Bermuda, Bahamas, Belize, Dominica, St. Lucia, St. Vincent & the Grenadines, Grenada, Trinidad & Tobago,, Jamaica, Guyana, St. Kitts and Nevis, Suriname and Haiti. (http://www.caricom.org/jsp/community/member_states.jsp?menu=community)

[9] Key informants

[10] This information was derived from 5 key informants: 3 from the Ministry of Agriculture, Guyana and 2 others from the NGMC and PTCB respectively.

Literature indicates some of the possible reasons for farmers' adoption of various practices. Doss (2003) records several factors which influence the adoption of technology and the subsequent practices utilised by farmers. These include: farmer's knowledge, farmer's experience, access to credit, education level of farmer, farmer's wealth, land tenure status, access to information and market access. Finlan (1998) mentions constraints to technology adoption which include inadequate knowledge, imperfect markets, tenure, inadequate extension services, unavailable credit and aversion to risk. Sources suggest that potential factors which influence agrochemical misuse in Guyana include: farm size, access to credit, education level of farmer, frequency of relevant education, farmer's income, land tenure status, and market access (Bovell et al, 2002; Chandran, 2006; IICA/JIFSAN, 2004; Lall, 2002; Spiller and Aleguas, 2007).

Chapter 4 of this thesis examined various features of Guyana's political economy and their influence on technology adoption among farmers. This assessment suggested that several political economy factors were potentially motivational to the misuse of agrochemicals by farmers. These include: credit availability, land tenure status, the type of market to which produce is sold, farmers' level of education, and income (Canterbury, 2007; Munslow, 1998).

Studies demonstrated that apart from features of the political economy and those variables which influence technology adoption, demographic variables such as age, ethnicity, farm size and farming experience, play a role in determining technology adoption among farmers (Chi and Yamada, 2002; Isham, 2000; Nganje *et al*, 2001; Spence 1999, cited by Potter *et al*, 2004, p125). Mathur (2002) suggests that the small sizes of farm holdings in Guyana are a possible hindrance to farmers' adoption of modern production.

However, no previous study on Guyana utilised a targeted approach for determining the reasons of farmers' persistent overuse of agrochemicals. My investigation utilised both quantitative and qualitative strategies to identify and explain farmers' reasons for this practice. Within the former approach, a combination factors from categories of political economy, technology adoption and demography were utilised as independent variables for determining their association with pesticide and fertiliser overuse in vegetable farmers. These factors comprised farmers' age, education level, land tenure status, area cultivated, credit access and the 'source-type' of information received. Within the latter strategy, in-depth qualitative investigation was conducted, through the analysis of interview data from farmers and key informants', to determine and explain the reasons for overuse and provide targeted recommendations to combat this problem.

1.3 RATIONALE FOR STUDY

Against a background which demonstrates the significance of inappropriate agricultural technology adoption in Guyana, specifically, the overuse of agrochemicals, but simultaneously reveals a dearth of information concerning farmers' overuse of these chemicals, several arguments which support the rationale of this study are proposed.

Firstly, concerns of agrochemical overuse in arable farming of Guyana are identified in literature,[11] but the subject remains highly under-researched and still lacks specific empirical data. Baseline information concerning farmers' pesticide and fertiliser practices is absent. Previous research lack theoretical and analytical guidance and are not cognisant of farmers' standpoints for their overuse practices. Hence, the reasons for this behaviour are not identified, understood nor explained.

Secondly, suggestions for farmers' overuse practices are confined to single factors including the education level of farmer, land tenure status and market access; all indicative of linear associations or single-factor reasons (Bovell *et al*, 2002; Chandran, 2006; IICA/JIFSAN, 2004; Lall, 2002, Spiller and Aleguas, 2007). No previous study for Guyana has suggested the integration of several factors to influence overuse. In addition to the absence of knowledge which identifies and explains the reasons for this puzzling behaviour of farmers, background investigation reveals the lack of appropriate policies and use of mismatched interventions to address problems of agrochemical overuse among farmers.

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[11] Bovell *et al*, 2002; Chandran, 2006; CLSS, 2005; IICA/JIFSAN, 2004; Lall, 2002

Based on the preceding arguments, this research investigated fertiliser and pesticide overuse in arable farmers. The study population comprised farmers who cultivated two widely utilised non-traditional crops: *Vigna unguiculata sesquipedalis*, (known as bora, string bean, asparagus bean, snake bean or chinese long bean) and *Solanum melongena* (known as boulanger, aubergine or eggplant), within regions 3 and 4 of Guyana (see map in appendix 1). These regions were chosen since they contain the primary production areas of non-traditional crops, for which farmers generally utilise agrochemicals. The study crops are two of the most commonly cultivated vegetable crops, for both local and domestic market and are both implicated in agrochemical overuse[12]. There is also severe lack of investigation of this type, within the two study regions[13].

My study addressed the research question:

'What are the reasons for pesticide and fertiliser overuse in some arable farmers in the Guyana context, 2000-2010?'

The objectives utilised to answer this question were:

- To ascertain the proportion of selected arable farmers engaged in practices of pesticide and fertiliser overuse practices in regions 3 and 4 of Guyana.
- To determine the main forms of intensity of pesticide and fertiliser overuse practised by farmers; whether by higher concentrations or increased frequency of application.
- To identify and assess the factors significant to farmers' practices of pesticide and fertiliser overuse.
- To critically examine and analyse the explanatory/causal factors which motivate pesticide and fertiliser overuse in farmers.
- To assess farmers' perceptions concerning (i) the effects of pesticide and fertiliser overuse and on crop production (yield, protection against disease and quality) and (ii) the potential environmental and economic effects of pesticide and fertiliser overuse.

[12] Key informants

[13] Of the ten regions in Guyana, most vegetable production occurs in regions 2, 3 and 4 (Mathur, 2002). However, according to key informants, in region 2 the vegetables produced are primarily those of vine crops for which farmers do not regularly utilise agrochemicals.

This investigation initially utilised quantitative techniques to first reveal the proportion of practising arable farmers in regions 3 and 4 which were engaged in practices of pesticide and fertiliser overuse; then determine the main forms of intensity for both types of overuse among farmers, and also identify factors which were significant to overuse. Factors which showed statistical associations with pesticide and fertiliser overuse were useful in suggesting motivations for farmers' overuse, but further investigation was necessary to determine additional unknown factors and the role of these factors in influencing overuse. Hence, where limitations of quantitative investigation existed, in-depth qualitative investigation was conducted to determine and explain reasons for farmers' overuse practices.

My study is the first of its kind to be conducted for Guyana, where farmers' practices are studied utilising an objectivist and constructivist approach. This investigation adopted a sociological approach and employed the use of sociological investigatory methods. Reasons for farmers' overuse behaviour in this study were initially explored based on those factors which were significant to overuse, but more extensively analysed through in-depth thematic analysis of farmers' discourses. The research utilised the precepts a grounded theory approach, aided by NVivo analysis. This approach enabled the abstraction of the various identified causal reasons of overuse into categories of contingent, support and contextual factors. The manner of integration of these factors to influence farmers' overuse practices was explained through adopting the principles of Sayer (2000) critical realist interpretation of causality (Sayer, 2000, p13-17) and Collier's explanation of Bhaskar's (1989) analysis of reasons as causes (Collier, 1994). Sayer's (2000) interpretation of causality is exemplified by the following diagram (Figure 1.1).

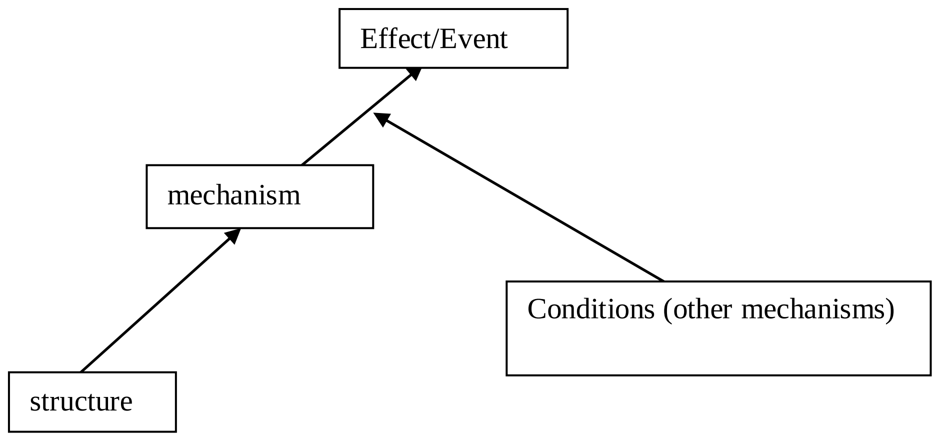

Figure 1.1: A Critical Realist View of Causation (Sayer 2000, p15)

Sayer (2000) interprets the social world as an open system. This is opposed to the notion of a closed system[14] of consistent happenings where causal powers are stable. Causation in the closed system is interpreted by a regular succession of events. On the contrary, in the open system, causes are based on the identification of causal mechanisms and subsequent understanding of how these mechanisms work, what is responsible for their operation and the conditions under which they operate. In this open system, structures have causal powers which depend on other conditions to be activated. The interactions of similar causal powers can produce different outcomes while the interactions of mechanisms can produce different outcomes based on their context and relationships with structures. In the open system, causes are explained by the interaction of structures, mechanisms and conditions (Sayer, 2000, p13-17). In a similar manner, Collier (1994) highlights Bahskar's (1989) explanation of causes as being derived from interpretation of reasons, which are explained within discourses.

Collier's explanation, of Bhaskar's interpretation of reasons as causes, supports the approach which this study adopts for determining farmers' reasons for overuse. In this interpretation a reason is considered as a cause once based on its sufficiency to influence the occurrence of the events under study. This is further explained within chapter 7, section 7.1. The reasons which farmers provided for their overuse practices were analysed to determine the causes for this behaviour, based on the sufficiency of these reasons to influence overuse behaviour.

[14] 'Closed' systems are characteristic of experimental settings where internal conditions (objects which have causal powers) and external conditions (context) are stable (Sayer, 2000, p14-15).

This study argued and proved that reasons for farmers' overuse practices are not influenced by and cannot be explained as mere liner associations between factor and event (overuse). Rather, several factors are integrated to influence farmers' overuse behaviour. Determining the reasons for farmers' overuse therefore required investigation beyond association. Based on the findings of this study, an original model was developed, to demonstrate and explain the integration and role of various contingent, support and contextual factors which influenced farmers' overuse of pesticides and fertilisers. This model is presented and elaborated within chapter 7, section 7.1 (Figure 7.1).

Initial quantitative investigation of this research produced descriptive statistics on the prevalence and intensity of farmers' overuse of agrochemicals and also identified factors (independent variables) which were significant to pesticide and fertiliser overuse (dependent variables). These findings support Doss's (2003) view concerning the importance of basic descriptive information on technology adoption for the formulation of 'policies aimed at improving agricultural productivity' (Doss, 2003, p4).

However, this author and other writers also highlight the importance of farmers' standpoints in understanding the reasons for their decisions on technology adoption and note that several factors may be interrelated and require investigation beyond a descriptive type (Doss, 2003; Feder *et al*, 1985; Finlan 1988). Feder *et al*, (1985) points out that several variables integrate to determine technology adoption. Finlan (1988) proposes that factors may be embedded in mechanisms or contextual situations, while Doss (2003) explains that the key to understanding the way in which farmers make decisions is to allow these very farmers to identify the factors which were important for adoption of these decisions.

This study acknowledged the writings of these various authors. In-depth analysis of farmers' discourses uncovered reasons for their overuse behaviour which were not potentially considered. This type of analysis also indicated the roles and interrelatedness of the various contingent, support and contextual factors which influenced farmers' overuse practices. Findings of this study are embedded within and explained by an elaboration of the entire thesis.

1.4 Overview of the Research

Thorough investigation into the use of agrochemicals in arable farmers of Guyana, conducted through this thesis, revealed a mass problem of pesticide and fertiliser overuse practices. Overall, these practices were strongly influenced by the lack of an enabling environment which is capable of initially encouraging farmers' adoption of appropriate agrochemical practices and subsequently facilitating the continuity of such practices if and when they were adopted.

It can be argued that farmers should be proactive in ensuring that their practices are conducted in the appropriate manner. However, it must also recognised that the reasons for revealed by this study for farmers' overuse practices, have their origins in Government failure, reflected by lack of policy or lack of effective policy enforcement, in those cases where appropriate policy exists. Thus, while farmers have their role to play in conducting appropriate agrochemical use, addressing this problem must be initiated by Government's creation of an environment which encourages and fosters farmers' willingness to adopt correct practice.

It may also be posited that the sample of interviewees whose conversations were analysed to indicate the reasons for these practices was a relatively small one; 38 interviewees. However, this sample was randomly selected from the survey population, thus giving all members of the entire population an equal chance of being selected. Also, conducting surveys, gave the research team a chance to meet with a wider cross-section of farmers, whose practices; while not invested in detail as those of the interviewees, revealed common reasons for their overuse practices.

Examination of the contextual setting within which these practices occurred, revealed that a grassroots approach to address the problems of agrochemical overuse was missing in most of the policies and interventions designed to combat the problem. Generally, strategies were either mismatched to the reality of the existing situation or simply omitted. Evaluation of previous studies revealed the lack of an appropriate conceptual theory and subsequent theoretical framework which are required to identify the core elements of the problem and inform on strategic interventions.

This investigation utilised a defined theoretical and analytical framework and thoroughly investigated, established and explained the reasons for overuse of pesticides and fertilisers among selected arable farmers of Guyana. Based on sound investigation, the research presents original findings concerning farmers' agrochemical overuse by unravelling and explaining the paradox of sustained pesticide and fertiliser overuse practices in vegetable farmers of Guyana. The results of both quantitative and qualitative analysis conducted in this research provide the basis for implications to address this problem and further areas for research. This investigation was conducted over a three year period; comprising nine months of fieldwork. To achieve this, a '3 tier' approach was adopted, based on background findings of three main categories of information gaps.

The first stage of this study addressed the general lack of a structured investigatory approach noted in previous studies which investigated agrochemical overuse in Guyana[15]. To address this gap, principles of the theory of practices were utilised to elucidate the interpretation of a practice within the context of this study. Within this research, a practice was interpreted as the result of combined mental and physical actions, conducted by social agents. Based on this understanding, a sociological approach of investigation was adopted. The methodology of this study was guided by a critical realist approach which encompassed the use of a mixed methods strategy and utilised complementary quantitative and qualitative data gathering and analysis techniques.

The second phase of this investigation addressed the paucity of both descriptive and explanatory information surrounding farmers' overuse of agrochemicals in Guyana. Analysis of survey data from 229 respondents, conducted through the use of SPSS data analysis, revealed widespread overuse of pesticides and fertilisers among selected farmers of regions 3 and 4. More than 60% of these practising farmers engaged in both pesticide and fertiliser overuse. This practice was conducted primarily through the use of increased concentrations of chemicals, in the case of fertilisers and through increased frequencies of applications, in the case of pesticides. Factors which were significant to pesticide overuse were farmers' land tenure status,

[15] Main studies for Guyana include those conducted by Bovel *et al*, 2002; Chandran, 2006; Lall, 2002 and Spiller and Aleguas, 2007.

area of land cultivated, age and 'source-type'[16] of information, while those showing significance to fertiliser overuse were farmers' education level and the source-type of information. The 'source-type' of information accessed by farmers was significant to pesticide and fertiliser overuse, both independently and in association with most of the other factors.

Qualitative analysis complemented the quantitative phase of this investigation, initially, by facilitating further investigation into those factors which were significant to farmers' overuse. More importantly, qualitative analysis was conducted on the interview data of 38 farmers and 19 key informants for determining and explaining the causes for farmers' overuse practices. This analysis revealed that, while quantitative analysis showed that some factors were significantly associated with pesticide and fertiliser overuse, the primary causes for farmers' overuse of agrochemicals were beyond these factors.

Qualitative thematic analysis of farmers' interviews revealed that their overuse of agrochemicals was primarily motivated by interactions of contingent, support and contextual factors. Contingent factors were those of farmers assuming dosages, farmers depending on their own experience, farmers' need for a marketable crop to survive, farmers demonstrating uncertainty of the information they received and farmers receiving distorted information, based on the self interest and deception of information sources. In addition to these contingent factors, farmers' overuse practices were sustained by other factors which provided a support network for this behaviour.

Support factors were identified as: Disorganised information systems, compromised agrochemical regulations, and irregular marketing systems. The interactions of contingent and support factors occurred within several contextual situations to influence farmers' agrochemical overuse. These contextual situations were identified as: Incapable extension services, mismatched strategies/interventions, absence of appropriate policy intervention and adverse marketing conditions. Understanding farmers' perceptions also played a key role in explaining their reasons for overuse, as

[16] 'Source-type' primarily indicates the source of information, but takes into account that the source of information influences the type of information which is disseminated.

their beliefs reflected the thoughts which influenced their actions. Interventions would therefore be incomprehensive, if farmers' perceptions were omitted.

In the third stage of this research, analysis of the aforementioned findings was utilised to address the third knowledge gap of inappropriate policy and interventions. Based on in-depth evaluation of the causal (contingent, support and contextual) factors of farmers' overuse; complemented by an understanding of farmers' perceptions, implications for addressing farmers' persistent overuse problem primarily comprise targeted policy-based strategies. My research concluded that Guyana did not provide an enabling environment which could encourage, facilitate and support farmers' adoption of appropriate chemical use practices. The current interventions utilised to combat this problem were largely unsuccessful since they were mismatched and inappropriate; not derived on the basis of sound investigation.

Unlike previous studies, the implications for addressing the problem of overuse outlined in this investigation, comprise a compendium of strategic policies and interventions which are derived from an understanding of farmers' overuse, within a wider context; as a 'policy deficiency' dilemma rather than a 'farmer delinquency' problem.

1.5 STRUCTURE OF THESIS

1.5.1 Thesis Outline and Framework

Investigation into the overuse of pesticides and fertilisers in selected arable farmers of Guyana is recorded and extensively discussed through the nine chapters of this dissertation. This introductory chapter primarily provides the history and evolution of agrochemical use, both globally and in Guyana's context. The chapter highlights the importance of these chemicals in agricultural production and the significance of this investigation in unearthing and explaining the reasons for their inappropriate use by farmers in Guyana.

Chapter 2 follows up on chapter one by describing a specific country and sector-based context and significance of the study. The chapter initially conducts an evaluation of Guyana in terms of its history and present economy then briefly assesses the relative contribution of sectors to the economy. The importance of the agricultural sector as a primary contributor to the economy is evaluated in relation to the geographical, economical and environmental conditions of the country. This assessment underscores the need for agricultural practices (including agrochemical use), to be conducted in an appropriate manner. The chapter concludes with an evaluation of the agricultural sector which encapsulates a critique of the various initiatives undertaken within this sector to address the problems of agrochemical overuse.

The third chapter of this dissertation addresses the theoretical framework which guided the study and presents the most relevant literature review undertaken for the investigation. The chapter informs on the importance of a conceptual theory in research and discusses the development theory of farming, where the main concepts of farming, through a debate of modernist and post-modernist views of farming are introduced. Within this discussion, the main concept of the study; agrochemical overuse, is defined and explained. The chapter then presents various theories; Practice Theory (PT); Rational Choice Theory (RCT); Rational Peasant Economics (RPE); New Household Economics (NHE); Sustainable livelihood concept literature - Sustainable Livelihoods Approach (SLA), which are useful for explaining farmers' decisions. The penultimate section of this chapter presents a critique of these theories and demonstrates partial acceptance of some of these theories for this study. However, the theory of practices is highlighted as being most suited for the conceptualisation of farmers' overuse practices. The chapter concludes with a literature review of competing studies, simultaneously presenting a critique of these studies.

Chapter 4 conducts an investigation into the political economy of Guyana with reference to its influence on farmers' practices of agrochemical use. The chapter first describes the general history and importance of political economy and then explains the influence of political economy on agricultural technology adoption. Emphasis is placed on those factors of the political economy which have potential to influence farmers' decisions on the adoption or non-adoption of agrochemical practices. The chapter concludes with discussion on the importance of political economy in influencing farming practices and introduces the need for a type of methodology which not only investigates potential factors of overuse, but gives scope for the identifying new causal factors of overuse and explaining their various roles in influencing this practice.

The fifth chapter explains the methodology and research design of this thesis and highlights the choice of an appropriate methodology which is suited for identifying reasons and also explaining their role in influencing farmers' overuse. This chapter emphasises the importance of methodological theory as a research guide and demonstrates to the reader the manner in which a critical realists' theory and mixed-methods analysis guided the conduct of investigation and data analysis within this thesis. Emphasis is placed on the role of a critical realist theory in investigating farmers' practices as physical occurrences, and also as being socially constructed. The appropriateness of triangulation as a mixed methods strategy for deeper understanding of farmers' practices is underscored in this chapter.

Chapter 6 presents an analysis of research objectives 1 through 3. The chapter initially discusses the prevalence and intensity of pesticide and fertiliser overuse in arable farmers of Guyana, based on SPSS analysis. Subsequently, factors which are statistically significant to pesticide and fertiliser overuse are examined, based on the results of logistic regression analysis. However, the restrictions of this analysis in identifying reasons for overuse are demonstrated. The chapter concludes with a critique on the limitations of quantitative investigation for this explanatory type of study and highlights the usefulness of complementary investigation; thereby introducing the qualitative analysis and discussion presented in the following chapter 7.

The seventh chapter addresses objective 4 of the research question and identifies and explains the contingent, support and contextual causal factors which influence farmers' overuse of pesticides and fertilisers. The originality of these findings is highlighted. Causal factors are discussed, with supporting excerpts and appropriate conclusions, which include the researchers' views and those of various authors. The interrelatedness of the various categories of causal factors (contingent, support and contextual factors) in influencing overuse is elaborated in written, diagrammatic and tabular formats; the later two forms being presented within chapter 7, section 7.1 and appendix 3, respectively. The chapter concludes with a summary of findings within the context of their usefulness for strategic interventions and introduces chapter 8 by simultaneously indicating the importance of farmers' perceptions in guiding these interventions.

Chapter 8 provides continuity to 7 and introduces the usefulness of farmers' perceptions for guiding the content and level of training interventions. The chapter presents an analysis and discussion of farmers' perceptions concerning the overuse of agrochemicals in relation to crop production, economic and environmental effects. This penultimate chapter critically examines farmers' perceptions against corresponding scholarly literature and information from learned key informants. This chapter concludes by emphasising the strengths and weaknesses of farmers' perceptions; indicating the appropriateness of this information for guiding feasible interventions.

The final chapter presents the overall findings of the investigation which highlights the comprehensive reason for farmers' overuse of pesticides and fertilisers as one of policy deficiency and underscores the lack of an enabling environment to promote and support the appropriate use of agrochemicals by farmers. This argument is primarily based on the analysis and discussions of chapters 6 to 9, but is also derived from analysis and discussions of chapters 2 and 4, which evaluate the contextual setting of the study and the influence of political economy on agrarian change in Guyana, respectively. The chapter concludes with implications for appropriate interventions to address agrochemical overuse in Guyana's. Implications are discussed in tandem with a critique of the current strategies and policies currently employed. Areas for further research are suggested.

1.5.2 Scope and Limitations

Various limiting factors were noted for this investigation. The use of the farming household as a case assumed that each household member had similar perspectives concerning overuse practices. To address this shortcoming, any contrary opinions by other family members were noted, but the recording of divergent opinions depended on the presence of these individual(s) during the interviews and their willingness to express those views.

Examination of the farmers' register revealed inadequacies. Additions or exclusions were not updated for approximately seven years. Omissions were noted since registration was not mandatory. Pertinent information for farmers such as their contact details were missing. The inadequacy of this research instrument caused an initial setback as detailed updating of the register had to be conducted by a small team of research assistants.

The population of Guyana is approximately 762,000. This populace are located within a geographical area 83, 000 square miles or 215,000 square kilometres (FAO, 2000). Farming is not conducted within designated areas. Farming households are sparsely distributed, requiring extensive travel via water or non-paved roadways. While planning was conducted, repeat visits could not be avoided and were necessary in some instances of qualitative investigation (interviewing), when new factors emerged and required additional information.

Questioning revealed some instances of farmers' offences against laws or their deviation from required practices, such as their use of banned chemicals and non-payment of taxes. Farmers were aware of the implications involved and were therefore reluctant to reveal some types of information. One of the main instances was that of farmer income, which had implications for farmers' negligence of payments such as insurance and taxes. The use of income as a factor for influencing overuse was replaced by the proxy factor of marketing potential, as questioning on income revealed vast discrepancies or outright refusal. Some sensitive information such as refusal of consignments of vegetables from importing countries due to violations of agrochemical residues was also reluctantly answered and confirmed by some key informants.

1.6 SUMMARY

Investigation into pesticide and fertiliser overuse in Guyana revealed the general lack of an enabling environment to initiate and support farmers' adoption of appropriate agrochemical practices. This deficiency was strongly supported by the absence of appropriate policies and the use of mismatched interventions to address problems of agrochemical overuse.

In agreement with literature, this study revealed that farmers' decisions are influenced by information from trusted sources in addition to their own 'experience, values, beliefs and habits' (GRDC, 2006, p10). More importantly, findings of this study supported the view that technology adoption in agriculture (in this instance farmers' adoption of agrochemical use practices), is determined by an interrelation of different groups of factors, integrating at different times (Barao, 1992; Pannell, 2007).

Findings of this thesis described widespread prevalence and intensity of overuse practices of farmers, which occurred in more than half of the study population, through the use of increased concentrations and applications of these chemicals. Factors which were statistically significant to pesticide overuse included farmers' land tenure, area cultivated, age and source-type of information, while those significant to fertiliser overuse were farmers' education level and the source-type of information. However, the roles of these factors in influencing overuse were not explained due to the limitations of quantitative investigation.

Qualitative investigation revealed that while these factors some association with farmers' overuse practices, the reasons for farmers' inappropriate overuse practices were embedded within and explained by an all-encompassing network of contingent, support and contextual factors. Analysis of this network highlighted the problem of agrochemical overuse as one of policy-deficiency and not farmer-delinquency, as was established in previous studies and reports. In view of this new understanding, implications to address the persistent problem of farmers' overuse are presented within the context of policy reformation, complemented by subsequent strategic interventions.

In complementing the technical context and importance of this study explained in this chapter, the following chapter presents a country specific context in which this study was conducted. Chapter 2 emphasises the significance of inappropriate agrochemical overuse in relation to impact of this practice on the agricultural sector and also within in a wider context.

CHAPTER 2: THE NATIONAL CONTEXT OF AGROCHEMICAL USE AND OVERUSE

2.1 INTRODUCTION

> *'Pesticides are relevant for food control and food safety. Excessive and improper use, however have a negative impact on human, animal and plant health as well as the environment. Furthermore, improper use sends up the cost of production and endangers the export of agricultural products and affects trade negatively. I would like to throw out a challenge to the meeting, here in Guyana, since we are the lead country in CARICOM, to take cognizance of the complexity surrounding the use and management of pesticides and craft a work plan that will take pesticides management to the next level in our countries… And for food exporting countries such as Guyana, the requirements must be such that our products can enter the different markets in the region'* (MOA, 2009)[17].

This chapter describes the national context in which pesticide and fertiliser overuse practices are investigated for this study. The discussion introduces Guyana by describing the country's history and present economy and then briefly evaluates the relative contribution of the various country sectors to the economy. In accordance with the focus of this study, the agricultural sector is discussed in relation to its economical, social and environmental significance to Guyana. This three-fold significance forms the basis for emphasising the need for appropriate conduct of agricultural practices, especially agrochemical use, and briefly supplies evidence of the problems surrounding inappropriate agrochemical use. The chapter concludes by presenting and critiquing some of the primary initiatives undertaken to address this problem.

2.2 COUNTRY REVIEW

Guyana is geographically located within the northern section of South America, and shares borders with Venezuela in the west and northwest, Brazil in the south and southwest, and Suriname in the east. The country is bounded on the north by Atlantic Ocean, having a coastline which is approximately 430 km and 15-65 km wide, along the Atlantic Ocean (Baber and Jeffrey, 1986; FAO, 2000; GOG, 2001). This coastline

[17] Minister of Agriculture, Guyana**:** Remarks to the 14th Coordinating Group of Pesticide Control Board of the Caribbean, June, 2009

is made up continuous deposits of sediments from the sea and comprises mostly clay-type soil (EC, 2006). Generally, climate in Guyana is between 24°C to 32°C, with average year-round humidity of about 70%. Rainfall occurs throughout the year, but mostly during what are termed the 'rainy seasons' occurring from May to July-August and November to January (EC, 2006; FAO, 2000; GOG, 2001). The country is vulnerable to droughts and floods, with a major flood occurring in January, 2005 (EC, 2006).

Guyana is the only English speaking country in South America (Canterbury, 2007; Clarke, 2005; GOG, 2001), influenced by its heritage of colonisation which involved the plantation-type cultivation of sugar cane and subsequent export of processed sugar primarily to European territories (Adamson, 1972; Mandle, 1973). From colonisation into post independence Guyana has remained essentially an agricultural economy, with the agricultural sector being the most important export sector (Canterbury, 2007; GOG, 2001; Singh *et al*, 2005; Thomas and Bynoe, 2006). The National Development Strategy (NDS) accurately summarises:

> *'...the political economy of the country has been neither restructured, modernised, nor diversified. We are still basically an agricultural society which depends, more or less, on the same crops which we have been producing for over a hundred and fifty years'* (GOG, 2001: 2.12).

The present agrarian structure of Guyana is still influenced by the plantation type system utilised during colonisation (Gafar, 2003). Sugar remains the main crop; rice is the second most important crop, while 'other agriculture'[18] which includes other crops and livestock continues to be primarily dominated by small scale enterprises (EC, 2006; FAO, 2000; Thomas and Bynoe, 2006). A dual production system exists where cultivation of traditional crops; sugar and rice, is conducted on highly mechanised estate, extensive-type systems, primarily for export. On the contrary, production of non-traditional crops is conducted on small-scale farming systems, primarily for domestic use (Thomas and Bynoe, 2006). The post independence period demonstrated sustained emphasis on agriculture as a main pillar of the Guyanese economy and demonstrated changes which greatly affected the agricultural sector (Canterbury, 2007; GOG, 2001).

[18] Also called non-traditional agriculture

The post independence era of Guyana can be characterised by two main periods, which are explained in greater detail within chapter 4 which explains the political economy of Guyana and its influence on the agricultural sector. The first era was characterised by much state intervention, during 1970-1985, highlighting national-led development (FAO/WB, 2005; MacCuish, 2005; Singh *et al*, 2005; Thomas and Bynoe, 2006). Government played a dominant role, characterised by limited private sector involvement and price control of most food commodities. One of the main policy emphases of this era was food security; represented by a number of agricultural projects aimed to achieve this goal. This period was however marked by major economic issues, such as increased foreign debt and widespread emigration.

The second phase of the post-independence era commenced in the late 1980s and was characterised by a liberalised, market-oriented economy, which was greatly influenced by the private sector (MacCuish, 2005; Singh *et al*, 2005; Thomas and Bynoe, 2006). Price control measures for food were aborted and there was confirmation to a common exchange rate to facilitate trade transactions. Like the first post independence era, this period had several effects on the agriculture sector. Being part of the Caricom, provisions of the World Trade Organization/Agreement on Agriculture (WTO/AOA) and the CET (Common External Tariff) affected agricultural trade arrangements. Under these regulations, the systems of export quotas were restricted and imports of food were liberalised. Imported food items were subsidised by their respective exporting countries and caused hardship in some of the national agricultural sub-sectors, since these items were offered at lower prices compared to locally produced items. But consumers were the beneficiaries of a wider variety of products at better prices and quality. Guyana's main agricultural exports, rice and sugar, depended and still depends largely on the European market where preferential arrangements for exports of these products are an intricate part of support systems provided by the EU (Loxley and Jamal, 1999; Thomas and Bynoe, 2006; WTO, 2009).

Agriculture remains the main economic activity which is conducted on the coast of Guyana. However, because of the geographic location of the country, especially its coastal region (bordered by the Atlantic Ocean) and related inherent physical characteristics (low landform compared to sea level), various types of agricultural activities pose a threat to economic, social and environmental well-being of the country's citizenry (GOG, 2001). These effects are discussed in more detail within section 2.3 of this chapter which address the economic, social and environmental importance of the agricultural sector, within the context of agrochemical use and abuse. The following sections on the geographic and economic overview of the country sets the stage for understanding the importance of inappropriate agricultural practices on the economic, social and environmental wellbeing of Guyana's economy.

2.2.1 Geographic Overview

Guyana is geographically located in the northeast of South America. However, due to colonial legacy, the country is historically, economically, politically and culturally, also part of the Caribbean (Adamson, 1972; FAO/WB, 2005; Mandle, 1973). Mandle (1973) records that the country shares a similar economic history with Caribbean territories like Barbados, Jamaica and Trinidad and Tobago; referring to a past colonial system of plantation-type sugar production and export oriented agriculture.

Baber and Jeffrey, 1986 note the similarity of Guyana's colonial past with other countries of the commonwealth Caribbean. Guyana's population is multiracial, comprising a range of cultures; primarily African, Amerindian, Asian and European, which symbolises a past history of slavery and indenture-ship (Baber and Jeffrey, 1986; EC, 2006: 17; GOG, 2001). The country possesses an area of 83,000 square miles or 214 970 square kilometres (FAO, 2000: GOG, 2001), but is sparsely populated, having a population of approximately 762,000 (estimated at 2009) (FAO, 2000). It is one of the least populated countries in relation to its area, where there is actually no population pressure on the country's natural resources (FAO, 2000: GOG, 2001).

Geographically, Guyana is divided into four natural regions, based on the types of landform. These include: (1) a flat coastal belt which is about 1.5 to 2 metres below sea level at high tide (Baber and Jeffrey, 1986; EC, 2006), protected by sea defences and characterised by clay soil, where most of the country's agricultural activity is conducted; (2) a hilly sand and clay area, comprising about 25% of the country, located in the northeast of Guyana and inland of the coastal belt; (3) an interior savannah area, which primarily comprises grasses and low trees. This area accounts for approximately 11% of the total country area and extends from the south of the hilly and sand area towards the west and (4) a forested highland area which comprises about 64% of the total country's area, where tropical forests and mountain ranges are located (EC, 2006; GOG, 2001).

Ironically, the coastal belt, which is below sea level during periods of high tide, is the most inhabited region. This region is occupied by over 90% of the population and it is within this very area that most economic activities, including agriculture are conducted (Clarke, 2005; EC, 2006; FAO, 2000; FAO/WB, 2005; Gafar, 2003; GOG, 2001). This coastal region represents just approximately 7.5 % of the country's total area and is thus overcrowded. The FAO and World Bank note the importance for the conduct of main economic activities within this sensitive geographical location of Guyana and record:

> *'Over 80% of the GDP, including the entire agricultural production and the vast majority of all non-mining industrial activities are concentrated in the coastal area, which is below sea level, thus needing constant protection from the sea. Main industrial and agricultural productions include sugar, rice, timber, fisheries and in particular shrimps, textiles, bauxite and gold mining'* (FAO/WB, 2005, p1).

The sea defence board is responsible for managing and maintaining the country's sea defences. The coastal plain is protected by a variety of defences including seawalls, natural sandbanks, earthen dams and mangroves. However, these defences are sometimes breached by wave action from the Atlantic Ocean, resulting in damages to agricultural crops and villages (EC, 2006; FAO/WB, 2005). Additionally, various agricultural activities conducted in an inappropriate manner, have the potential to exacerbate the already environmentally sensitive nature of this region (GOG, 2001).

Due to the inherently sensitive nature of this region, various agricultural activities, even when conducted in a normal way, have the potential to be detrimental to the environment. The National Development Strategy notes that the heavy dependence of the country on coastal agriculture constitutes one of the reasons for Guyana's vulnerability to environmental pressures (GOG, 2001). This highlights the need for comprehensive investigations which can investigate and inform on the conduct of agricultural activities especially those which threaten environmental well being, but simultaneously acknowledge the social and economic importance of the sector.

2.2.2 Economic Overview

Guyana's economy is dominated by three main industries: sugar, rice, and mining. While the economy is primarily supported by agriculture, the mining sector also plays an important role, especially through exports of bauxite and gold. Main agricultural exports include sugar, rice and forestry products (FAO/WB, 2005; GOG, 2001; MacCuish, 2005; WTO, 2009). Cultivation and exports of non-traditional agricultural crops are limited (EC, 2006; FAO/WB, 2005). Success of the economy hinges on international trade of agricultural commodities (WTO, 2009; WTO, 2003). But trade, especially in non-traditional commodities, is subjected to quality restrictions including stipulations on the agrochemical content of produce according to WTO governed Sanitary and Phytosanitary requirements [19] (NDS, 2001). Violation of these requirements can lead to loss of export markets and even dumping of produce, reducing export contribution to the economy (Lall, 2002; SN, 2009; SN, 2008).

In terms of contribution to GDP for the period 2000-2009, the agricultural sector was the single most important sector; contributing an average 32% GDP, followed by 'government services' sector (contributing 12.4%), 'transport and communications' sector (contributing 11.2%), 'engineering and construction' sector (which contributed 9.4%) and 'mining and quarrying' sectors (which contributed 8.8%), in that order (Table 2.1).

[19] Stipulates health requirements for agricultural produce including agrochemical residue limits compliance with WTO agreements

Table 2.1 Guyana: Sector Contribution to Gross Domestic Product (GDP) (%): 2000-2009

SECTOR	2000	2001	2002	2003	2004	2005	2006	Revised 2007	Revised 2008	Revised 2009	Average
Agriculture, Forestry and Fishing	**33.2**	**33.6**	**35.2**	**34.9**	**35.4**	**31.1**	**31.6**	**30.2**	**27.5**	**27.7**	**32.0**
Sugar	15.8	16.1	18.5	17.0	18.0	13.9	13.9	13.6	11.2	11.3	**14.9**
Rice	3.4	3.6	3.2	4.0	3.6	3.1	3.3	3.0	3.2	3.5	**3.4**
Other Crops	2.2	2.2	2.2	2.4	2.4	2.3	2.2	2.1	2.2	2.2	**2.2**
Livestock	5.2	5.1	5.1	5.3	5.3	5.3	5.4	5.3	5.5	5.7	**5.3**
Fishing	3.1	3.0	2.9	2.9	2.8	2.9	2.7	2.7	2.5	2.2	**2.8**
Forestry	3.5	3.6	3.3	3.3	3.3	3.6	4.1	3.5	2.9	2.8	**3.4**
Mining & Quarrying	11.7	11.9	11.0	10.1	9.3	7.8	5.8	6.7	6.9	6.8	**8.8**
Manufacturing	5.8	5.7	5.7	5.6	5.5	6.3	6.3	6.0	5.8	5.6	**5.8**
Distribution	7.9	7.8	7.6	7.5	7.5	8.8	9.2	9.5	10.4	10.8	**8.7**
Transport and Communication	8.9	9.2	9.6	10.0	10.3	11.5	12.0	12.9	13.7	13.7	**11.2**
Engineering and Construction	8.4	8.4	8.0	8.5	8.7	9.7	10.4	10.4	11.0	10.9	**9.4**
Rent of Dwellings	1.7	1.7	1.7	1.8	1.8	1.9	2.0	2.0	2.0	2.0	**1.9**
Financial Services	5.8	5.4	5.2	5.3	5.3	5.7	5.9	6.0	6.5	6.6	**5.8**
Other Services	3.7	3.7	3.7	3.8	3.8	4.2	4.3	4.3	4.4	4.4	**4.0**
Government	12.9	12.6	12.3	12.5	12.4	13.0	12.5	12.0	11.8	11.5	**12.4**
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	**100.0**

Source: Guyana National Bureau of Statistics (GNBS): http://www.statisticsguyana.gov.gy/nataccts.html#statsbull

Within the agricultural sector, sugar and rice are the main crop contributors to the economy (EC, 2006; FAO, 2000; GNBS, N.D.; Loxley and Jamal, 1999; Singh, 2005) (Table 2.1). Production, processing and export of sugar is managed by the state-owned, Guyana Sugar Corporation (Guysuco) (EC, 2006; Loxley and Jamal, 1999). Rice is produced on small, medium and large farm operations. Production of non-traditional or other crops and livestock is characterised by small-farm type production, of average farm size six hectares or 15 acres. It is estimated that about 75% of farm households are less than 15 acres. These are classified as small farms and account for approximately 23% of agricultural land. These farmers generally have varied cropping calendars (FAO, 2000; Thomas and Bynoe, 2006). One of Government's key strategies for the agricultural sector includes diversification away from heavy dependence on the 2 traditional crops (rice and sugar), to include development of the non-traditional sector (GOG, 2001; Singh, 2005; WTO, 2009).

2.3 SECTOR REVIEW AND SIGNIFICANCE: THE AGRICULTURAL SECTOR

2.3.1 Economic Significance

The agriculture sector contributes an average of 30% to GDP and provides about 30% of employment. The sector accounts for about 40 % of export earnings (FAO, 2008). For the period 2000 to 2009 the agricultural sector's contribution of average 32% to GDP, comprised the following input from the various sub-sectors: Sugar, 14.9%; rice, 3.4%; other crops, 2.2%; livestock, 5.3%; fishing, 2.8% and forestry, 3.4% (Table 2.1).While sugar is state-owned, rice production is conducted by private producers. Non-traditional crops are primarily produced on small farms which are mostly labour intensive, in comparison to the highly mechanised production system of rice and sugar (EC, 2006; Singh, 2005). The non-traditional sub-sector was the least contributor to GDP, of agricultural sub-sectors for the period 2000-2009; accounting for an average of 2.2% (Table 2.1).

Raw sugar is Guyana's main export and approximately 90% of the country's production is exported to the United Kingdom via preferential access to the EC market since the 1970s. Terms of export are based on the Sugar Protocol, which included a guarantee by the EC to purchase 159,410 tonnes of sugar (white sugar equivalent) from Guyana at a pre-determined price (WTO, 2009). For the period 2000-2009; sugar exports comprised an average of the 255,000 tonnes (Table 2.2).

Table 2. 2: Annual Exports of Selected Agricultural Commodities by Volume ('000): Guyana; 2000-2009

Period	Commodity ('000 tonnes)		
	Sugar	Rice	Non-traditional Crops
2000	277.0	208.0	3.3
2001	252.0	209.0	3.3
2002	282.0	193.0	4.1
2003	312.0	200.0	4.1
2004	290.0	243.0	4.6
2005	230.0	182.0	4.7
2006	239.0	205.0	5.2
2007	246.0	269.0	7.4
2008	205.0	196.0	7.1
2009	212.0	261.0	9.4
Total	**2,545.0**	**2,166.0**	**53.2**
Average*	**255**	**217**	**5**

*Figures are rounded
Source: Guyana National Bureau of Statistics (GNBS): (http://statisticsguyana.gov.gy/trade.html); New Guyana marketing Corporation, Guyana

Preferential agreements for the export of sugar have eroded based on major changes conducted to the EC's import system for sugar, which commenced in 2006. Changes include reduction in the quantity and quota prices of imports. New terms indicate that all sugar exports from CARIFORUM countries[20] will be imported duty free and quota free into the EC by 2012; but this is governed by a special safeguard clause. In the interim, to facilitate preparation for this change during the marketing period of 2008/9, there was commitment by the EC for an additional tariff rate quota of no duty for 60,000 tonnes of sugar imported from CARIFORUM countries, but half of this quota is exclusive for the Dominican Republic. In response to these changes, the GOG embarked upon changes within the sugar industry to increase competitiveness (Singh, 2005; WTO, 2009).

Rice is the second most important export crop and like sugar is exported primarily through preferential schemes. Marketing of rice within Guyana is controlled by the state-owned Guyana Rice Development Board (GRDB) (Loxley and Jamal, 1999). Main import countries for Guyana's rice are CARICOM countries, especially Jamaica

[20] CARIFORUM/CARICOM countries are: Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, St. Kitts and Nevis, St. Lucia, St. Vincent, Suriname, Trinidad and Tobago (FAO, N.D.)

and Trinidad and Tobago. Additionally, rice is also exported to the EC under preferential conditions (Loxley and Jamal, 1999; WTO, 2009). However, in 1997 most of the preferential quota access for export of Guyana's rice to the EU was lost. Drop in world prices, indebtedness of producers and bad weather all contributed to decreased rice exports from Guyana (WTO, 2003). During 2000-2009; rice exports were an average of 217,000 tonnes (Table 2.2).

Loss of preferential access for export of traditional crops has necessitated diversification into and development of, the non-traditional sector (GOG, 2001; GOI, N.D.; Singh, 2005; WTO, 2003). However, distinct underdevelopment of the non-traditional sub-sector is noted. As stated earlier, the average contribution of this subsector was the least (2.2%) compared to other subsectors of the agricultural sector; sugar, rice, livestock, fishing and forestry over the period 2000-2009 (Table 2.1). A comparison of exports of this sub-sector compared to that of the main traditional crops for the period 2007 and 2009 showed great disparity. Compared to average exports amounts of 255,000 and 217,000 tonnes for sugar and rice respectively, non-traditional exports for this corresponding period was 5,000 tonnes (Table 2.2).

Authors note that lack of development within the non-traditional sub-sector prevents the full achievement of this sub-sector's potential. Singh (2005) records the prevalence of labour intensive small-farm type systems with limited mechanisation compared to the highly mechanised production systems for the main crops, sugar and rice. He notes:

> *'There is scope for significant entrepreneurial activity here given the wide range of agricultural raw material that the country is capable of producing…clearly, non-traditional crops must be given more prominence and priority if they are to successfully compete in the international market place over the medium-to long-term'* (Singh 2005, p vii and 13).

In a similar context Forde (N.D.) states:

> '*The non-traditional sector has the best possibility for growth over the next decade. However, radical changes in the structure of the sector will have to be addressed if the sector is to realise its fullest potential. These embrace adjustments to infrastructure, including land rights and in the size of farms, as well as improvements in, will be necessary'* (p4).

With respect to the use of agrochemicals, quality control and monitoring is undeveloped and largely unmonitored in the non-traditional sub-sector when compared to that of the traditional sub-sector. This disparity is demonstrated primarily by monitored, mechanised application of agrochemicals (GOG, 1996) and well established laboratory facilities for quality control testing within the traditional sub-sector (GRDB, 2007a; GRDB, 2007b; NDS, 1996), compared to unmonitored, manual application of agrochemicals and now-emerging laboratory facilities within the non-traditional sub-sector (PTCB, N.D.).

2.3.2 Social Significance

> *'.... the agricultural sector has been identified as the foundation sector for increasing food security, thereby reducing malnutrition'* (FAO, 2008, p3).

> *'The agricultural sector... represents the main source of employment for the rural population of the country, employing 30% of the country's labour force'* (Singh, 2005, p2).

In addition to its economic importance to Guyana, the agricultural sector is also of social significance to the nation (WTO, 2009). Much of the country's populace depend either directly or indirectly on agriculture for employment (EC, 2006; Singh, 2005). Within the sector, the state-owned Guyana Sugar Corporation (Guysuco) is a main employer. The WTO mentions absence of relevant data, but however recognises this company as the largest employer within the agricultural industry, providing work for 19,018 persons in 2007 (WTO, 2009). The sugar industry is singled out for providing income and also contributing to the overall welfare of its employees and their families in terms of 'health care, education, housing, community services, and development of agricultural and industrial skills' (Guysuco, 2009, p30).

The non-traditional sub-sector is a major contributor to the livelihoods of rural households and national food security (Guysuco, 2009). Guyana is now a net importer of food. Poverty mostly occurs in the rural areas, but the populace in these areas have the capacity to cultivate basic food items (FAO, 2008, GINA, 2003). Cultivation of these food items comprises mostly small farming of non-traditional crops, especially vegetables. The social significance of this type of cultivation to agrochemical use is especially noted where informal means of information sharing concerning the use of agrochemicals[21] is conducted, compared to the mechanised means of agrochemical application within traditional farming[22] (GOG, 1996). Findings discussed within chapter 7, sections 7.2 and 7.3, reveal that these social interactions between farmers, in the absence of appropriate extension information, determine the quality of information which is disseminated among farmers, in many instances, influencing the overuse of agrochemicals.

2.3.3 Environmental Significance

Guyana does not have formal environmental indicators, but the NDS (2001-2010), provides guidelines for sustainable management and protection of the environment, including the sustainable management of natural resources (EC, 2006; NDS, 2001**)**. Environmental management is primarily monitored through the responsible focal point agency, the Environmental Protection Agency (EPA) of Guyana, (EC, 2006; NDS, 2001). The NDS states:

> *'Our agricultural practices also adversely affect the environment in several ways. For example, the intensive cultivation of our main crops requires the use of fertilisers, the excess of which is carried by runoff or by leaching into waterways. The resultant nutrient enrichment of the waters induces an intense growth of aquatic vegetation which in turn blocks and fouls the water courses, and changes their ecology. In addition, chemical pesticides are utilised to control pests. Inevitably, these percolate or are washed into streams where they may directly destroy aquatic life, or enter the food chain through the process of bioaccumulation, causing either the extermination or the decline of wildlife'* (NDS, 2001: 5.I.8.1).

The EC identified the use of agro-chemicals as a cause of environmental pressure in Guyana (EC, 2006).

Literature highlights various indiscriminate agrochemical practices (Bovell et al, 2002; Chandran, 2006; Lall, 2002; MOA, 2005; Munslow, 1998: 47); some specifically indicating overuse of these chemicals (Bovell et al, 2002; Chandran, 2006; Lall, 2002; MOA, 2005). These sources constitute some the primary records which highlight agrochemical abuse in Guyana, but they lack appropriate empirical data which can provide adequate understanding of this problem. Discussion on agrochemical abuse within Guyana is primarily spontaneous and generally occurs within informal

[21] Mostly 'farmer to farmer' or 'dealer to farmer'
[22] Key informants; National Development Strategy (NDS): http://www.guyana.org/NDS/chap18.htm

conversations of the populace. While the average citizen expresses concern, there is general lack of formal records. Concerns are generally conducted and terminated as matters of daily conversation. The problem is however acknowledged at governmental level, as it is recorded in the NDS (GOG, 2001) and some initiatives within Guyana's agricultural sector have been utilised to address the issue. These are discussed within the subsequent chapter section.

2.4 SECTOR INITIATIVES: THEIR ROLE IN AGROCHEMICAL ABUSE

> *'The heavy agricultural chemical inputs of fertilizers, pesticides, etc. is of major concern. There is evidence that chemicals are used in an indiscriminate manner. The extent of the misuse is difficult to quantify as there is no monitoring of pesticide residues in crops, animals or water'* (Munslow, 1998: 47).

While there is no vast literature to identify farmers' practices of agrochemical abuse and more specifically, overuse, in Guyana, the limited investigations conducted concerning this phenomenon have succeeded, albeit in an unorganised manner to convey its occurrence. Studies mentioned in chapter 1, section 1.1.2 and further explained in chapter 3, section 3.4, have recorded incidences of agrochemical misuse, indicating overuse as a prevalent form of this abuse, but have done so in a shallow manner, with varied focus.

Chandran (2006) in his report on weed management practices of farmers in Guyana, highlighted general abuse including the use of incorrect chemicals by farmers for various problems, but highlighted that farmers' decisions for dosages were based on trial and error. Bovell *et al*, (2002) disclosed general misuse of pesticides by farmers of a farming community in Guyana and like Chandran (2006) the authors indicated farmers' overuse of these chemicals. Lall (2002) records the excessive use of pesticides by farmers, based on an interview conducted with the director of the NARI in Guyana. This report highlights excessive agrochemical use and notes some of the corresponding effects of this practice, such as rejection of agricultural exports by importing countries and the possible consumption of agricultural products, especially vegetables, containing excesses of agrochemicals. Spiller and Aleguas (2007) investigated agrochemical exposure in small farmers in Guyana. In focussing on the effects of exposure on farmers' heath, record of their misuse practices was made. The

Ministry of Agriculture in its 2005 Annual Report cited persistent indiscriminate use of agrochemicals by farmers in spite of several efforts made by the ministry to curb this practice (CLSS, 2005).

Analysis of relevant literature (some of which are cited in the previous paragraph), is addressed in greater detail in Chapter 3, section 3.4 where a literature review is conducted. This review of studies reveals a distinct paucity of in-depth information concerning the phenomenon of agrochemical overuse, despite its mention within the literature. The review reveals the absence of scholarly-type, comprehensive and structured investigations into the phenomenon, which can establish the occurrence of overuse, and also provide valid explanation for its occurrence. Data which explains the basis for continuity of this phenomenon, despite several initiatives aimed at curbing these practices, is lacking. While the literature review of chapter 3 primarily examines existing studies, the following chapter section critically assesses those sector initiatives which have been directly and indirectly utilised to address the problem of agrochemical overuse in Guyana.

2.5 Summary and Conclusions: A Critique of Sector Initiatives

Initiatives used to address the indiscriminate use of agrochemicals in Guyana are neither clearly defined nor are they developed, based on targeted research. However, they exist as parts of policies and interventions which address the production of safe agricultural products, primarily in compliance with export requirements. Two main initiatives include farmer-training in agrochemical use and the establishment of a Pesticides and Toxic Control Board and laboratory; both initiatives primarily established for the production of non-traditional agricultural produce which is free from chemical residues, in compliance with export requirements.

The conduct of agricultural production and related activities in Guyana falls primarily under the purview of the MOA which is mandated to '...ensure the formulation and implementation of policies and programmes which facilitate the development of agriculture and fisheries in Guyana...' Within the MOA, the CLSS is responsible among other duties to provide extension services, including instruction for crops and livestock producers. The CLSS comprises various departments including a training division, which is responsible for training of agricultural stakeholders across the country (CLSS, 2006). The MOA extension service is therefore responsible for informing farmers on agronomic and related issues, including the use of agrochemicals.

Within the MOA's extension services department, the Agriculture In-Service Training & Communication Centre (AITCC) conducts farmer training on the appropriate use of pesticides and fertilisers through seminar-type instruction on Good Agricultural practices (GAPs) and Farmer-Agent training. However, the effectiveness of training is often hampered by irregular funding and staff shortages and inefficiency. Extension officers of the AITCC collaborate with agricultural health experts of the IICA in Guyana, to inform farmers on GAPs, which focus on the appropriate use of agrochemicals[23]. Officers of the AITCC conduct Farmer-Agent training which comprises the instruction of selected groups of farmers from districts within regions. It is expected that these agents will then disseminate relevant information to other farmers, primarily through demonstration on their own farms, under the guidance of the MOA's officials.

The Ministry's officials and records suggested that efforts were made to curb farmers' overuse practices via farmer-training on vegetable production, which included agrochemical use (CLSS, 2005) and GAPs. But the CLSS Annual Report of 2005 informed that vegetable farmers continued their indiscriminate use of agro-chemicals despite the Ministry's efforts to curtail this practice. The MOA's officials suggested that the pesticide legislation which was previously enacted should be implemented as a deterrent to farmers overuse practices (CLSS, 2005). However, in the absence of an updated farmers' register, it is questionable how appropriate farmer selection was conducted for dissemination of this knowledge. Moreover, the practice of GAPs is only mandatory for farmers who produce vegetables for export and farmer-training on agrochemical is not consistent.

The PTCB also conducts training for farmers in appropriate pesticide use. But some of the sections of this training such as pesticide use for specific crops are not within the mandate of the PTCB. In many cases training is even hampered by the

[23] Information from MOA and IICA personnel

ineffectiveness of the MOA extension services. The PTCB relies on the MOA extension services department for farmer-information required to make choices for the conduct of their seminars, but in many instances this information is either lacking or incomplete. In some cases identification of farmers for training exercises was dependent on the GRDB's extension services, since staff of this agency also had some contact with vegetable farmers. Hence in this context, targeted and continuous training is not achieved.

The NARI also conducts training for farmers in agrochemical use, primarily concerning the appropriate use of fertilisers. Like the training conducted by the AITCC, instruction is generally disseminated to farmers' groups. Official report from this agency indicates the persistent use of agrochemicals by farmers, despite the training disseminated to them[24] (Lall, 2000). But training is conducted via farmers' groups and the manner of training for those areas where groups are non-functional is unclear. Additionally, the overall consistency of this training could not be defined.

In all instances of farmer-training conducted by the relevant agencies, a targeted approach was missing. Training was not based on research which informed on farmers' specific needs, including appropriate content and dissemination techniques, neither was evaluation conducted to ascertain the effectiveness of training exercises. The mismatch of training interventions for addressing the problem of overuse was mirrored in the establishment and functioning of the PTCB and corresponding PTCL to address agrochemical overuse.

The PTCB was established with a mandate to educate on and control the quality, sale and use of pesticides and other toxic chemicals and ensure the interest of stakeholders (EC, 2006; PTCB, N.D.). Legislations enacted through this board include: the Pesticides and Toxic Chemicals Control Act 2000 (No. 13 of 2000), the Pesticides and Toxic Chemicals Control Regulations 2004 (No. 8 of 2004), the Pesticides and Toxic Chemicals (Amendment) Regulations 2007 (No. 8 of 2007) and the Pesticides and Toxic Chemicals (Amendment) Act 2007 (No. 13 of 2007). While these laws are enacted, enforcement in various areas, especially those concerned with the appropriate use of pesticides on vegetable products demonstrated weaknesses. Laws governing the

[24] Also Key informants' report

monitoring of agrochemical residue in agricultural products are still not practical for the situation of overuse. For example according to regulations, the PTCB is authorised to seize agricultural crops which contain in excess of the stipulated limit of agrochemical, but the board is unauthorised to destroy these products[25].

The PTCL was commissioned on February 8, 2008, primarily for testing pesticides and pesticide residues in foods, which is within the board's mandate. But interviews with key personnel revealed several inadequacies. This laboratory is still largely non-functional. Some equipment is acquired, but there is still lack of important equipment and numbers of staff to conduct appropriate testing, especially the much needed agrochemical residual testing for agricultural products. Even though the PTCB conducts seizure of prohibited agrochemicals, trade in these chemicals is persistent, to the extent of seriously affecting legitimate trade of the agrochemical agents, where an agrochemical store was closed and another experienced serious loss due to unfair competition from illegal imports (SN, 2004).

A review of the initiatives indicates great dependence on farmers' ethical guidance for adherence to the stipulated regulations concerning agrochemical purchase and use; requiring intensive public-awareness campaigns and effective training. Farmers' decisions concerning the adoption of appropriate or inappropriate agrochemical use practices are pivotal to the continuance or restraint of these practices; exhibiting the need for sustained and targeted training. But an overview of training conducted by the various organisations, revealed the lack of a precise mandate concerning the training requirements for each agency and the absence of monitoring which assessed the effectiveness of farmer-training.

An overview of both training and regulatory interventions, regarding their appropriateness for addressing overuse practices, reveals incompatibility and indicates the need for comprehensive investigation which can inform on appropriate strategies of intervention. Studies which examine the phenomenon have suggested reasons for overuse, but have not examined or related them to the existing interventions, which to date have been unsuccessfully utilised to address the overuse problem. Nor have these

[25] Information from key informants

studies included both aspects of overuse; pesticide and fertiliser, which as this study indicates, operate ‘hand in hand’. Further, none of these studies have utilised a theoretical or analytical framework to guide their investigation in a manner which examines this problem in both a physical and social dimension.

This study is the first of its kind which adopts a mixed methods approach and presents both quantitative and qualitative evidence on both pesticide and fertiliser use in Guyana, in a comprehensive manner. It is original in its use of an analytical and theoretical framework to guide the investigation of farmers’ practices, in a manner that facilitates the analysis of agents’ (farmers’) views. This investigation is also the first study conducted on famers’ agrochemical practices in Guyana, at a scope which is beyond the boundaries of a village or district level investigation. No previous studies of this nature have been undertaken.

Compared to the previous chapter, which examined the technical context within which this study was carried out, this chapter provided a country specific context within which the investigation into agrochemical overuse was conducted. The chapter examined the role of the agricultural sector in Guyana’s economy, highlighting the non-traditional sub-sector as one which is lately emerging and dependent on export for the realisation of its full potential. In this context, the appropriate use of agrochemicals for satisfying export market requirements of non-traditional crops was indicated. With this background, the chapter presented two main categories of initiatives; training and regulatory, which were utilised to address the problem of inappropriate agrochemical overuse, but indicated their inefficiency, which is largely due to their implementation in the absence of appropriate research to ascertain their suitability.

In view of this deficiency, the following chapter highlights the need for appropriate research methodology, which is suited for investigating farmers’ practices of overuse beyond a mere descriptive role. In this context, the methodology employed in this study is emphasised as one which adopts appropriate techniques for unearthing the reasons for farmers’ overuse practices and providing the basis for targeted interventions to address the problem of agrochemical overuse. In the following chapter the theoretical framework which guides this investigation demonstrates the relevance of various theories in explaining farmers' actions, but highlights the significance of 3 theories[26] in elucidating farmers' behaviour of agrochemical overuse.

[26] The practice theory, rational choice theory and theory of the risk averse peasant

CHAPER 3: THEORETICAL FRAMEWORK AND REVIEW OF LITERATURE

> *'Far too often the introduction of research-generated recommendations into farmers' practices is narrowly regarded as a strictly technical matter. This is an error…Such an image excludes other quintessential components that account for farmer rationale and behaviour. Farmers' production problems are by no means only technical, but also sociocultural…'* (Cernea *et al*, 1985, p8).

3.1 INTRODUCTION: ROLE AND IMPORTANCE OF CONCEPTUAL FRAMEWORK

It is useful in any study to highlight the conceptual underpinning which provides insights for understanding and analysing the phenomenon under investigation. In this study, agrochemical overuse is conceptualised in both technical and social dimensions. Within the former, the overuse of agrochemicals is understood as farmers' use of these chemicals over the manufacturer's prescribed dosages. In this context a more descriptive, scientific understanding of overuse is assumed, based on modernist and post modernist views of farming. The former school supports the intensive use of pesticides and fertilisers for increased production and protection against diseases, while the latter advocates more moderate use of agrochemicals, with consideration for negative effects.

Within a social dimension, overuse is conceptualised as socially constructed behaviour, primarily explained by theories of practice and partially described by rational choice and risk-averse behaviours of farmers. Farmers are recognised as social agents, whose practices are influenced by prevailing conditions. Further, overuse is not appropriately conceptualised by separate underpinnings of the technical and social dimensions, but rather an integration of these dimensions, which is explained by the precepts of a critical realist theory. Precepts of a critical realist theory acknowledge the technical aspect of overuse, but unearth in-depth explanations for this action based on the recognition of these practices as socially constructed phenomena.

This chapter first presents a conceptual framework, initially comprising a critical review of the developmental concepts in the practice of farming, with particular emphasis on modernist and post modernist views. Findings revealed that most farmers (over 60%) adopted a more postmodernist manner of farming through intensive use of both pesticides and fertilisers, but in this study farmers' intensive use was extended to the point of overuse[27]. Reasons for this behaviour were explained by the social and theoretical conceptualisation of overuse. Following the review of development concepts, the chapter then progresses with a brief account of theories which explain the mechanics of farming practices.

Within this discussion, accounts of the theory of practices demonstrate that farmers' decisions to overuse were largely based on their 'habitus' or prevailing circumstances, such as incapable extension services, which in this study were mostly policy induced. Farmers' decisions for overuse were also partially explained by elements of the rational choice theory and risk-averse behaviour, based on farmers' justification for overuse and response to various situations such as undetermined markets. This chapter concludes with a critical review of main studies which investigated farming practices; highlighting overall strengths of these studies regarding the choice of targeted study locations and populations, but demonstrating general weaknesses in the lack of theoretical framework and appropriate methods.

3.2 Critical Conceptual Review of the Development Theory of Farming

3.2.1 Modernist Views of farming: A Review of various perspectives

Perspectives concerning the conduct of farming are expressed by various authors and represent a highly contested field which attracts a wide collection of beliefs. Main views comprise two major categories: modernist views, which justify the use of intensive farming methods for increased production and profitability and post modernist perceptions, which oppose modernist arguments and favour farming which is less intensive and concerned with natural resource and environmental conservation (Goklany, 2001; Pretty, 1995; Schaller, 1993, Tilman *et al*, 2002; Uphoff: N.D.). Modernist views of agriculture generally advocate farming that is specialised and capital intensive; focusing on and justifying the use of mechanisation and modern technologies and relying heavily on exogenous inputs to achieve increased output

[27] Incremental amounts of both chemicals used by farmers were not subjected to the manufacturers' stipulations; suggesting that while modernist views did not support overuse; intensive use of these chemicals could be extended to a total disregard of governing guidelines for their use.

(Goklany, 2001; Hansen, 1996; Lyson, 2002; Pretty, 1995; Schaller, 1993, Tilman *et al*, 2002; Uphoff: N.D.).

Pretty (1995, p3-6) presents modernist agriculture views of various authors and institutions. He records Donald Plunkett's (1993) description of the phenomena as:

'…the greatest agricultural transformation in the history of mankind… brought about by the rise of science-based agriculture which permitted higher and more stable food production , ensuring food stability and security for a constantly growing world population'

and Norman Borlaug's (1992) view: 'The advent of cheap and plentiful fertilizers has been one of the greatest agricultural breakthroughs of human kind''. Schaller (1993) notes the belief of modernist proponents that technology can remedy problems arising from these types of farming practices.

Modernist views about farming propose several supportive arguments; the major ones are embedded in attaining sufficient production to feed the world's population and maximizing profitability (Pretty, 1995; Schaller, 1993). Some views express concern for the threat of food sufficiency and even, likely starvation in the absence of modernist-type farming (Goklany, 2001; Pretty, 1995; Tilman *et al*, 2002). Other views in support of the system include its ability to create employment and alleviate poverty (Pretty, 1995), while some beliefs suggest that this system should be adopted since traditional agriculture is destructive to the environment and utilises more natural ecosystems (Pretty 1995; Tilman *et al*, 2002).

In relation to agrochemical use, authors note that modernist-type agriculture supports the use and increased use of pesticides and fertilisers as part of a package designed to increase crop yields (FAO, 1993 and 1991, cited by Pretty, 1995; Goklany, 2001; Lyson, 2002; Tilman *et al*, 2002). But even supporters of this system indicate adverse effects of their use; and more importantly, their abuse. For instance, Goklany (2001, p13) reports that '...fertiliser use has, in some cases, doubled yields' but notes that: 'The use-and abuse-of fertilisers is the major source of nutrient loading in the world's waters.' This author also states: 'In the absence of pesticides and other pest controls, an estimated 70 % of the world's crop might be lost, instead of the 42%', but he also records: 'It is true that as much as 99 (+) % of pesticides are wasted and end up in the environment.' The writer concludes: 'Recognizing the benefits of these technologies does not mean that we should ignore the tendency to overuse inputs such as water, fertilisers, pesticides…' Pretty (1995, p6), records FAO's (1993 and 1991) views on modernist agriculture: ''It seems likely that much of the growth in agricultural production will take place through increased use of external inputs'', but this organisation also noted:

> *''When managed well, external inputs can lead to greater yields and improved nutrient content...Used incorrectly, however, they can result in environmental pollution, threats to human and animal health, greater volatility in production levels, and reduced production and incomes''.*

While the supporters of modernist agriculture indicate the benefits of this system, their acknowledgment of the adverse effects, substantiates some of the concerns of post-modernist proponents. The following section of this chapter presents the views of supporters of post-modernist farming and a critique of modernist farming based on the principles of the former system.

3.2.2 Post Modernist Views of Farming: A Review of Perspectives and Critique of Modernist Views of Farming

Post modern and modern views of farming demonstrate both dualism and common ground. The latter is primarily demonstrated in the general acceptance of agrochemical use. However, distinct dualism regarding the intensity in the use of these chemicals separates the two schools of thought.

Post modern views of farming emphasise farmers' roles as agents in agricultural practices; where human behaviour is viewed as being integrated with nature. The behaviour of the human agent is considered critical in determining how nature is shaped and thus central to agricultural development (Pretty, 2002; Robinson, *et al* 2001). While post modernist views do not totally reject modernist agricultural practices, their main focus in not intensification or profit maximisation, but rather preservation of natural resources and the environment (Lyson, 2002; Pretty, 1995; Smith, 1990).

Robinson (2001, p4) describes post modernist agriculture as a system where interface with society is conducted, environmentalism is included and guiding principles for production and consumption are 'probably more moral and ethical rather than scientific and economic'. In post modernist systems, the farm is likened to an agro-ecosystem. Farming activities are conducted in such a manner that, while production occurs, emphasis is placed on conserving environmental integrity. Agriculture is viewed as integrated with nature into a system, where humans play an important role (Pretty, 2002). Post modernist views suggest that high input farming, as conducted in a modernist system, is not necessary. This school proposes management of the resource base as a more long term approach (Conway and Barbier, 1990).

Uphoff (N.D.) outlines guidelines and principles of post-modern agriculture which include: agricultural systems which manage all inputs, plants and animals within the system; practices which are labour-saving and less dependent on chemical inputs, depending more on biological or natural alternatives; reduction of soil and water pollution; systems which can withstand adverse conditions of climate and pest and disease damage, supported by polycropping; ability to operate without subsidies and accessibility to the poor by requiring less investment than modern agriculture.

The possibility for overlap of views regarding modern and post modern agriculture lie in the acceptance of agrochemical use within stipulated guidelines, as exemplified by several authors who support the use of agrochemicals, but specifically condemn their overuse (Goklany, 1996; Ntow *et al*, 2006; Tillman, 2001; SN, 2009). This possible overlap of the 2 schools is more emphasised in the subsequent critique of modernism.

i. Critique of Modernism

Pretty (2002) indicates that proponents of modernist agriculture generally regard humans as separate from nature; supporting the separation of agriculture from conserved areas. Modernist agriculture is characterised by monoculture, industrialised and commodity orientation, with focus on specific values of identified categories of human agents and is generally inflexible towards cultural values. These characteristics, Pretty notes, lead to social exclusion, loss of livelihoods and destruction of nature which cannot be corrected in total. Edwards *et al*, (1993) shares Pretty's view of irreversible destruction to nature caused by modernist agricultural practices and also states concern of farmers' inability to access necessary inputs for a modernist system.

While proponents of modernist agriculture laud the achievements of this system, adverse effects accompany these achievements. Pretty (1995) indicates FAO's mention of negative effects of modernist agriculture, resulting from abuse of this system, where adverse effects outweighed the benefits. The author does not reject the improvements brought about by modern agriculture, but notes that technologies of agricultural modernisation are more available to the 'better off', since highly specialised packages are unavailable to many farmers, due to varying causes such as inadequate funds, poor delivery services or even lack of irrigation water (Pretty, 1995, p3).

Despite the reasoning proposed for modernist agriculture, which is based on the need to feed a growing world population and avoid starvation (Goklany, 1996; Tilman, 2001), authors note that in the face of modernist systems of agriculture, many instances of hunger and poverty still exist (Pretty, 1995; Uphoff, N.D.). Various adverse environmental and sociological problems are associated with modernist systems. Major categories of the former include contamination of water, food and the atmosphere, damage and depletion of natural resources and displacement of traditional varieties. Adverse social issues include transformation of rural communities, loss of jobs and livelihoods and lands, increased disadvantages to women and increasing gap between the economic categories (Pretty, 1995). Lyson (2002, p194-196) indicates that problems associated with modern agriculture exist in environmental, social and community spheres and include land and water pollution, high energy use and neglect of 'farm household and community welfare'.

In relation to the use of agrochemicals, authors indicate detrimental consequences of agrochemical use as some of the main adverse effects of modernist-type farming. Concerns of this modernist system are not merely the use of agrochemicals, but rather their abuse, and more specifically the overuse of these chemicals and corresponding negative results. Mention is made of harmful environmental effects such as water pollution from high pesticide and fertiliser application and adverse health effects to human and aquatic life (Conway and Barbier, 1990; Goklany, 2002; Tilman, 2002).

Views in support of modernist type of farming systems and their contesting views in support of post modernist farming systems therefore provide a backdrop for the definition and comprehension of those concepts which define and explain farming practices, especially those of agrochemical overuse. This study does not adopt a position of support for modernist or post modernist views of farming methods, but investigates pesticide and fertiliser use in farmers, which according to the preceding literature bridges both views, if the use of these chemicals is conducted within recommended limits. It is therefore within this context of appropriate or inappropriate use of these agrochemicals that the following definitions of concepts for this study are derived and discussed.

3.2.3 Definition of Main Concepts

i. Farm

A farm can be conceptualised in various ways. For the census purposes, the USDA defines a farm as 'any operation that sells at least one thousand dollars of agricultural commodities or that would have sold that amount of produce under normal circumstances' (USDA, 2008). This source however indicates that different definitions for a farm can be formulated based on the specific issue which is being studied. In a similar manner as the USDA, for the purpose of census, the US Centre for Disease Control and Prevention (CDC) defines a farm as: 'any operation with $1,000 or more of gross agricultural production within a calendar year and included both crop and livestock operations' (CDC, 2004).

As stated by the USDA, the concept of farm depends on the context within which it is being studied. For instance, the Unemployment Insurance (UI) division of the New York State Department of Labour (NYSDL) defines a farm as a unit which:

> *'includes stock, dairy, poultry, fur-bearing animal, fruit and truck farms, plantations, nurseries, greenhouses or other similar structures, used primarily for the raising of agricultural or horticultural commodities, and orchards'* (NYSDL, N.D.)

In a similar manner, the Michigan Farm Market Task Force (MFMTF) defined a farm according to the Right to farm Act (RTF) Act as:

> *'the land, plants, animals, buildings, structures, including ponds used for agricultural or aquacultural activities, machinery, equipment, and other appurtenances used in the commercial production of farm products'* (MFMTF (N.D.).'

For the purposes of this study, a farm is defined as: ‘a unit which is used for the cultivation of agricultural commodities, including the production of vegetables, for both domestic and marketing purposes.’

ii. Farming Practices

Farming practices may also be termed farm operations or activities. Definitions and explanations of farming operations describe these activities as those required for agricultural production, with an intention for desired results which are mostly products or services. Farm operations include a wide range of activities such as cultivating plants and rearing animals or the production of primary products from those activities. More specific activities include irrigating land, making compost material, land preparation; using farm machinery and equipment, applying agrochemicals such as fertilisers and pesticides, applying non-chemical substances such as biological agents and harvesting and preparing plant or animal material for marketing (MAFF, 2004; NLPC, 2007). For the purposes of this study farming practices are defined as: ‘agricultural operations or activities which are conducted for the production of agricultural commodities’. In this study practices of fertiliser and pesticide application were investigated.

The following paragraphs draw largely from scholarly articles to explain via working definitions what will be considered as pesticide and fertiliser within the context of this study. Working definitions seek to be context specific, but do not attempt to distort what is factual and foundational concerning pesticides and fertilisers. These definitions therefore include both universal and contemporary understandings of pesticides and fertilisers.

iii. Pesticide

Various sources define pesticide (FAO, N.D.b: 30; EPA/US, 2010; FIFRA, 2006; FEPA/UK, 2009). These sources generally recognise a pesticide as a substance or mixture of substances which is utilised to prevent, destroy or control pests. Within this context, pests are determined as harmful organisms, and include unwanted species of plants and animals which may also be vectors (carriers) of human and animal diseases. Pesticides are used for the protection of animals, plants and plant products from pests. Major categories of pesticides include herbicides, fungicides and insecticides. Some authors distinguish between categories of ‘chemical’ and ‘biological’ pesticides, the former comprising synthetic types, which include the majority of pesticides currently utilised and the latter meaning pesticides which are of natural origin (Dewhurst, 2001; Friedrich, N.D.; FSC, 2004; Ongley, 1996; Sjoblad *et al*, 1992).

For the purposes of this study a pesticide is defined as: ‘Any chemically prepared substance or mixture of substances intended for preventing, destroying, repelling or mitigating any crop pest; including’ herbicides, fungicides and insecticides.’ This definition is based on the main types of pesticides utilised by the study population. The distinction of chemical pesticides is made since eight farmers from surveys and three farmer interviewees indicated their tryout of biological pesticides However this use was spontaneous and not the prevalent pesticide category utilised. Due to time lapse between these ‘trials’ and the interviews and inconsistency of their use, farmers could not verify the dosages of biological pesticides which they used.

iv. Fertiliser

FAO and IFA (2000, p30) define a fertiliser as ‘any natural or manufactured material, which contains at least 5% of one or more of the three primary nutrients (N, P_2O_5, K_2O)’; nitrogen, phosphorous or potassium. Other writers support this definition by claiming that a fertiliser should be considered as any natural or manufactured material which is utilised for enhancement of plant nutrient content in soils and which contains the three main plant nutrients; nitrogen, phosphorous or potassium and (ECD, 2000; EPA/US, 2009; FAO N.D.a).

Various authors widely classify fertiliser into two main categories; organic and inorganic, where the former is fertiliser of natural or organic origin and the latter is mechanically or industrially manufactured fertiliser (ECD, 2000; EPA/US, 2009; FAO, 2000; FAO N.D.a). In my investigation a fertiliser is defined (based on a partial adopts the definition of FAO, 2000 and other mentioned sources) as: ‘any manufactured material, which contains one or more of the three primary nutrients (N, P_2O_5, K_2O); nitrogen, phosphorous or potassium.’ This definition takes into account the dominant type of fertiliser used by farmers in this study and the reason for a partial adoption of FAO’s definition is further explained in the following paragraph.

Field investigations revealed that farmers generally utilised non-chemical fertiliser consisting of animal manure, and widely termed 'mould' by farmers. This fact cannot be appropriately integrated into the working definition for this study as various key informants, comprising technical agricultural resource personnel, indicated that the nutrient content of animal manure was variable. Therefore, laboratory analysis of manure was required before it could be successfully utilised as fertiliser. This information was corroborated by authors who indicated that nutrient content of manure was variable, based on several factors such as the species of animal, the manner in which the manure is handled, the method of storage and variable rates of crop absorption of the nutrients contained in manure. Knowledge of the chemical analysis for the assessment of nutrient content of manure was therefore required, prior to its successful use in the capacity of a fertiliser (Barry, *et al*, 2000; Mitchell and Donald, 1999; UOA, 1998; Whiting *et al*, 2010; Zhang, N.D). This analysis is not conducted in Guyana.

v. Pesticide and Fertiliser Overuse

Concepts of pesticide and fertiliser overuse are more implicit than clearly defined in literature. However, literature which addresses aspects of agrochemical overuse provides a basis for understanding these concepts (Dasgupta *et al*, 2007; IDRC, 2001; SANDEE, 2009; Waichman, 2007). These studies conceptualised overuse as farmers' use of agrochemicals, in amounts which exceeded the recommended dosages indicated by the manufacturers of these products. Overuse was conducted through application of unnecessarily high dosage rates or increased numbers of applications of the chemical. For the purposes of this study, working definitions of pesticide and fertiliser overuse are formulated based on a combination of the general meaning of overuse and an understanding of overuse in the context of farmers' agrochemical use.

The term overuse is defined by reputable dictionaries, indicating the excessive use of something, achieved by too much or too frequent use (AED, N.D.; CED, N.D.; OED, 2009). The Collins English Dictionary defines overuse as: 'to use too much or too frequently' or 'to injure by excessive use', while the Oxford English Dictionary states that overuse means 'excessive or too frequent use'. According to the Audio English Dictionary, to overuse is to 'make use of too often or too extensively'.

In the context of this study, pesticide and fertiliser overuse, is interpreted as: 'the deviation from the recommended dosage of a pesticide or fertiliser, to excessively utilise that pesticide or fertiliser by applying too much or too frequent dosages of the pesticide or fertiliser'. In this investigation, the overuse of agrochemicals comprised farmers' use of too high dosages of the chemicals or their use of increased frequencies of applications of these chemicals, in contradiction to the manufacturer's instructions.

The definitions utilised in this section are primarily based on US law. This is because enquiry from PTCB revealed that there are no unique Caribbean laws and definitions utilised in local laws are those adopted from US law. For instance definitions utilised within the Pesticides and Toxic Chemicals Control Act of Guyana, are mainly adopted from those of US law.

Overuse in this investigation is recognised as a component of misuse or abuse of the relevant agrochemicals. Misuse or abuse of agrochemicals indicates any form of agrochemical usage which involves deviation from the recommended instructions for appropriate use of these chemicals. This can include under or overuse or use in any alternative inappropriate manner such as application at the incorrect time. This study focuses on overuse as a specific form of misuse or abuse of these chemicals, which has been identified in Guyana.

Farmers' overuse of agrochemicals and other farming practices can be explained by various theories which explain farming behaviour. The following chapter section presents and critiques some of these theories. The discussion demonstrates why theories of practices are most appropriate for conceptualising farmers' overuse habits in this study.

3.3 Theoretical Framework: A Contrast and Critique of Theories

A compendium of theories which address the conduct of agricultural practices and their manner of analysis are discussed by sources. Some of the main theories include: Rational Choice Theory (RCT), Rational Peasant Economics (RPE), New Household Economics (NHE) and the Sustainable livelihood concept literature or Sustainable

Livelihoods Approach (SLA). These theories inform the conceptual understanding and analysis of agricultural practices. A critical analysis of their basis for understanding farmers' actions is conducted in this chapter, with an aim to reveal the most relevant theories which facilitate deeper understanding of farming practices within this specific study. In this respect, the theory of practices, as conceptualised by three main practice theorists was identified as the basis of the theoretical framework of this investigation.

3.3.1 Theory of Practices

Theories of practices are presented by various authors (Carolan, 2005; Reckwitz, 2002; Schatski, 1996; Warde, 2004). There is no defined method of classification of these theories, but authors present varying themes as the main focus in their explication of practice theories. Reckwitz (2002, p244) records the 'lack of systematic analysis', by some theorists. He does not attempt to analyse these theories, but rather distinguishes this theory from competing alternative theories and utilises the vocabulary of this theory to visualise 'social and human agency'. Similar to Reckwitz (2002), Warde (2004, p2) recognises many varieties of practice theories and the lack of an 'authoritative' version. He believes that an attempt to identify common features yields 'distinctive characteristics' and highlights the importance of differentiating positions.

Main interpretations of theories of practices which inform and lend theoretical support for conceptualising farming practices in this study constitute those of Reckwitz (2002), Schatzki (1996) and an account of Bourdieu's (1997) and (1990) theory of practices by Carolan (2005). All accounts explain the theory of practices through main themes which in various ways; though not conclusively, favour the interpretation and application of these theories to farming practice. Reckwitz (2002) explicates the theory of practices by utilizing seven major key terms or themes: body, mind, things, knowledge, discourse/language and structure/process and agent/individual. Carolan's (2005) account analyses practices through themes of habitus, field and cultural capital while Schatzki (1996) assumes a different approach. He bases his account of practice theory on Wittgenstein's analysis of the social nature of the individual and thus reformulates the theory of practice, with emphasis on increased understanding of how the individual is socially constructed (Schatzki, 1996).

Reckwitz (2002) initially explains the importance of recognising bodily actions as routine and influenced by mental thoughts. He notes the importance of things as integral to any practice; since in many instances their absence causes a practice to cease existence or operation. The discourse or language of practices does not achieve mere communication, but conveys an understanding and 'know-how' of the practice as perceived by agents. Reckwitz' s interpretation of the social structure of practices, explains structure as a process involving interconnection of routine activities involving the body, mind, desires and things, all culminating in a practice. The structure of practices therefore does not consist purely of body and mental processes but combined routine actions. According to Reckwitz, the concept of routine is indicative of temporality since routine may be interrupted or altered by situations (of interpretation and knowledge) which confront the agent, thus effecting change in the structures of practices. The agent/individual of practice theory is not just a mere 'carrier' of the practice, one who utilises both body and mental routines, but one who possesses knowledge which equips him with necessary understanding and motivations required for the conduct of that specific practice.

Utilising Reckwitz (2002) theory of practices for explication of farming practices, I argue that while farmers conduct practices through bodily action, this certainly involves mental thought. Further, 'things' constitute major elements of the farming practices under investigation. To consider a practice of fertilizer application without actual fertilizer leaves the practice unaccomplished. The farmer, through regular acts of fertilizer application acquires routine activity, but must be conscious of the implications of application; implying mental thoughts, based on his knowledge, desires and his motivation for conducting that practice. The farmer's discourse about this fertilizer application is governed by basic communication rules, but includes a deeper meaning which constructs and expresses his understanding of the practice; hence his discourse is critical to understanding his practice.

Schatzki's (1996) account of the practice theory utilises Wittgenstein's analysis of the social nature of an individual and presents concepts of mind/action/body integration.

The mind/action is represented by an expressive body, whose actions are largely socially constructed. Socially constructed actions take place in socially constituted contexts or situations and conditions of life. The author thus demonstrates that the mind/action/body integration is socially constituted. This integration forms the main constituent of practices; hence practices are socially constituted.

Schatzki (1996) recognises three perceptions or themes of practices: expertise, which involves improving one's performance through repeated work, practice which can be regarded as cultural (which he describes as 'a temporary unfolding of and spatially dispersed nexus of reactions' or what he terms 'doings and sayings') and a third perception of performance which is the carrying out of the second perception (the 'doings and sayings') Schatzki, (1996, p89). The author's exposition of a practice utilises the latter two perceptions: the nexus of reactions or 'doings and sayings' and the actual act of performing these reactions. These reactions only become a practice when the performance is conducted.

According to this author, practices are dispersed and integrative; the former as being 'widely dispersed among different sectors of social life' with examples like practices of describing and ordering (Schatzki, 1996, p91). These practices are actions, linked by understanding and ability to respond to the practice and are only present when established ways of responding exist, for example greeting or reporting have established ways of responding. Actions of dispersed practices are established mainly by understanding and not by principles or instructions. Integrative practices are more complex practices which make up specific spheres of social life. Examples cited include farming practices, business practices and teaching practices among others.

Schatzki (1996), reports that actions of integrative practices are also linked by understandings but these are (regular and 'sensitized' understandings); 'explicit rules, principles, precepts and instructions and 'teleoaffective structures hierarchies of ends, tasks, projects, beliefs, emotions, moods and the like' (Schatzki, 1996, p99). Regular understandings are those required for dispersed practices, while 'sensitized understandings' refer to understandings within a particular sphere of that practice, for example as Schatzki explains, understanding rules and specific meanings within a military sphere. Rules are institutions that govern the actions, while 'teleoaffective structures' may be seen as possible orders of life, (Schatzki, 1996, p101) which I will refer to as purposes.

In applying these principles to farming behaviour, the actions ('doings and sayings') which constitute farming practices are linked by understandings (both regular and 'sensitized') and rules which govern these actions and 'teleoaffective ' structures (purposes), such as beliefs, purposes and projects which affect or influence these actions. Regular understandings of actions constitute those of simple activities for example applying pesticides, while 'sensitized' understandings constitute those of more technical actions which are in the farming domain, such as spraying at a particular time or at a particular dosage according to recommendations. Rules may include those which govern the practice, for example instructions for the use of the pesticide, while teleoaffective structure in this instance is the purpose, such as the purpose for spraying.

Carolan (2005) conceptualises Bourdieu's (1997) and (1990) analyses of the theory of practice according to three themes: habitus, capital and field. Habitus is the consequence of past action but expressed by present actions. The habitus is composed of 'dispositions and schemas' which are 'taken-for-granted shared meanings and behaviours... that 'function below the threshold of discursive consciousness' (Carolan, 2005, p390); implying routine or unconscious actions. The actor's habitus will dictate his thoughts, perceptions and actions. Unconscious actions are subject to change through 'innovation and creativity' since actors are not 'cultural dopes' (Carolan, 2005: 390). Applying Carolan's (2005) account of Bourdieu's concept of habitus in farming practices, a farmer's habitus is past knowledge will influence or dictate his present perceptions and find expression in a particular practice.

Carolan's (2005) explanation of Bourdieu's theme of cultural capital, recognises capital as resources which have exchange value within their specific fields. Capital is therefore field-specific and 'cultural capital' is explained as the exchange value for forms of culture in society. Forms primarily constitute tastes and values. While economic capital is the most obvious form of capital and often seen as the important form of capital in modern and intensive farming systems; sociological, traditional and post-modernist views of farming emphasise the importance of cultural capital, seen as the environment within which the farming is conducted. This understanding partially rationalises the direction of this investigation, with respect to negative environmental and health effects of overuse practices. The value of capital varies in different fields. Thus in this investigation of reasons for agrochemical overuse, cultural capital is of importance.

Carolan's (2005) account of Bourdieu's third theme of practices describes field as 'a network, or configuration of objective relations between positions'. Fields are differentiated by logic, expressed by actions, which confer value to social capital (Bourdieu and Wacquant, 1992, p97, cited by Carolan, 2005, p391). Based on this account a field is likened to a sphere of specific principles which define conditions for various actions. Fields are contested, indicating their temporal nature; and this temporal nature allows actors to change their habitus in response to different situations. The applicability 'fields' in the theory of practices represents the possibility of agents' (farmers') contesting a present field of overuse and instituting change in their habitus.

The conceptualisation of practices by these authors: Bourdieu, through Carolan (2005); Reckwitz (1996) and Schatzki (1996), highlight various areas of similarities which are important for interpreting farmers' overuse practices. Firstly, all authors agree that practices are socially constituted. This indicates the rationale that inquiry into the elements of practice must include the 'actors' views of that practice and highlights the importance of including agents' (farmers') perspectives in any study of practices. Secondly, authors point out that the actors' discourse should be interpreted beyond a basic mode of communication; indicating the need for interpretative analysis of farmers' discourses. Thirdly, the writers indicate that the farmers' present actions are indicative of past learning, pointing out the importance of the farmers' knowledge. Fourthly, the sphere in which actors function influence their actions, hence there is need for examining the contextual situations within which these practices are conducted.

3.3.2 Rational Choice Theory (RCT)

RCT is used to explain the manner in which human beings/actors make decisions in various contexts, with the main aim to derive the most rewarding result through maximisation of any cost-benefit balance (Boudon, 1998; Denzin, 1990). While the theory is interdisciplinary, two general perspectives have been presented: a sociological and an economic version.

Presenting a sociological perspective of the theory, Denzin (1990) critically analyses how emotionality is interpreted and represented in the theory. He initially utilises the work of various authors to outline the main assumptions of the theory, which first presupposes a human being to be 'egotistical, hedonistic, asocial, rational and purposive in his or her actions' (Denzin, 1990, p174). This rational human or actor, when faced with options, decides on those actions which are most rewarding. To achieve this, the actor is equipped with all information of the situation he or she faces and aware of all possible choices, and outcomes. He or she is capable of recalling stored information without forgetting or misinterpreting. The actor's choice is therefore a reflection of careful assessment, based on having all the knowledge concerning the situation, with an aim for the most rewarding result he or she seeks. In the event that human being adheres to emotions and sentiments in making choices, these are considered irrational or socially conditioned choices.

Should this rational actor be required to make decisions in a collective manner, these are decided based on group interest. Harmony within a group is maintained through control mechanisms of obligations and persuasion; designed to promote members' compliance. Denzin (1990) notes the limitation of the theory in presenting rationale for the collective action of humans. The author believes that the theory is limited for its use as social theory, due to ambiguous terminology and inadequate interpretations and demonstrations of human life activities and experiences.

Denzin's (1990) points out Hechter's (1987) conception that the fundamental motive for group action is to attain that which cannot be achieved individually. In this scenario, control mechanisms are pertinent for group compliance. A group therefore exists because it has a function to perform within the ambits of regulated norms, which according to Denzin comprises structural and formative reasoning. Denzin calls attention to the ambiguity in Hechter's presentation of the origin of solidarity. He also criticises Hechter for analysing a group action of solidarity within the theory, while omitting personal preferences of individuals belonging to this group, citing this as an example of inadequate interpretation.

Denzin (1990) argues that rational choice theorists have failed to demonstrate how the precepts of this theory can be applied to typical everyday activities of life. Actors are assumed to face similar temporal situations and communication is supposedly conducted only in a defined social group where individuality is absent. Decisions are personally influenced by individual motives, and norms are seen as ideal norms, or methodological principles which are more focussed on enforcing conformity and not ideal daily routines. Emotions which are critical to social life and decisions are not considered vital to interaction, and are viewed as temporal or due to weak will.

Denzin (1990) focuses more on this failure of the theory to accept or represent emotionality and experience. He cites emotionality as a fundamental part of human interaction and exemplifies this by noting instances where a person's emotionality takes pre-eminence over doubt and selfish desires and is moved by another's feelings and experiences, to the extent of rendering assistance. The absence of emotionality in rational choice theory therefore assumes that the rational individual will not enter into the arena of another's experience, which is untrue of the normal human behaviour. The scope of the theory is not sufficiently extensive to interpret human behaviour. He cites Derrida's (1978) assumption of the full presence of actor in a situation, noting that this assumption lacks consideration for deterrents to a full presence such as actors' lack of full meanings or understandings. The author notes that the theory is ceases to exist in the absence of choices.

Preliminary assessment of the applicability of this theory to farming practices suggests unsuitability, with respect to the description of the nature of the individual actor. Realistically, a farmer is hardly in the position to have absolute knowledge of any situation in which he is required to make a decision. In the event that this farmer is even equipped with most of the pertinent information, externalities exist, imposing events of emotionality and sentiment. Further, with respect to views of collective action and emotionality noted in Denzin's critical analysis of the theory, farmers' groups are often locations of high levels of interaction and sharing of experiences. In this arena, emotionality is prevalent, compromising total rational behaviour of farmers, according to the precepts of this theory. Findings however suggest a partial acceptance of this theory in explaining farmers' behaviour, which is examined in section 3.5 of this chapter.

An account of the sociological aspect of the rational choice theory is presented by Boudon (1998), with focus on its limitations in explaining all social phenomena. Boudon notes that the theory is based on the belief that actions within the theory explain themselves; as he quotes, 'the rational action explains itself.' From a preliminary assessment of this view it may be then assumed that the action itself is the cause or reason, which is not the case when applied to an investigation of practices.

Boudon (1998) argues that the theory is not applicable to all situations since it assumes the individual's action is to achieve a specific goal. On the contrary, an individual's action is not always or solely motivated by the desire to attain specific goal(s), but may be founded on other factors such as beliefs which necessitate further explanation. The explication of these beliefs is beyond the scope of rational choice theory. Thus the assumption of action being purely instrumental in a rational choice context, limits the scope of the theory for investigation which goes beyond that of actions being rational or not. It is limited for investigations of causality or for determining reasons. In its relation to the study of farming practices, while farmers' overuse of fertilizer may be viewed as a rational action based on the result they seek, it (overuse) does not explain the reasons for these actions. The action therefore, does not explain itself, as the theory suggests.

Boudon (1998) indicates that the actor's statements of facts should not be taken as causes but rather, facts to be considered and explored. This implies the need for analysis which is beyond the scope of indicating rationality or irrationality. He suggests that assuming the actor's belief as the real cause is assuming 'false consciousness', to the actor (Boudon, 1998, p819-820). Behaviour that is subjected to what is seen does not explain this 'false consciousness'. The author indicates that rational choice theory is not general and cannot be applied to all social phenomena due to its very specific definition of rationality in terms of ‘intentionality, self-interest’ and ‘maximization’ Boudon (1998, p821).

3.3.3 Economics of Sustainable Farming

Theories and concepts which focus on the economics of farming include the New Household Economics (NHE) theory, Rational Peasant Economics (RPE) and Sustainable Livelihood Approach (SLA). Peasant economic theories focus primarily on explaining peasants’ choices as rational; constituting various trade-offs aimed at maximising production and utility. The SLA focuses on strengthening assets of the poor.

i. Rational Peasant Economics

Ellis (1993) defines peasants as:

> ‘…*households which derive their livelihoods mainly from agriculture: utilise mainly family labour in farm production, and are characterised by partial engagement in input and output markets which are often imperfect or incomplete’* (p13).

Economists have utilised various assumptions to develop models which explain the behaviour of farm households. Theories of the optimizing peasant assume that the behaviour of peasants is rational, with respect to choices they make to maximize within constraints. Authors cite Michael Lipton's (1968) 'Theory of the Optimizing Peasant' for explanations of peasant behaviour (Ellis, 1993; Mendola, 2007; Milich and Al-Sabbry, N.D.). Ellis (1993, p64) notes that it is the general assumption that ‘the peasant household maximises one or more household objectives’.

ii. Theories of peasant economics

Theories of peasant economics include those of the profit maximizing peasant, the risk-averse peasant and the drudgery-averse peasant. The theory of the profit maximizing peasant assumes that no adjustments of inputs or outputs take place within the farming system. In this situation the household derives a higher net income which is measured in monetary or physical terms. Economic efficiency is attained through a combination of technical efficiency, (the maximum attainable output for any given input level) and allocative efficiency (the adjustment of inputs and outputs to reflect relative prices for a chosen technology) (Ellis, 1993; Milich and Al-Sabbry, N.D.). Mendola (2007) notes that the model of the profit-maximizing peasant is criticized for ignoring consumption as part of the decision making in peasant households.

The theory of the risk-averse peasant proposes distinctions in the use of terms risk and uncertainty. Risk suggests that the outcome is unknown, but the probability of the adverse condition occurring is known. Conversely, uncertainty implies situations where the likelihood of occurrence of events is unknown hence it is impossible to apply measures of probability (Ellis, 1993; Milich and Al-Sabbry, N.D.).

Ellis (1993) mentions that risk is used to describe the mechanism by which farmers make decisions with respect to uncertain events, while Milich and Al-Sabbry (N.D.) record the need for farmers to plan for both risk and uncertainty to ensure their well-being. Ellis records several peasant behaviours which are assumed to be risk-averse behaviour. These include farming practices which encourage diversification; both spatially (of plots) and with respect to crops (mixed cropping), which can increase income. The author notes that as wealth and income increase, risk-aversion decreases and explains that higher-income households can withstand losses better than lower-income types.

The theory of the drudgery-averse peasant focuses on the subjective decision of the farm household concerning the amount of labour to be committed to farm production to meet consumption needs. The theory encompasses the Chayanov farm household model which is based on maximisation of household utility. Focus is on the relationship between farm work, which is seen as drudgery, and leisure, which is not part of farm work. The theory assumes that a trade off between farm work and leisure is influenced by the household size and composition of working and non-working members; thus the optimum level of labour utilised, is subject to the size of household. As the consumer-to-worker ratio increases, higher labour input per farm worker is required (Ellis, 1993; Milich and Al-Sabbry, N.D.).

Theories of peasant economics have been criticised for several reasons. Ellis (1993, p3) notes that ‘peasants occupy the margins of the modern world economy’ and ‘peasant populations are rarely prosperous’. He suggests that improvement of their conditions lie in utilisation of methods which provide an ‘accurate perception of the nature of their problems'. Although theories of peasant economics attempt to do so, they are not based on an analysis of the thoughts and perceptions of these peasants, from detailed information gathering exercises such as in-depth interviews. Ellis (1993, p66) records, that methods used 'to substantiate the hypothesis of the efficient peasant were derived from sample surveys of peasant farmers'. The author highlights several limitations of these theories. Firstly, the household is understood as a single unit for decision making, where it is assumed that goals of the household head represents those of all household members. Secondly, the household head is assumed to be a male and issues of division of labour between men and women and their rights over resources are neglected.

iii. New Household Economics (NHE)

The need for a model which could relate to realistic features and 'cultural characteristics' of peasant households economic behaviour led to the discovery of the theory of NHE and 'rediscovery of Chayanov's theory of peasant economic behaviour'(Ozanne, 1999, p261).

Theories of NHE differ from the conventional perspective primarily in the definition and understanding of consumer utility. In the conventional perspective, utility was viewed as the order of preference the consumer chose in purchasing of market goods and services. In the NHE utility is understood as the happiness derived from the use or final values of goods and services. Hence, it is on the final values (consumption) of the goods and services that utility is derived. The household is a production unit where the time of its members is combined with purchased goods or services to derive final utility (consumption) (Ellis, 1993).

The theory incorporates the Barnum Squire farm household model and Low farm model. Based on the concepts of NHE, the Barnum Squire farm household predicts the responses of the farm household to changes in domestic and market variables. The model assumes that a labour market exists and thus labour can be hired out and in. Land available to the household is fixed and activities such as production of goods and services and leisure, are combined for achieving maximum utility. The household choice between ‘own consumption’ and sale of products for the purchase of non-farm products is important. Uncertainty and risk are ignored.

This model is useful for integration of production and consumption decisions of the household into the wider economic system. However, weakness of the model lies in its assumption of markets which are developed and competitive. This assumption describes the farm household as a commercial rather than peasant type. The only main peasant characteristics are household choices in home consumption of own-farm products. The assumption of this model concerning capacity of the household to hire labour is descriptive of capitalist-type farming rather that peasant-type farming where the latter is characterised by decisions concerning the extent to which hired labour is used (Ellis, 1993).

The Low farm household model was developed for analysis of agricultural production in African countries which border South Africa. The model assumes the existence of a labour market with varying wage rates for different categories of labourers, indigenous land tenure systems with flexible land access according to family size, semi-subsistence farming where farm gate price is different from retail market price and farm households which experience food deficit and hire out labour (Ellis, 1993).

Ellis’ (1993) analysis of these farm household models reveals areas of weaknesses in their applicability to a study of farmers’ household practices. He notes that these models depend on empirical investigation for generation of policy implications. The author points out that while some behaviour can be predicted based on the principles of models, ‘aggregate behaviour is dependent on the exact size of response elasticities and their interaction in the larger economy’(Ellis, 1993, p142-143). The writer emphasises the occurrence of significant deviation, pointing out variation in behaviour with respect to a wide variety of spatial locations[28], market imperfections, land availability and type of labour market.

[28] community, region, country and characteristics

3.3.4 Sustainable livelihood concept Literature - Sustainable Livelihoods Approach (SLA)

The sustainable livelihoods concept was introduced by Robert Chambers and Gordon Conway in 1991 and has since been adopted by various donor institutions and organizations. The concept evolved into to an approach which:

> *'…entailed elaboration of livelihoods frameworks, description and analysis of driving forces, pressures, and impacts of all types of activities related to the local livelihood situation'* (Knutsson, 2006, p 90).

DFID (1999) explains that:

> *'The livelihoods approach is a way of thinking about the objectives, scope and priorities for development. A specific livelihoods framework and objectives have been developed to assist with implementation, but the approach goes beyond these. In essence, it is a way of putting people at the centre of development, thereby increasing the effectiveness of development assistance'* (p1).

Ellis (2000) presents a policy framework for diversified rural livelihoods analysis, based on work of several researchers, where focus on the asset status of the poor is utilised for understanding their options, the strategies they adopt and their vulnerability to adverse situations. These studies correspond with the basis of the livelihoods approach, which emphasises focus on enhancing assets of the poor and activating those that are dormant, rather than focusing on negative situations of the poor. While Ellis highlights the applicability of the framework in guiding micro policy analysis for rural poverty reduction and assessing local impact of macro policies, he notes that the framework is appropriate for large scale domains, since policies which appear beneficial to the populace in these domains may not be sensitive to variants within the domain.

The latter observation identifies the need for analysing individual perspectives in investigations. While the SLA may be applicable for policy analysis, Ellis (2000) notes that the livelihoods framework is not devised for solving causes and effects of rural poverty. Rather, the SLA focuses on identification of main livelihoods components noting links and constraints among them, in an effort to overcome these constraints and productively utilise assets. This demonstrates the non-applicability of the SLA in this study which was aimed at revealing reasons for farming practices. Ellis points out that poverty must be addressed to halt damage to the environment.

While from a livelihoods perspective, this may be true, it cannot be a predetermined conclusion that poverty is solely responsible for overuse practices. Reasons vary and are not superficial, and therefore require analysis of farmers' perspectives in this investigation, necessitating a different approach to that of the SLA.

The SLA has been criticised for several reasons. Knutsson (2006) records that despite the approach being intended for solving societal problems it has been primarily employed for knowledge production and dissemination rather than application. While dissemination of information is a major part of the framework, for transforming analysis to problem solving, the framework is rarely perceived as a tool for dissemination. The SLA is recognised as a holistic and integrative approach, with the primary purpose of developing a new framework for relating separate units of knowledge to each other, and to the framework; rather than establishing new knowledge. Knutsson suggests the need for increased acknowledgement and integration of different uses of the approach, clear definition of the purposes of knowledge integration, integration of theories relevant to the approach, development and integration of relevant methodologies for information dissemination and institutional integration of SLA.

Bebbington (1999) mentions the need for a framework that is more in harmony with the diverse livelihoods that actually exist. He calls for a shift away from addressing poverty in a materialistic way of merely emphasising persons making a living, to one of understanding how agents' perceptions of poverty influence their livelihood choices, strategies and capabilities. In perceiving livelihoods as partially dependent on social capital, Bebbingtion believes that access and social capital are critical concepts within the framework for understanding relationships between agents in the household and other agents for the accessing of resources. The author points out that access to other agents precede access to resources, required for livelihoods. The various dimensions of access must be captured within the livelihoods framework.

The following chapter section reviews relevant literature which primarily investigates farmers' practices of agrochemical use. The reports are examined in total but specifically scrutinised for competing aspects in relation to this investigation, primarily in areas of theory, methodology and analysis. One of these studies does not investigate agrochemical use, but was chosen for its comparative methodology in relation to this investigation.

3.4 Review of Empirical Literature

Various studies have investigated farmers' practices. The studies reviewed for this thesis, are of variable scope; investigating from one to several aspects of farmers' agrochemical use. While investigations utilised methodologies which comprised varying methods, most studies used a combination of quantitative and qualitative measures; the latter being significant for developing causal linkages or reasons and suggesting policy recommendations.

Robinson *et al*, (2007) investigated pesticide use, in the study 'Motivations behind farmers' pesticide use in Bangladesh rice farming'. Objectives of the study focused on farmers' knowledge of arthropods, farmers' perceptions about pests, diseases and pest damage and reasons for farmers' decline from the use of recommended pest management practices. Comparative study was conducted between two categories of farmers; trained and untrained, within two geographic areas.

This study utilised a mixed methods approach, comprising quantitative and quantitative methods and analysis. Qualitative methods and analysis were based on the premise that understanding farmers' motives and constraints, rather than observing pesticide use, was likely to be a better approach for improving training techniques. Methods included semi-structured interviews, focus group discussions and structured farmer questionnaires.

Structured questionnaires were utilised for gathering quantitative data concerning farmers' perceptions of the pesticide use and pest attacks. Relatively small samples of 31 from a population of 1700 in one district and 23 from population of 1500 in the other district were justified by indicating the importance of the investigation which was to determine motivations and norms, rather than variation. Quantitative findings were combined with information from qualitative investigation. Based on results from these questionnaires, four categories were identified to define pesticide usage, comprising: (1) no use of pesticides, (2) pesticide use as a precautionary method, (3) pesticide use after a pest attack and (4) a combination of pesticide use as a precautionary measure and after a pest attack.

Data from focus group discussions was used to complement the questionnaire findings and indicated that motivations for farmers' behaviour were dependent on the farmers' perceptions of pesticide, severity of pest attack and farmers' financial situation. The qualitative aspect of the study supported the establishment of causal links to behaviours exhibited in the quantitative analysis. The role of the pesticide dealer in farmers' use of pesticide was also explained through focus group discussions. This result was effectively achieved through quantitative analysis. The study demonstrated the combined use of quantitative analysis (of pest management applications) and qualitative analysis (of motivations) to categorize farmers according to their motivations for pesticide application.

Ngowi *et al*, (2007) reported on pesticide use practices, perceptions and health costs of smallholder vegetable farmers in Northern Tanzania. This study was conducted in four rural districts of Tanzania and revealed sale of pesticides form general shops, inappropriate retailing of pesticides, farmers' application of mixtures of pesticides and farmers' use of pesticides to more than up to five times per cropping season. The study revealed lack of instructions for pesticide use from labels and extension workers, and the occurrence of pesticide-related health symptoms illnesses in farmers, to the extent where farmers incurred medical expenses attention to address these illnesses. The study recommended policy reformation for the safe and effective use of pesticides by these farmers.

For this study, face to face interviews with 61 small-scale farmers and farm workers were conducted by scientists with relevant experience. Selection of the sites for the sample population depended on number factors: the crops grown, pesticide usage, accessibility, cooperation with village and extension personnel and willingness of farmers/workers to participate. An important criterion for selection of the study population was their cultivation of crops which required chemical pesticide.

Questions comprised structured, semi-structured and unstructured types, based on previous literature. Field observations were also conducted. Pre-testing of the questionnaire was conducted. Data collected comprised information on farmers' personal issues and farming practices; including pesticide use and health costs. Leading questions were avoided. Though interviews were conducted, data analysis was conducted using SAS software where statements from open-ended questions were utilised to corroborate numeric-type data.

While this study utilised an appropriate methodology based on its purpose, the type of analysis conducted seems more suitable for investigations which are not intended for in-depth explanatory and precise recommendations. Results of the study presented numeric data on several areas of investigation, including types of pesticides used by farmers, availability of pesticides, frequency of pesticide application, farmers' reports on perceptions concerning pesticide use trends and symptoms of poisoning and costs for medical attention. However, presentation of these results shows lack of in-depth farmer discussion concerning these issues. The report utilised suggestions to explain the results, indicated by terms such as: 'probably based on', 'this may explain', 'seems to be' and 'probably due to', among others. The study proposed policy improvement for farmers, but specific policy areas were not identified.

Iosifides and Politidis (2005) investigated critical methodological strategies employed in the qualitative study on local socioeconomic development and desertification in Greece (Western Lesvos). While this study was not conducted on agrochemicals its choice for literature review was based primarily on the applicability of the chosen methodology and also investigation of similar issues.

The main objective of the inquiry was to determine the main socioeconomic driving forces of unsustainable natural resource use which influence land degradation and desertification. Specific objectives included: (1) identifying most common production practices and natural resource uses of local producers; (2) determining how practices are influenced by local socioeconomic features, characteristics and national and EU rural policies and (3) determining attitudes and actions of local producers to environmental protection and conservation and how these are influenced by socioeconomic factors.

Research location was chosen based on a combination of features of research interest; including socioeconomic, spatial and development disadvantages, along with a sensitive environment, land degradation and desertification. Since the study sought to identify and analyse links between the local socioeconomic pathways and environmental marginality, qualitative methodology was employed, through the use of in-depth individual and collective interviews. These methods were ideal for understanding and explaining processes and interactions, and links between socioeconomic factors and also for identifying environmental issues, through assessing participant's interpretations.

This type of methodology was also well suited for an area which lacked full research potential and where research trend was generally from a natural science perspective and therefore lacked identification of necessary linkages and stakeholders' perspectives. While some knowledge was available on the subject of inquiry, detailed hypotheses were to be developed from data collected. In-depth interviews were conducted with 35 livestock-breeders from seven communities, on five areas: general characteristics of stock-breeding, rural development and corresponding policies, socio-economic and spatial conditions, survival and social reproduction strategies and local attitudes to land degradation and desertification with respect to natural resource management and production practices.

The dynamic nature of the interview schedule permitted changes as were necessary, based on participants' responses. Participants were selected for research based on specific criteria which included production characteristics, extent of knowledge on local development and the environment and time of involvement in the sector of interest. Apart from capturing participants' perspectives in an individual and collective setting, the choice for both interview types; individual and collective, was reportedly done for validity and reliability and ensuring rigour and quality of the process. Data from an earlier set of interviewees was utilised for theme building, to facilitate conservation with other interviewees.

Data analysis was enhanced by the coding process which permitted grouping and standardisation of information for ease of discussion and avoiding bias respectively. The authors report that the research process ended when saturation was achieved, meaning when the research questions were appropriately answered and repetition of responses of responses increased. This was characteristic of a grounded theory approach. Findings showed that actions of producers were not due to their indifference to environmental protection but their ensnarement by socio-economic disadvantage.

This study reported, but did not focus on findings. Emphasis was placed on the use of qualitative methodological strategies in investigation of socio-environmental problems to identify suggestions for alleviating these problems. The usefulness of this type of methodology for explanatory studies was demonstrated by the development of a conceptual model which linked socio economic disadvantages to land degradation practices.

Spiller and Aleguas (2007) investigated agricultural chemical exposure in small farmers in Guyana. While the investigation was centred on analysing self reported injury from exposure to agricultural chemicals, data on pesticide types used and frequency of applications was also collected. The study was conducted among 190 agricultural workers, in four regions where vegetable farming was done, utilising a mixed methods approach.

Methods utilised for this study comprised survey, on-site interview and observation. Through survey questionnaires, data concerning demography, crop types, pesticide types used and frequency of application, adverse experiences and action taken (treatments), was collected. The target population was small farmers, operating less than 40 acres, who were willing interviewees. On site observation was utilised for verification of chemicals utilised and protective action taken. Similar to a study by Ngowi *et al*, (2007) interviews were conducted, but data analysis and results were conducted and presented in a quantitative manner, utilising mostly percentages. Thus, some possible explanations and suggestions offered were not recorded as based on perspectives of participants, but deductions from analysis.

The study indicated morbidity of 46% among the study population due to exposure from agricultural chemicals, with only 11% and 1% seeking medical assistance via visits to the local doctor and hospital respectively. Only 9% of study population used protective gear, 42% used simple barriers in the form of clothing, while the remaining 49% used no protection. Eighty percent (80%) of the study population was engaged in spraying at least weekly. The study explained that the type of sprayer used by farmers predisposed them to chemical exposure and suggested that education on protective equipment and the use of less dangerous insecticides may reduce both related injury and the risk of injury respectively.

Bovell *et al*, (2002) investigated pesticide misuse in farmers within a district of Guyana. The study aimed to discover pesticide types used by farmers, application doses and safety measures and to determine existence and reasons for pesticide misuse within the selected location.

Methodology for this investigation suggested the use of mixed methods, since data was obtained from questionnaires, interviews, observations and literature review. But similar to studies conducted by Ngowi *et al*, (2007) and Spiller and Aleguas (2007) qualitative methods were indicated but data analysis was conducted quantitatively, through the use of SPSS programme.

Results indicated farmers' use of 33 pesticides. Eight most commonly used pesticides were misused through farmers' use of over or under the recommended dosages. Five of the commonly used pesticides were misused by all farmers, while the other three were misused by 71-96 % of the study population. No precautions were taken by 60% of farmers. The study suggested that the main contributory factors for pesticide misuse appeared to be inefficient agricultural extension services, absence legislation enforcement and illiteracy. Recommendations included upgrading of the MOA's extension services and research on the effects of pesticide use in Guyana with subsequent dissemination of results to stakeholders.

Lichtenberg and Zimmerman (1999) conducted study on 'Information and farmers' attitudes about pesticides, water quality, and related environmental effects'. This study investigated how information from different sources affects farmers' beliefs and attitudes with respect to the effectiveness of pesticides and other agricultural chemicals. The study revealed that the type of information source had an effect on farmers' attitudes concerning the environmental effect of agricultural chemicals. This finding was important for choosing information to reverse adverse effects of pesticide use.

Authors reported a complex relationship between farmers' beliefs concerning environmental quality and their information sources. Farmers' beliefs influenced their choices of information sources and their evaluation of this information. These beliefs and assessments impacted upon farmers' levels of reception to that information and their perceived relevance for decision making (Lichtenberg and Zimmerman, 1999).

The study utilised quantitative investigation methods. Original survey data was obtained from 2700 farm operations, selected by stratified sampling method. Stratification was conducted based on pre-existing information designed to capture variances in pesticide practices with respect to size of farm operation and crop. Two sample crops were utilised; corn and soybean. Survey administration was conducted via mail with follow-up by telephone and achieved 60% response.

Assessing farmers' level of concern with respect to environmental quality and importance of information from various sources was conducted by utilising scales of measure along levels of seriousness, similar to those of attitude scales. Focus was on expressed preferences of farmers, rather than revealed preferences where the former comprised statements by respondents and the latter was deduced by farmers' behaviour. The survey included various information sources: news media, cooperative extension service, pesticide dealers, other growers, field observation and labels. Farmers were questioned in relation to general environmental concerns surrounding farming and industrial activities, and specific concerns about the effects of pesticide use. Choice of the two crops utilised for this investigation was based on their significance to the study, with respect to the acreage occupied by farmers and the use of pesticide.

Results on farmers' attitudes and information sources were quantitatively analysed via difference-of-means test for attitudes, average importance of information sources and regression analysis for associations between information sources and attitudes. Results demonstrated medium concern of farmers in both water quality and pesticide related issues. With the exception of factory related water pollution, pesticide issues related to farming were considered more serious than those distant from the farming operation. Results of farmers' attitudes compared with a similar survey conducted on the general public, demonstrated similarity in beliefs.

Farmers' first preference of information resource was 'first hand sources' (for example field observation and pesticide labels) with second choice from institutions (for example extension services and dealers). The more processed information was before reaching farmers, the less significant it was perceived to be. Varying results were noted in the relationship between information sources and attitudes of farmers. Farmers, who attached more importance to information from news media, had greater concern about agriculturally related pesticide problems. In instances where farmers placed more importance on information from cooperative extension services, their concerns were primarily pesticide mixing and loading, residual effects on food and quality of drinking water. Farmers, who attached greater importance to information form pesticide dealers, were less concerned about environmental quality and more interested in quality of drinking water and wildlife safety.

While the study utilised the expressed preferences of farmers rather than revealed preferences, it lacked additional explanation of those revealed preferences, which could have been better clarified via qualitative investigation methods such as interviews. Conclusions of the study were therefore based on quantitative analysis, revealed by difference-of-means and averages, in definite contrast to my study of practices where quantitative analysis is expanded and complemented by qualitative analysis.

Chandran (2006) assessed weed management practices utilised by vegetable farmers in Guyana and presented recommendations to improve their farming ability. The study utilised qualitative methods, including personal observations and interviews with a wide range of stakeholders including farmers and personnel form academic, business and organisational spheres. The author recorded farmers' limited knowledge concerning the appropriate use of agrochemicals (herbicides) for weed control. He noted farmers' use of trial and error and opinion-based information concerning the use of agrochemicals and their practice of substituting herbicides with plant growth regulators.

The use of a qualitative strategy enabled the researcher to record actual expressions of the farmers, but lack of in-depth interviews limited the explanation of farmers' practices. The study revealed that transformation of weed management information from research extension services to the farmers was inadequate according to farmers' opinions. Farmers' comments indicated their lack of knowledge in weed management. Based on data from personal interviews, the researcher cited instances of bureaucracy, distrust among agencies, incompetency and staff shortages, among other factors as contributors to inadequate information flow. Farmers' misuse of herbicides and associated equipment was noted.

The researcher made various recommendations, which primarily comprised targeted dissemination of relevant information to farmers and other stakeholders, through the use appropriate techniques. While the use of a qualitative strategy enabled the researcher to note perceptions and opinions expressed by farmers, the study lacked a theoretical framework and therefore appeared disjointed in the absence of a specific methodology. In-depth interpretation of farmers' views was absent.

The summary of this chapter presents a critique of the preceding studies and competing theories. Both negative and positive features of the studies are discussed. In the case of competing theories, various elements of the practice theory are highlighted as the primary theoretical underpinning of this study, with partial acceptance of elements from the theory of the risk-averse peasant and rational choice theory.

3.5 Summary and Conclusion: A Critique of Literature and Theories

Analysis of reviewed studies demonstrated both strengths and weaknesses. Strengths included the targeted choice of research locations and criteria-based selection of study population, which were guided by the phenomenon under investigation and the objectives of the studies (Iosifides and Politidis 2005; Ngowi *et al*, 2007; Robinson *et al*, 2007; Spiller and Aleguas, 2007). Additionally, those studies which utilised both quantitative and qualitative methods of investigation and analysis, demonstrated the aptitude of the latter method for generation of in-depth discussion and explanations of reasons (Iosifides and Politidis, 2005; Robinson *et al*, 2007).

Weaknesses of these studies included a common lack of theoretical framework. Studies generally utilised specific methodologies, but these were more quantitatively biased. Even in studies where interviews were conducted, analysis and results followed a quantitative format (Bovell *et al*, 2002; Ngowi *et al*, 2007; Spiller and Aleguas, 2007). In studies which utilised purely quantitative investigation and analysis, although conclusive theories were made, detailed discussion was restricted. Genera lack of theoretical guidance in the reviewed studies highlighted the importance of an appropriate theoretical framework to inform the process of investigation. Absence of in-depth interpretative-type discussion in these studies also underscored the need for appropriate methodology, which is capable of generating the type of data and subsequent analysis to answer the research questions. This is especially so where there is need for generation of conclusive theories.

Examination of various theories revealed that that the theory of practices is most appropriate for explaining farmers' practices in this investigation. The study however partially adopts elements of elements of the rational choice theory and theory of the risk-averse peasant. Findings of this study corroborated with the conceptualisations of practice theorists in revealing that farmers' practices were socially constructed (Carolan 2005; Reckwitz, 2002; Schatzki, 1996). While overuse practices were observed literally, detecting and understanding the reasons for farmers' conduct of these practices were embedded within the farmers' discourses. Findings corroborated with the beliefs of practice theorists, that practices were physically conducted, but were actually a product of mental and physical actions. This was demonstrated through the capability of all farmer interviewees to explain the reasoning (mental action) which formed the basis for their actions.

The utilisation of mental and physical faculties by famers to produce their action of overuse, also led to partial acceptance of the rational choice theory for this investigation. While farmers' final actions of overuse are inappropriate and may be considered unethical, interviews revealed that these actions were decided after careful thought of the various consequences. This reasoning reflects Denzin's (1990) view of the actor making a careful assessment for a particular result, in the rational choice theory.

Reckwitz' (2002) theorisation of a practice being composed of the actors' mental and physical actions and desires is reflected in farmers' strong desires to have a marketable crop. Farmers' primary desire to have saleable crops played a major role in their decision to overuse agrochemicals or not. What is different in this case is the possibility that farmers' desires can override their mental action (reasoning). This was exemplified where farmers professed to have the correct information concerning the use agrochemicals but they were still prone to overuse, based on their desires for a specific result[29].

The theory of the risk-averse peasant partially explains farmers' choice for overuse based on the elements of 'risk' and 'uncertainty'. This theory proposes that 'risk' indicates an unknown outcome but the chance of occurrence of the adverse condition is known. Uncertainty indicates that the occurrence of events is unknown and so measures of probability cannot be applied (Ellis, 1993; Milich and Al-Sabbry, N.D.). Elements of both 'risk' and 'uncertainty' were indicated in farmers' overuse habits, where they generally took the chance of overusing chemicals with the knowledge that over the dosage may or may not produce the desired results. Farmers were uncertain of the outcome but however, they preferred to take the risk of overuse, compared to the possibility of having severely damaged, or no crops.

In the following chapter, some of the key factors which influence farmers' choices of agricultural practices, including agrochemical overuse are discussed. These factors are presented initially, within the general context of political economy and more precisely from the standpoint of Guyana's political economy, by emphasising its evolution and influence on agrarian practices.

[29] For example when questioned concerning the reason for his overuse practice in spite of knowing that this was incorrect, farmer DK expressed: '*The instructions will tell you not to increase the dose but then again you try desperately to control the pest.'*

CHAPTER 4: POLITICAL ECONOMY OF AGRICULTURE AND AGRARIAN PRACTICES

4.1 INTRODUCTION

> *'As farming is a way of life and not a mere profession, the sociology and the (micro) political economy of this way of life explain the adoption or nonadoption of novel agrotechnologies'* (Cernea, et al,1985, p8).

The previous chapter described the conceptual framework utilised for this study, primarily through exemplifying the role of the practice and critical realist theories, and theory of the risk-averse peasant, in explaining the mechanics of farmers' agrochemical overuse behaviour. This chapter explains the influence of political economy on farmers' decisions for adoption of farming practices. Initially, a brief introduction to political economy which gives the reader foundational insight regarding the history and meaning of political economy is provided with subsequent explanation of the relevance of political economy within an agrarian context. The influence of political economy on agrarian change, specifically technology adoption, is discussed initially, in a general sense and then more in-depth in the Guyana context. The chapter is then specifically devoted to the influence of Guyana's political economy on adoption of agricultural technology, tracing a historical to present perspective and in keeping with the objective of the study, specifically highlighting the influence of political economy on adoption or non-adoption of farmers' agrochemical practices. The chapter concludes with a brief discussion which demonstrates the relevance of political economy in a study of farming practices.

The concept of political economy was founded on the common view that political factors play a pivotal role in determining economic outcomes. The concept examines how choices are made in a society; noting that political influence may guide decision making in a manner that is different from how it socially preferred. The study of political economy embraces a number of disciplines; for example economics, political science and law and integrates aspects of these disciplines to provide a basis for understanding how individuals or groups within a community utilise political power to effect desirable economic outcomes. The discipline examines how relationships of power are created, maintained and changed over time for distribution of authority and wealth among groups in a community. Analysis of economic and political processes is utilised to assess public problems with the aim of finding their origins, how they evolved, relationships between and among problems, how decision making concerning these problems is conducted and how these problems affect human life (Bohmer, 1996; Drazen, 2000; OECD, N.D.; Uphoff and Ilchman, 1972).

Political economy of agrarian structure and change has often been utilised to understand processes of power and change in the agricultural sector and the forces which influence technology adoption. Authors indicate that technology adoption and use in agriculture are largely influenced by features of the political economy such as land tenure, credit availability, market structure and complementary infrastructure (Boucher, 1999; Griffin, 1979; Paarlberg and Pray, 2007).

Griffin (1979) points out that technology adoption and use are influenced by factors of political economy. While technology may be widely publicised, the availability, levels and scope of adoption by farmers are largely determined by politically motivated interests. Griffin posits that technical change credited to the Green Revolution (GR) was in fact the result of politically influenced decisions; biased in favour of some farmers and fostered by unfavourable government policies. Policies were designed to increase marketable output rather than improve the welfare of the population and thus favoured larger farmers. The author proposes that land tenure, market structure and government policy influence technology adoption in a biased manner which favours landowners.

Paarlberg and Pray (2007) argue that agricultural changes and introduction of new technologies are largely influenced by political actors and cites the introduction of technologies associated with the GR as an example. Boucher (1999) believes that the GR was influenced by political interests. The following discussion examines the political economy of Guyana and its influence on agriculture technology adoption and use during three main eras. While emphasis is placed on the present era, a background of the previous two eras is significant for understanding the characteristics of the present period, especially within the context of the agricultural sector.

4.2 POLITICAL ECONOMY OF GUYANA AND ITS ROLE IN AGRICULTURAL TECHNOLOGY ADOPTION: A HISTORICAL TO PRESENT PERSPECTIVE

The political economy of Guyana is documented by various authors, who trace the origins of various fundamental processes to the colonial era and document impacts of this period which are still experienced in the present era (Adamson, 1972; Baber and Jeffrey, 1986; Canterbury, 2007; Munslow, 1998). The NDS of Guyana, which represents the highest level of national planning, indicates that despite interventions, the political economy of Guyana has not been restructured nor diversified and is still very dependent on agriculture (NDS, 2001). This chapter conducts an analysis of the Guyana's political economy, emphasising its interrelatedness with agriculture and effects on technology adoption and farmers' practices.

From the colonial to present era, agriculture has been a main pillar of Guyana's economy. Records show three major leadership regimes: colonialism, nationalism and neoliberalism; each having distinct effects on the way agriculture was and is conducted for each period. During the colonial period, agriculture was plantation based. Land was state owned with the most fertile areas of land utilised for the main crop, sugar, which was marketed in Europe. Towards the end of this era, less valuable land was sold to workers of the plantations which resulted in a distinct dualism: the development of peasantry system alongside the plantation system. Due to the relatively infertile nature of these peasant lands, unfavourable taxes, policies, equipment and infrastructure, peasant farmers were unable to conduct agriculture in a viable manner (Adamson, 1972; Canterbury, 2007; Rajack and Barhate, 2004).

Infrastructure was developed to suit to suit sugar production but limited for non-traditional crops. For example, sugar plantations were equipped with their specific drainage and irrigation and road systems while no such infrastructure was developed for non-traditional crops. Larger land plots, when broken into smaller ones for planting of non-traditional crops, could not be serviced by the traditional drainage system. Further, flooding of peasant lands were often due to broken drainage and irrigation structures which were left unrepaired, while crops were sometimes wilfully destroyed (Adamson, 1972; Baber and Jeffrey, 1986; Canterbury, 2007; Munslow, 1998: 46; Rajack and Barhate, 2004).

Sugar production required and still requires industrial operations which must be supported by major technological investments in areas of knowledge and equipment along with managerial and administrative skills. Technological intervention was therefore directed at the main crop at the expense of non-traditional crops. No market existed for non-traditional crops as farmers were all producing similar commodities in close proximity. This led to migration from rural villages to urban areas, where markets were more readily available. These constraints created a distinct dualism of peasantry alongside plantation production (Adamson, 1972; Canterbury, 2007).

In an effort to reduce this obvious dual structure of agriculture, the colonial government took several measures which included developing land settlement schemes, creating rural employment to reduce rural to urban migration and attempts at diversifying agriculture. Land distribution was instituted to address housing issues while marketing boards were established to stabilise farm income and retail prices. In the case of the latter initiative, a government department purchased farmers' produce at competitive prices and resold them at consumer-affordable prices. Rural agricultural problems for alternative agriculture in the late colonial era were also addressed by technological assistance, but with less intensity than those directed at the main crop, sugar (Canterbury, 2007).

Technological intervention included the introduction of agrochemicals within the non-traditional cropping. Fertiliser use in particular, was aimed at combating the negative effects of the relatively low fertility of the soils in areas where non-traditional crops were cultivated; representing the introduction of technology in peasant farming or what is now recognised as non-traditional agriculture, in Guyana. Attempts to increase production in rural areas were addressed by initiatives to modernise and reorganise agriculture. Apart from introduction of new technology, rice cultivation was promoted. With the introduction of rice, several other services were provided to the non-traditional sector. Extension services of agricultural departments played a major role in providing the advisory services to peasant or small farmers on land preparation and input use (Baber and Jeffrey, 1986; Canterbury, 2007).

Apart from issues directly related to production, the structure of Guyana's political economy exerted effects on race and class which extended into the agricultural sector, but had relatively low effects on agriculture and technology adoption. Race and class typology emerged during the colonial era as a method of maintaining control over the labour force (Canterbury, 2007). Europeans represented the dominant race and class causing the two factors to be inextricably linked, with the ruling class presented as the superior race. Non-European races occupied a lower class category and were presented as the inferior race and class (Baber and Jeffrey, 1986). Intentional division of races during the colonial era was utilised to maintain supremacy of owners over workers: the two main factions of workers being those of African descent and those of East Indian descent (Adamson, 1972; Canterbury, 2007).

Because of indenture-ship, at the end of colonial era, the populace comprised a mixture of immigrants of several ancestries: European, African, East Indian, Chinese and Portuguese. The society was characterised by cultural rather than racial differences. A middle class comprising a mixture of all ancestries emerged and aspired to attain social mobility through enhanced education and movement away farm or agriculture-type jobs. This middle class moved into the commercial and public sectors, forming a local middle class. Beneath the local middle class emerged a lower class which comprised workers of both African and Indian ancestry who were involved in agricultural field and plantation type employment and conducted subsistence farming to supplement their small wages. Thus farming became associated with poverty and lower status or class. This perception continued into the present era, encompassing farmers of both African and East Indian ancestry. This view can affect the level and type of education disseminated to farmers concerning technology adoption, which in turn will affect the way in which farmers choose farming practices (Baber and Jeffrey, 1986).

In my opinion, a more racial divide in agricultural technology adoption may have emerged due to national and subsequent residential separation of the main ethnic groups of African and East Indian ancestry, following the post colonial rule. Racial tensions and violence which emerged during the 1950s and 1960s were considered to be initiated by breakdown of the monopoly of European rule, which led to internal self government which was granted to Guyana in 1961 (Baber and Jeffrey, 1986; Munslow, 1998). Tensions represented a struggle for power between the two dominant ancestries and national separation of the two groups was also represented by residential separation as both ancestries moved to locations which they perceived to be racially. This separation reflects the racial composition of many villages even in this present era.

In reference to agricultural technology adoption, this segregation may be representative of the type of crops which are dominant in certain locations. Different races tend to cultivate crops according to their ethnic ancestry. The level of technology is a function in many instances of the type of crop under cultivation. Potter *et al*, (2004) report that Caribbean agriculture reflects cultural influence; with farmers cultivating crops according to their ancestry. Thus while it may be a perception of race influencing the type of technology adopted, the latter may be more a function of the crops which are cultivated, rather than race. For instance, East Indian farmers, because of their ancestry are involved in rice cultivation which requires more mechanisation while farmers of African ancestry may be oriented to cultivation of root crops which require less mechanisation and chemical inputs.

During the nationalist period the two main racial factions became more distinct as the ruling People's Progressive Party (PPP) split, creating a divide along communist and what was termed 'moderate' groups; the communist group representing the PPP, dominated by populace of East Indian origin and the 'moderate' group representing People's National Congress (PNC), comprising mostly population of African origin. Thus the era of nationalism was one of race issues, with the populace of East Indian Ancestry supporting the PPP and those of African ancestry supporting the PNC (Baber and Jeffrey, 1986; Canterbury, 2007; Munslow, 1998). The effect of this divide and other and other characteristics of the nationalist era on agriculture and subsequent technology adoption, including specific practices, are discussed in the following paragraphs on the nationalist era.

The nationalist era consisted of two main phases: 1953 to 1964 under the rule of the PPP and 1964 to 1992 under ruler-ship of the PNC. Both eras were characterised by anti-imperialist and anti-colonial ideologies with promotion of self-dependence. This first era was noted for inadequate wages and high rentals. The structure of agriculture under this nationalist era was not much different from that of the colonial era. There was no significant land reform, unavailability of land, inadequate drainage and irrigation, low farm produce prices, and use of inadequate technology. Sugar remained the dominant crop with some expansion of rice cultivation. These conditions persisted into the present era and may be another contributing factor to the lack of, or slow adoption of technology by farmers, reflected in the practices they conduct (Canterbury, 2007; Singh *et al*, 2005).

Rule under the PPP was not supported by the United States of America (USA) on the grounds that this government was pro-communist. In the view of the USA there was no major political difference between nationalism (practiced by the PPP government) and communism (Baber and Jeffrey, 1986; UNDAF, 2001). The PPP advocated nationalism of main industries including the sugar industry to break ties with colonialism since Guyana portrayed limited constitutional rule. However towards the end of the first nationalist era in 1964, the characteristics of agriculture were very much the similar to the colonial era with similar problems including lack of adequate drainage and irrigation, poor research and development, inadequate land reform, high rural to urban migration, bias in the agriculture industry with attention to the main traditional crops, land wastage and lack of adequate road structure to support rural farming (Canterbury, 2007); again presenting disincentives for technology adoption in the non-traditional sector.

The second nationalist era commenced in 1964 and lasted until 1992, under the rule of the PNC. Cooperative socialism was the ideology, with Guyana becoming a cooperative socialist republic in 1970. Goals during this period were two-fold: attaining self sufficiency in food and achieving adequate, nutritious and varied diets for the population. To achieve these goals various initiatives were implemented which included: focus on education in agricultural related areas, reducing mono-crop production[30] of sugar by increasing rice production, focus on cultivation of other crops and food preservation. Farmers' cooperatives were promoted to enable small farmers to benefit from economies of scale and encourage better utilisation of scientific inputs and adoption of mechanisation, through pooling of resources. Pooling of assets was designed to improve credit worthiness of individual small farmers; permitting access to loans for investment from an agricultural bank or cooperative bank (Canterbury, 2007).

[30] Single-crop production

Larger scales of production instead of subsistence-level types were encouraged. Individual cultivation, comprising mixed farming, was discouraged in favour of joint-venture farming. Crop diversification was encouraged with focus on larger scale cultivation of specific crops and implementation of agro-processing initiatives. Import substitution together with increased exports was envisioned as the answer to agrarian problems. Certain foods were banned which were perceived to be not needed or had the potential to be produced locally. It was envisioned that these initiatives would require increased modernisation, especially in areas of farming methods and marketing procedures for the production of good quality commodities which could compete in export markets; thus recognising the need for appropriate technology adoption (Baber and Jeffrey, 1986; Canterbury, 2007).

However, despite this extensive vision and implementation of some initiatives, after a decade, the objective of self-sufficiency in food was not achieved. Hence in 1979, a new directive was assumed with focus on the agrarian sector. This sector was to supply adequate, nutritious diet to the population. This was to be achieved via increasing and maintaining production levels to supply local nutrition needs and generate surplus for export. Initiatives promoted under cooperative socialism in the nationalist era comprised self-help, indigenous banking, plans to achieve food sufficiency, clothing and housing of nationals, price control, banning of some imported food items and nationalising of state economic organisations (Baber and Jeffrey, 1986; Canterbury, 2007).

Many initiatives experienced stagnation and were met with opposition by general civil society and organisations such as trade unions and opposing political parties. The latter part of this era was characterised by emergence of colonial-type ruler-ship, where land was still government controlled. Cooperative-type crop farming was encouraged (Baber and Jeffrey, 1986; Canterbury, 2007; Lemel, 2001; Munslow, 1998). While some success of initiatives promoted under this nationalist period was reported, many initiatives were either short-lived or did not materialise. Literature records that during the 1980s some agricultural diversification achieved, for example heart of palm (EC, 2006). Baber and Jeffrey (1986) note some benefits of this period, which include more managerial positions being available to Guyanese, democratisation of the education system, increased number of secondary schools and improved housing conditions.

Some negatives of this period include increased unemployment, decreased import of basic dietary items without adequate substitution and general financial crisis which led to poor wages. Canterbury (2007) records incidences of food shortages and emergence of new food types, along with significance emigration of Guyanese of all skill levels, to neighbouring territories of Brazil, Suriname and Venezuela and also North America.

Negatives of this era which directly affected agriculture and technology adoption include lack of production material and poor incentives for farming (Baber and Jeffrey, 1986). Land was still state owned while road infrastructure and marketing systems were inadequate (Canterbury, 2007; Lemel, 2001). Lands were abandoned due to migration from rural areas, resulting from disincentive to farming. Support systems for farming were absent or lacking. For example, drainage and irrigation systems were inadequate and there was limited market access. The rice sector experienced inadequate maintenance of drainage and irrigation structures, non-operational storage facilities, poor conditions of access roads and breaches in the conservancy. Loss of rice lands were experienced because of poor sea defence and many rice farmers changed to production of other crops (Munslow, 1998).

The events in the preceding two paragraphs led to the adoption of an Economic Recovery Programme (ERP) in 1988, marking commencement of the neoliberal era, moving towards a market-oriented economy. This occurred just prior to change of government in 1992. In 1988 the nationalist government adopted an International Monetary Fund (IMF)/World Bank ERP, characterised by selling, liquidating, closing and privatising state enterprises. The rice industry was already privatised, the sugar and bauxite industries remained state owned. Through the ERP, a target of 4% GDP increase was projected to be attained through enhanced agricultural performance. While sugar and rice remained the dominant crops, the ERP stated that high potential for non-traditional crops existed and indicated the need for improved price incentives to enhance agricultural development, once again paving the way for technology adoption (Canterbury, 2007; Hendrix, 1993; Singh *et al*, 2005; UNDAF, 2001).

After 1992, a full strategy of market liberalisation in this era was enforced by the World Bank and IMF. With respect to agriculture, this era further emphasised the need for technology adoption to achieve competitiveness on a liberalised market. Increased sugar and rice production was to be achieved via a combination of reduced production costs and increased productivity; to be attained through technological and managerial improvements. The ERP proposed a review of the costs for drainage and irrigation services as a means of addressing operating and maintenance costs, thus transferring these costs to the producers (Canterbury, 2007).

Understanding the evolution of Guyana's political economy presented useful insights especially into the policy-motivated factors and contexts which influenced farmers' overuse behaviour. Some of these factors and contexts, especially credit, unfavourable information dissemination and adverse marketing conditions, presented within this chapter (sections 4.2 - 4.4) corroborated with findings of this study and are discussed in chapter 6 section 6.4 and chapter 7, section 7.4, respectively. While factors and contexts of the political economy demonstrated influential roles in farmers' behaviour, the theoretical framework of chapter 3 interpreted farmers' reactions[31] to these influences, based on an understanding of behaviour as explained by the practice and critical realist theories and theory of the risk-averse peasant. The following section explains the influence of the present political economy on farmers' adoption of technology.

4.3 Present Political Economy: The Growing Influence on Core Technology Adoption Elements

Several sources corroborate with the NDS (GOG, 2001), that the political economy of Guyana has not been reorganised and is characterised by an agricultural society which is still very dependent on the same crops which were produced for over 150 years (Baber and Jeffrey, 1986; Canterbury, 2007; FAO/CARICOM, 2005; FAO/GOG, 2006; Singh, *et al* 2005**)**. Literature indicates that agriculture continues to be the most important sector of Guyana's economy, contributing approximately 30% of GDP, 30% of employment and 40% of export earnings. About 400,000 acres of irrigated land is utilised by agriculture. Within the sector, sugar and rice continue to be the

[31] Farmers' overuse practices

major crops, with respect to the area of land occupied by these industries, their value of production, ability to create employment, and contribution to export earnings. Sugar production occupies about 130,000 acres, rice occupies approximately 200,000 acres, while an average of 70,000 acres are utilised for other crops and livestock (FAO/CARICOM, 2005).

Present features of the political economy which influence technology development and adoption, especially within the non-traditional sector, will be dealt with in the following paragraphs and subsequent chapter section. Features discussed in the following paragraphs include core components of: policy, land ownership, access to credit and gender. The subsequent chapter sections discuss both private and government institutionally led aspects of the political economy which influence technology adoption are discussed. A third feature of non-organisational type structures, comprising interest groups and initiatives which also influence technology adoption, is discussed.

4.3.1 Policy

Present policy for the agricultural sector promotes increased competitiveness within the traditional sub-sector and focus on diversification within the non-traditional sub-sector for increased production, export and job creation (FAO/GOG, 2006; GOG/PS, 2006). Griffin (1979) indicates that focus on increased export output does not favour small farmers. Proposed diversification efforts include strategies for improvements in extension services, provision of marketing and credit services, formation of rural centres and cooperatives, provision of relevant education and mechanical inputs, establishing and monitoring adequate germplasm supply, providing relevant plant protection services and developing and facilitating appropriate agronomic practices.

Specific strategies for developing appropriate agronomic practices include areas of pest control and fertiliser application. Various policies have placed emphasis on development of the non traditional sector (FAO/GOG, 2006; GOG/PS, 2006). The impact of these policies on technology adoption presents mixed results based on several interrelating factors and situations, which are discussed in the subsequent sections of this document. Singh *et al*, (2005) indicates that the effectiveness of these policies depends on their implementation. The authors identify the need for more defined objectives and strategies with specific time-lines.

Despite present policies for focus on the non-traditional sector, the impacts of globalisation (eroded trade preferences and market liberalisation) present the need for increased competitiveness within the traditional sector. This requires even further technological development for the production of main crops, sugar and rice. Hence, while efforts are aimed at technological development within the non-traditional sector, because of the relative importance of traditional crops compared to the non-traditional these efforts stand a chance of being attributed second place in relative importance. Singh *et al*, (2005) record that:

> *'small farms with low levels of technology, low volumes of output and high production costs exist side by side with modern commercial farms, more appropriately structured and equipped to become competitive. Although mechanization is widespread in sugar and rice, other agricultural industries are generally labour-intensive'* (p vi).

The author also highlighted inadequate emphasis on small-farm technology and mechanisation.

4.3.2 Land Ownership

Approximately 90% of land in Guyana is owned by the State. Leases for specific periods or grants of absolute title may be made according to the State Lands Act. Cap 62:01. The right to ownership of private land is primarily governed and determined by the Deeds Registry Act Cap. 5:01 of the laws of Guyana and the Land Registry Act, Cap. 5:02. (FAO/GOG, 2006). Land tenure arrangements are of two main types: state owned lands and freehold lands. Freehold lands are those purchased from the state or previous owners. About half of the farms are freehold lands, with a distribution of mainly small farms of approximately five to fifteen acres each. Administration of State lands is not a very clear process which may frustrate farmers' efforts to obtain information on leases and the availability of unutilised idle land. The identification of land boundaries is not precise. Various agencies have jurisdiction over land, for example the Lands and Surveys Department, the Geology and Mines Commission, and the Forestry Commission; thus demarcation of which land is under the authority of the various agencies is unclear (GOG, 2001; Hendrix, 1993).

There is competition for available land required for 'traditional and non-traditional crops, housing, and industrial land developers' (GOG, 1998: 12.II.1.3). The traditional layout of drainage and irrigation infrastructure from colonial era is suitable for rice and sugar production but inappropriate for production of non traditional commodities. Modifications to the land infrastructure to enhance production of non-traditional crops were not made. Land ownership for the traditional sector is a more straightforward process, as sugar production is state controlled and acquisition for most lands in rice production is controlled by as a specific organisation the Mahaica/Mahaicony/Abary-Agricultural Development Authority (MMA/ADA), through the Government of Guyana (GOG) - MMA/ADA Act (GOG, 1998).

The Lands and Survey commission became a semi autonomous agency in 1997 and some land issues such as longer leases for farming and land titles were addressed. However, farmers still complain of land tenure issues. No land use policy is currently in use. A Draft National Land Use Policy is before the Government of Guyana for consideration and provides the policy context for all land uses (GOG, 2001; UNCCD/GLSC, 2006). Literature notes the possible reluctance of farmers in Guyana to invest in appropriate practices due to lack land ownership (IICA/JIFSAN, 2004). Singh, *et al* (2005) highlights the need for a land-use strategy and land market, to encourage investments and support commodity competitiveness within the agricultural sector.

4.3.3. Access to Credit

No specialised agricultural credit institutions are operational in Guyana. Local credit is accessed mainly through the commercial banking system. Credit availability over the last few years has been mainly short-term types of loans at very high interest rates. During the latter part of the 1980s the interest rates on loans had reached 40%. During the 1990s however the interest rate on loans was reduced to approximately 20%. Interest is usually compound type with each institution determining its own interest rate and method of calculation. This interest rate is often too high for farmers. Apart from commercial banks the Institute of Private Enterprise Development (IPED) provides loans, at approximately 15% interest for small and micro enterprises, which includes farming initiatives (FAO/GOG, 2006; Singh *et al*, 2005).

4.3.4 Gender

Gender has been addressed at the highest level of national planning in Guyana within the NDS, but its specific role in agriculture has not been defined or assessed. The NDS identifies exclusion of women's needs from planning processes and low level of recognition of their various roles. Constraints noted include perceptions of inferiority with respect to women's political, economic and social status, lack of recognition of women's role in national development, lack of assessment which determines cost effectiveness of gender mainstreaming, limited capacity of the private sector in addressing gender-related issues and limited access for women's contribution in political and economic decisions (NDS, 2001). USAID (2003) records that gender issues in Guyana are considered within the broader context of social, economic, and political issues. The NDS mentions the need for gender mainstreaming to address constraints women face in Guyana, but does not specify policy initiatives for agricultural development within a gendered context (NDS, 2001). Apart from an Inter-American Development Bank/Government of Guyana (IDB/GOG) funded programme[32] which concluded in 2007, no specific agricultural programmes target women in agriculture.

The Women's Affairs Bureau (WAB) of the Ministry of Labour is responsible for women's legal rights. Poverty levels of Guyanese women vary across ethnic and social groups with Amerindian (indigenous) women experiencing highest poverty levels. There is high prevalence of female-headed households, which generally receive lower incomes. No legal barriers prevent participation of women in political

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[32] The Poor Rural Communities Support Services Project (PRCSSP) was a community initiated agricultural, rural and community development project, which aimed to alleviate poverty in two coastal regions of Guyana, namely Regions 2 & 3, by increasing rural household incomes through providing efficient and sustainable support services to rural communities, with particular focus on poor households, Amerindian communities and women-headed households (http://www.agriculture.gov.gy/Gain/moa_mfcl/moa/index.htm; http://www.gina.gov.gy/archive/daily/b061012.html).

processes but women are underrepresented in politics. Education is equal for both men and women. While in some sectors women comprise the majority of workers, they are often in the lowest paid occupations. Access to credit is not legally limited for women but because of high levels of collateral required and high interest rates many women do not qualify for formal credit. More men than women hold land titles to property in Guyana. Women have equal right to land ownership according to law but in many instances land titles are in their husband's name (Baber and Jeffrey, 1986; IWRAW, 1999). These factors, singly or combined, may influence women's role on agricultural technology adoption. While gender may be interesting, literature does not indicate its association with agrochemical use in Guyana.

4.4 The Role of Guyana's Political Economy in Institutions Responsible for Technology Adoption

Institutions responsible for technology adoption within the agricultural sector are categorised within this study as private sector, government-controlled and non-organisationally structured types, the latter comprising interest groups and initiatives which are joint government and other stakeholder controlled. The role of private sector institutions in influencing agricultural technology adoption is primarily in the capacity of investment, while Government-led institutions which are responsible for technology adoption within the agricultural sector function primarily within educational, marketing and research capacities. The non-organisationally structured institutions exhibited variable roles in influencing technology adoption, within capacities of investment, educational, marketing and research.

4.4.1 Private Sector Institutions: their role in Technology Adoption

Within Guyana's private sector, institutions which play a role in stakeholder's adoption of agricultural technology are primarily responsible for fostering investment. Investment within the agricultural sector is guided by two main agencies: The Guyana Office for Investment (GO-Invest) and the Institute of Private Enterprise Development (IPED).

GO-Invest is a semi-autonomous agency which is under the purview of the Office of the President. This agency was established under the Public Corporation Act (1994) and is the main contact for investors and exporters. The agency mediates with government ministries and related agencies on behalf of investors and exporters to facilitate and expedite the processing of applications which are required for concessions and other government support. The agency's activities comprise two main factions: promotion and facilitation of investment, and promotion of exports. Through these divisions services are disseminated to local and foreign investors and exporters (FAO/GOG, 2006; GOI, N.D.).

GO-Invest's services for promotion and facilitation of investment include providing investors with guidance concerning initiation of business, incentives and regulations, and available investment opportunities available. The agency also coordinates activities of local and foreign investors and provides policy advice to government. Services for promoting exports include providing current and potential exporters with necessary market information and export advice, and conducting product-promotion activities (FAO/GOG, 2006; GOI, N.D.). While the agency assists farmers who are exporters or potential exporters, its mandate does not address technological development in a direct manner. The agency is proactive in sourcing markets for farmers, which could be an incentive for technology adoption, but this is more export oriented.

i. The Institute of Private Enterprise Development (IPED)

It was previously noted that farmers are affected by lack of adequate agricultural credit facilities which can address their specific needs. Since the closure of the country's agricultural development bank in 1992, there is no specific agricultural lending facility (Forde, 2005; NDS, 1996). Apart from high interest rates of commercial banks, many farmers do not have necessary collateral to access loans. The Institute of Private Enterprise Development (IPED) is a company, registered under the Company Act, Chapter 89:01 of the Laws of Guyana. This company provides supervised loans and services for business development, to groups and individuals who are involved in micro and small businesses throughout Guyana. It is the main institution which provides financial and technical assistance to small entrepreneurs.

IPED functions via a credit department and an Entrepreneurial Development Centre (EDC). The credit department provides field counselling and supervision, supported by related training. The EDC provides a complementary service, to improve the chances of entrepreneurs' success through the provision of Business Development Services (FAO/GOG, 2006; IPED, 2010). While IPED facilitates credit to micro entrepreneurs (which includes farmers), like GoInvest, its scope is limited in agricultural related training and technology development. Within this study five farmers highlighted the plight of securing the relevant documents for obtaining loans from this institution.

Findings corroborated the lack of effective entrepreneurial policies and demonstrated a possible link between inaccessible credit and farmers' overuse behaviour. For instance, three farmers indicated that lack of adequate funding necessitated their acceptance of credit from agrochemical dealers, where the required pesticide and fertiliser was taken from the dealer and paid for when produce was sold. This credit relationship invariably placed farmers in a position of disadvantage where their choices of agrochemicals were influenced by dealers; who in many instances sought to fulfil their own interests.

4.4.2 Government-Led Institutions: their role in Technology Adoption

Government-led institutions provide support for agriculture technology adoption based on Government's policy for agriculture. Present agricultural policy promotes expansion and diversification of the agriculture sector mainly because of decreasing preferential market arrangements for the sugar and rice industries. Plans for diversification include increased competitiveness in traditional crops (rice and sugar), but also increased focus on the non-traditional crop sector. The Ministry of Agriculture is the main institution, which supports the non-traditional crops and livestock sectors. Agencies within the Ministry which directly support technology adoption include the CLSS, the NGMC the NARI and the Guyana School of Agriculture (GSA). Supporting organisations include the University of Guyana (UG), the Regional Democratic Councils (RDCs) and the Neighbourhood Democratic Councils (NDCs). The Ministry of Agriculture (MOA) is responsible for formulating, implementing and monitoring agricultural policies. The MOA's mandate also includes collecting, processing, analysing and disseminating relevant information (FAO/GOG, 2006; GOG, 2001; GOG/PS, 2006).

i. The MOA and Education for Technology Adoption

The CLSS division of the MOA is mandated to provide extension services, which includes technical information, to farming communities. However, extension activities are sub-standard. Current rehabilitation of the CLSS is ongoing to improve the extension services capabilities of this department. The Agricultural In-service Training Communication Centre (AITCC) is a department under the CLSS, which is responsible for training of farmers and other stakeholders within the agricultural sector. Extension services provided by the CLSS are sometimes complemented by those from other government agencies (for example NARI and NGMC), semi-autonomous, regional and international agencies. Limitations of government institutions in providing extension services include inadequate funding, staff shortages, poor salaries and transport facilities, and inadequate and infrequent meetings of relevant personnel. In some instances, research is unrelated to the needs of farmers, while regional training is limited (GOG, 2001; IICA/JIFSAN, 2004). Findings in this study substantiated the above mentioned limitations of these institutions and are discussed in chapter 7, sections 7.3 and 7.4.

ii. The New Guyana Marketing Corporation and Marketing Support for Technology Adoption

The NGMC is a government corporation, which was established in 1963 under section 46 of the Public Corporations Act, Cap 19:05 of the Laws of Guyana. The corporation promotes the cultivation and export of non-traditional agricultural crops of Guyana, and provides market information, extension and export services to agricultural producers and exporters. This agency also provides recommendations to Government on domestic agricultural policy and promotes activities to stimulate exports of non-traditional commodities. The services offered by this agency are provided via two main departments: a marketing department (comprising Customs Brokerage Unit, Central Packaging Facility and Supermarket) and a technical department (comprising the Market Intelligence Unit and Technical Services Unit) (NGMC, N.D.b)

The NGMC initially played a major role in purchasing farmers' produce at competitive prices and then reselling these produce at affordable prices to consumers. This role assured farmers of a reliable domestic market and prices for their produce, which could be instrumental in encouraging technology adoption. But in 1985, the policy of the NGMC changed and all buying and selling operations ceased. The Corporation's mandate was oriented towards a more facilitator's role in providing market facilitation services for the export of non-traditional agricultural produce (Canterbury, 2007; NGMC, N.D.b).

In 1997 the company resumed the role of purchasing farmers' produce along with processed agricultural products which were locally manufactured. Prices were derived through direct negotiation with farmers and manufacturers, and purchasing was limited to produce of stipulated quality, for which demand existed. While this policy may have encouraged the production of quality produce, it also might have been a deterrent to technology adoption as farmers were unsure of their produce being sold. NGMC also conducted promotion of locally made products, through series exhibitions throughout Guyana (NGMC, N.D.b).

The Corporation recently resumed a market facilitation role. Focus in 2007 was directed towards restructuring of NGMC, with an amended mandate 'to facilitate and coordinate development of non-traditional agricultural produce and products for export and enhance the services offered…' A centre was established to provide market information to guide clients on market trends and global demand (GINA, 2007). Changes in the role of the company can directly influence on the type of technology adopted by farmers in a situation of non-guaranteed markets. While on one hand market links are important, on the other hand, farmers' willingness to adopt appropriate technology may be curtailed by the inability of the corporation to assure farmers of returns for their investment. Literature indicated that farmers may be unwilling to adopt appropriate practices of agrochemical use due to easier access to local markets, compared to more restricted access of export markets, which require strict compliance regarding agrochemical limits (IICA/JIFSAN, 2004). Findings of this study revealed that un-assured markets, partially due to incapacity of NGMC to assure farmers of markets for their produce, proved to be motivational in farmers' agrochemical overuse. This is discussed in greater detail in chapter 7, sections 7.3 and 7.4.

iii. The National Agricultural Research Institute (NARI) and other Institutions: Research and Support for Technology Adoption

Other agencies which play a role in technological development include NARI, GSA, UG, RDCs and NDCs. NARI is mandated to develop and advise on mechanisms which encourage diversification of agriculture through appropriate research. The institute is responsible for facilitating the use of improved technology for agricultural production, and creating appropriate mechanisms for feedback. GSA conducts certificate and diploma programmes in agriculture. The certificate programme emphasises practical training and is designed to equip young persons with appropriate farming skills. The diploma programme emphasises sub-professional training. UG offers first degree agricultural programmes conducted by the faculties of agriculture and education. RDCs and NDCs collaborate with the MOA to conduct planning, with respect to addressing the needs of farmers and the wider community (GOG, 2001).

While these institutions all play a role in delivering agriculture technology at various levels, several constraints are experienced. Regular programme delivery to enhance technology development is negatively affected due to staff and budgetary constraints. This affects the necessary follow-up required to make these programmes effective. Programmes offered at tertiary level target mainly agricultural professionals, and not farmers. The NDS notes that agricultural technology is often provided to stakeholders without relevant support services. Lack of an integrated approach then results in poor absorption of the delivered technology (GOG, 2001). This investigation revealed that haphazard information systems were one of the main motivations for farmers' overuse practices, as discussed in chapter 7, section, 7.3.

Other issues within the non-traditional sector which influence non-adoption of technology are recorded. These include seasonal demand of export, weather patterns, and price fluctuations of inputs and unstable supply of produce, characterised by periods of glut and scarcity. Production levels and farmers' choice of commodities cultivated are influenced by the availability of inputs, farmers' experience and perceived demand. Poor organisation among farmers with limited exchange of information sharing is noted. Knowledge of production and marketing information is restricted and poorly assembled. Poor transport and related infrastructure impede marketing of agricultural products and contribute to the wide disparity between farm-gate and retail prices. Inadequate transport affects many riverain[33] producers and consumers as transport via both water and road are unreliable and expensive in these areas. Poor conditions of local roads exist. Lack of knowledge in areas of post harvest training, handling and storage is also noted (FAO/CARICOM, 2005; GOG/PS, 2006; IICA/JIFSAN, 2004; NDS, 2001). Findings in chapter 7 sections 7.3 and 7.4 revealed that lack of appropriate marketing structures and unstructured educational systems influenced farmers' non-adoption of appropriate agrochemical practices.

4.4.3 Interest Groups and Initiatives: their role in Technology Adoption

i. Interest Groups

Interest groups such as cooperatives and associations play an important role in agricultural technology adoption. Cooperatives were unique in Guyanese history and were recognised as economic units in the 1970s within the socialist system. Cooperatives were responsible for distributing benefits and supporting initiatives. For example, land cooperatives responsible for distribution of house lots and coordination of livestock rearing and other agricultural activities. During the later late 1980s transformation to a market economy, resulted in cooperatives being viewed with a socialist meaning. Government bureaucracy hinders the functioning of cooperatives as economic units. For example, it may be difficult to exclude a non-contributing member from receiving benefits. There is little incentive for active participation in cooperatives and contribution of resources (Baber and Jeffrey, 1986; POA, N. D.). Within the traditional sector interest groups include the Cane Farmers Association (CFA) and Rice Producers Association (RPA). These groups play a major role in lobbying for interests of stakeholders, including farmers. Within the non-traditional sector, interest groups are primarily farmers' organisations which are mostly informal and disorganised (Baber and Jeffrey, 1986)[34]. This was corroborated by this investigation which revealed that while farmers' groups for non-traditional crops were registered, they were largely non-functional. Within the two study regions, of four farmer groups which were supposedly functional, only one group was able to organise themselves for my visit. In districts of both study regions, some farmers were unaware of the existence of these groups.

[33] Riverside locations
[34] Information also from Key Informants: MOA and IICA

ii. Initiatives

While various constraints to technology adoption are noted, some initiatives have been conducted which foster agricultural technology adoption at various levels. Export allowances are granted for the export of non-traditional commodities to markets outside of the Caribbean Community (CARICOM). These allowances are calculated within a range of 25% to 75% of the export profits. 'Tax holidays' for up to ten years are granted for pioneering type investments of new products or for production conducted within specified locations. Projects conducted within specific areas are eligible for waiver of customs duty and consumption tax on all imports of plant, machinery, equipment and spare parts and waiver of customs duty, consumption tax and purchase tax on all vehicles imported specifically for manufacturing and agricultural business investments. Firms in agricultural and agribusiness sectors are entitled to waiver of customs duty and consumption tax on several types of machinery and equipment utilized during agricultural production such as materials for packaging fruit and vegetable exports and agro-processing equipment. Importation of various types of agro-chemicals is duty free, while allowances are granted for cost associated with development and improvement of land for agricultural initiatives (FAO/GOG, 2006).

Some initiatives which address issues of technology adoption, especially with respect to use of pesticides and fertilisers were implemented. One of these is the PTCL, launched in 2008, primarily for testing for residue limits of agrochemicals in agricultural commodities (MOA, 2008). While this facility will be extremely useful for export commodities, which have direct marketing chains, there is limited scope for agro-produce sold on the domestics markets for which direct marketing chains are not established. Recent plans for the non-traditional sector include finalisation of a US$20.9 million IDB funded Agricultural Diversification Programme (ADP) and US$6.8 million IFAD and GOG funded Rural Enterprise and Agricultural Development (READ). The ADP aims to increase exports through developing commodity chains for non traditional agricultural commodities and enhancing the role of service providers and institutions which function in value added and marketing systems, respectively (MOA, 2008).

Findings revealed that the initiatives mentioned in the two preceding paragraphs, demonstrated influence on farmers' decisions concerning agrochemical use. However, these initiatives are directed towards export and of less benefit to farmers engaged in domestic production. Firstly, farmers did not gain from duty free imports of agrochemicals as this trade is private sector controlled. Rather, farmers complained of exorbitant prices imposed by dealers. High uncontrolled agrochemical prices influenced farmers to purchase sub-standard chemicals[35]. Secondly, vegetable farming is primarily small scale and labour intensive, hence farmers did not benefit from duty free exemptions for agricultural machinery. Thirdly, while the PTCL was established, residual testing is not yet conducted, hence there is no local monitoring of agrochemical residue in agricultural produce. A more specific relationship between political economy and farmers' adoption of agrochemical use practices is discussed within the following chapter section.

4.5 SIGNIFICANCE OF POLITICAL ECONOMY IN THE STUDY OF FARMING PRACTICES

Analysis of Guyana's political economy strongly indicates that several factors of the political economy impact on the adoption of agricultural technology and thus may influence farmers' adoption or non-adoption of certain farming practices (specifically those of pesticide and fertiliser overuse). These factors therefore comprised some of the independent variables utilised within this investigation. Independent variables included credit availability, land tenure status, ethnicity, market type accessed, and information 'source-type'. While all of these variables were not statistically tested, because of reasons explained in chapter 6, section 6.4, the significance of these variables to farmers' adoption of pesticide and fertiliser practices is discussed hereafter.

Farmers' lack of access to credit may restrict their adoption of technologies which require significant investments (Doss, 2003; Finan, 1998). Questions concerning credit availability in this study enquired whether farmers utilised various sources of credit and what are for the reasons for their utilisation or non-utilisation. This study revealed that of 229 farmers, only seven (3%) accessed credit. Of the remaining 222

[35] Discussed in chapter 7 section: 7.3

or 97% of farmers who did not access credit, 193 or 87% did not do so because of fear of inability to repay loans. In this research it was postulated that some variables were interlinked with others. It was expected that linkages between and among variables would be discovered through the qualitative phase where farmers were given the opportunity to express their perceptions. But while linkages were discovered, they were not those expected prior to the research, as is explained in the subsequent paragraph.

Land tenure is a feature of the political economy which was postulated to be motivational in farmers' adoption of overuse practices. It was believed that in the absence of sound tenure agreements, farmers would be reluctant to invest in technology on land, without the certainty of being beneficiaries of this investment (IICA/JIFSAN, 2004). However, linkages could exist between land tenure and credit, as land tenure frequently has implications for credit access. Ownership of land is sometimes a prerequisite for obtaining credit as land title is often used as collateral. Farmers with no land or land of inadequate value may be denied access to formal credit. It was expected that these linkages, once present, would be identified through farmers' discourses, as contingent, support or contextual factors. Further, land size under cultivation may be important in determining reasons for various practices. Farmers with larger land sizes under cultivation may be more willing to invest in certain practices due to larger scales of cultivation.

However, findings, discussed in chapter 7, sections 7.2-7.4, indicate that the reasons for farmers' overuse practices, discovered through qualitative analysis were very different from the expected. In the case of land tenure and area cultivated, quantitative analysis revealed that both of these factors were significant to pesticide overuse. However, qualitative investigation did not indicate these factors as motivational to farmers' overuse practices. Interviewees did not indicate a possible change of their agrochemical practices if their land tenure status and area cultivated were different.

Farmers need access to appropriate information concerning new technologies before they can make decisions about adopting them. Extensions services of a country's agricultural department are often an important source of information for farmers on issues of new technologies (Cernea *et al*, 1985). Farmers' access to extension services can therefore be used to measure their access to relevant information. It was expected that farmers' 'source-type' of information would be motivational to their overuse practices. In this study, questions were directed to farmers concerning their source-type of information, initially within the quantitative phase. Logistic regression revealed that this variable was significant to both pesticide and fertiliser overuse. Further investigation during the qualitative phase, revealed that farmers' source-type of information was one of the most motivational influences for their overuse practices.

Access to markets plays an important role in the practices farmers adopt. Farmers will be more willing to invest in adoption of correct practices if they are assured of the returns for their investment in technology. In a market oriented economy, farmers need to achieve and maintain competitiveness to secure markets. This sometimes requires investments in technology. This study revealed the need for farmers to utilise available technology for pesticide and fertiliser use, to ensue the production of commodities which with desired residue limits. However, it may be difficult to assure farmer of returns for investment in a free market situation (Doss, 2003). Information on farmers' accessibility to markets was derived by inquiry concerning the market types (export or local) to which farmers sold their produce and the types of arrangements in which they engage. While this variable was not utilised within the quantitative phase due to its propensity to distort results (explained in chapter 6, section 6.4), inadequate marketing arrangements were found to be highly motivational in farmers' overuse practices, as explained in chapter 7, sections 7.3 and 7.4 .

The farmers' income may determine how much he/she is willing to invest in technology adoption. While the adoption of a specific practice may be correct, farmers assess the potential result(s) of adoption based on knowledge of their peculiar circumstances. For instance, in the context of this study, farmers' inappropriate use of agrochemicals, to assure a marketable crop and desired income, may be a more favourable option to farmers than the adoption of appropriate agrochemical use, with possible crop losses and high income variations. This variable was not statistically tested, because of farmers' lack of record keeping and their unwillingness to divulge information, because of discrepancies such as tax evasion. For this investigation, income was qualitatively investigated by utilising market potential of farmers' produce as a proxy for income. Qualitative analysis revealed that the use of excessive pesticides and fertilisers was driven by the farmers' 'desperate' need for desired income within a context of unsure markets, discussed in chapter 7, sections 7.2 and 7.4, respectively.

The role of ethnicity in technology adoption may not be as clear as other variables. However, as noted in the earlier discussion on Guyana's political economy, the cultivation of certain crops is associated with different ethnicities, through ancestral influences[36]. Since different crops require various levels of chemical inputs, this study postulated that any associations between ethnicity and chemical misuse should be further assessed. However, ethnicity was not statistically tested due to its propensity to distort results (over 90% of farmers being of one type ethnicity). More importantly, the sensitive nature of this variable in the context of Guyana's politics did not permit qualitative investigation. However, based on my observations in the capacity of researcher, this variable did not explain farmers' practices of overuse.

Women's role in agriculture and the constraints they experience have been addressed by several authors (CIDA 1999; CS, 2001; FAO, 1995; Hafkin and Odame, 2002; WOCAN, 1996). These authors note that while women play an important role in agricultural development, this role has been underemphasised and women are often excluded from important policy decisions concerning agricultural development. Specific constraints faced by women involved in agricultural production include: lack of access and entitlement to land, lack of or reduced access to vital resources such as access to credit, inputs and technology, inaccessibility to market information and exclusion from activities of planning and policy development for the agricultural sector; all of which may play a role in technology adoption. Like ethnicity, gender was not statistically tested, as 86% of farmers were males.

The preceding discussion provides a backdrop for understanding why farmers may or may not adopt technologies. In the specific cases of pesticide and fertiliser overuse, a critical examination of the country's political economy and its influence on the agricultural sector of Guyana provides various factors which influence choice of farming practices. This study of farmers' overuse practices utilised some of these

[36] Discussed within section 4.2 of this chapter

factors to ascertain their possible influence on farmers' overuse. While factors of land tenure, area cultivated, education level and source-type of information showed significance to farmers' overuse, further investigation through qualitative analysis of farmers' discourses revealed that farmers' reasons for overuse were explained by a much more intricate system comprising the interaction of factors, mechanisms and situations, and not the influence of single factors.

4.6 SUMMARY

An assessment of Guyana's political economy provides an understanding of the structure of the agricultural sector in relation to technology adoption and farmers' choices of practices. While three eras of rule represented different ideologies, core focus and strategies for the agricultural sector have presented striking similarities. Changes in the political economy under each era have therefore influenced the adoption or non-adoption of technologies in similar ways. Technology adoption has occurred at varying rates within the different agricultural sub-sectors, for different crops; subsequently influencing the agricultural practices adopted for different crops. Though much attention has been directed towards technology adoption for increased productivity of traditional crops; sugar and rice, this level of attention has not been equally directed towards the non-traditional sub-sector.

Farmers of non-traditional crops can benefit in limited measure from policies which encourage investment in technology but these policies remain more beneficial for farmers of traditional crops. For example, duty free imports of agricultural machinery benefit rice and sugar production in a greater measure since these crops utilise more mechanical inputs that non-traditional crops. Policy initiatives aimed at improving marketing services and infrastructural requirement for non-traditional farming are limited. Markets for sugar and rice are established while those for non-traditional crops are rarely established or assured markets. Non-traditional produce is exported mostly via bilateral agreements for certain crops or conducted through weak export agreements, some of which are verbal (FAO, 2004). In the absence of assured markets for non-traditional products, this study revealed that farmers were interested in securing the highest possible returns to investment for every crop cycle and this influenced their overuse practices.

Land policy for cultivation of traditional crops is much more defined compared to that for the non-traditional sector. The sugar industry is state-owned, with operations conducted on state lands. Land policy for most rice farmers is clearer with the majority of land acquisition and related issues being managed by a single agency, the MMA/ADA. While land tenure issues are now addressed through a semi-autonomous agency, the Lands and Survey Commission, land tenure issues are still areas of much concern for non-traditional crop farmers. In the initial stages this study suggested that while farmers may be aware of technology required for appropriate use of pesticide and fertiliser, investing in adoption of these technologies will hardly seem worthwhile to farmers where tenure status is uncertain. But while quantitative analysis demonstrated significance of land tenure to pesticide overuse, qualitative analysis did not indicate this factor to be motivational to farmers' agrochemical overuse.

Credit for agricultural investment in Guyana is affected by the absence of agricultural credit facilities and farmers' lack of collateral required to approach commercial banks. Even if farmers approach commercial loaning agencies, interest rates of approximately 20% are generally too high. Technology adoption often requires initial investment. Incentives which are structured to reduce input cost may not be realistic because of impinging or uncomplimentary mechanisms. For example, a zero tax on agrochemicals and agricultural implements in Guyana may encourage these inputs to be retailed relatively cheaply. However, this was not the case, as retail businesses are private sector managed and no price control is operational. All interviewees (38 or 100%) complained of high agrochemical prices. It is perceived that lack of credit and variation of input prices fostered a situation where farmers tried to use the cheapest inputs to attain the most profitable mode of production. But while this was the case expressed by two interviewees, even for higher priced chemicals, overuse was practiced.

Farmer education in the non-traditional sector is supplied primarily by various agencies of the MOA, but is subjected to budgetary, staff and other constraints. When compared to instruction methods within the traditional sector, instruction for non-traditional farmers is lacking, both in scope and intensity. Farmer education and related technological development for stakeholders in the semi-autonomously controlled rice sub-sector and state-owned sugar corporation are specific to these crops and focused on equipping stakeholders in necessary technological development. The former has a Farmers' Field School (FFS) system for training together with its own research station, while the latter is equipped with training and research facilities which instruct on various facets of technology production. In the absence of adequate information, the perception of farmers may be that a greater volume of these chemicals will assure favourable growth and provide increased assurance against pest and disease, thereby ensuring a final harvest. This was confirmed by farmer interviews and clearly expressed in farmers' perceptions, discussed in chapter 7, section 7.2 and chapter 8, section 8.3, respectively. Another common uncomplimentary mechanism includes instances where retailers of agro-chemicals are often informants to farmers during sale activities, but these retailers are not equipped with relevant knowledge.

With reference to gender, many existing gaps are noted in statistical data concerning Guyanese women (UNDP, 1996). The ILO's 1990-2000 distribution of active female population in selected commonwealth countries indicates that 14% of women are employed within Guyana's agricultural labour force (CS 2001, p18). Despite limited information on women in Guyana, there is long historical tradition of rural women's involvement in agriculture. No distinct demarcation exists between duties for men and women and women are involved in all aspects of agricultural production. In recognition of women's role in Guyana's agricultural sector, it is suggested that attention be given to the disaggregation of data by gender. Training and focus on enhancing economic returns to women in agriculture, through addressing their access to credit, technical assistance, marketing and other opportunities is also suggested. Agricultural programmes include women but are not specifically structured to women's needs (UNDP, 1996). As previously mentioned, this variable was not investigated.

Based on the possible influence of the aforementioned variables on farmers' agrochemical practices, most of these variables were investigated in this study for detection of their possible role in motivating farmers' overuse practices. The manner in which this investigation was conducted is explained in detail in the following chapter, 5 which addresses the methodology of this study.

CHAPTER 5: METHODOLOGICAL FRAMEWORK

5.1 INTRODUCTION

> *'Despite the large increases in food production brought about by chemical inputs such as pesticides, the agricultural, environmental and health costs arising from pesticide use are high. In such a case the question that is often asked is why do farmers continue to use pesticides? There are many reasons for this paradox'* (Wilson and Tisdell, 2001, p456-457).

While the authors of this excerpt refer to farmers' sustained agrochemical use as a paradox, the chosen methodology for this study demonstrates that it is possible to investigate and unravel meanings for similar paradoxical farming behaviour. In my study, practices of pesticide and fertiliser overuse were investigated by utilising an original methodological approach, which not only examined these practices as physical occurrences, but also as socially constructed phenomena. In their study on land degradation assessment in South Africa, Stringer and Reed (2007) highlight the importance of integrating scientific and local knowledge and the utilisation of various methods for determining potential land degradation indicators.

In a similar manner, the methodology for my investigation demonstrates the capability to utilise a critical realist point of view; integrating quantitative and qualitative strategies, to provide both descriptive and explanatory aspects of agrochemical overuse practices. The methodology of this investigation is specifically designed to initially describe farmers' prevalence and intensity of agrochemical overuse and subsequently elaborate on the reasons for this practice.

This chapter gives a detailed account of the methodology which guided this study. Initially, the research setting section identifies the background which influenced the choice of the research investigation and relates this background to the specific objectives, which were designed to answer the main research question. Contributions of each objective to the general research question are outlined and then related to the chosen methods which enabled these objectives to be achieved.

Embedded within the methods employed, were ethical concerns, especially where questioning revealed incidences of unlawful behaviour by farmers and sensitive information divulged by key informants. As the chapter progresses, these concerns are identified, indicating the manner in which they were addressed. While ethical issues are important for the entire research, they are primarily addressed within the methodological aspect of the study. The penultimate section of this chapter presents the details of data collection and analysis, outlining the procedures for both phases and also emphasising the significance of each phase in answering the research objectives. The chapter concludes by explaining the measures taken to enhance reliability and validity within this research.

5.1.1 Research Setting

The concept of agrochemical overuse is widely embedded in writings of the Green Revolution (GR), which trace the origin and expansion of an industrialised agriculture, aimed at increasing crop production through the use of new technologies and inputs, such as high yielding varieties of crops and intensive use of agrochemicals. Authors debate the merits and demerits of the green revolution. Merits cited primarily include increased yield especially in staple crops (such as rice, wheat and maize), lowered incidences of poverty and increased incomes, as opposed to demerits of inequitable capability for technology adoption which favours larger farmers, uneven distribution of income gains and high dependence on inputs (Evenson and Gollin, 2003; IFPRI, 2002; Pearse, 1974; Ruttan, 2002; Wharton, 1969). Literature links the GR to the increased use of agrochemicals and highlights the harmful effects of sustained and excessive use of pesticides and fertilisers (IFPRI, 2002; Waichman *et al*, 2007; Wilson and Tisdell, 2001).

There is no readily available definition for pesticide or fertiliser overuse, but working definitions were developed for this study, within the context of farmers' non-adherence to the guidelines for the dosages of these agrochemicals, presented by competent authorities. This is extensively explained in chapter 3. For the purposes of this study, literature which explained the concept of agrochemical overuse was used to develop working definitions of pesticide and fertiliser overuse. These sources suggested that guidance for appropriate dosages of agrochemicals were those directed by the manufacturers, which were usually expressed on the labels of the containers of these chemicals (Huang *et al*, 2003; ILO, 1991; Waichman *et al*, 2007). This is widely discussed within section 5.1.3 of this chapter, where the epistemology of what of what defines agrochemical overuse, both generally and in the context of this study for Guyana, is discussed in more detail.

The study of pesticide and fertiliser overuse practices is important for Guyana because of the impact of these practices on the environment and economic activities, more specifically water contamination (Ansari and Waleema, 2009; EC, 2006; NDS, 2001) and achieving export requirements (Lall, 2002; Persaud, 2009), respectively. While negative impacts on health from agrochemical overuse are widely recorded (Ahmed, 1994; IFPRI, 2002; Waichman et al, 2007; Wilson and Tisdell, 2001), in the case of Guyana, reports of these concerns are very limited and confined within the perspective of farmers' health from exposure (IICA/JIFSAN, 2004; Spiller, 2008). Very little has been said; and mostly in an informal manner concerning the health of the average consumer in relation to effects from agrochemical use. For this investigation, 11 farmers cited cases of feeling unwell during and after the use of pesticides but these incidences were not reported to the Ministry of Health. This coincides with Wilson and Tisdell's (2001) belief that the incidence of pesticide poisoning might be underestimated because of under-reporting and data deficiency. The paucity of this information in Guyana was corroborated by key informant 3 of this study, who noted that;

> '*Consumer advocacy for the sale of safe products is not strong…there is a lot of information about the connection of cancers and health issues with excessive use of agrochemicals but sensitisation and medical research is lacking, especially for use here in this country…'*.

While health concerns relating to overuse are obscure in Guyana, those relating to the environment and economic issues are more pronounced.

Literature points out Guyana's inherent environmental sensitivity and the implementation of main economic activities, including farming, within those very locations which are environmentally sensitive. The effects of pesticide and fertiliser use on water contamination are noted (EC, 2006; EPA/ICZM, N.D.; NDS, 2001). About 90% of Guyana's population inhabits the coast which is about 430 kilometres long and 1.4 metres below sea level, at high tide[37]. Approximately 75% of the main

[37] Full description in chapter 2, section 2.2.1

economic activities are conducted on this coast line which is very vulnerable to flooding and erosion. Agriculture is the major economic activity which is conducted along Guyana's coastline (EPA/ICZM, N.D.; NDS, 2001). The NDS highlights the country's vulnerability to environmental pressures, noting that ordinary economic activity poses environmental threat. This source identifies fertilizer use in intensive cultivation of main crops and use of chemical pesticides as two main agricultural practices which adversely affect the environment (NDS, 2001). The Guyana Country Environmental Profile relates 'intense agricultural practices and poor farming' to the presence of pesticides and chemicals in surface waters (EC, 2006, p34).

Concerns of the impact of pesticide and fertiliser overuse on economic activities lie primarily within the context of Guyana's adherence to export protocol for agricultural commodities, especially vegetables, where residual limits for agrochemicals are strictly monitored. Main importer countries of vegetable products have clearly outlined import regulations which govern accepted agrochemical limits (NGMC, N. D.a) Of particular concern is the possible rejection and dumping of export produce for which residual tests indicate over the minimum limit of agrochemicals, since this is indicative of economic losses in terms of monetary value and the subsequent loss of export markets. Lall (2002) records the concerns of an agricultural official, who stated: 'If [the produce] are found to have certain levels of pesticide they dump the entire thing...when you use pesticides indiscriminately that possibility exists.' This occurrence has not been publicised for Guyana, but 10 sources participating in this study (eight farmers and two key informants) indicated knowledge concerning the rejection of Guyana's agricultural commodities due to failure of compliance with stipulated residual agrochemical limits. Of these sources, Key informant 3 of this study indicated;

> '*There have been isolated cases where produce sent overseas was tested and dumped…residue testing was not done here (in Guyana) before they (the produce) were exported…'*

While in the preceding three paragraphs sources have mentioned instances of agrochemical abuse and specifically highlighted overuse of the chemicals, comprehensive studies which undertake holistic type investigation into the occurrences of these practices and motivations for such occurrences in Guyana is lacking. Even studies and reports which investigate the phenomenon and propose reasons for the occurrence, have done so in a limited capacity, and demonstrate lack of a definite theoretical framework and structured analysis (Bovell et al, 2002; Chandran, 2006; IICA/JIFSAN, 2004; Lall, 2002). My research proposed that identifying and understanding the motivations for farmers' agrochemical overuse practices are the key guidelines for development of practical solutions which can successfully address and alleviate these practices. This study thus employed a more holistic approach, in investigating overuse practices. Investigation was conducted through the use of a distinct methodology which was guided by an appropriate theoretical framework.

The methodology of this study was original in various ways. A new dimension to the study of farmers' practices was introduced where limitations previously existed. The research was informed and investigated through a critical realist approach which permitted the study of overuse practices to be conducted within a new dimension; as physical aspects, as well as socially constructed phenomena. Further, increased awareness of the sociology of farming was implemented where practices in the context of this study were conceptualised as meanings and not just acts of farming. Appropriate methods were utilised to answer the research objectives. The use of these methods facilitated the provision of both factual information and deeper implications to the research question.

5.1.2 Answering the Research Objectives

My research aimed to identify and explain the paradox of sustained agrochemical overuse in arable farmers of Guyana by identifying and elaborating the reasons which influenced farmers' overuse behaviour.

Each objective answered a particular dimension of the research question by addressing research and information gaps. Sources mentioned the existence of overuse practices in Guyana but research which identified the extent and intensity of these practices was lacking (Bovell et al, 2002; Chandran, 2006; IICA/JIFSAN; 2004; Lall, 2002). This knowledge gap was addressed by the first 2 objectives. Additionally, investigations suggested factors which may be associated with overuse, but in-depth analysis to establish these suggested associations were not conducted (Bovell et al, 2002; Chandran, 2006;). The third objective of my study addressed this gap. Factors which could possibly influence farmers' overuse practices, both in the Guyana context[38] and in a global context[39] were tested for their significance to farmers' overuse. Logistic regression analysis was conducted on variables of farmers' age, experience, education level, land tenure status, area cultivated and source-type of information for assessment of their significance to farmers' overuse practices.

However, while factors which were statistically significant to pesticide overuse[40] and fertiliser overuse[41] were identified, the role of these factors in influencing overuse was not explained. Investigating the reasons for farmers' overuse necessitated in-depth qualitative-type investigation which was capable of yielding explanatory type data to produce more illuminating results (Punch, 2004). This was achieved by utilising a grounded theory approach to answer objectives 4 and 5. Qualitative analysis of farmers' and key informants' interviews identified reasons for farmers' overuse behaviour and enabled the differentiation of these reasons into categories of contingent, support, and contextual factors. Relationships among the various categories were also identified.

Answering objectives 4 and 5 revealed that understanding the reasons for farmers' overuse and their perceptions of these practices was critical, for in-depth analysis of farmers' motivations; discussed in chapters 7 and 8, and also important in defining practical interventions which matched the reality of the existing problem and which are discussed in the recommendations of chapter 9.

5.1.3 Methodological Theory

The methodology of research depends on the social context in which that research takes place (May, 2001). In social research, methodology is defined as a proposed set of techniques combined with the underlying assumptions about the world (the ontology) and the assumptions about how to establish true statements about the world (the epistemology) (Olsen, 2007a). The methodology of a study presents the rules

[38] (IICA/JIFSAN, 2004; Chandran, 2006; Lall, 2002, Spiller and Aleguas, 2007, Bovell et al, 2002; Canterbury, 2007; Munslow, 1998: 44-50; Mathur, 2002)
[39] (Griffin, 1979: 175-246; Isham, 2000; Feder and Umali, 1993; Baber and Jeffrey, 1986: 124-125, 147; Chi and Yamada, 2002; Nganje et al, 2001; Spence 1999, cited by Potter et al, 2004: 125)
[40] (tenure, area cultivated, age and source-type of information)
[41] (farmers' education level and the source-type of information)

which guide the process of data collection and analysis (Billig, 2004). The focus or nature of research determines whether the methodology chosen will employ a single method or combination of methods.

This research utilised triangulation as a mixed methods approach for the study of farmers' pesticide and fertiliser overuse practices in Guyana. Triangulation is defined as the use of more than one method or source of data or strategy for the study of social phenomena (Bryman, 2004). While Denzin (2003) partially agrees with this definition he notes that defining triangulation as the use of multiple methods is a conventional assumption and explains that triangulation may involve the use of varieties of data, investigators and theories and methodologies. He explicates that methodological triangulation involves the use of 'within-method' triangulation (where one method and several strategies are utilised) and 'between-method' triangulation (where different methods are used to measure similar units).

'Between-method' triangulation is utilised in this investigation, where a number of methods (surveys, interviews and observations) are used and the strengths of one method compensate for the flaws of other methods, thereby achieving the best result of the combined methods. Combined methods require assessment of their relative weaknesses and strengths and combination in a manner to reduce threats to validity and achieve theoretical relevance (Denzin, 1970). Jick (1979, p603 and 604) reports the use of triangulation 'to examine the same phenomenon from multiple perspectives' and 'enrich our understanding by allowing for new or deeper dimensions to emerge'. He notes that 'effectiveness of triangulation rests on the premise that the weaknesses in each single method will be compensated by the counter-balancing strengths of another'. In this study triangulation was utilised for deeper understanding of the motivations of farmers' overuse practices, through the use of various methods which complemented each other. The use of combined methods produced data which facilitated analysis in a manner to accomplish theory generation, thus supporting the epistemological assumptions of the study.

The epistemology of what defines agrochemical overuse in this study was guided by literature which examined guidelines for the use of agrochemicals within various contexts. Several authors indicated that guidance for dosage rates of agrochemicals were based on stipulations of the manufacturers' guidelines or other competent authority. Guidelines were commonly presented on agrochemical product labels (FFTC, 2009; Huang *et al*, 2003; ILO, 1991; Waichman *et al*, 2007). Technical personnel[42], who were key informants of my investigation, endorsed the views of these authors, indicating that the authority for determining dosages and the overuse of agrochemicals was the guidelines of the relevant manufacturers.

While some farmers in Guyana utilised conventional practices in applications of fertilisers, such as the use animal manures in conjunction with chemical fertilisers, the issue of determining overuse was resolved by defining overuse within the context of the use of chemicals fertilisers. The manufacturer's guidelines were dictated as the authority for the use of these chemicals. This resolution was based on information from both literature and technical personnel which indicated that soil and manure analyses were necessary for determination of recommended dosages of manure, based on the chemical composition of the manure (Barry, *et al*, 2000; Mitchell and Donald, 1999; UOA, 1998; Whiting et al, 2010; Zhang, N.D)**.** Some soil analysis is conducted in Guyana by the National Agriculture Research Institute (NARI), but analysis of manure is not usually done. The context within which farmers' agrochemical overuse was interpreted, defined the epistemology of agrochemical overuse in this study. Defining the epistemology of agrochemical overuse was critical for identifying the manner in which this study was conducted, especially from a theoretical perspective.

Epistemological views concerning the investigation of farmers practices; specifically the use and misuse of agrochemicals, vary and represent differing standpoints of reality; both physical and social. Some investigations place emphasis on the study of agrochemical use in a positivist or objectivist manner according to the manner of natural science (Bryman, 2004). In this approach focus is on measuring and assessing the physical elements of agrochemicals, such as their presence and quantities in soil (Dai *et al*, 1998; Seth *et al*, 1998), water (Ansari and Waleema, 2009; Seth *et al*, 1998; Tabucanon and Boonyatumanond, 1998**)** and crop produce, including vegetables (Baloch and Haseeb, 1998; Dai *et al*, 1998; Seth *et al*, 1998). This type of research is useful for defining the presence and amount of agrochemicals within a particular location, as in the case of determining residual limits, but is limited in the assessment

[42] Key informants from the MOA and IICA

of processes (current practices) and the motivations for these practices. These studies support a more positivist approach which favours quantitative type research. Denzin and Lincoln (2003) note that this quantitative-type study emphasises measurement but is limited in the study of processes.

Conversely, some investigations have acknowledged the physical aspects of these practices but also adopted a more constructivist view, incorporating within their study, the perspectives of stakeholders with regard to the practices they adopt (Bovell *et al*, 2002; Iosifides and Politidis, 2005; Lichtenberg and Zimmerman, 1999; Mireri *et al*, 2007; Robinson *et al*, 2007; Waichman *et al*, 2007). These studies demonstrate a changing open system between positivism and constructivism by conceptualising the attitudes of agents (Lemon, 1973). My investigation represents this second approach where the epistemology is suggestive of bridging the gap between positivism and constructivism. My study is conducted from a critical realist standpoint, where the practices of overuse are viewed as having natural existence where their physical nature is acknowledged but importance is also attached to the social construction of these practices as revealed by the agents' (farmers') perspectives.

The philosophy of critical realism introduced by Roy Bhaskar proposes that 'the real is whatever exists, be it natural or social…' and '…the real is in the realm of objectives, their structures and powers' (Sayer, 2000, p11). This implies that investigation of the real includes the study of objects, their structures and related causality, or in this study, reasons. Critical realism differentiates between real and actual where real denotes 'structures and powers' of objects while actual indicates the outcomes when powers are activated. Applying this philosophy to my study, 'structure' denotes not merely the manner or way that the farmers in this investigation chose to apply agrochemicals (i.e. they conduct overuse practices), but utilising a critical realist perspective, 'structure' represents that which directly influences this manner of agrochemical application, comprising the reasons (in this study), which influence farmers' overuse practices.

From a critical realist's perspective, the ontology of this study proposes that farmers' practices of overuse are contained within their general farming environment; constituting a pre-existing system and are therefore all real, but are also socially constructed by the actions of agents (farmers) and therefore cannot be judged or studied independently of these social agents. In this sense, constructivism regards practices of pesticide and fertiliser overuse as both real but also socially constructed; built upon the perceptions and actions of social actors (Bryman, 2004). This study also demonstrates an overlap between objectivism and constructivism, as the views of agents are constructed, hence having some subjectivity, but also considered objective according to the position of these agents. Position in this sense denotes a standpoint and not necessarily a physical location (Sen, 1992).

Critical realism associates 'situated knowledge' with decisions concerning what constitutes knowledge. Realism examines these various standpoints to avoid misrepresentation of objects under study (Sayer, 2000, p51). Sen (1992, p133) presents a view of standpoints as various positional observations and views, and argues that 'positional observations are not simply subjective', but have 'some claim to being objective within their own terms'. Further, he notes that:

'...it can be argued that anyone's actual observations and actual beliefs can be explained entirely by an adequate specification of the positional parameters that influence his or her observation and understanding' (p136).

Sen therefore suggests from his arguments, that there is an overlap between objectivity and subjectivity. Sayer (2000) proposes that the influences of standpoints should be considered since they affect the thoughts and observations of agents.

My study included both descriptive and constructive dimensions of social phenomenon (overuse practices), noting in agreement with critical realism that social phenomena are not merely outwardly descriptive but also interpretive. Understanding the meaning of farmers' practices therefore goes beyond the descriptive stage to one of interpretation. This underscores the need for first obtaining participants' perceptions or understandings and second, combining both the researcher's and participants' perceptions, while simultaneously recognising that meanings are not reducible to those of either party. Realism therefore does not assume that all causes are merely physical, but are rather both physically and conceptually established (Sayer, 2000). This socially constructed nature of reality is emphasised by qualitative research (Denzin, 2003).

Creswell (2007) notes the role of constructivism within a grounded theory school of approach in qualitative study, where the development of a theory explains processes, actions and interactions. Strauss and Corbin (1990, p23-24) define a grounded theory approach as ‘a qualitative research method that utilises a systematic set of procedures to develop an inductively derived grounded theory about a phenomenon’ and a grounded theory as ‘one that is inductively derived from the study of the phenomenon it represents’. Gibbs (2002) and Denzin and Lincoln (2003) mention debates concerning the acceptance and adoption of a constructivist or realist approach in the application of grounded theory. In adopting elements of a grounded theory approach, this study utilises both realist and constructivist characteristics; the former to a lesser extent in recognising what physically constitutes overuse practices and the latter for explanation and understanding agents’ (farmers’) perspectives (Denzin, 2003) and how these socially construct and motivate the conduct of these practices.

While my research investigated reasons for overuse, it adopted a critical realist approach for understanding reasons, where the effects or outcomes of a process (overuse in this case) were not based on, or proved by repetition of events but rather, on what was necessary for the outcome. In this context, indentifying the factors which motivate, or were necessary for the outcome (farmers’ overuse), and understanding how these factors function, provided reasons for farmers’ practices. More precisely, my study assumed an open system where different factors interacted in various contexts to produce effects or events (overuse) (Sayer, 2000).

Effects (overuse) in this study were not entirely the result of a defined ‘factor-factor’ action, but were also influenced by other prevailing conditions or contexts. Different ‘factor-factor’ interactions produced the same result, within different contexts or situations. These interactions are introduced in chapter 1, section 1.3, subsequently exemplified, through findings in chapter 7, section 7.6 and presented in matrix format in appendix 3. Thus, there were no regular associations to produce effects. The manner in which my investigation interpreted reasons for farmers’ overuse in thus study, from a critical realist perspective is initially explained by Sayer’s, (2000, p15) model presented in chapter 1, and later elaborated by an original model of causality generated for explaining farmers’ reasons for overuse in this study. This new model is presented and explained in chapter 7, section 7.1. Utilising a critical realist perspective of causality for determining the reasons for farmers' overuse behaviour influenced the design of this study, in particular, the collection of appropriate data.

5.2 RESEARCH DESIGN

The purposeful collection of data which constitutes evidence is important to research. A research design is a plan or framework which guides the collecting and analyzing of data evidence in such a manner that makes it possible for the research questions to be answered (Bryman, 2004; Ragin, 1994). The research design should have capacity to create conditions which enable a contribution to theory (Gerson and Horowitz, 2002). Different research techniques or methods are associated with different research designs.

Choice of research design depends on the dimensions and priority of the research, examples being, establishing causal relationships, generalising with respect to a larger population, understanding behaviour and its meaning within specific contexts and understanding interconnections of social phenomena within specific time (Bryman, 2004). The research design of this study comprised a mixture of both quantitative and qualitative aspects, formulated for the purposes of generalising with respect to a larger population, in a limited manner, but more designed to establish motivational relationships and understanding agents' behaviour in specific contexts. The design for collecting and analyzing data for this research is introduced in this section and dealt with in greater detail under sections 3.3 and 3.4; Data Collection and Data Analysis, respectively.

Generally, a research design provides information on the strategy to be utilised (qualitative or quantitative), type of framework, sampling techniques and data collection procedures (Punch, 2004). Several research designs have been identified and include experimental, cross-sectional, longitudinal, case study and comparative designs. This quantitative aspect of this research utilised a cross-sectional design, which involved data collection on several variables of interest, from a number of farming households (cases); each case supplying data in a single encounter (Bryman, 2004). A variable can be defined as a general feature or aspect which differs among cases in a specific set (Ragin, 1994). Variables utilised in this study for quantitative investigation were farmers' age, experience, credit status, education level, area cultivated, land tenure status and source-type of information. These variables differed among cases (farming households) within a set of arable farmers. Farming households constituted cases and data was supplied through methods of surveys, semi-structured interviews, and observation, where possible; representing triangulation of methods (Denzin and Lincoln, 2003).

Surveys in this investigation utilised questionnaires to supply quantitative data for the selected variables, in what constituted a 'first phase' of the research. This stage answered the first three research objectives for establishing the prevalence and intensity of pesticide and fertiliser overuse and establishing significance between overuse and identified factors. The cross-sectional design used in this study is associated with quantitative research, but also employed in qualitative research through the use of semi-structured and unstructured interviews. However, a limitation of this design in quantitative study is its ambiguity in establishing causal influence (Bryman, 2004).

This limitation was noted in this study, where the significant relationships established between some variables and farmers' overuse[43], were limited with respect to establishing the roles of those variables in influencing farmers' overuse behaviour. For instance, the source-type of information was statistically significant to both pesticide and fertiliser overuse, but the role of the source-type of information in motivating overuse could not be explained by merely identifying this significant relationship. The capacity of survey information was therefore limited to providing empirical type information such as the identification of statistically significant relationships between dependent and independent variables (May, 2001).

May (2001) indicates that the aim of social research is not simply to collect observations but to examine these within a theoretical framework for underlying mechanisms. The author points out that:

[43] For pesticide overuse, significant factors were tenure, area cultivated, age and source-type of information; while education level and source-type of information were significant to fertiliser overuse

> *'examining and explaining underlying mechanisms cannot use the methods of empiricism as these simply reflect the everyday world, not the conditions which make it possible' (p12-13).*

It is due to the limitation of explaining reasons for overuse in the 'first phase' of design that the 'second phase' of this investigation utilised the strengths a qualitative strategy through the use of semi-structured interviews, to obtain farmers' discourses which comprised explanatory or descriptive data concerning their overuse practices (Kvale, 1996). These discourses were analysed to determine their role in influencing overuse, through utilising the elements of a grounded theory approach.

Various studies have produced data and postulations for farmers' adoption or non-adoption of various farming practices (Drost *et al*, 1996; Iosifides and Politidis, 2005; Lichtenberg and Zimmerman, 1999; Mireri *et al*, 2007; Robinson *et al*, 2007) and more specifically for farmers practice of pesticide misuse, including overuse in Guyana (Bovell *et al*, 2002; Chandran, 2006; Lall, 2002). While this investigation acknowledges these hypotheses, the research adopted a more holistic approach in seeking to identify and explain the reasons for these overuse practices. This investigation did not assume the reasons for overuse which were postulated by other studies. In this way, this study did not reject deduction but favoured induction where the main focus was theory generation, from the data gathered. The use of surveys, interviews, observations and other methods utilised in the study, favoured an inductive approach.

Photographs were taken where possible to supplement data which was generated by the other techniques (see appendix 5) (Plummer, 2004). Various methods were combined in this study for their capacity to complement each other in elucidating the dynamics surrounding overuse practices; demonstrating the use of triangulation for deeper understanding; as exemplified in other studies (Hulme 2007; Lawson *et al*, 2007; Olsen, 2007). The applicability of the various methods in this research is exemplified both in the following diagram and subsequent chapter sections on data collection and analysis.

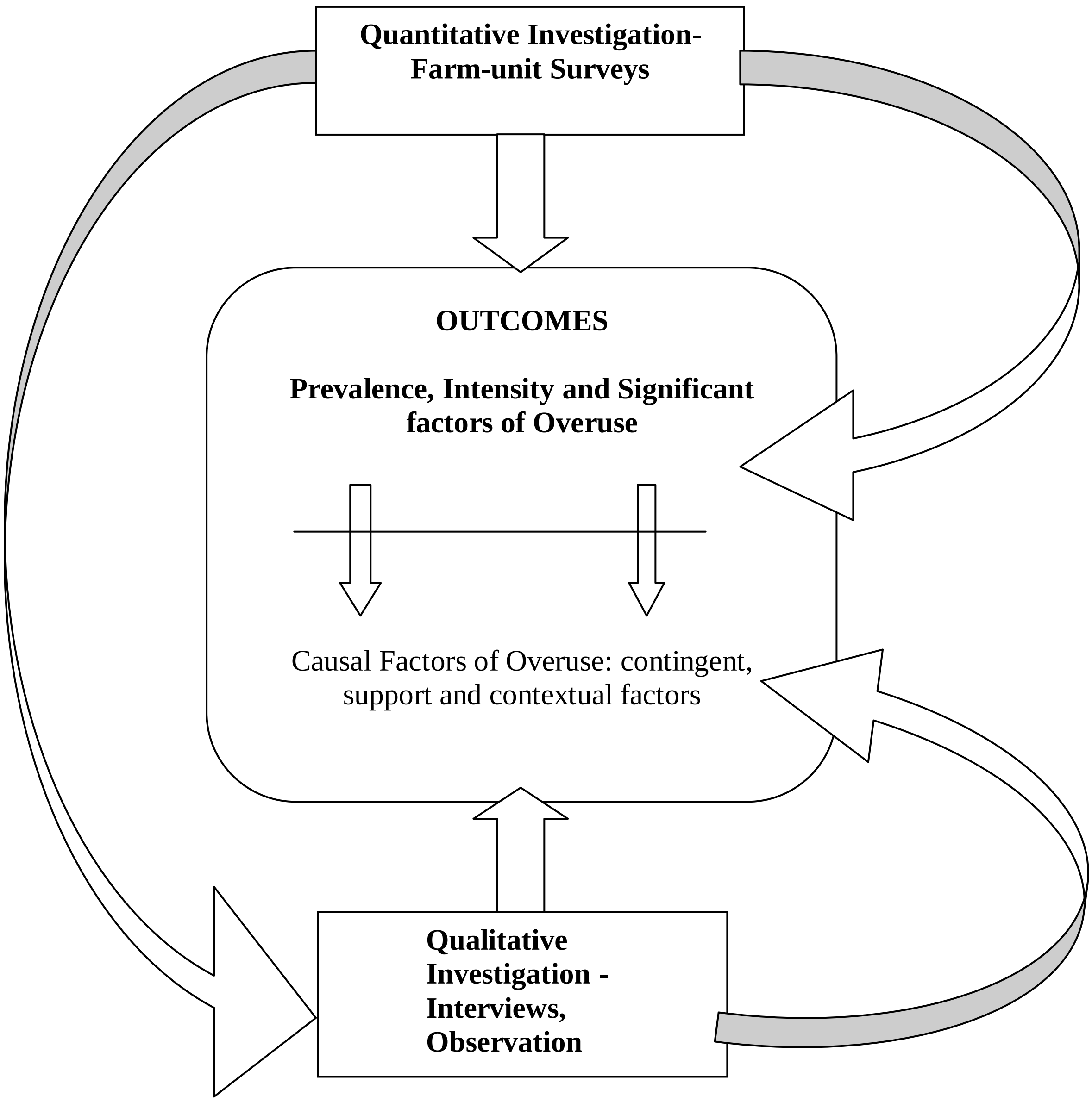


Figure 5.1: Model demonstrating the research design of this study

5.3 DATA COLLECTION

The sampling strategy employed, the research instruments utilised and the process of data collection was guided by the type of data to be collected. In turn, the type of data gathered was determined based on the suitability of this data for the type of analysis required to yield the desired information which answered the research question and objectives.

5.3.1 Data Collection Process: Preliminary Procedures

Preliminary activities for data collection were conducted, within what was considered as an ‘introductory qualitative phase’, constituting discussion with field staff, visits to study areas and conducting pilot surveys and interviews. These preliminary activities were useful for establishing relationships with respondents and gaining knowledge of their surroundings and culture. This phase was also important for assessing and improving the suitability of the data collection instruments; survey questionnaires and interviews (see appendix 1) (Gerson and Horowitz, 2002; Kvale, 1996; May, 2001). Three preliminary meetings were conducted with relevant agricultural staff and other prospective key informants (field officers, technical managers and training officials) while six preliminary visits; three to each study region were conducted in the company of agriculture extension staff in two instances. The accompaniment of extension agents was intended to facilitate good relationship between the researcher and respondents since ideally these agents were supposed to be well known to farmers, but ironically this proved otherwise as is later discussed in chapter 7, section 7.3, under the sub-theme of abandonment. Six pilot survey questionnaires and four pilot interviews were conducted in each study region.

Preliminary activities indicated the necessary amendments required and crucial areas to note, especially in relation to the question structure, the type of approach best suited and even cultural norms which influenced the process of data collection. For instance, the presence of an interview schedule and recorder resulted in a guarded attitude of answering in farmers and even key informants. The interview schedule was amended as the interview exercise progressed.

An average of four to five questionnaires was completed per field day, due to travel between remote farming locations and the need to give assistance to farmers who were partially literate or illiterate. For the qualitative phase, an average of one to two interviews was conducted per field day, again, taking into account travelling between remote farming locations and in this case, the need for thorough questioning and recording. While recording of interviews based on the consent of respondents was planned, in most cases, the attitudes of the interviewees’ were also noted. Notes were also taken through the use of a field diary, mainly to record non-taped interviews, body language and observations which were not captured in the other methods. Observations were also recorded through the use of photographs (Keats, 2000; Kvale, 1996; Mason, 2000), to support authenticity of the study.

Key informants, comprising appropriate 'front line' agricultural workers who are involved in policy decisions, such as agriculture officers, technical managers and programme officers and the various agents and dealers of agrochemicals were contacted and briefed beforehand concerning my study and the importance of their contribution in this investigation. The participation of this group was important for corroborating, contradicting and adding to the views of the farming community; but more importantly, for their ability to identify and explain the contextual situations of farmers' overuse practices. This capability was discovered during the pilot sessions.

5.3.2 Sampling and Data Collection Strategy

i. Sampling

In this investigation, quantitative data, comprising survey information, was required for establishing the intensity, prevalence and significant factors of overuse while qualitative data, comprising interviewees' discourses was important for establishing and analysing reasons for farmers' overuse practices.

Guyana's population is less than 800,000 (see chapter 2, section 2.2). The average farmer population is 3,000. This includes farmers of both traditional and non-traditional crops. Of this number, approximately 1,000 farmers consistently cultivate non-traditional crops across the 2 study regions. Of these, some 600 farmers are those which cultivate vegetables, including the study crops. Census for this study revealed that of these 600 vegetable farmers, 267 farmers consistently cultivated the study crops.

For survey purposes, random sampling of actively registered farmers of the study crops was conducted across the two main vegetable producing regions (3 and 4), of Guyana. The sampling frame utilised for the research comprised a farmers' register, accessed from the Ministry of Agriculture, but which had to be updated through census conducted within the study regions. Cases were randomly sampled to permit representativeness and generalisation concerning practices conducted by the target population (arable farmers) (May, 2001). From a population of 267 farmer units, 229 were randomly selected. The original intention was to sample 200 units and thus 230 units were sampled to cater for any spoilt questionnaires. However, the strategy of 'face-to-face' surveys reduced this risk. Hence, from a total of 230, only 1 questionnaire was spoilt. It was decided that 229 completed questionnaires would be all utilised.

In relation to interviews, both random and purposive sampling was conducted. Thirty eight farming units were randomly selected from survey units where pesticide and fertiliser overuse was conducted, across the two study regions. Apart from 38 farmer interviews, those of 19 key informants were also conducted and comprised strategically selected informants from government and private institutions, including agrochemical dealers and agents (see appendix 1). Hence, interviewees were largely selected according to their suitability in enlightening the issues under study (Gerson and Horowitz, 2002). The characteristics of the study population for both surveys and interviews are described in the following chapter 6, section 6.4 and appendix 3, respectively.

ii. Data Collection Strategy

In this research surveys were conducted via a 'face-to-face' approach conducted with farmer representatives of randomly selected farming units. This approach permitted the contexts of the interviews as well as non-verbal communications of the respondents to be noted (Keats, 2000; May, 2001). This 'face-to-face' strategy was also useful for building initial rapport with farmers, ensuring maximum response and clarifying any doubts of the respondents during the questioning process.

Survey data comprised information on dependent and independent variables. In the case of dependent variables, data comprised information on factors of 'overuse' and 'no overuse' for both pesticide and fertiliser, while for independent variables, data collection focussed on various factors which, according to relevant literature[44], were possibly significant to farmers' practice of overuse. Independent variables comprised factors of farmers' age, experience, credit status, education level, area cultivated, land

[44] Discussed in Chapter 4, sections 4.5 and 4.6

tenure status and the ‘source-type’ of information. Data for selected independent variables of farmers’ age, experience, and area cultivated were recorded in both continuous and categorical formats while those factors of credit status, education level, land tenure status, source-type of information and dependent variables of pesticide and fertiliser use were recorded in categorical format. Data coding was utilised to facilitate analysis and reporting. Levels of measurement were identified for each variable (Bryman, 2004; May, 2001).

While survey questions were centred on relevant variables of farmers’ demographics[45], farm unit factors[46] and variables concerning pesticide and fertiliser use[47], additional questions relating to other farming variables such as rotation, marketing and general constraints were asked for two main reasons. In the first instance these variables were investigated to provide information which can enhance the description of the farmers’ profile in relation to the use of agrochemicals. Some of these variables were not utilised in statistical tests (regression) because of their propensity to distort results. This is explained in greater detail in the following chapter 6, section 6.3. For instance 98% of farmer population indicated that they sold to the domestic market. It was later revealed that some of these farmers engaged in export which was not regularised, but conducted as a spontaneous activity among farmers, and determined by whoever was able to supply a quota demand at a particular time[48]. In the second instance questioning on these additional variables gave the farmer a sense of ownership in the exercise, instead of a feeling of exploitation. Some farmers had expressed feelings of exploitation during the pilot studies, noting that in some survey exercises, information was elicited from them, where questioning did not permit them to express concerns on other issues which affected them.

Detecting this concern of farmers and considering the exploratory nature of some of the research, qualitative investigation which comprised semi-structured interviews of farmers was conducted in two main sessions per farmer, instead of the originally planned, one session. An initial interview session was conducted which permitted farmers to converse on their general farming and agrochemical practices. These

[45] For example age and gender
[46] For example area cultivated, tenure status, etc
[47] For example types, amounts and number of applications (within 1 week) for pesticide and fertilisers
[48] These quotas often supplemented larger demand amounts, which exporters were unable to satisfy

discourses were critical for identification of contingent and support factors, which influenced farmers' overuse practices. Follow-up interviews were conducted, where questioning was more directly related to overuse with focus on the contingent and support factors which were identified in the former interview sessions. The introductory sessions of farmers' interviews proved to be pertinent in eliciting a general description of interviewees' farming practices and also significant for indentifying, original causal factors of farmers' overuse, which were unknown prior to this investigation.

The choice of semi-structured interviews in this investigation was based on the type of information required (Gerson and Horowitz, 2002). The semi-structured approach was adopted, primarily utilising open-ended questions which permitted respondents to reply freely. This approach elicited information in discourse format, which was explanatory and also facilitated probing where necessary (Bryman, 2004; Gerson and Horowitz, 2002; Keats, 2000; Kvale, 1996, May, 2001). The conduct of interviews was supported through the use of an interview schedule to guide the interviewing process and maintain focus during the exercise (Kvale, 1996). However, while sequencing of question topics within the schedule was initially designed for smooth flow during the interviewing exercise, this sequence was amended to facilitate farmers' discourses. The respondent's own words were often used for initiating the next question and maintaining good rapport, especially within the first phase of farmers' interviews (Bryman, 2004; Keats, 2000; May, 2001; Moser and Graham, 2004).

Interviews with key informants were important for corroboration of contingent and support factors identified by farmers and also for identifying contextual situations which were tangential to farmers' overuse practices. Examination of information supplied by key informants in the pilot sessions, revealed their knowledge of and involvement in, the contextual situations which were identified. Initially, key informants were asked to identify the wider contextual situations which they believed were relevant and tangential to farmers' overuse. However, because interviews revealed that the key informants were mainly responsible for implementing and managing those contextual situations identified, it was posited by the researcher that these informants would hardly or reluctantly identify the shortcomings of these situations.

Hence the initial strategy of direct questioning concerning the influence of these contextual situations to farmers' overuse was modified, where key informants were asked to describe the services they offered to farmers (for example marketing and extension services), as these services were essentially the wider contextual situations. With the situations identified, probing for information on the manner in which these services (situations) affected overuse was then conducted. In order to avoid bias, the contingent and support factors which were identified by farmers' interviews were presented to key informants for their opinions, at the conclusion of their questioning. Key informants' discourses concerning contingent and support factors offered corroboration to farmers' views and also added validity to this study, which is later discussed in section 5.4.3 of this chapter on reliability and validity.

While in many instances the themes expressed by the farmers were not conveyed in similar words by the key informants, there was high corroboration of themes, between the two categories of respondents. For example, farmers expressed themes of abandonment by the relevant extension services. While key informants did not utilise a similar expression, they admitted their inability to render appropriate extension services to famers due to staff shortages and other situations. My observations in the role of researcher were also important for corroboration of respondents' (both farmers' and key informants) views. However, in addition to substantiating the various views, I also noted the significance of research ethics in relation to some of the answers supplied by the respondents. There was need for respondents' assurance of confidentiality as anticipated, but issues of confidentiality also occurred in unexpected circumstances.

5.3.3 Research Ethics

Appropriate ethical guidelines accompanied the methods utilised for this investigation. Guidance was derived from various documents including the following: (1) the 'University of Manchester Committee On The Ethics of Research on Human Beings, Policy Statement', (2) the ethical declaration form of the School of Environment and

Development (SED): ‘*Ethical Practice in conducting Research and Consent*, for the researcher’, (3) the Faculty of Humanities ‘Consent Form for Participants Taking Part in Student Research Projects’ and (4) the SED Risk Assessment (see appendix 1).
In various instances, answers to the research questions constituted sensitive information, for example, some queries which were based on pesticide and fertiliser use and occupancy status. Various agencies within Guyana are endowed with the mandate for exercising law on various areas of query encompassed by this study. The following discussion indicates some specific areas where questioning revealed sensitive information and explains how these were managed.

The PTCB in Guyana, falls under the purview of the MOA and has the mandate for ‘making arrangements and providing facilities for controlling the manufacturing, importing, transporting, storing, selling, using and advertising of pesticides and toxic chemicals’ (PTCB, N.D.). Regulations under The Pesticides and Toxic Chemicals Control Act, 2000, specify rules for pesticide use. In some instances farmers were utilising prohibited pesticides, sourced from dealers, which constituted an unlawful act for both parties. In some cases these sources were hesitant to reveal this information.

The Lands and Survey Commission of Guyana has the mandate to ‘to survey and map the land and water resources of Guyana, to be custodians of all public lands and administer these effectively in the national interest, and to provide land-based information to a broad range of public and private sector entities and interests’ (LSC, N.D.). The mandate of this agency includes specific duties to ‘survey, sub-divide and demarcate publicly-owned to facilitate issue of title to farmers, entrepreneurs and other developers’. In some instances ‘rental’ of farmers’ lands was not conducted in a transparent and lawful manner. Informal renting procedures were prevalent. Farmers who conducted this practice were reluctant to divulge information.

In addition to the above regulatory mechanisms, was the issue of farmers’ tax evasion discussed in chapter 1, where many farmers evaded the payment of tax on income. Despite assurances of confidentiality, farmers generally opted not to disclose their incomes, in view of the penalties for tax evasion, which include fining and prosecution[49]. It was significant that over 60% of farmers queried whether my investigation was concerned with tax.

In the instance of key informants, another dimension of ethical concern was noted, especially in the case of government employees who seemed reluctant to divulge some types of information. Understandably so, one of the main instances concerned the rejection of Guyana's vegetable exports some by importing countries, because of higher than the stipulated residue levels of agrochemicals. Another instance was the reluctance of field officers, and in some instances their supervisors (manager level staff), to admit deficiency in the visits by the designated extension agents to their assigned areas.

In light of the above discussion, prior to the survey and interviews, farmers and key informants were assured of anonymity and confidentially of the information they divulged (Keats, 2000). Interviews were recorded by audio tape recorders (with due consent) and notes were taken through the use of a field diary. Observations were recorded through photographs, depending on consent. Additionally, participants were informed of their right to withdraw from the process upon request. However, signing of a consent form was inappropriate in some instances where inadequate literacy was noted among farmers. For some farmers, providing a signature seemed indicative of committing themselves to undesirable situations or binding commitments. Thus, wherever farmers consented, signatures were obtained, but generally a signed statement from the researcher, assuring farmers of anonymity, confidentiality and withdrawal rights, was read to farmers.

Notwithstanding, the assurance of confidentiality, I observed that while interviewees gave consent for recording, interviews where information was more readily supplied by informants, were those where recording was not conducted. Further, after the recording of interview, an informal conversation following this interview revealed much relevant information which was withheld during the recorded session. Thus, while the main structure for interviewing was maintained, constant revision and implementation of the interview strategy was conducted during the process.

[49]http://www.guyanachronicleonline.com/site/index.php?option=com_content&view=article&id=18598:gra-successful-in-detecting-tax-evasion-avoidance

5.4 DATA ANALYSIS

5.4.1 Data Analysis Strategy

Data generated during this investigation was utilised for two main types of analysis; quantitative and qualitative. Quantitative analysis, considered as the ‘primary’ analysis of this research was conducted via SPSS analysis. This ‘first phase’ of data analysis, was descriptive, constituting percentages and frequencies within categories of dependent variables to assess the prevalence and intensity of overuse practices. Additionally, logistic regression was conducted to establish relationships between independent variables and dependent variables which represented overuse practices (pesticide and fertiliser overuse). This analysis identified factors which were significant to overuse and established statements or hypotheses concerning associations between independent and dependent variables (May, 2001).

While this type of analysis produced hypotheses; for example, farmers’ age and source-type of information being significant to farmers’ overuse of pesticide, it was inadequate to determine the role of these factors in influencing overuse and also not enough to identify reasons for overuse. Qualitative analysis was performed to determine reasons for overuse (contingent, support and contextual factors), based on the discourses of farmers and key informants and supported by a grounded theory approach. This was considered the ‘secondary’ analysis of this research and constituted content analysis as conducted within ‘empirical social sciences’ (Bauer, 2000, p13). A grounded theory approach, aided by computer software (NVivo) analysis, was utilised for qualitative analysis of respondents’ discourses (Seale, 2004). Various authors give detailed accounts of this analytic approach (Creswell 2007; Gill, 2000; Strauss and Corbin, 1990).

Gill (2000, p188) records an initial ‘careful, close reading that moves between text and context to examine the content, organization and functions of discourse’, implying both descriptive and interpretive dimensions of the process. Fairclough and Wodak (2004, p357) report that ‘discourse is socially constitutive as well as socially shaped: it constitutes situations, objectives of knowledge, and the social identities of and the relationships between people and groups of people’. In this investigation, interviewees' discourses concerning their agrochemical practices were examined for both descriptive as well as socially shaped elements. For example, farmers' need for assurance of a desired income which influenced their overuse practices was not defined as 'greed' or 'unscrupulous' behaviour as noted by some key informants, but rather as 'desperation' since this motivation occurred within a context of unregulated markets, implying uncertain income.

Potter and Wetherell (2004) mention the need for focus on the constructions of participants' language. This investigation examined the constructions of respondents' discourses for the identification and analysis of reasons for farmers' overuse behaviour. For example, farmers' explanation of applying dosages based on their 'experience' was constructed to simply mean experience. Rather, 'experience' was interpreted as farmers' motivations of self confidence developed within a context of deficient information services. Farmers' discourses in this study therefore constituted raw data which was qualitatively analysed through a grounded theory approach to determine reasons based on interpretations and not mere descriptions.

A grounded theory approach was utilised for analysis of interviewees' discourses, with focus on the generation of theories from data which was derived from these sources (Creswell 2007, Strauss and Corbin, 1990). Analysis of these discourses was aided by NVivo; an example of Computer-Assisted Qualitative Data Analysis Software (CAQDAS), which is specifically designed to support qualitative analysis (Gibbs, 2002). Advantages of utilising this software include easier interpretation of data via analysis which is more accurate, reliable, transparent and not difficult. NVivo was especially utilised for its suitability in exploratory analysis and applicability to a grounded theory approach (Gibbs, 2002).

A grounded theory approach was appropriate for identifying the main themes which explain the reasons for overuse practices in Guyana and establishing interconnections among categories of reasons[50]. NVivo analysis was conducted mainly through the steps recorded by Creswell's (2007) report of Strauss and Corbin's (1990 and 1998) approaches and accounts of Gibbs (2002), Gibbs (2007) and Strauss and Corbin,

[50] Contingent, support and contextual factors

(1990). Thorough reading of interview transcriptions was initially conducted for familiarisation with the content (Gerson and Horowitz, 2002; Gibbs, 2002) and preliminary examination of interviews were conducted to identify themes contained in the data. The interviews were then imported into NVivo to facilitate analysis (Bazeley, 2007). Similar themes expressed in different sections of the text, were connected through coding in NVivo analysis for the purpose of generating theory (Strauss and Corbin, 1990).

In the first stage of NVivo analysis, themes or categories were identified and recorded (Strauss and Corbin, 1990). Coding was conducted to link areas of the text which are related to each other, not merely by having similar words or expressions, but articulating similar ideas or having the same 'word sense' (Weber, 2004, p121). These themes constituted free nodes. Coding was conducted via a data-driven approach, where preconceived ideas were put aside for focus on what was actually reported within the data (Charmaz 1983, p111, cited by Kelle, 2004, p315; Gibbs, 2002). This type of coding was more descriptive than analytic; to identify, link and aid in retrieving related texts (Bazeley, 2007; Gibbs, 2007). Gill (2000, p179) highlights the need for initial coding of discourses to be as inclusive as possible; identifying 'borderline instances'. Strauss and Cobin (1990) note the identification of dimensions and properties of nodes. In this investigation, dimensions and properties of some nodes (themes) were noted. For example, the node or theme 'Disorganised information systems' was characterised by a general haphazard type of information dissemination and supported by three attributes or dimensions of 'Selectivity', 'Dissemination of inappropriate/abstract information' and 'Abandonment'. Examination was conducted for any competing perspectives (Gibbs, 2002) or 'borderline instances' (Gill, 2000, p179).

In the second stage of analysis, NVivo coding was more analytical, in this instance, referred to as axial coding. This exercise established relationships between categories and sub-categories, identifying categories or key themes, which could encapsulate other themes (Gibbs, 2002, Gibbs, 2007; Strauss and Corbin, 1990; Weber, 2004) and developing hierarchal structures. These structures formed tree nodes, which constituted parent nodes and their corresponding sub nodes or children nodes. Relationships between these categories were based on various aspects including support qualities, context, or interactions (Strauss and Corbin, 1990), but with major focus on determining categories of contingent, support and contextual factors according to the characteristics of each category. For example, the theme or category of 'farmers' uncertainty of dosages' denoted a contingent factor of farmers' doubt of information they received concerning dosage rates, while the support factor of 'Compromised agrochemical regulations' indicated a process where inefficiency and absence of appropriate regulations governing the procurement and use of agrochemicals was noted. Coding was again conducted in a data-driven manner, based on what was actually recorded from the interviews, supporting a grounded theory approach. Subsequent to identification of major categories, further examination of interviews was conducted for any ideas which may have constituted areas of competing views or controversy or Gill's (2000, p179), 'borderline instances'.

The third stage of NVivo analysis constituted integration of categories for formation of grounded theory; known as selective coding. This stage involved identifying the most important themes within the categories of contingent, support and contextual factors, and establishing the interconnectedness of themes within these core categories (Strauss and Corbin, 1990), to explain reasons for the overuse practices adopted by farmers. For example, farmers' assumptions of dosages were supported by a support factor of disorganised information systems which occurred within the context of incapable extension services.

Additional qualitative analysis included the examination of farmers' perceptions concerning the effects of their overuse practices on elements of crop production and the environment, and economic considerations. Evaluating the reasons for farmers' overuse, in combination with farmers' perceptions concerning these practices, was useful for defining strategic interventions to combat the problem of overuse.

5.4.2 Reliability and Validity

Reliability and validity are concepts which are traditionally and commonly utilised in quantitative research. In quantitative context, the former implies the ability to reproduce similar results of a study while the latter suggests accuracy of measurements; that is, whether measurements are actually measuring what is indented to be measured or suitability of the design for intended measurement (Creswell, 2007; Golafshani, 2003). In the context of quantitative research, the concepts of reliability and validity have been observed in the following manner:

> *'…The extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability and if the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable'* [and] '*Validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are…researchers generally determine validity by asking a series of questions, and will often look for the answers in the research of others'* (Joppe, 2000, p1, cited by Golafshani, 2003, p598 and 599).

However, when utilised in qualitative research, the concepts of reliability and validity are more concerned with 'trustworthiness, rigor and quality' (Golafshani, 2003, p601-602). In qualitative research reliability refers to an evaluation of quality, where the main purpose is to create understanding (Golafshani, 2003). Bauer (2000, p143) defines reliability as 'agreement between interpreters'. Oppenheim, 2004, notes that reliability refers to consistency in the respect that if similar measures were to be applied to the same object at a different time, results should be similar, unless a change in the object occurred. However, both authors agree that perfect reliability or total consistency is difficult to attain in instances where human judgement is involved and may be limited by complexity of coding frames, since humans may react differently to different scales of measurement at different times (Bauer, 2000; Oppenheim, 2004).

While in qualitative research a number of terms are used to define validity, the concept is more concerned with the procedures and purposes of methodologies utilised in research (Golafshani, 2003). Validity, in social science context 'refers to the degree to which a result correctly represents the text or its context' (Bauer, 2000, p144); or 'to what extent the event being measured corresponds to what is intended to be measured' (Denzin, 1970, p104). Creswell (2007, p206-207) considers validity in qualitative research as 'an attempt to assess the ''accuracy'' of the findings, as best described by the researcher and the participants'. Validity in this context is therefore concerned with how the research design, including data gathering, permits conclusions to be drawn in a confident manner and therefore examines how well data can be interpreted based on the specific procedure utilised. In qualitative study content analysis should be clear on procedures utilised; such as coding frame used, interview guides and interpretations of interviews, so as to demonstrate or increase the validity of the research (Gaskell and Bauer, 2000). In qualitative research validity is concerned with 'description and explanation and whether or not the explanation fits the description', taking into account that there is no one interpretation of an event that is assumed to be the only correct one (Denzin and Lincoln, 2003, p69).

Approaches for attaining validity and reliability in social research have been proposed. Creswell (2007, p207-209) suggests various strategies and believes that at least two should be utilised in any study to achieve validation. Strategies include: adequate interaction and detailed observation in the field which permits knowledge concerning culture and builds trust of research subjects, triangulation of 'sources, methods, investigators and theories to provide corroborating evidence', peer review or debriefing sessions where the researcher is asked questions as an external evaluation of the research process, refining of hypotheses as new evidence arises, clearly demonstrating any researcher bias by providing aspects which have influenced the research approach, seeking participants' views concerning the credibility of research findings and interpretations, providing detailed descriptions which permit readers to decide if findings are applicable to other scenarios and external assessment from persons outside of the study.

Similarly, approaches for attaining reliability in qualitative research have been suggested. Creswell (2007) notes, that ensuring good quality recording and transcribing can enhance reliability in qualitative research. He records the importance of agreement in the coding process when analysing data with respect to determining what codes represent, agreeing on code names and the manner of coding passages, together with agreement on the use of themes or codes. The author mentions that while the process may be flexible there is need for consistency in the procedure chosen. Other authors propose that reliability addresses the consistency of measurement in the study and can be enhanced in social research by carefully establishing and maintaining criteria for the coding process (Bauer, 2000; Gaskell and Bauer, 2000).

In this investigation, reliability and validity of the research process were achieved via various procedures. A grounded theory approach facilitated correct interpretation of stakeholder perspectives (Gaskell and Bauer, 2000) while triangulation of sources (interviewees, key informants) provided corroboration of evidence (Creswell, 2007). Comparison of study results with findings from previous studies examined in the literature review was conducted and discussed within the discussion chapters 6 and 7, while interview transcripts and recordings are available (Creswell, 2007). Golafshani, (2003, p603-604) notes that in qualitative research 'Triangulation is typically a strategy (test) for improving the validity and reliability of research or evaluation of findings' and 'Engaging multiple methods, such as, observation, interviews and recordings will lead to more valid, reliable and diverse construction of realities'. In my study, triangulation of several methods (surveys, interviews and observations) was also employed.

5.5 SUMMARY

The methodology of this study was theoretically informed and conducted based on elements of a critical realist approach which conceptualised overuse practices as 'real' or physical occurrences, but also as socially constructed by agents (farmers). Thus these practices were investigated after a physical manner and also as embedded in social structures; integrating both descriptive and interpretive phases. The descriptive phase of this investigation was guided by a quantitative strategy where the physical occurrences of overuse practices were investigated and described. The interpretative phase utilised a qualitative strategy where the reasons for farmers' overuse practices were elaborated. The descriptive phase was not separated from the interpretative phase but rather demonstrated a continuum between two sets of divides: descriptive and interpretative, and quantitative and qualitative.

The quantitative phase of this research provided insight into the overall occurrence of farmers' overuse practices and the relative dimensions in which these occurred. Quantitative analysis identified significant associations between independent and dependent variables, for example the significance of the area cultivated to pesticide overuse. This analysis, while useful on its own, was not isolated, but suggested areas for focus in the qualitative phase. The quantitative phase demonstrated interconnectedness to the qualitative phase by providing the researcher with useful foundation aspects required for interviewing. Some of these included: establishing relationships with the subjects of the study, discovering the contexts in which some practices occurred and in some instances determining the approach to be adopted, while gaining an appreciation of cultural and other related issues.

The qualitative phase of the research was partially informed by the quantitative phase of the investigation but did not presuppose the hypotheses generated by this phase. Rather, the qualitative phase utilised these hypotheses as guidelines where necessary. For instance, the source type information was recognised as a significant factor to both forms of overuse, but this did not exclude exploratory type of concerning farmers' access to information. The qualitative phase permitted respondents the opportunities to reveal their own perspectives, which in some instances corroborated with the hypotheses generated by the quantitative phase, but more importantly revealed reasons which were not indicated in the quantitative phase. In this respect, the qualitative aspect of this study required a more extended or exploratory form of data which was utilised for content analysis. This data was in the form of discourses. The content of discourses was analysed and interpreted; hence the theories generated form this analysis are said to be grounded in the data collected (Gibbs, 2007).

The grounded theory approach facilitated the organisation of qualitative data into a logical format by initially adopting a process of data familiarisation and seeking instances of connectedness within the data text, not merely by familiarity of words but through the sense conveyed by respondents' terminology. For example, farmers' self confidence concerning their use of too high dosages was noted as stubbornness by key informants. However, in the absence of appropriate and consistent information on the use of agrochemicals, it was my view that farmers' manner of determining dosages through their own reasoning, was more one of confidence they developed over time, from self reliance, rather than a stubborn attitude. A grounded theory approach complemented by compatible software, NVivo, was utilised in this study to facilitate this type of analysis which extended beyond the descriptive phase to interpretation of data. This was especially enhanced by coding which was conducted according to interrelatedness of categories.

Results from both quantitative and qualitative phases of the research were utilised for theory generation. According to the manner and sequence of this research, hypotheses generated are formulated based on the analysis of primary information, thus generating theory which is grounded in primary data. A critical realist theory adopted for this study facilitated interconnectedness of qualitative and quantitative components of the research demonstrated through the application of quantitative and qualitative strategies; namely quantitative (surveys) and qualitative data collection (interviews and observations), followed by quantitative (SPSS) and qualitative (grounded theory) analysis. Results generated from this study answered the research objectives by first providing from the quantitative phase, prevalence and intensity of overuse together with factors significant to overuse. The qualitative phase answered the research objectives by providing reasons (including contingent, support and contextual factors) for farmers' pesticide and fertiliser overuse practices, together with farmers' perceptions concerning these practices.

The following chapter 6 discusses the results obtained from quantitative analysis conducted on survey data gathered through the quantitative methods explained within this chapter. Chapter 6 presents these results in logical sequence according the objectives of the study and answers the hypotheses postulated for the quantitative type research objectives; 1 to 3. Results which answer the qualitative objectives 4 to 6 are discussed in chapters 7 and 8.

CHAPTER 6: A QUANTITATIVE ACCOUNT OF THE PREVALENCE, INTENSITY AND SIGNIFICANT FACTORS OF PESTICIDE AND FERTILISER OVERUSE

6.1 INTRODUCTION

This chapter presents a quantitative account of farmers' agrochemical behaviour. An overview of results is initially presented, followed by a description of farmer and farm unit variables utilised within this investigation. Detailed results are then presented. Quantitative analysis, conducted on survey data, through the use of SPSS, initially determined the prevalence and intensity of pesticide and fertiliser overuse and later, established the significance of several factors to farmers' overuse practices. The results of this analysis are discussed based on 3 tested hypotheses, which answer the first three study objectives regarding prevalence, intensity and significant factors of overuse. Where relevant secondary data was available[51]; these are recorded and discussed, though not much detail, due to a general paucity of secondary agrochemical data for Guyana and lack of any definitive trends in this data. The chapter concludes with a brief analysis which debates the suitability of quantitative analysis for determining the reasons for agrochemical overuse.

6.2 OVERVIEW OF RESULTS

Quantitative analysis indicated the prevalence of both pesticide and fertiliser overuse in more than half of the study population; 69% in the case of pesticide overuse and 66% in the case of fertiliser overuse. In the case of pesticide overuse, this practice was conducted primarily through increased frequencies of applications of the chemicals by 55% of the population. In the case of fertilisers, overuse was achieved mainly through the use of increased concentrations of these chemicals, revealed in 58% of the study population.

Statistical analysis of factors which were likely to be significant to pesticide and fertiliser overuse was conducted through the use of logistic regressions. Factors tested for significance to pesticide and fertiliser were: farmers' age, education level, farming

[S]Secondary data comprised import and consumption figures of pesticides and fertilisers experience, farm size, access to credit and information source. For the regressions, the equations are of this form:

The odds of overuse = f (farmers' age, education level, experience of farming, farm size and access to credit), and a secondary model is offered for comparison in Tables 6.4 and 6.5, of this form:

The odds of overuse = f (farmers' age, education level, experience of farming, farm size, access to credit and information source).

The logistic regression model offers a way to study how the independent variables affect the odds of overuse. Each raw coefficient B has a corresponding odds ratio, the exponent of B, as shown.

Findings revealed that factors showing significance to pesticide overuse were tenure, area cultivated, age and source-type of information while in the case of fertiliser overuse, significant factors were farmers' education level and the source-type of information. Regression analysis further revealed that farmers' source-type of information was significant to both fertiliser and pesticide overuse, independent of and in association with most of the other usual factors.

The follow chapter section describes the characteristics of the variables which were investigated, in relation to the survey population. Some variables were not tested for their significance to overuse. Brief discussions of these variables which include the reasons for their omission in significance testing are conducted. Variables utilised for this study are also termed structural factors, firstly, because of their nature (embedded within the farmer or farm unit structure) and secondly, for differentiation from the causal factors of overuse, identified through qualitative analysis.

6.3 FARMER AND FARM UNIT CHARACTERISTICS

6.3.1 Continuous Variables

i. Age

Data for the variable age was collected in both continuous and categorical (ordinal) format. Within the ordinal format, age groups were: 18-30; 31-40; 41-50 and >50 (coded as 1, 2, 3 and 4 respectively). Descriptive analysis revealed that most respondents were between the ages of 41-50 years; representing 34% of the population, while the least of the respondents were between ages of 18-30, representing 17% of the population. The mean age of the study population was 42 years (Table 6.1). This variable was statistically significant only to pesticide overuse in this investigation.

Table 6.1 presents the means and percentages of continuous and categorical variables which were generally investigated in this study, including those utilised within the logistic regression analysis.

Table 6.1: Means and percentages of variables: Farmer and farm unit characteristics

Farmer and farm unit characteristics	Value
Continuous variables	**Mean**
Mean Age (years)	41.6
Mean Area Cultivated (acres)	4.9
Mean Experience (years as % of age)	30.7
Categorical variables	**Percentage (%)**
Credit	
'Accessed' (1)	11.8
'Did not access' (2)	88.2
Education level	
'Secondary level and above' (1)	42.4
'Primary level and lower' (2)	57.6
Tenure	
'Own' (1)	45.4
'Rent' (2)	54.6
Source/type of information accessed by farmers for pesticide use	
'Label instructions' (0)	36.2
'Extension worker' (1)	10.0
'Pesticide dealer' (2)	30.1
'Other farmer/farmers' group (3)	17.0
'Experience/none' (4)	6.6
Source/type of information accessed by farmers for fertiliser use	
'Label instructions' (0)	15.7
'Extension worker' (1)	9.6
'Fertiliser dealer' (2)	29.7
'Other farmer/farmers' group (3)	13.1
'Experience/none' (4)	31.9
Rotation	
'Practices rotation' (1)	16.6*, 1.7**
'Does not practice rotation'(2)	83.4*, 98.3**
Market type	
'Local' (1)	98.3*, 94.8**
'Export' (2)	1.7*, 5.2**
Gender	
'Male' (1)	85.6
'Female' (2)	14.4
Region	
'Region 3' (1)	53.3
'Region 4' (2)	46.7
Pesticide/Fertiliser Use	
'Overuse' (pesticide, fertiliser) (0)	69, 66
'Not Overuse' (pesticide, fertiliser) (1)	31, 34

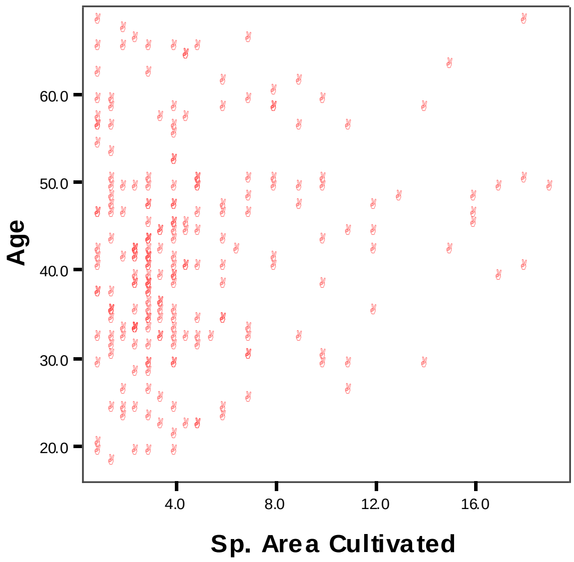
Source: Field Survey Data; Guyana – 2008/9
N = 229 farms
* Reported; ** Actual

ii. Area Cultivated

The area cultivated was found to be a more practical variable for this study, when compared to farm size, since farmers did not cultivate their entire land holding in many instances. Like age and experience, data for this variable was collected in both continuous and ordinal formats, measured by acres. Within the categorical format, 4 groups were utilised: <5; 6-10; 11-15 and >15 acres, coded in a similar manner as that of age and experience. Most of the farmer population cultivated <5 acres of land, represented by 70% of the population, while those farmers cultivating over 15 acres were least in the population, accounting for only 4%. The mean area cultivated was 5 acres (Table 6.1). For this study, the area cultivated by the farmer was statistically significant only to farmers' pesticide overuse practice.

Investigation into the variable area cultivated; conducted through cross tabulations, revealed that the highest incidences of both pesticide and fertiliser overuse seemed to occur in farmers who cultivated less than 5 acres of land. However this result may have been due to the fact that in the general study population most farmers (70%) cultivated less than 5 acres of land (see appendix 2).

Farmers' age and area cultivated are two continuous variables which indicated widespread ranges of values among the study population. These two variables are therefore well suited to describe the survey population. Descriptive statistics of continuous variables (see appendix 2) and the scatter diagram presented below (Figure 6.1) demonstrate the variability of farmers' age and area cultivated within the population. The scatter diagram indicates that both young and older farmers cultivated small land sizes.



Source: Field Survey Data; Guyana – 2008/9; N=229 farms

Figure 6.1: Scatter diagram of Farmers' Age and Specific Area Cultivated

iii. Experience

Farmers' experience represented the average number of years the farmer was involved in cultivation of the study crops. Data for this variable was also recorded in both continuous and ordinal format. In the ordinal format 4 categories were utilised: 3-5; 6-10; 11-15 and >15 years, coded in a similar manner as the variable, age. Most farmers had over 15 years experience; represented by 38% of the population, while those having the least experience of 3-5 years, accounted for 13% of the population. The mean experience of the farmer population was 31 years (Table 6.1). Cross tabulation s revealed that for both pesticide and fertiliser, farmers who had over 15 years of experience seemed more likely to engage in overuse practices. However, like area cultivated, this result may have been due to the fact that in the general study population most farmers (38%) had over 15 years of experience (see appendix 2).

6.3.2 Categorical Variables

i. Education Level

Farmers' education level was categorised as an ordinal variable within 2 groups: 'secondary and higher' and 'primary and below' (coded as 1 and 2 respectively).

Initially, 3 categories were utilised, the additional category being tertiary level education. However, surveys revealed only 6 respondents were of this category hence regrouping was conducted. Descriptive statistics revealed that most farmers; 58% of the study population, were of primary and lower education level, while the remaining 42% were educated to secondary and higher education level (Table 6.1). In this investigation, farmers' education level was statistically significant only to fertiliser overuse.

ii. Land Tenure Status

Farmers' land tenure status was categorised as an ordinal variable, with categories of 'own' and 'rent' (coded as 1 and 2 respectively). Most of farmers rented the land they cultivated, representing 55% of the population while the remaining 45% owned the land they cultivated (Table 6.1). The land tenure status of farmers in this study was statistically significant only to their pesticide overuse practice. Cross tabulations revealed that for both pesticide and fertiliser overuse farmers who rented land seemed more likely to engage in overuse practices, represented by 60% of the population in the case of pesticide overuse and 58% in the case of fertiliser overuse (see appendix 2).

iii. Credit

Farmers' credit status was classified as a categorical variable, with values of 'yes', meaning 'accessed credit' and 'no', meaning 'did not access credit' (coded as 1 and 2 respectively). Most farmers (88%) did not access credit, while the minority (12%) did so (Table 6.1). Of the 12% of farmers who accessed credit, 8% did so from a commercial lending institution, while 4% accessed credit from a relative or friend. Of the 88% of farmers who did not access credit, 52% declined because of fear of inability to repay loans, 16% stated they did not have the required documents and collateral for accessing credit, while 20% were just 'not comfortable' with taking credit (see appendix 2) .

This information revealed by farmers, support findings discussed in the earlier chapter 4 on the political economy, which revealed the unfavourable state of credit for farmers in Guyana, including the lack of lending institutions with low interest repayment rates[52] and farmers' report of the demand for collateral which was unattainable[53]. Based on interview data, farmers' decline to access credit also substantiates the support factor of irregular and unregulated marketing systems and the contextual factor of adverse marketing conditions and pressures, discussed within the following chapter, sections 7.3 and 7.4, respectively, where farmers are not guaranteed a market for their produce. These conditions are reflected in farmers' wariness to access credit, based on their fear of inability to repay.

iv. Source-type of Information

Farmers' main source of information for agrochemical use was more aptly categorised as 'source-type' based on the belief that the type of information supplied will be typical of its source. This variable was placed into categorical (nominal) groups, as detected by pilot survey information. Categories comprised the following information source-types: 'label instructions', 'extension workers', 'pesticide dealers', 'other farmers/farmers' groups' and 'farmers' experience' (coded as 0 through 4, respectively). 'Farmers' experience' was often termed as 'no source' by the farmer, indicating a form of self-reliance on their experience for guidance concerning agrochemical use.

In relation to pesticide use, statistics revealed that most farmers (83 or 36%) utilised instructions from the labels; 69 (30%) were mainly dependent on instructions from the dealer; 39 farmers (17%) received instructions from other farmers or farmers' organisations; 23 (10%) utilised information from the extension worker while 15 farmers (6%) were dependent on their own experience. In the case of fertiliser use, most farmers (73 or 32%) relied primarily on their own experience; 68 farmers (30%) received information primarily from the dealers; 36 farmers (16%) utilised the label instructions; 30 farmers (13%) were mostly dependent on other farmers of farmers' organisations for information, while for 22 farmers (10%), their main source of information was the extension worker. In this study, the source-type of information accessed by farmers was statistically significant to both pesticide and fertiliser overuse practices among farmers (Table 6.1).

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[52] Discussed in detail in chapter 4: section 4.3
[53] Reported by 5 interviewees

Investigation into the variable source type of information was conducted in relation to education level of farmers, through cross tabulations. This analysis revealed that while for both categories of education levels, the labels were the most frequently used sources of information, this source was accessed more by farmers of secondary and higher education level (41%), than farmers of primary and lower education level (33%). In a similar manner more farmers of primary and lower education level relied on other farmers and farmers' groups for their source of information (20%), than farmers of secondary and higher education level (13%) (see appendix 2).

This finding may have implications for policy in several areas. Firstly, it can be suggested that training should be conducted in various levels as farmers' can better understand training which is conducted at their various intellectual levels. This policy implication is dealt with in more detail with chapter 9, section 9.3. Secondly, findings indicate that farmers of primary level education accessed information in almost equal proportions from the label and pesticide dealer (33% and 30%, respectively) (see appendix 2). These findings may be an indication that farmers are more comfortable in accessing information from sources which are more informal. This highlights the need for policy which addresses the training of dealers as these persons are in many instances the main source of information for many farmers. This policy implication is discussed in greater detail in chapter 9, section 9.3.

v. Pesticide and Fertiliser Use

An introduction to the dependent variables 'pesticide and fertiliser overuse' is conducted within chapter 3, section 3.23 (v), where pesticide and fertiliser overuse is to indicate farmers' deviation from principle prescribed dosages to entail their use of increased frequencies or concentrations of these chemicals.

In this investigation, pesticide and fertiliser use were dependent variables, both nominally categorised to indicate whether a farmer overused pesticide and fertiliser or not. Categories were: 'Overuse' and 'Not Overuse' (coded as 0 and 1 respectively), in both cases of pesticide and fertiliser. The possibility of presenting this variable in continuous format with multiple categories such as 'some excessive use', 'moderately overuse' and 'significant degree of overuse' was considered. However the manner of overuse conducted by farmers prevented the possibility of this format of categorisation. Notwithstanding this limitation, tenets of the 'Uncertainty principle' were applied to 229 farmers' survey responses concerning their manner of applying agrochemicals. According to this principle, farmers' responses may have been influenced by the interviewer (i.e farmers' responses may have been dependent on whether they were being questioned by researcher or research assistants) (ESC, 2011; McKerrow and McKerrow, 1991; WOD, N.D.). Hence farmers' responses were recorded as per interviewer. This principle and corresponding details of farmers' responses are discussed within section 6.4.1 of this chapter.

The use of these relatively broad categories for determining farmers' overuse, as opposed to utilising levels of overuse was influenced by farmers' haphazard use of both pesticides and fertilisers. For instance, farmers typically chose a chemical they 'knew' from 'experience' was good for a certain condition and applied this chemical as much or often as needed for a desired result. In this disorganised method of application, farmers had no records concerning the precise amounts of chemicals which were applied. Farmers typically interpreted an unfavourable response after applications, as the result of 'weak chemicals' which required increased amounts or applications. Additionally, dosages were not regulated according to the crop or pest types, as instructed on the labels of chemicals. In the latter case this was primarily due to farmers' non-recognition of pests.

Farmers' haphazard agrochemical application in this study corresponds to various reports in literature. Ntow *et al*, (2006, p363) in a study on farmers' pesticide use in vegetable production in Ghana record farmers' use of a wide range of pesticides and pesticide dose rates for all crops. The authors note that:

'Vegetable farmers sprayed the same very wide range of pesticides on all their crops' and *'A wide range of dose rates (both reduced and excessive) were applied on some crops'*.

Carson (2002, p180) points out:

'…there remains the well-known fact that farmers very frequently exceed the prescribed dosages, use the chemical too close to the time of harvest, use several insecticides where one would do, and in other ways display the common human failure to read the fine print'

In a report on the use of pesticides in commercial vegetable cultivation in Nepal Ghimire and Khatiwada (2001, p10-11), record:

'Farmers in one hand, are using fungicides to control the insects …they use pesticides indiscriminately, without considering the pests status even in some case by following the neighbours practice…Farmers do not consider the dose of pesticides to be used and repetition of application'.

In my investigation, similar application procedures were noted for both pesticides and fertilisers. Overuse by farmers was not limited to or predisposed by the use of a specific type of pesticide or fertiliser, but rather a function of the farmers' observation for a desired result. While farmers acknowledged their use of chemicals in excess of recommended dosages, this was not a precise measurement of the excess dosage. More precisely, over the dosage comprised increments which were either considered 'strong enough' to kill the pests or sustained increments of amounts until a desired reaction was achieved. A detailed record of increments was not considered necessary by farmers, which was not surprising, farmers generally did not keep records. This lack of record keeping was substantiated by 4 key informants[54]. However, while these informants expressed concern over the state of farmers' absence of records, no system was in place to correct this practice. Key informants revealed that the maintenance of a farmers' diary is optional for farmers. The main groups and types of pesticides and fertilisers utilised by farmers were recorded based on survey and interview information. These chemicals are partially classified according to the classification method of FAO's statistical database[55] (see appendix 2).

Additional variables for which information was gathered during the survey, but which were not utilised for significance testing include: rotation, market type, gender and region. These are discussed in the following chapter sections.

vi. Rotation

Information concerning farmers' rotation was recorded as a categorical variable, utilising groups of: 'practices rotation' and 'does not practice rotation' (coded as 1 and 2, respectively). Discrepancies in farmers' reports of this variable were noted.

[54] Of the 4 key informants; 3 were of the MOA and the other, the key informant of IICA

[55] For fertilisers categories are: Nitrogen fertilisers {mixtures of Nitrogen, Phosphorous and Potassium (NPK) and urea}; phosphate-based fertilisers and potash-based fertilisers. In the case of pesticides, categories comprise: insecticides, fungicides and herbicides.

Farmers claimed to practice rotation but inquiry their understanding of rotation, revealed their misunderstanding. What respondents called rotation was not consistent with the meaning of this practice. While 17% of farmers reportedly practiced rotation, only 2 % were found to be actually conducting this practice (see appendix 2). This variable was therefore not utilised for significance testing in relation to overuse. The finding of farmers' misinterpretation of the meaning of rotation, draws a parallel result to the support factor of disorganised information sources, where farmers experienced abandonment and/dissemination of inappropriate information (chapter 7, section 7.3).

Authors mention the role of rotation in reduction of pests and improving soil fertility; both having implications for farmers overuse of pesticides and fertilisers, respectively. In their investigation on technology adoption in paddy farmers of Iran, Bagheri *et al*, (2008) record farmers' experience of increased yields through the practice of rotation. The authors however note that many farmers were constrained in adopting this practice because of small land sizes. A similar finding was revealed in this study, where 2 interviewees indicated their inability to adopt this practice because of small cultivation plots and also due to market demand[56]. In their review of extensive production practices, Tilman *et al*, (2002) report the increased profit and reduced use of a potent pesticide through farmers' practice of rotation and the increased susceptibility to pests and diseases where this practice was neglected. Based on technical knowledge revealed by these sources, farmers' neglect of this practice noted in this study may, to some extent, explain the persistence of pests and subsequent high dosages of pesticides used by farmers to combat their pest problem. Farmers' lack of rotation might also explain why they believed that excessive fertilisers were needed for desired crop yields.

vii. Market Type

The market type which farmers accessed was categorically classified as: 'local' or 'export' (coded as 1 and 2, respectively). As in the case of rotation, discrepancies in farmers' reports were also noted concerning this variable. Most farmers (98%)

[56] For example farmer Too explained: *'He (a foreign expert) told us about it (rotation), but we can't do that...because if we put another crop there, when the market wants Boulanger where will we plant it?...remember too we have to plant what the market wants...'*

indicated their access of the local market, while a mere 2% reportedly accessed export markets. While figures confirm that the majority farmers were indeed domestic market suppliers, information revealed that some of these farmers supplied the export market through informal and illegal channels. What is locally termed the 'suitcase export' was conducted by approximately 3% of farmers (see appendix 2). Additionally, some farmers spontaneously acted as 'intermediaries' in supplying produce to large-scale farmers who then exported this produce[57]. As in the case of rotation, this variable was not utilised for significance testing.

viii. Gender

Gender was categorically categorised as 'male' and 'female' (coded as 1 and 2, respectively). Most farmers (86%) were males (Table 6.1). This variable was therefore not utilised for significance testing. Investigation into the variable gender; conducted through cross tabulations, revealed that men seemed more likely to overuse both pesticides and fertilisers than women; represented by 87% and 89% of the study population respectively (see appendix 2). While this may have been due to the general higher proportion of men in the study population, interviews corroborated this finding. Interviews revealed that women farmers were mainly single parents who chose farming as a livelihood. Women whose partners were farmers, and who were available during interview sessions, systematically referred to the men for answers when questioned in relation to general farming practice and overuse.

Additionally, these women were mostly involved in what can be considered as 'lighter' farm work such as cleaning and sorting vegetables after harvest. Alternatively they were otherwise employed (in non-agricultural jobs). This seeming trend of relatively low involvement of women in farming may have been due to the view of farm-work as drudgery, originating from the colonial times and persisting into eras of self-government (discussed in chapter 4, section 4.2). Other contributory factors may be the low prevalence of women having land titles and lack of a definite policy and corresponding interventions for women's involvement in agricultural activities. These are discussed in detail with chapter 4, section 4.3.4.

[57] In some instances large-scale export farmers were unable to supply a desired amount to an export market and relied on produce from several small-scale farmers.

This trend of women's low involvement in farm-work was not pursued in detail in this study, due to scope of this investigation and time-related constraints. This may be an area for independent investigation.

ix. Region

This study was conducted in the 2 main vegetable producing regions of Guyana; regions 3 and 4, which were coded as '1' and '2' respectively. Fifty three percent (53%) of the study population resided in region 3, while the remaining 47% inhabited region 4 (Table 6.1). Statistical testing via logistic regression showed that there was no significance difference in the overuse practices of farmers of the 2 regions. Qualitative investigation also revealed similar farming practices among farmers of both regions. This variable was not utilised in the final regression analysis but the results of its inclusion within the logistic regression are recorded within appendix 2.

6.4 Prevalence and Intensity and Significant Factors of Farmers' Overuse

6.4.1 Prevalence of Overuse

In investigating the first research objective, a hypothesis was formulated that: 'A significant proportion (more than half) of practising arable farmers in regions 3 and 4 are engaged in practices of pesticide and fertiliser overuse'. Statistical analysis conducted through the use of SPSS indicated that 69% of the study population engaged in practices of pesticide overuse, while 66% practiced fertiliser overuse (Table 6.2). This analysis was based on corrected data[58]. Results therefore confirmed the hypothesis that: 'A significant proportion (more than half) of practising arable farmers in regions 3 and 4 are engaged in practices of pesticide and fertiliser overuse'.

[58] Farmers' reports which were correlated with visual inspection conducted during spraying or follow-up questioning revealed that while many farmers stated their compliance with label instructions, this was not reflected in their actual practices.

Table 6.2: Prevalence of Pesticide and Fertiliser Overuse in Study Units of String Bean and Egg Plant Cultivation

Prevalence	Actual Pesticide use (Population %)	Reported Pesticide use	Actual Fertiliser Use (Population %)	Reported Fertiliser use
Overused	69.4	56.3	65.9	52.0
Did not use/Overuse	30.6	43.7	34.1	48.0
TOTAL	100.0	100.0	100.0	100.0

Source: Field Survey Data; Guyana – 2008/9
N = 229 farms

The ‘Uncertainty principle’ or what is commonly known as Heisenberg Uncertainty principle (introduced in section 6.3.2 (v) of this chapter), is based on the concept that any act measurement or assessment will influence the state of what is being measured. While this principle is founded based on the work of the German scientist, Werner Heisenberg (1901–1976) and was originally applied to the field of quantum mechanics, the concept also extends to social science. In this context, the uncertainty is thought to affect determinism, where it is impossible to precisely determine the present state of the world or any part of the world. In the realm of social science the ‘Uncertainty principle’ conceptualises that within a study the observer has effects on what is being observed. Hence investigatory methods should be designed to permit minimum interference with the observed phenomenon (ESC, 2011; McKerrow and McKerrow, 1991; WOD, N.D.).

Due to the possible influence of the ‘uncertainty principle’ on farmers’ responses disaggregation of responses by interviewer was conducted. This disaggregation is included in the format of summary statistics in appendix 2. This information is presented for three (3) sub-samples of survey responses, according to the three (3) respective interviewers. While there as possibility of farmers’ responses being influenced by interviewers, these results do not demonstrate systematic differences among responses across interviewees’ responses to the respective interviewees.

6.4.2 Intensity of Overuse

In investigating the second research objective, a hypothesis was formulated that: ‘Fertiliser and pesticide overuse in farmers is conducted mainly through the use of higher concentrations than is recommended, rather than increased frequency of applications’. SPSS statistical analysis of data indicated that of the population who overused, the most prevalent form of intensity was through increased concentrations in the case of fertilisers (57.6%), while in the case of pesticides the most prevalent form of intensity was achieved via increased frequencies of applications, practiced by 54.6% of the study population. Some farmers practiced overuse via combined forms of intensities for pesticide and fertiliser overuse, 21.4% and 7.4%, respectively (Table 6.3). Results therefore indicate that the hypothesis: 'Fertiliser and pesticide overuse in farmers is conducted mainly through the use of higher concentrations than is recommended, rather than increased frequency of applications' was supported in the case of fertilisers but not confirmed in the case of pesticides.

Table 6.3: Intensity of Fertiliser Overuse in Study Units of String Bean and Egg Plant Cultivation

Intensity		Pesticide (Population %)	Fertiliser (Population %)
Overused	**By Concentration**	14.8	50.2
	By Frequency	33.2	8.3
	By Both	21.4	7.4
Overused (Total)		69.4	65.9
Did not use/Overuse		30.6	34.1
TOTAL		100.0	100.0

Source: Field Survey Data; Guyana – 2008/9
N = 229 farms

6.4.3 Significant factors

In investigating the third research objective, a hypothesis was formulated that: 'Factors which influence fertiliser and pesticide overuse in Guyana are farmers' information source-type, in addition to the farmers' age, credit access, education level, land tenure type, area of land cultivated and farmer experience'. This hypothesis could be more precisely interpreted that: 'the specific source-type of information is going to affect the overuse of fertiliser and pesticide, independent of and in addition to all the usual factors'.

Logistic regression via SPSS was conducted where structural factors (variables) were tested for their significance on both pesticide and fertiliser overuse. For each form of overuse (pesticide and fertiliser), 2 models were used. The two models differ in their sets of independent variables as shown. Model 1 did not include the variable ‘source-type of information’ while model 2, included the variable ‘source-type of information’ (Tables 6.4 and 6.5). Regression analysis indicated that farmers’ access to credit and area cultivated demonstrated significance in relation to pesticide overuse in model 1, while in model 2 (where the source type of information was included); the factors significant to pesticide overuse were farmers’ tenure status, area cultivated, age and the ‘source-type’ of information they accessed (Table 6.4). The odds of farmers’ pesticide overuse were therefore a function of farmers’ tenure status, area cultivated, age and the ‘source-type’ of information they accessed. The equation is of this form:

The odds of pesticide overuse = f (farmers’ tenure status, area cultivated, age and the ‘source-type’ of information they accessed).

Table 6.4: Factors Explaining Pesticide Overuse in farming Units of Combined String Bean and Egg Plant Production

VARIABLE	MODEL 1		MODEL 2	
	(B, Exp(B)	p	(B, Exp(B)	p
Age (years)	-0.159, 0.853	0.068	- 0.204, 0.815	0.032**
Age²	0.002, 1.002	0.097	0.002, 1.002	0.037
Credit				
- Access	(ref. category)		(ref. category)	
- Did not access	-1.579, 0.206	0.016**	-1.262, 0.283	0.056
Experience (Years as % of age)	0.002, 1.002	0.906	0.011, 1.011	0.454
Area Cultivated (acres)	0.338, 1.402	0.015**	0.408, 1.504	0.005*
Area Cultivated²	-0.013, 0.987	0.100	-0.017, 0.983	0.050
Land Tenure				
- Own	(ref. category)		(ref. category)	
- Rent	0.399, 1.491	0.216	0.787, 2.197	0.035**
Education level				
- Secondary and above	(ref. category)		(ref. category)	
- Primary and below	0.316, 1.372	0.329	0.161, 1.174	0.635
Information Source/Type				
- Label instructions			(ref. category)	0.015**
- Extension Worker			-0.154, 0.858	0.798
- Fertiliser Dealer			1.395, 4.035	0.002*
- Other Farmer/Farmers' Group			0.536, 1.708	0.277
- Experience/None			-0.554, 0.575	0.400
Constant	4.326, 75.664	0.031	3.654, 38.615	0.092

Source: Source: Field Survey Data; Guyana – 2008/9
N= 229 farms
Notes:
B = coefficients (the sign of the coefficients are important); Exp (B) = Odds ratio

Model 1: Both Age² and Area Cultivated² were included in the model, while Information Source/Type was excluded
Model 2: Information Source/Type was included; this variable acted as a control.
* p<0.01
**p<0.05
***p<0.001

In the case of fertiliser overuse, the significant factors in model 1 were farmers' access to credit and farmers' education level while in model 2, factors significant to fertiliser overuse were the farmers' education level and the 'source-type' of information (Table 6.5). The odds of farmers' fertiliser overuse were therefore a function of farmers' education level and the 'source-type' of information they accessed. The equation is of this form:

The odds of fertiliser overuse = f (farmers' education level and the 'source-type' of information they accessed).

Table 6.5: Factors Explaining Fertiliser Overuse in farming Units of Combined String Bean and Egg Plant Production

VARIABLE	MODEL 1		MODEL 2	
	(B, Exp(B)	p	(B, Exp(B)	p
Age (years)	-0.088, 0.916	0.281	- 0.100, 0.905	0.250
Age²	0.001, 1.001	0.450	0.001, 1.001	0.376
Credit				
- Access	(ref. category)		(ref. category)	
- Did not access	-1.235, 0.291	0.032**	-0.871, 0.418	0.140
Experience (Years as % of age)	-0.005, 0.995	0.693	0.004, 1.004	0.790
Area Cultivated (acres)	0.161, 1.175	0.218	0.183, 1.201	0.185
Area Cultivated²	-0.005, 0.995	0.505	-0.006, 0.994	0.475
Land Tenure	(ref. category)			
- Own			(ref. category)	
- Rent	0.143, 1.153	0.650	0.213, 1.237	0.584
Education level				
- Secondary and above	(ref. category)		(ref. category)	
- Primary and below	1.051, 2.862	0.001*	0.836, 2.306	0.015**
Information Source/Type				
- Label instructions			(ref. category)	0.006*
- Extension Worker			0.892, 2.440	0.173
- Fertiliser Dealer			1.905, 6.722	<0.001***
- Other Farmer/Farmers' Group			1.070, 2.915	0.068
- Experience/None			1.133, 3.104	0.036**
Constant	3.067, 21.472	0.098	1.506, 4.510	0.452

Source: Source: Field Survey Data; Guyana – 2008/9

N=229 farms

Notes:

B = coefficients (the sign of the coefficients are important); Exp (B) = Odds ratio

Model 1: Both Age² and Area Cultivated² were included in the model, while Information Source/Type was excluded

Model 2: Information Source/Type was included; this variable acted as a control.

* p<0.01

**p<0.05

***p<0.001

The hypothesis that: 'the specific source-type of information is going to affect the overuse of fertiliser and pesticide, independent of and in addition to all the usual contextual factors' was therefore not supported. No model demonstrated the significance of all variables to pesticide or fertiliser overuse. Rather, it could be said that: 'the 'source-type' of information of the farmer was significant to pesticide and fertiliser overuse, independent of and in association with most of the other usual factors.'

i. Factors Exclusively Significant to Pesticide Overuse

Farmers' Age

Analysis revealed that while farmers' age was significant to pesticide overuse, this significance was negligible. For every additional year's increase in a farmers' age, they was less likely to overuse pesticide by a factor of 0.8[59]. Studies report the influence of farmers' age on their pesticide use practices. Similar to the findings of this study, Huang *et al*, (2003), in an assessment of rice farmers' pesticide adoption practices in China, found that less pesticide was used by farmers as their ages increased. However, in a study on changing farmers' perceptions concerning insect control practices in the Philippines, Palis (1998) noted that as farmers' ages increased, they were less likely to change their perceptions of pest control practices.

Area Cultivated

In the case of area cultivated, analysis showed that for every additional acre that farmers cultivated, they were 1.5 times more likely to overuse pesticides[60]. While analysis demonstrates significance of increased acreage of cultivation to pesticide overuse, explaining of role of area cultivated in overuse is constrained by the limitations of quantitative results to explain. However it can be implied that in the context of unsure markets, which was revealed by and discussed in qualitative analysis, farmers' primary focus may be the prevention of crop destruction, especially where they would have invested more by increasing the acreage cultivated.

Literature indicates a relationship between farm size and farmers' agrochemical use practices. In investigating paddy farmers' attitudes towards the adoption of

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[59] (p=0.032); (B= - 0.204, Exp (B)= 0.815)

[60] (p=0.005); (B=0.408, Exp (B)= 1.504)

sustainable agricultural technologies Bagheri *et al*, (2008) record farmers' excess use of agrochemicals to acquire increased yields from small plots of land. Correlating with findings in my investigation, Huang, *et al*, (2003) assessment of rice farmers' pesticide adoption practices in China, revealed increased frequencies of pesticide application with increased farm size. However, Ntow *et al*, (2006) investigation on vegetable farmers' pesticide use in Ghana, revealed extensive use of pesticides on both large and small vegetable farms. In another study, on the impact of agrochemical use on productivity and health, Dung *et al*, (2003) record the decreased use of fertilisers by vegetable farmers in Vietnam, as their farm size increased, but associated this decrease, especially for potassium, with decreased yields.

Land tenure

Analysis revealed that farmers who rented cultivated land were 2 times more likely to overuse pesticides[61], when compared to those who owned the land they cultivated. Similar to the case of area cultivated, explaining the significance of land tenure to pesticide overuse is limited by the non-explanatory nature of quantitative analysis. However, it can be suggested that farmers were focussed on making as much profit as possible, for such time as they had use of the land; especially within a context of unsure markets[62] for their produce. Contrary to these findings, Palis' (1998) study on changing rice farmers' perceptions on pest control practices in the Philippines revealed that land tenure had no effect on changing the way farmers' thought about using pesticides for pest control. However, Prowse and Chimhowu (2007) link land access to decisions which favour better resource management.

Generally, interview data did not reveal that farmers' land tenure status and the area cultivated were associated with their overuse practices. When questioned concerning a possible change of their overuse practices, if their area cultivated or tenure status was changed, all farmer interviewees indicated in the negative, revealing that their practices were likely to be the same even with any changes in the two variables (see appendix 2). Farmer interviews also revealed their engagement in similar overuse practices, irrespective of age.

[61] (p=0.035); (B=0.787, Exp (B)=2.197)
[62] Revealed by qualitative investigation

ii. Factors Exclusively Significant to Fertiliser Overuse

Education level

In the case of the farmers' education level, analysis showed that compared to those farmers who had secondary level education and higher, farmers with primary and lower level education were twice likely to overuse fertilisers[63]. While significance of farmers' education level to their overuse of fertiliser was noted; like the other factors, the role of education level in influencing overuse was not explained by quantitative results. However, it can be implied that based on the contingent and contextual factors of self interest and deception and incapable extension services[64], which explained the purposeful misinformation of farmers (conducted by other farmers and dealers), and incapacity of extension services; farmers who had primary or lower level education, may not have understood the dosage rates indicated for the fertilisers they used.

Contrary to instances of area cultivated and land tenure; qualitative analysis substantiated the importance of farmers' education level to their overuse practices. While only 1 farmer had indicated his possible use of less pesticide and fertiliser if he was better educated (appendix, 2), the support factor of disorganised information services revealed that dissemination of inappropriate/abstract information influenced farmers' overuse behaviour. Similarly, the contextual situation of incapable extension influenced farmers' overuse, where farmer-training lacked clarification and reinforcement. Both factors are explained in detail within the following chapter 7, sections 7.3 and 7.4, respectively.

Studies record the influence of farmers' education level on their agrochemical use practices. In investigating the impact of agrochemical use on productivity and health in Vietnam, Dung *et al*, (2003), points out knowledge deficiency of fertiliser composition and pesticide use in vegetable and rice farmers'. The authors associated this lack of knowledge with farmers' of low level education. Other studies record similar and differing relationships between farmers' education level and their agrochemical use practices.

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[63] (p=0.015); (B=0.836, Exp (B)=2.306)

[64] These factors are full elaborated in chapter 7, sections, 7.2 and 7.4

In their study on technology adoption in paddy farmers of Iran, Bagheri *et al*, (2008), note that more educated farmers had a more positive attitude towards practices which promoted less use of agrochemicals. Waichman *et al*, (2007), in a study on vegetable farmers' understanding of pesticide label information in Brazil, link a lower education level to farmers' misunderstanding of pesticide use information stated on pesticide labels and their subsequent inappropriate use of pesticides. However, the authors note that even more educated farmers did not read labels for guidance on use, and considered them to be too technical. These findings partially support those of Palis (1998) whose investigation on rice farmers' perceptions concerning pest control practices, revealed that farmers' education level had no effect in changing their perceptions of pest control practices.

iii. Factors Significant to Both Pesticide and Fertiliser Overuse

The 'source-type' of information accessed by farmers was the only variable which demonstrated significance to both pesticide and fertiliser overuse practices. The significance of this variable to farmers' overuse was highly corroborated by qualitative results.

Source-type of information

In the case of pesticide overuse, logistic regression analysis indicated that, compared to farmers who used instructions from the label, those farmers who took instructions from the dealer were four times more likely to overuse pesticides[65], while those whose instructions came from other farmers/farmers' groups were two times more likely to overuse pesticides[66]. In the case of fertiliser overuse, regression analysis indicated that, compared to farmers who used instructions from the label, farmers who accessed instructions from the dealer were seven times more likely to overuse fertilisers[67]; farmers who took instructions from other farmers/farmers' groups and those who used their experience were three times[68] more likely to overuse fertilisers, while farmers

[65] (p=0.015); (B=1.395, Exp (B)=4.035)
[66] (p=0.015); (B=0.536, Exp (B)=1.708)
[67] (p=0.006); (B=1.905, Exp (B)=6.722)
[68] Farmer's groups: (p=0.006); (B=1.070, Exp (B)= 2.915); Experience: (p=0.006); (B=1.133, Exp (B)= 3.104)

whose instructions came from extension workers were two times more likely to overuse fertilisers [69].

The significance of farmers' source type of information to their overuse practices was substantiated by qualitative findings of my study, which indicated farmers' hesitance and inability to utilise some sources and their reliance on others. Interviews revealed farmers' unwillingness to utilise the label instructions and their inability to source advice from extension dealers. Farmers then relied on other sources of information, mainly dealers, other farmers' and their experience; which were those available and convenient to them. In both instances of pesticide and fertiliser use, less than half of the farmer population relied on the manufacturer's instructions for applying dosages of chemicals. In the case of pesticides 36% of farmers followed the label instructions while in the case of fertilisers 16% utilised instructions from the label (Table 6.1).

These findings were substantiated by qualitative results. The contingent factors of farmers' uncertainty of dosages and their dependence on experience for deciding dosage rates, explained their unwillingness and inability to utilise authentic sources for instructions on application of agrochemicals (chapter 7, section 7.2). The low rate of farmers' reliance on the extension worker for dosage instructions; 10% in both instances of pesticide and fertiliser use (Table 6.1) corroborates with the influential role of the support factor, disorganised information services, discussed in chapter 7, section 7.3.

Literature associates farmers' 'source-type' of information with their agrochemical use practices. In investigating pesticide use practices in small farmers of Tanzania, Ngowi *et al*, (2007), reveal high reliance of pesticide use among farmers who did not receive information from extension services. The authors also note farmers' influence of pesticide use by dealers who were interested in achieving high pesticide sales. This finding correlates with the contingent factor of self interest (of dealers and other sources) revealed by my study and discussed in the following chapter, section 7.2. Bagheri *et al*, (2008) point out that those farmers, whose advisory sources were agricultural experts and researchers, demonstrated a positive attitude towards the

[69] (p=0.006); (B=0.892, Exp (B)=2.440)

adoption of practices which favoured less use of agrochemicals. In a study on farmers' understanding of pesticide label information, Waichman *et al*, (2007) link the importance of farmers' understanding of pesticide use instructions to their pesticide use practice. The authors note the inappropriate use of pesticides by farmers who did not utilise label instructions and lacked guidance from the extension services[70].

In a study on fruit growers' perceptions on pesticide use, Isin and Yildirim (2007) record fruit growers' disregard of technical information sources for pesticide use in turkey; (conducted by only 15% of study population). These farmers exhibited low compliance with the recommended dosages. In assessing rice farmers' attitudes on recommended pesticide usage in China, Huang, *et al*, (2003), note that less than half of the farmers in the study (14%), used dosages according to the label instructions. The authors revealed that these farmers generally considered the recommended dosages to be 'under-use' of pesticides. The writers mentioned farmers' dependence on traditional channels for information on pesticide use[71] and indicated the possible impact of both the information source and quality of source on farmers' pesticide use practice.

In a study on investigating pesticide use of vegetable farmers in Ghana, Ntow, *et al*, 2006), revealed that less than 50% of farmers' received information for agrochemical use from the pesticide label or the agricultural extension officer. Findings from Huang and Ntow, substantiate quantitative findings in my study, where less than 50% of farmers' utilised the labels or extension services as their sources of information for both pesticide and fertiliser use (Table 6.1). Findings by these authors also corroborate with those of my investigation, where the quality of extension services impacted on the farmers' agrochemicals use practices. This is explained in my study as through the support factor of disorganised information systems, where inappropriate information was disseminated to farmers (chapter 7, section 7.3).

[70] Only 5.3% of the farmers in the study received information from the relevant extension services

[71] 54% of farmers in the study depended on traditional information sources for pesticide use such as friends, relatives, salespersons, etc.

Secondary data concerning agrochemical use was sought with an aim to discover trends which may substantiate or enrich the findings discovered by this study. However this exercise was limited by a general paucity of statistical data concerning agrochemical use. Qualitative findings indicated that some pesticide and fertiliser products are reported to be smuggled in, across land borders, but these cannot be recorded in the tables. Nevertheless, some available data are presented within the following section showing that pesticide and fertiliser imports are varied and have not shown any strong downtrend in recent years. I will describe both pesticide and fertiliser imports which affect the use of such products.

6.5 Secondary Data: Trends and Analysis

Authors highlight the practice of agrochemical overuse in Guyana (Bovell et al, 2002; Chandran, 2006; CLSS, 2005; EC, 2006; IICA/JIFSAN, 2004; Lall, 2002; Spiller and Aleguas, 2007). While these sources indicate prevalence of this phenomenon, precision on various aspects of the phenomenon is absent or unclear in written accounts. Further, statistical data for Guyana which may be used to support or guide and establish claims made by these sources, are scant and also generally lack precision and continuity in reporting trends; thus rendering them less than ideal sources for sound analysis. Literature generally lacks supporting precise empirical data which can be used to first, establish a general overview of the phenomenon and thereafter explain the extent and other dimensions of this practice.

Statistical data which can provide supporting evidence for agrochemical use and overuse; such as imports and consumption data, are also sketchy and in many instances data sets which record this information have reported much of the required information on Guyana either as not available, as averages or outdated. Some data is reported in aggregate form by few sources (BOS, 2009; Caricom, 2003; FAO, 2009; WRI, 2003.). The Food and Agricultural Organisation of the United Nations Statistical database reports on various dimensions of agrochemical trade and use for various nations; but has recorded widespread unavailability of data for Guyana in many instances. Aggregate data for some years is available. The Caricom Secretariat's Report on the Environment, 2003 has indicated data for agrochemical use in various Caricom states. While data for pesticide use is noticeably absent for

Guyana, data for fertiliser use has been recorded for the period 1990 to 1999. Data for pesticide use is absent from the country report by the World Resources Institute while that presented for fertiliser presents is merely an average for 1999 (WRI, 2003). The Ministry of Agriculture, Guyana, does not collect data on agrochemical use.

The lack of statistical data for agrochemicals is much more pronounced in the case of pesticides. The Food and Agricultural Organisation of the United Nations (FAO) Statistical database reports on importation and consumption amounts (tonnes) of various fertilisers and presents this data both singly and aggregated. However, similar data for pesticides is not available for Guyana in this database. This data is presented as value of imports (US$1,000). The WRI has presented data on fertiliser consumption for Guyana for 1999, but similar data for pesticides is absent. This source indicated that general lack of data for pesticides in their database was due to non-response from countries. Caricom (2003) reports on pesticide use for Caricom countries but data for pesticide use in Guyana is noticeably absent. Data for fertiliser imports is recorded by the National Bureau of Statistics bulletin in aggregate format, in value of imports (millions of Guyana dollars), but no similar data for pesticides has been presented by this source.

The best sources of secondary data for pesticides and fertilisers proved to be the FAO and the Guyana National Bureau of Statistics (GNBS) Guyana. It is data from these sources which is presented in this chapter. Imports and consumption figures presented by the FAO are primarily in aggregate format. Disaggregated import data of pesticides and fertilisers, provided by the GNBS, is presented in tables 6.7 and 6.9, respectively. Compared to the presentation of data provided by FAO, the categories of pesticide and fertilisers presented in the data provided by the GNBS are more representative of the categories of pesticides and fertilisers utilised by farmers of the study population.

6.5.1 Secondary Analysis: Pesticides

Data presented in the FAO statistical database on pesticide import values is recorded in Table 6.6, in both aggregates of pesticides and total pesticides. For the purpose of this study however, value of imports may not be the ideal data type as these values do not necessarily represent a fixed amount of the chemical, due to possible price changes. Import and consumption values may be more appropriate for evaluating trends in this study, but this format of data is presented by FAO for fertilisers and not pesticides. Data for total value of pesticide imports presented in Table 6.6 indicates a general decrease from 2000 to 2003 followed by fluctuating amounts both generally and within individual categories of pesticides.

Table 6.6: Recorded Import Values of Pesticides (US$1,000): Guyana; 2000-2006

Year	Category			
	Pesticides	Insecticides	Fungicides	Herbicides
2000	6012.00	1527.00	213.00	3759.00
2001	5847.00	1523.00	91.00	3663.00
2002	4601.00	1445.00	90.00	2481.00
2003	4295.00	1232.00	53.00	2263.00
2004	4497.00	1096.00	52.00	2736.00
2005	4548.00	1317.00	148.00	1949.00
2006	5020.00	1303.00	78.00	2791.00

Source: FAO Statistics Division 2009

Data provided by the GNBS, Guyana, for pesticide imports, was in less aggregated and more relevant form; including the main groups of pesticides utilised by farmers and the quantity of imports, for the period 2007 to 2009 (Table 6.7). Pesticides import data from the BOS revealed an overall fluctuation in import quantities for insecticides during this period. In the case of fungicides; gradual decrease was noted from 2000 to 2003, followed by a trend of fluctuating import quantities from 2003 to 2009, while in the case of herbicides increased import amounts were noted from 2000 to 2003, followed by a trend of fluctuating import quantities from 2003 to 2009 (Table 6.7). Based on the data presented by the 2 main sources, FAO and GNBS (Tables 6.6 and 6.7), no specific trends were revealed for pesticide imports, during the period 2000 to 2009.

Table 6.7: Recorded Import Quantities of Pesticides (kg): Guyana; 2000-2009

Year	Category and Amount of Pesticide (kg)		
	Insecticides for Agricultural Use	Fungicides	Herbicides
2000	458,356	29,166	421,052
2001	110,493	15,137	1,624,434
2002	143,055	8,652	2,794,036
2003	107,379	7,491	15,982,846
2004	61,715	24,976	345,595
2005	81,502	19,476	448,653
2006	93,881	9,764	530,348
2007	139,041	5,583	387,246
2008	93,355	10,163	403,300
2009	92,816	7,921	436,468

Source: Guyana National Bureau of Statistics: 2010

6.5.2 Secondary Analysis: Fertilisers

The FAO Statistical database reports on importation and consumption of various fertilisers presents data both singly and aggregated. This database has indicated unavailable data for Guyana in relation to imports amounts and consumption of most fertilisers, singly; but some aggregated data is available. Aggregated data on fertilisers for Guyana is available in categories according the type of main ingredient, namely: Nitrogenous fertilisers, Phosphate fertilisers and Potash fertilisers; reported both in import and consumption figures (Table 6.8).

Disaggregated data is available on one of the most important fertilisers utilised in arable farming; urea, with some sections unavailable. Importation and consumption data for Urea, a main fertiliser utilised in arable farming, has been presented singly for the period 2002-2007 with import and consumption figures for 2005 and 2007, respectively, reported as unavailable. Generally, trends have shown fluctuation of import amounts over the period, except in the case of potash fertilisers where gradual increase of both imports and consumption has been noted for the period 2002-2006. But this is followed by a decrease in 2007 (Table 6.8).

Table 6.8: Recorded Import Quantities and Consumption in nutrients (tonnes of nutrients) – Guyana

Year	Import and Consumption Quantities of Fertilisers (tonnes)							
	Nitrogen Fertilizers (N total nutrients)		Phosphate Fertilizers (P_2O_5 total nutrients)		Potash Fertilizers (K_2O total nutrients)		Urea	
	Import	Consumption	Import	Consumption	Import	Consumption	Import	Consumption
2002	13610*	13610**	1277*	1277**	13*	13**	20,707**	20,707**
2003	9619*	9619**	723*	723**	33*	33**	12,084**	12,084**
2004	19117*	19117**	550*	550**	508*	508**	38,183**	38,183**
2005	6180*	6180**	1601*	1601**	1500 (E)	1500**	NA	8,369**
2006	8300*	8300**	1521*	1521**	3863 (E)	3863**	10,802**	10,802**
2007	6364*	6364**	7338*	7338**	13*	13**	11,993**	NA

Source: FAO Statistics Division 2009
E = Expert sources from FAO (including other divisions); *= Official data (reported);**= Data obtained as a balance; NA =not available

Data supplied by the GNBS comprised fertiliser imports in aggregated, but more relevant format, than that supplied by the FAO; categorised by the main groups of fertilisers utilised by farmers with quantity of imports, for the period 2000 to 2009. However, examination of this data revealed that like in the general case of data presented by the FAO, no definitive trend was indicated; with fluctuations of import quantities in all three categories for the period presented (Table 6.9).

Table 6.9: Recorded Import Quantities of Selected Fertilisers (kg): Guyana

Year	Category and Amount of Fertiliser (kg)		
	Urea: Whether or not in Aqueous Solution	Super-phosphates	Mineral or Chemical Fertilisers Containing the three Fertilising Elements: Nitrogen, Phosphorous And Potassium
2000	15,197,570	1,406,186	794,554
2001	22,581,895	3,198,612	799,186
2002	20,707,189	2,176,964	-*
2003	12,084,708	1,550,000	69,590
2004	38,183,444	95,493	3,371,475
2005	8,369,039	2,429,856	257,980
2006	10,801,695	2,202,850	-*
2007	11,992,551	15,127,550	-*
2008	35,350,735	10,770,800	7
2009	13,602,250	510,540,423	415,831

Source: Guyana National Bureau of Statistics: 2010
*For these years imports not recorded

Overall, import data of both pesticides and fertilisers, reveal no specific trends, but do indicate that that a lot of imports of these agrochemicals were conducted. The general paucity of secondary data concerning agrochemical use, which can illuminate reasons for farmers' overuse practices, reiterate the general claim made by this study concerning the lack of appropriate studies which can inform on the problem of agrochemical overuse in Guyana. Lack of relevant data also substantiates the claims of this study for targeted investigation which is supported by empirical data, capable of unravelling the paradox of farmers' sustained agrochemical overuse. But while there is general lack of supporting data for agrochemical use practices and corresponding data in Guyana, this paucity seems more pronounced in the case of fertilisers. Further, previous studies conducted for Guyana revealed a bias in the reporting, with greater propensity for discussion of pesticide use. This study suggests that an overlap between the 2 practices, where the effects of pesticide overuse have the capability of downplaying those of fertiliser overuse may be the cause of this [72]imbalance.

6.6 Summary and Conclusions: The Inadequacy of Prevalence, Intensity and Significant Factors for Explaining Reasons for Overuse

Findings concerning the prevalence, intensity and the factors which were significant to farmers' pesticide and fertiliser overuse provided foundational information which was lacking concerning farmers' agrochemical practices in Guyana. However, while results of farmers' prevalence and intensity of overuse were sufficient to establish the occurrence of overuse practices, findings on factors which were significant to overuse were inconclusive regarding farmers' reasons for this practice.

Suggestions for farmers' overuse behaviour were formulated based on the significance and non-significance of factors, but establishing reasons for this behaviour was limited by the descriptive and non-explanatory nature of quantitative analysis and results. Further, based on arguments in support of the approach of this study (mentioned in chapter 1), even where factors showed significance to farmers' overuse, this linear association is not to be interpreted as the as the reason for overuse[73]. To assume that significant factors were reasons for overuse would be shallow since mere significant association could not provide the in-depth knowledge required to determine causes for farmers' overuse. Moreover, the role of causal factors in influencing farmers' sustained practices of overuse could not be explained by significance. For instance, quantitative analysis demonstrates the significance of farmers' age to their overuse practices but is limited in explaining the role of age in influencing overuse. Additionally, qualitative analysis in this study does not support this quantitative finding as farmers of a wide range of ages practiced overused these chemicals.

As previously pointed out in chapter 5, this study proposes an epistemological approach comprising an open system, which bridges the gap between positivism and constructivism; as put forward by Lemon (1973). Thus, the investigative approach of

[72] Bovell et al, 2002; Chandran, 2006; CLSS, 2005: 24; IICA/JIFSAN, 2004; Lall, 2002, Spiller and Aleguas, 2007
[73] Discussed in Chapter 1: sections 1.1 and 1.2.2

this study does not reduce any credence of quantitative investigation, but rather, points out its limitations in establishing and explaining reasons for farmers' practices. For instance, quantitative analysis demonstrates the significance of farmers' 'source-type' of information to their overuse practices, in cases of both pesticide and fertiliser overuse. Qualitative findings corroborate and explain this finding, through the roles of the support factor of disorganised information systems and the contextual factor of incapable extension services, which both explain farmers' decisions to overuse as I show in sections 7.3 and 7.4 of chapter 7. In that chapter I offer a detail interpretive framework (Figure 7.1) for understanding the roles of the various support and contextual factors. This framework will enhance the investigators' and readers' comprehension of the role of the information 'source-type' in influencing overuse.

In pointing out the limitations of quantitative investigation, for an explanatory type investigation, my study simultaneously indicates the need for qualitative investigation and supports Lemon's (1973) belief concerning the need for conceptualising the attitudes of agents. It is based on the significance of agents' understanding in providing reasons for their behaviour, that in-depth qualitative analysis was conducted for this study. The results of qualitative analysis are discussed in the two subsequent chapters.

The following chapters, 7 and 8, deal with the qualitative analytical component of this investigation and answer objectives 4 and 5. Chapter 7 discusses objective 4, which is to critically examine the explanatory factors which motivate farmers' pesticide and fertiliser overuse. Chapter 8 answers objective 5 and analyses farmers' perceptions concerning (i) the effects of pesticide and fertiliser overuse and on crop production (growth, yield, protection against disease and quality) and (ii) the potential environmental and economic effects of pesticide and fertiliser overuse.

CHAPTER 7: CAUSES OF PESTICIDE AND FERTILISER OVERUSE: CONTINGENT, SUPPORT AND CONTEXTUAL FACTORS

7.1 INTRODUCTION

> *'Misuse and overuse of pesticides are often observed in the developing countries…A clear understanding of farmers' knowledge, attitudes and practices regarding pesticide use is the first step toward understanding the reasons for overuse of pesticides by farmers'* (Huang *et al*, 2003, p8).

The sentiments expressed concerning pesticide overuse in the above excerpt, are also applicable for fertiliser overuse within this investigation, by reason of the similarity of these chemicals in their use as agrochemicals and also in the nature of their overuse revealed by this study.

Original, interpretative-type causal factors of overuse were derived from analysis of interview data. Qualitative findings of this investigation highlighted the limitations of the quantitative findings in the previous chapter and corroborated that which was posited in chapter 5, section 5.2, concerning the need for qualitative or more in-depth investigation to identify and explain the causes of farmers' overuse practices. Original results of this investigation established that causes for farmers' overuse were not those contained in previous literature and which demonstrated significance in quantitative phase, such as land tenure and others[74].

Collier, 1994 cites Bhaskar's definition of a cause as circumstances which '…so tipped the balance of events as to produce the known outcome' (Bhaskar, 1989, cited by Collier, 1994, p152). Collier cites Bhaskar's explanation that reasons, when explained within discourses, function as causes. Such explanations of reasons are analogous to causes and are also critical for providing empirical knowledge. In this study, the reasons explained by farmers are considered to be causal factors, having sufficient explanation which demonstrates their influence on farmers' overuse. Based on Bhaskar's definition of a cause, these reasons were sufficient to 'tip the balance of events', causing overuse of pesticides and fertilisers.

[74] Only one factor which demonstrated significance in the quantitative phase, proved to be influential to overuse based on qualitative investigation, and this was the source-type of information.

The interactions of contingent, support and contextual factors to influence farmers' agrochemical overuse also follow the principles of causation, explained by Sayer, 2000, critical realist conceptualisation of causation, where the causes of an event are those mechanisms or reasons (in this study) which explain the occurrence of the event. Causes are not interpreted by a regular succession of events, but rather on the identification of causal mechanisms, how they work, what is responsible for their motivation and under what conditions they are motivated. Causes are therefore explained by an interaction of structures, mechanisms and conditions. Understanding these structures, mechanisms and conditions is therefore key for explaining the role of these causes in influencing the event or outcome (Sayer, 2000). Figure 7.1 explains the causes for farmers' agrochemical overuse and depicts the interactions and roles of the various factors in determining and explaining farmers' overuse behaviour.

Causal factors of farmers' overuse comprise contingent (A), support (B) and contextual (C) factors, based on the characteristics of each group and their role in influencing farmers' overuse practices. Contingent and support factors are differentiated from contextual factors based on the presence and absence of farmers' reasoning, respectively. Contingent factors are those whose direct occurrence were required to effect the action of overuse, while support factors were not directly contingent to overuse, but sustained the practice of overuse. Farmers' reasoning was an integral part of contingent and support factors. This was emphasised by farmers' ability to explain the role of these factors in relation to their overuse practices. However, farmers' reasoning was not contained in contextual factors, as these were factors which were tangential to farmers' overuse practices, being mostly policy-related, but also integral for explaining overuse behaviour.

Contrary to suggestions made by previous studies, this investigation revealed that linear connections or reactions between factors and outcomes (pesticide and fertiliser overuse) do not explain farmers' overuse of agrochemicals. Rather, interactions between various combinations of contingent, support and contextual factors influence farmers' overuse practices. For instance, farmers' utilising their self-confidence (what they termed experience) in deciding to use over-dosages was necessary to cause overuse, but this action was supported by haphazard information (extension services) system and occurred within the wider context of incapable agricultural extension services, the latter being institutional and policy related.

Contingent factors for farmers' overuse were identified where farmers assumed dosages, farmers depended on their experience, farmers needed a marketable crop to survive, farmers demonstrated uncertainty of the information they received and where farmers received distorted information based on self interest and deception of information sources[75]. Disorganised information systems, compromised agrochemical regulations, and irregular and unregulated marketing systems were identified as support factors. Factors which defined the context within which farmers' overuse occurred were: Incapable extension services, mismatched strategies/interventions, absence of appropriate policy intervention, and adverse marketing conditions. The interaction of these categories of factors to influence overuse is explained via the following diagram.

[75] These sources were other farmers and agrochemical dealers

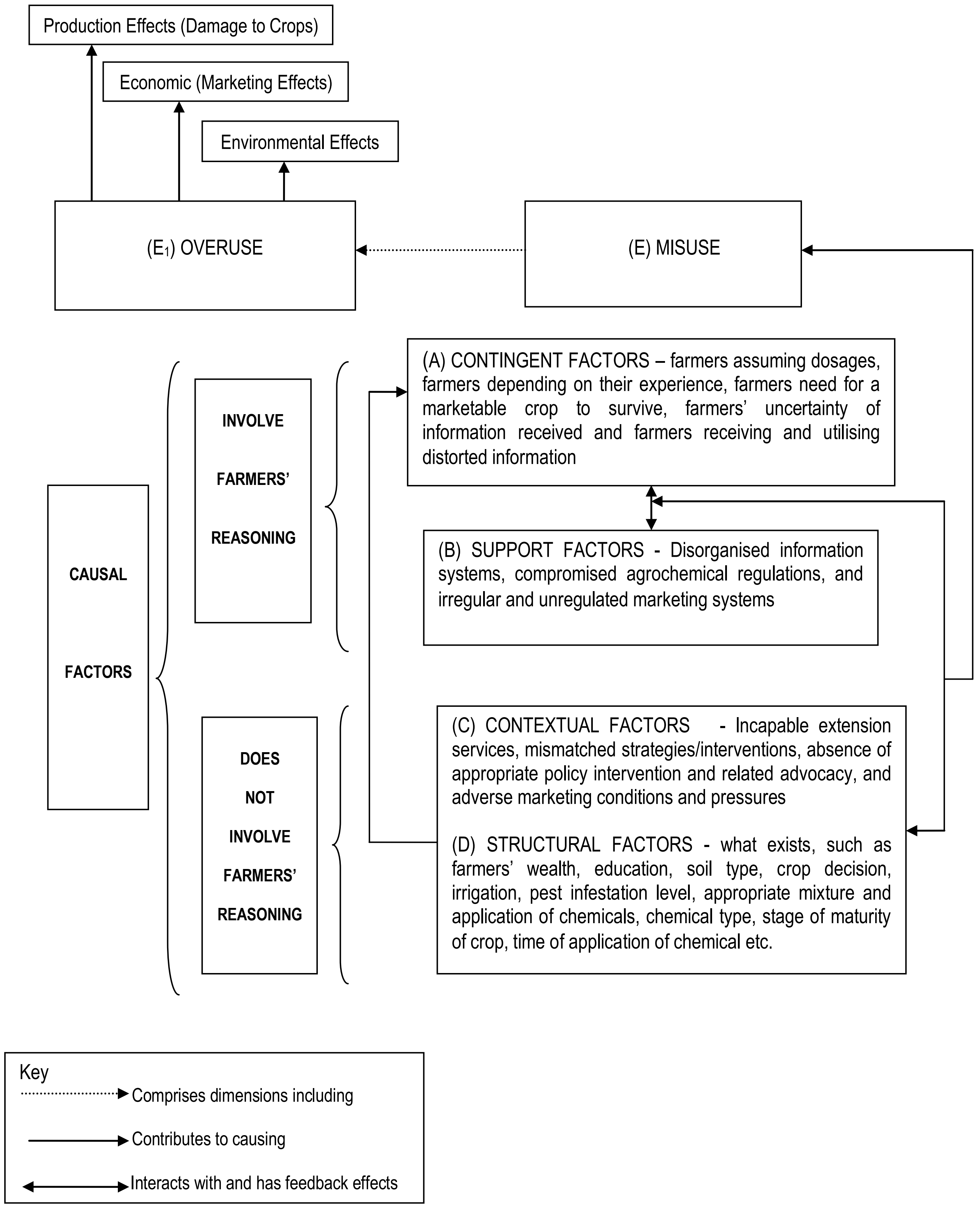

Figure7.1: Model of the Interactions of Contingent, Support and Contextual Factors in Explaining Causes for Farmers' Agrochemical Overuse

As diagrammatically represented in figure 7.1, overuse (E_1)[76] the effect or outcome of reactions between contingent (A) and support (B) causal factors, which occur within situations of contextual (C) factors. But the contextual factors within this study are the ones which trigger the reactions of the support and contingent factors. Contextual factors are primarily policy determined. Analysis therefore indicates that farmers' overuse problems result from policy-deficiencies rather than farmer-delinquencies, since both contingent and support causal factors are largely embedded within and influenced by contextual factors.

Apart from the 3 categories of causal factors identified by this investigation, structural factors (D), which represent what already existed within the farming system were also recognised as having some effect on farmers' overuse. The effect of these factors on farmers' overuse are primarily agronomic[77], hence the explanation of their role in farmers' overuse behaviour is explained by secondary literature discussed in chapter 8, section 8.2. For example, while the soil type and the level of pest infestation were integral for determining decisions of agrochemicals dosages, this study revealed that farmers' decisions on dosages were determined within a social context, explained by various causal factors.

The following sections of this chapter describe the causal factors of farmers' overuse behaviour, within prescribed categories, illustrating their role in influencing farmers' overuse practices, as explained by farmers' conversations. Main supporting excerpts are provided as appropriate. While farmer details are presented at the end of excerpts, particulars of key informants' data utilised for this chapter, are indicated within appendix 3. The role of the practice theory in explaining farmers' actions of overuse, is exemplified initially, utilising one farmer case (Box 7.1) and subsequently within discussions of the various causal factors of overuse.

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[76] Overuse (E_1) is a component of the wider phenomenon, Misuse (E)
[77] Indicative of the branch of science which involves plant production and soil science

Box 7.1 - Explicating farmers' Overuse via the Practice Theory: the case of Farmer RG

Farmers' excessive use of pesticides and fertilisers were primarily theorised through the tenets of the theory of practices, as recorded by 3 main practice theorists. Main principles of the practice theory which underpin farmers' overuse behaviour are exemplified through a partial account of farmer RG's overuse practices.

Practice theorists describe a practice as composed of mental thoughts and physical actions (Reckwitz, 2002: 243-246 and Schatski, 1996: 88-132). Reckwitz notes that the agent within the practice theory is not just a mere carrier or doer of the practice, but one who utilises both body and mental routines and possesses knowledge which equips him/her with necessary understanding and motivations required for the conduct of that specific practice. Schatski records that it is the mind/action/body integration which forms the main constituents of practices.

The concept of a practice being composed of mental thought and physical action was exemplified by farmer RG's reasoning concerning his excess use of agrochemicals. While the act of overuse was considered inappropriate, this farmer was capable of explaining his reason for adopting this practice, demonstrating the thought process which was reflected in his actions of overuse. In the case of pesticides he noted:
'I am using this (Karate) to spray (the bora plants)…I will use 2 corks to this can. This is a 4 gallon can, so it's about a cork to 2 gallons. Now the dealers will tell me to use 1 cork to the can… that is too weak. It won't work. I use according to how I see the insects and try to get rid of them.' (Male, 42 years, owns 3 acres of cultivated land, primary level education, 17 years experience, resides in Region #4).
Similarly, concerning his excess use of fertilisers, farmer RG explained:
'It is according to how the plants thrive. We might see the plants growing well and so we do not have to put so many times…but then again another time we might plant and our plants do not grow well…we have to use some common sense and see how the plants are growing and so we would not make the plants take a long time to grow… '

Farmer RG's account of his practices also substantiated the belief of the practice theorist Reckwitz, 2002: 243-246, who noted that the discourse or language of practices does not achieve mere communication, but conveys an understanding and know-how of the practice as perceived by agents. While farmer RG's previous explanation of the manner in which he decided on the dosages of chemicals, revealed uncertainty, this farmer's description of his practice also revealed his confidence in the practices he adopted.
For instance in the case of pesticides he explained:
'This thing about going by the label, I don't know for others but that small amount doesn't work, we are wasting our time to use that. We will soon see the pests again and more too. I just use the amount required to kill the pests. I think if I use after the pests die that is bad. But I use enough to make sure that the pests die. That is what I want… I use once I see a lot of them, like enough to cause 'disaster' to my crop. I put and then look to see how they (the crops) are doing and if what I put kill the pests, then I stop.'
His confidence was also conveyed in his explanation of fertiliser use.
'…sometimes I might put fertiliser…a type of fertiliser that I know is supposed to make the plant like grow or bear fruit…I would know the type…but let's say I know what I have to use but when I use it, I am still not seeing any results, that is when I know that it might need a little more…I think sometimes it is according to where the fertiliser comes from (is imported from)…some may be better than some…because some I use and have no problems…'. Farmer RG was not only capable of explaining his actions but also managed to communicate his conviction that his actions were correct, based on the outcome he desired.

In Carolan's, 2005, conceptualisation of Bourdieu's 1997: 79 and 1990: 66-67 accounts of the practice theory, the author introduces the concept of habitus as the consequence of past action, expressed by present actions. In this case, farmer RG's present use of over-dosages also finds explanation in the past actions of utilising his own resources, which were developed in the continuous absence of relevant information. This farmer explained:
'There are people (agricultural personnel) coming around but very rare in these areas. If I have a problem all I have to do is to reach an old farmer. Better than the agriculture people. Only the drugs (pesticides) they can tell me about, because they study about those kinds of chemicals… I would be told about the drugs, because I am not acquainted with all the drugs. But any problems with planting, I watch the dirt (soil) and the plants and think what to do and try this and try something else and come up with a solution.'
Even where information could be sourced through dealers, this farmer was comfortable in doing what he has done in the past, based on his habitus of deficient information. He elaborated:
…Well if you want directions they (agrochemical dealers) will give it to you. As I tell you farmers are so wise now you don't have to tell anybody what to do. Sometimes we read the label and don't even understand, but we use according to our experience...'

In conceptualising a practice Carolann, 2005 also introduced the concept of a field, which is likened to a sphere or context which defines the conditions for various practices to occur. In this case, farmer RG's decision to overuse was influenced by the sphere of conditions within which he operated. For example, in a context of unsure markets, farmer RG reasoned that overuse was necessary to have the yield which was necessary to ensure an adequate income. He explained:
'…we will see how the plants look… it is good to go by (follow) the label, but then again you have to remember that its reality…if we are planting greens (vegetables) then our greens have to give us enough money to live…we have a family to take care of… we have to make sure that the crop is giving the amount that we can sell for money…the label might just be a guide, but we who are planting have to know…'

Hence the farmers' actions, though scientifically and ethically inappropriate, are not a random series of events, but rather, carefully thought actions, influenced by and conducted within specific contexts or fields. In explicating Bourdieu's accounts of the practice theory, Carolann, 2005, proposes that fields are contested, indicating their temporal nature. The author recognises that this temporal nature allows actors to change their habitus in response to different situations. Similarly, based on the findings of this study, the problem of overuse is primarily embedded within the various contextual situations, which are mostly policy-based, but this study recommends a redress of policy as the basis for addressing farmers' overuse practices. This recommendation coincides with Bourdieu's belief of the temporal nature of fields, where changes of these fields can also influence change within actors.

7.2 CONTINGENT FACTORS

Contingent factors which explained farmers' overuse behaviour were common to both pesticide and fertiliser overuse, except in the case where farmers received distorted information based on self interest and deception of sources. Farmers' receipt and use of misinformation was exclusively causal to pesticide overuse.

7.2.1 Farmers Assuming Dosages

Interviews revealed that farmers observed the reaction of crops to the application of various dosages of chemicals, made assumptions that excess chemicals were necessary for the crop yield and protection they desired and subsequently acted on this assumption. Interview data of 20 farmers indicated that farmers' assumptions caused pesticide overuse. This was corroborated by 13 key informants. In the instance of fertiliser overuse only five farmer interviews pointed out this factor as causal to overuse and this was substantiated by 12 key informants.

For example, farmer RG theorised that over time of planting there was no need for precise adherence to instructions. He depended on his observations of crops after applications of chemicals, as a guide for the amount of fertiliser he utilised. This farmer explained:

> *'…the paper*[78] *has the amount, but then because you are accustomed to this, you do not really have to always look at what the paper says…you can average an amount in your hand and spread it around the roots of the plant...but let's say I know what I have to use but when I use it, I am still not seeing any results, that is when I know that it might need a little more…'* (Male, 42 years, owns 3 acres of cultivated land, primary level education, 17 years experience, resides in Region #4).

Key informant 8 confirmed this practice of farmers' fertiliser overuse when he expressed:

> *'Outside of the correct information, they (the farmers) will try all sorts of things and the results might be misleading, but remember that is what they see…if they notice an increase (of crops) when they put more fertiliser this is what they will believe…we try to show them that using the right stuff in the correct amount can give good results…'*

In the case of pesticides, farmer Chick explained:

[78] The written instructions found most often attached to the bag which contains the fertiliser

> *'Sometimes you buy the medicine and you spray the medicine and the medicine does not work; you have to get something else; sometimes the insecticide doesn't kill the insect…like the chemicals are coming weak now…we usually have to double the dose…'* (Male, 47 years, owns 4 acres of cultivated land, secondary level education, 19 years experience, resides in Region #4).

Key informant 1 substantiated this view:

> *'It is no secret of the 'cocktails' of chemicals that farmers use on their crops…they go according to what they see and no matter how we tell them over and over again, they depend on their observations…if to them a lot of pesticide seems to kill the pests quickly, this is what they will use…they forget all that we have told them…'*

Farmers' assumptions of dosages demonstrate one of principles of Schatski's (1996) account of the practice theory, where agent's practices are governed by what he termed orders of life, or the manner in which agents viewed their conditions and the way in which they reasoned things should be done, based on their conditions. In this case the farmers reasoned that observations were correct guidelines to decide on dosages. But literature indicates adverse effects of excessive dosages of both pesticides and fertilisers, for example, pesticide resistance and resurgence from overuse of pesticides (Wilson and Tisdell, 2001) and diminishing and negative returns, increased incidences of pests and damage to crops in the case of excessive fertilisers (Brenmer, 1995; 325; Dung et al, 2003: 15-16; Theobald and Talbot, 2002: 23; Xu *et al*, 1992).

Various studies point out farmers' use and overuse of pesticides based on their assumptions subsequent to their observations (Isin and Yildirim, 2007; Ngowi *et al*, 2007; Ntow *et al*, 2006; Palis, 1998). For instance, in a study on vegetable farmers' perception on pesticide use in Ghana, Ntow *et al*, (2006) record the farmers' timing for application of pesticides was mainly influenced by the presence of pests, while Ngowi *et al*, (2007) note farmers' application of pesticides in relation to the effectiveness of the chemicals.

7.2.2Farmers' uncertainty of the information they received

One of the prominent themes which explained farmers' overuse behaviour was their doubt of information concerning the dosages of pesticides and fertilisers to be utilised.

Farmers were uncertain that the authorised dosage rates could yield desired results such as a desired quantity of crop within a given time and guaranteed protection from pests and diseases. Farmers doubted both the prescribed manufacturers' dosages and the dosage instructions they received from other sources[79]. In many instances farmers believed that the instructions were a guide but not the authority for deciding on dosages. The causal role of this factor in farmers' pesticide overuse was indicated by 24 farmers and substantiated by 16 key informants, while for fertiliser overuse, 23 farmers revealed that their uncertainty caused overuse and this was confirmed by 12 key informants.

For instance farmer LM initially explained:

> *'…Yes we have to go by the instructions or we just would average an amount which will not cause the plant to be burnt[80]; just an average of the amount…'*, but later revealed: *'If we examine/observe the plants we might see that they are not thriving[81]; then we would interpret that the plants need some more fertiliser…'* (Female, 39 years, rents 4 acres of cultivated land, secondary level education, 11 years experience, resides in Region #4).

Key informant 9 substantiated farmers' uncertainty about fertiliser dosages:

> *'We always advise them (the farmers) to go by the directions on the label…some of them adhere but there has always been instances where others do not believe and feel that more gives a better result so they experiment…it is very dangerous…'*

In the instance of pesticides farmer DK was also uncertain concerning the dosage, as he explained:

> *'… I am using Pilarking right now and that is doing nothing…then the other medicine I bought, I mixed it strong, it burnt the Boulanger, all the bearing (fruit)…thinking that I can add a little more of the drug and the next thing you know I damage the plants…'* (Male, 24 years, owns 6 acres of cultivated land, secondary level education, 11 years experience, resides in Region #4).

Key informant 3 corroborated farmers' uncertainty of pesticide dosages:

> *'Without correct background information, farmers are unsure of the dose rates they should use…we contribute to their dilemma by giving them information which they do not understand and they do not say this…they also*

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[79] These included personnel from the extension services, pesticide dealers and other farmers.

[80] Farmers' reference to plants being burnt described scorching of the plant parts (leaves, stems, flowers etc), after application of fertiliser or pesticide in high amounts.

[81] Thriving of plants denoted their growing well or growing as desired

> *make matters worse by purchasing chemicals which are in another language, even though they are told that this is illegal…'*

Farmers' uncertainty of dosages, exemplifies the concept of 'habitus' within the practice theory as explained Carolan's (2005) account of Bourdieu's (1997 and 1990) conceptualisation of this theory. 'Habitus' is explained as the consequence of past action but expressed by present actions. In this case farmers' past knowledge which is incomplete influence or dictate their present perceptions and find expression in their overuse practices. But studies indicate that incremental applications of agrochemicals were only useful to a point, beyond which there were diminishing returns. This caused waste of these chemicals and increased cost of production (SANDEE, N.D.; Tilman *et al*, 2002).

Sources indicate that farmers' overuse of pesticides may be due to their uncertainty concerning the correct dosages. A study conducted on pesticides and productivity in Nepal revealed that while vegetable farmers spoke of using their experience for deciding prescribed amounts, they were unable to state precise dosages and estimated the amounts they used (SANDEE, 2009). In a study which analysed farmers' attitudes concerning recommended pesticide dosages, Huang *et al*, (2003, p15) related rice farmers' doubt of the label directions and technicians' advice to their overuse of pesticides.

7.2.3 Farmers' depending on their experience

While farmers demonstrated uncertainty in the fertiliser dosage they applied, it was common for them to convey self-confidence in their overuse practices. Farmers' expressed their self confidence as their capability to reconcile prescribed dosages with dose rates which they felt confident in applying. Farmers' confidence was largely guided by observation over time, which they interpreted as 'experience'. Farmers then utilised this experience for evaluating the amounts of agrochemicals to be applied and generally denied their practices of overuse because of the self-confidence they developed in these practices. This denial was not usually outright but chiefly comprised justifications by the farmers for the amounts of the chemical they chose to use. Twenty eight farmers, substantiated by 14 key informants, indicated that pesticide overuse was caused by farmers' dependence on their experience, while 12 farmers and equal numbers of key informants (12) pointed out that this factor was the also causal to fertiliser overuse.

For example, farmer RR indicated her confidence in the dosage of fertiliser she utilised:

> *'... if we throw (apply) a lot (of fertiliser) and it burns the plant we know that this amount will burn the plant; we have gained that experience; and if we throw a little and it (the plant) does not grow to the extent (as desired), we know that we have to throw a little more... the more we plant, more we gain experience…'* (Female, 26 years, rents 2 acres of cultivated land, primary level education, 11 years experience, resides in Region #3).

Key informant 1 confirmed farmers' feelings of self confidence in the dosage rates of fertilisers they utilised. He noted:

> *'Some of these farmers are accustomed to these practices…they see nothing wrong with it…they are sure that is what they are supposed to do…'*

In the case of pesticides, farmer CPG's views exemplified farmers' certainty concerning the application of excess dosages. He explained:

> *'...experience might tell you what to use, but then you have to let the plants show you how much to use…you can't say that you used 2 corks to a can last month so you will do the same this month...sometimes this month you might have to use double or sometimes even more…what I am saying is that you never really know how much you will really have to use until you see what is happening...it's long I am in this thing*[82]*...you can't do something for so long and not know what you have to do...you learn all the time…'* (Male, 62 years, rents 1 acre of cultivated land, primary level education, 8 years experience, resides in Region #3).

Key informant 10 confirmed this self confidence of farmers:

> *'...it is difficult to change what they (the farmers) are accustomed to without actually showing them that what you say will work…this is what they have been practising for years and it seems to work for them…'*

Farmers' use of self confidence in deciding on dosages, demonstrate Reckwitz's (2002) account of the theory of practice, which conceptualises that the discourse or language of practices is more than mere communication and conveys an understanding and 'know-how' of the practice as perceived by agents. In this case farmers' explanations of their practices not only related what they did but also

[82] By saying: '*it's long I am in this thing',* he means that he has been applying pesticides for a long time.

indicated their conviction that these practices were correct. But literature indicates that in spite of farmers' use of long term trial and error processes to develop solutions to problems, there is need for technical information and guidance concerning practices such as the use of agrochemicals (Cernea *et al*, 1985).

Studies record farmers' use of their experience as a guide for agrochemical use. Waichman *et al*, (2007), in a study on Brazilian vegetable farmers' understanding of information on pesticide labels, mention farmers' use of their own experience as a main source for guidance on pesticide use. This occurred due to absence of regular extension services and farmers' lack of understanding of pesticide label information. Isin and Yildirim (2007) record farmers' sole dependence on their own experience for decisions on pesticide use, in the absence of adequate information dissemination by the responsible Ministry. The authors note that while all of farmers within a study population report that they read directions for usage, only 15% of these farmers used the recommended amounts; with most farmers applying between 1 to 100% over the recommended dosages. In a study on the impact of agrochemical use on productivity and health Dung *et al*, (2003) report Vietnamese vegetable and rice farmers' disregard of extension advice to follow their own practices in the application of pesticides. The authors relate this tendency to farmers' practice of overuse.

7.2.4 Farmers' need for a marketable crop to survive

For a number of farmers, their excessive use of agrochemicals was caused by their desperate need for a marketable crop which could ensure their survival. This theme described farmers' desperate need for an assured yield which could provide adequate income to support the commitments for themselves and family. Farmers believed that the use of excess chemicals produced crops with appearance which was more desirable to consumers and thus increased their chances of sale. Key informants primarily described this factor as farmers' greed, but in my opinion, in the absence of an assured market for farmers' produce, the term 'greed' was not a true depiction. The views of 16 farmers, confirmed by 12 key informants indicated that farmers' desperation was causal to their overuse of pesticides, while in the case of fertilisers only six farmers and eight key informants indicated that farmers' need to survive was the cause of their overuse.

For example farmer RG expressed his overuse practice in relation to his daily needs. In response to my query concerning his possible use of less fertiliser than the excess he utilised, this farmer noted:

> *'...the plants would grow more slowly…with the present cost of living, one cannot afford to plant (cultivate crops) in that way.'* (Male, 42 years, owns 3 acres of cultivated land, primary level education, 17 years experience, resides in Region #4).

The views of Key Informant 1 exemplified other key informants' support of this theme:

> *'...the farmers may be facing competition in the market, especially in times of glut…'*

Farmer CP's conversation indicated her actions of pesticide overuse as a desperate action to ensure maturity of the crop in which she invested. This farmer explained her need to overuse:

> *'It depends on how heavy[83] the pests are on the plants. If it's plenty pests, we cannot wait for long because then we will lose all of our crop (the entire crop). We try (spraying) again like next 2 days. But if the pest is not so much then we can take about 3 or 4 days before we try again.'* (Female, 28 years, owns 2.5 acres of cultivated land, secondary level education, 11 years experience, resides in Region #3).

But I noted based on the label instructions for this chemical[84] there should at least be 7 days interval before applications. In response to my unbelieving expression she supplied this explanation:

> *'Remember this is our living (our means of earning); we can't sit and watch pests destroy our whole crop and 'our money in there already'* (we have already invested money).

But the views of the key informant 7 exemplified the opinions of other informants, indicating farmers' greed rather than survival attitude:

> *'They (the farmers) know that they are not supposed to overuse these chemicals…they are driven by profit…they want to make a certain amount of money…'*

On the contrary, the views of Key informant 1 indicated farmers' desperate position rather than greed:

> *'...they (the farmers) try to prevent the pest from affecting the plant at all costs…'*

[83] *'How heavy'* means: the level of infestation or how many pests are observed on the plant
[84] Caprid

Farmers' survival or desperation exemplifies Reckwitz's (2002) conceptualisation of the practice theory where practices are social structures, explained as a process involving interconnection of routine activities involving the body, mind, desires and things, all culminating in a practice. The farmers' desires obviously played an important role in their practices of overuse. They desired to see certain results; the chief one, to rid the plants of pests. This desire played a major role in their decision to overuse or not. What was different in this case is that the component of desires seemed to have a greater effect on the choice the famer took. The farmers' desires seemed to override his/her reasoning. For instance, while farmers professed to have the correct information they were still prone to overuse for a desire (specific result). But literature indicates that while incremental quantities of agrochemicals increase yields for short-term, this practice over long term could lead to decline in soil fertility and increased incidences of pest infestation, which necessitates the application of additional agrochemical inputs and increases total costs of production (Wilson and Tisdell, 2001).

While literature did not use the terms 'survival' or 'desperation', these sources indicated similar characteristics of farmers identified in this category. Prowse and Chimhowu (2007) indicate the relatively high use of agrochemicals in Vietnam as a source of exit from poverty. Isin and Yildirim (2007) in their study on farmers' perception on harmful effects of pesticides, point out that while farmers professed awareness of the recommended dosages for pesticide, based on the label instructions, they chose to use above the recommended dosages to guarantee a certain amount of yield and quality of fruit. The authors relate that farmers' knowledge of the harmful effects of overuse was secondary to their quest to prevent damage which would result in economic losses. Dung *et al*, (2003) record vegetable and rice farmers' overuse practices in Vietnam through preventive use of pesticides by applying these chemicals even in the absence of pests. The authors note that farmers primarily produce for maximum yields rather than profits. In a study which examined rice farmers' perceptions concerning insect control in the Philippines, Palis (1998) records farmers' use of pesticides as preventive action. Other literature on pesticide use in China directly relates rice farmers' perceived yield loss to their overuse practices (IDRC, 2000).

7.2.5 Farmers receiving distorted information based on self interest and deception of the sources

In some instances farmers' overuse practices were caused by misinformation disseminated to them, based on the self interest of sources. These sources comprised pesticide dealers and other farmers. Three main facets of this theme were noted: instances where dealers disseminated misinformation in the interest of having their product sold; cases of farmers maintaining secrecy concerning dosage rates and other information and instances of farmers misguiding their colleagues as a means to reduce market competition. Nineteen (19) farmer interviews indicated sources' self interest to be causal to the practice of pesticide overuse. This was corroborated by 13 key informants.

Farmer DK's views exemplified the self interest of the dealers as he explained the deception they practised to have their pesticides sold:

> *'When you go at the drugs store out there and you tell them what is the problem sometimes they will tell you to increase the dose; when you go and increase the dose now, all of the young buds and flowers, everything drops out…So when you buy the medicine and you invest the money to get something; you have nothing to get from it…'* (Male, 24 years, owns 6 acres of cultivated land, secondary level education, 11 years experience, resides in Region #4).

In the case of farmers misguiding their colleagues, farmer RG's views were exemplarily of other farmers expressing this belief:

> *'If you are new to this thing then you have to take blows (suffer losses) for a while or ask somebody you know. Its not even everybody that you ask will tell you…some don't know for a fact, but the majority of them tell you lies.'*

Along with other informants, the views of Key informant 3 substantiated the self interest of sources:

> *'Farmers mostly consult the dealers for advice on dosage rates because this may seem practical to them as they buy the chemicals there, but for the dealers this is primarily business and many times the farmers are deceived…the more of the chemical they use means more sales…''*

The explanation of key informant 5 exemplified the standpoints of other informants concerning the deception of farmers by their own colleagues:

> *'They (farmers) give chemicals when they are desperate, when they give some (chemicals) to other farmers, they do not give them enough to control all (the pests), they give them a short amount (not enough to be effective); so it will*

not be effective enough. So the farmer tells you that the chemical was not effective when he used it and he continues to do wrong. It is a ''dog eat dog''[85] *kind of world out there.'*

The theme of self interest exemplifies risk-averse behaviour in farmers, as explained the theory of the risk-averse peasant, where farmers make decisions according to uncertain circumstances and also to guarantee their well-being (Ellis, 1993; Milich and Al-Sabbry, N.D). In this case of unfavourable circumstances, such as absence of assured sale of their produce, farmers were reluctant to divulge information which could increase production among their colleagues and thus increase market competition. But literature indicates that the use of excessive agrochemicals could lead to adverse effects where residues of these chemicals, can remain in crop produce and negatively affect the marketability of produce (Baloch and Haseeb, 1998: Kotey et al, 2008).

Coinciding with reports from Guyana, authors mention the misguidance of farmers by various information sources for their own self interest. Dung *et al*, (2003, p21-22) record the coercion of farmers by vegetables dealers in Vietnam to apply the pesticide Azodrin to vegetables just prior to marketing to have produce which appear, *'...good, smooth and juicy',* despite the fact that this pesticide is extremely toxic and banned for use on vegetables. The authors also note farmers' application of pesticides on vegetables 3 days prior to harvesting. Ngowi *et al*, (2007) call attention to instances where farmers' choice of pesticides is influenced by the suppliers.

The following chapter section describes the support factors of farmers' overuse. These factors were identified as: Disorganised information systems, compromised agrochemical regulations, and irregular and unregulated marketing systems.

7.3 SUPPORT FACTORS

Support factors which explained farmers' overuse behaviour were common to both pesticide and fertiliser overuse. Interviews revealed that these factors were critical for sustaining farmers' overuse practices as they formed a link between contingent and

[85] He means a situation where each farmer is only interested in himself to the detriment of others.

contextual factors of overuse; interacting with the former and being influenced by the latter, to cause overuse.

7.3.1 Disorganised information systems

Disorganised information systems explained a haphazard mode of information dissemination by resource personnel, especially unsystematic visits to farmers and a subsequent confused manner of information dissemination. This factor was expressed by 24 farmers and corroborated by 18 key informants. Within this factor, four features [86] were noted: Abandonment, dissemination of inappropriate/abstract information, selectivity and unsystematic or haphazard information channels. Each aspect was expressed by varying numbers of farmers and key informants.

i. Abandonment

Abandonment explained the sustained absence of the correct guidance or access to relevant information by the farmer, due to incapability of extension services. Of the 18 farmers expressing this theme, farmer Sub's elaboration exemplified the feelings of other farmers:

> *'…we don't even get a field officer from them (the MOA) that comes around here… we used to, but now we don't get.'* (Male, 56 years, rents 11 acres of cultivated land, primary level education, 27 years experience, resides in Region #4).

Similarly farmer Roz noted:

> *'They (the extension agents of NARI) have stopped coming to check on us, stopped doing research, demonstration – they have stopped all of that; we have nothing doing here – like no one regards us here…they do not come into this area; Ministry of Agriculture does not come into this area too…they only make a fool of us that people are coming, but no-one comes…'* (Male, 66 years, owns 7 acres of cultivated land, secondary level education, 30 years experience, resides in Region #3).

Of the 4 key informants supporting this view, Key informant 1 explained:

> *'Farmers' claim of ''invisibility'' of extension officers is largely due to severe understaffing. We operate with just about 33% of the required staff…it is not possible for these officers to reach farmers to be effective… only 3 officers are assigned to the coastal region[87] …how visible can 3 persons be?'*

[86] Sub-themes
[87] This area has approximately 3,000 farmers

But in corroborating the theme of abandonment key informant 5 had another outlook. He elaborated:

> *'When we go to do training and we call the names of some extension officers, the farmers say: ''Who? We don't know those people'' If we ask the farmers ''Do you know who is the extension agent in the area or do you know the name of your extension agent?'' they answer: ''No''…that is the reality'.*

Literature records negative effects of farmers' lack of information. Ngowi *et al*, (2007, p1622-1623) attribute the '*almost absence of extension services and training'* to vegetable farmers' lack of knowledge in pesticide use in a study on pesticide use in vegetable farmers of Northern Tanzania. In a study on pesticide overuse in Bangladesh, Dasgupta *et al* (2007) link rice, fruit and vegetable farmers' lack of relevant information to their overuse of pesticides in developing countries. Based on analysis of farmers' attitudes concerning recommended pesticide dosages, Huang *et al*, (2003) record the prevalence of pesticide overuse among rice farmers in China, whose information concerning dosages was accessed from a variety of traditional and other information sources[88] rather than the label and extension services. Dung *et al*, (2002) link the intensive use of fertilisers among vegetable and rice farmers' in Vietnam, to their lack of appropriate knowledge.

ii. Dissemination of inappropriate or abstract information

Dissemination of inappropriate or abstract information described the distribution of information to farmers in a format which was abstract or inappropriate to their needs and understanding. Of the four farmers making this claim, farmers' JW's views explained:

> *'…well they (indicates the shops) don't have the measurements, they say use by the spoons; well if you use by the spoons and you can't get what you're looking for (desired results), you add a little more…But sometimes you add a little more and it burns the plant. So that is taking a chance, because some drugs like Karate, if you spray it on bora (string bean); it causes a kind of curled leaf…'* (Male, 52 years, rents 4 acres of cultivated land, primary level education, 25 years experience, resides in Region #3).

Farmer RG stated:

[88] Traditional information sources are: farmers' own experience, friends, relatives
Other sources are: pesticide salespersons and others

> *'Sometimes we read the label and don't even understand but we use according to experience…'* (Male, 42 years, owns 3 acres of cultivated land, primary level education, 17 years experience, resides in Region #4).

Similarly, farmer MX noted:

'We have to read the label on the bottle. And if we don't know to read the label we have to guess.' (Male, 37 years, owns 3 acres of cultivated land, primary level education, 14 years experience, resides in Region #3).

Of the 13 key informants' who substantiated this claim, the views of Key informant 3 revealed:

> *'Information does not relate to farmers' needs, it is too abstract… While some information is delivered to the farmer, the intellectual level at which this delivery is made is way above that of the farmers' level. The farmers cannot reconcile this information with their understanding and daily operation. For instance farmers are told of grams, millilitres (mls) or cubic centimetres (ccs) of products… farmers are told of scientific measuring units such as the measuring cylinder, when they measure by teaspoons and corks…'*

I observed that most farmers measured chemicals by corks or simply poured the chemicals into the spray can. In the case of fertilisers they generally used a few 'handfuls' to sprinkle around the plants, but an assessment of these formal measurements conducted by myself and field assistants indicated that they were way over the prescribed dosages[89].

In a similar case as noted in this investigation, Waichman *et al*, (2007), in their study of vegetable farmers' understanding of label information in brazil, record farmers' discouragement from reading pesticide labels due to too technical language and lack of clarity of the label information. The authors note that this leads to misunderstanding of the product information and inappropriate use. The writers also mention the irregularity of relevant information from extension services, noting the subsequent use of pesticides by farmers based on knowledge from retailers or farmers' own experience. Dasgupta *et al* (2007), mention that inadequate labelling of pesticides contributes to farmers' overuse behaviours.

[89] For instance the average farmer indicated that they complied with label instructions but observations revealed that about 2 handfuls of fertiliser was utilised. Farmers explained that they were using about an ounce of fertiliser but this was about 4 ounces. There was similar occurrence in the case of pesticides. This occurred in more that half of the cases (more than 20 farmer interviewees).

iii. Selectivity

Selectivity was utilised to explain a discriminatory nature with which some visits of extension personnel and invitations to seminars and workshops were conducted. Of the 13 farmers expressing this theme, farmer MK's comments were exemplary:

> *'Some farmers are invited to the workshop... even if they (the Ministry of Agriculture) have big workshops, like at Pegasus, they choose farmers. I know farmers from this area who were chosen and when they go (attend); they say nobody is coming at their field to learn nothing from them.'* (Male, 58 years, owns 6 acres of cultivated land, primary level education, 24 years experience, resides in Region #4).

Similarly, farmer Sub's views substantiated the discriminatory visits of extension personnel:

> *'...like the field assistant comes; 2 or 3 farmers might make friends with him and when he comes he just goes to them and he goes back…he just drives in and goes to the one man whom he knows; that man gives him little information and tells him everything is alright with everybody; that's it…they 'talk talk' and they're gone.'* (Male, 56 years, rents 11 acres of cultivated land, primary level education, 27 years experience, resides in Region #4).

Also in relation to the visits of extension personnel, farmer RR sarcastically explained:

> *'There are ''special people'' that come into this backdam (back of the village) and go to ''special people''; further down, like if you go towards Namryk; ''those people'' might be able to tell you.'* (Female, 26 years, rents 2 acres of cultivated land, primary level education, 11 years experience, resides in Region #3).

Five (5) key informants substantiated this selectivity and explained reasons for this behaviour. For example Key informant 1 noted:

> '*What farmers may look at as being selective in the way we operate, is the manner in which we have to train based on the staff we have…this does not mean that they are left out of the picture, but group training is done and this is then disseminated by the agents whom we train…'*

But upon enquiry I found that there was no monitoring conducted to assess the effectiveness of this dissemination strategy and some farmers blatantly indicated to me that they would not share information based on a similar attitude by others. [90]
Key informant also substantiated selective behaviour of information sources and stated:

[90] For example farmer MX explained to me: *'A lot of them (farmers) come to me to know what drugs to use; like when things are eating their plants they don't know; some of them come to me and ask. Who I care to tell, I will tell and who I don't care to tell, I will tell that I don't know.'*

'…what we have been doing in some cases is establishing trials using the Farmers' Field School (FFS) approach... in some areas like Parika they might tell you that is what we used to do, but now it is different…you'll find that, and that is where farmers' groups come in…you can do some of these things for individuals but if you have them in groups that is where I find success, wherever the groups are operational…'

But of the 6 farmer groups pointed out to me across the two study regions, only one was functional; where I met and interacted with farmers. Hence it is doubtful whether this strategy can be effective, in the absence of functional farmer groups.

In a study concerning technology adoption in paddy farmers of Iran, Bagheri *et al*, (2008) demonstrate the selective use of limited extension activities for small groups of farmers (rural extension agents). But the authors note that these agents were not active in information dissemination as was expected; thus depicting failure of this selective system as indicated by farmers in Guyana. The authors pinpoint the need for selection and training of farmers who demonstrated willingness to function as contact farmers. On the contrary, Barrera *et al*, (2005) record success in selective farmer training and subsequent information dissemination from trained farmers to others, through the Farmer Field School (FFS) method, in a study on adoption of Integrated Pest Management (IPM) technologies among potato farmers of Ecuador. The authors however, note that quality of the information disseminated was not assessed.

iv. Unsystematic or haphazard information channels

Unsystematic or haphazard information channels described an unstructured network of information which was available to farmers. This factor was identified by 21farmers. For instance, farmer Vib indicated the occasional visits of agricultural officers:

'The thing is like when they are coming in; they don't notify anybody; they come 'on the spot' (unexpectedly/unannounced…' (Male, 48 years, owns 16 acres of cultivated land, secondary level education, 12 years experience, resides in Region #4).

Farmer Bud substantiated this claim by indicating an unorganised manner of obtaining information. Initially he indicated:

'I normally go to the drug store and ask ...well people pass on information here, what you can use for the fungus, then you go to the store and ask for the type of drugs, according to the kind of information that you get…like from other farmers you seek information concerning pests and those things. Where I

> *grew, I experienced most of the knowledge I have for farming…'* (Male, 65 years, rents 3 acres of cultivated land, primary level education, 30 years experience, resides in Region #3).

Seven (7) key informants substantiated the mechanism of Unsystematic or haphazard information channels. Of these, Key informant 1 revealed:

> ' *The group training method is adopted, as in this way it is far more possible to reach more farmers…This type of training is not of the best…it is not sufficient or the best way, but it is what is possible for the moment…it depends a lot on what the farmer-agent reports.'*

Key informant 7 stated:

> *'For farmers to say that they have no one to talk to or they see no one is not completely true…in some areas there are limited extension services…the limited visits of extension officers are not a function of the officers themselves, sometimes they have cars but cannot get to the very remote areas to conduct visits…'*

However, the views of key informant 5 substantiated farmers' expressions and my observations[91]. This informant revealed:

> '*Well do you know how they[92] are meeting now? It's at a common meeting place like under a tree outside of someone's place; that is how they are meeting…'*

He later exemplified disorganisation of the extension information sources:

> *'The coordinator for Region X arranged training for Friday when the farmers were going to market, no-one turned up…there are some people out there who are performing, but some just have a laid-back attitude… '*

Literature connects farmers' inappropriate practices to delinquent information sources. Dasgupta *et al*, (2007) links farmers' lack of information in developing countries to their overuse of pesticides. Similarly, in a study which examined pesticides and productivity, in vegetable farmers of Nepal, farmers' overuse of pesticides was associated with lack of appropriate information (SANDEE, 2009). Huang *et al*, (2003) link rice farmers' pesticide overuse practices in China, to inadequate extension services and the lack of information on the impacts of pest diseases. The authors advocate strengthening of the local agricultural extension system. Tilman *et al*, (2002)

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[91] I was invited to one of these meetings, which was intended to be a spree. The agent declined to assist in organising the event which seemed strange to the others as it was clear that this was a regular event.
[92]Referring to extension agents' meeting with farmers

note the need for effective extension service activities to promote the efficient use of fertilisers. Other literature on rice farmers' overuse of pesticide in China suggests the education of farmers concerning proper pesticide use as a means of reducing farmers' pesticide use (IDRC, 2000).

7.3.2 Compromised agrochemical regulations

Compromised agrochemical regulations was more applicable to the case of pesticide overuse and described a system where laws concerning the sale of pesticides and fertilisers were either non-existent or not enforced, permitting the adoption of lawless sale procedures by dealers. This mechanism was indicated by 19 farmers and confirmed by 18 key informants. Three (3) features of this mechanism include (i) pervious and inappropriate law or regulation; where illegal chemicals were introduced into the system: (ii) inappropriate retailing systems; where farmers were often the recipients of unsuitable chemicals, including those which were prohibited, expired and not suited for the desired purpose and (iii) Irregular supply and price of chemicals (including absence of price control for chemicals); which fostered indiscriminate pricing systems. Explanation of the various facets of this support factor gives a clearer understanding of its role in influencing farmers' overuse practices.

i. Pervious and inappropriate law or regulation

Farmer RG was one of 8 farmers whose views indicated a system of pervious and inappropriate law. He explained:

> *'Most people don't go to chemical places for drugs (pesticides). So many people and places are selling drugs...even from Suriname...it's just like when you're going to buy food...'* (Male, 42 years, owns 3 acres of cultivated land, primary level education, 17 years experience, resides in Region #4).

Similarly, farmer MK elaborated:

> *'They (the pesticide authorities) say some of the drugs are not working (not effective) that come 'back-track' (illegally) from Suriname, and we use the same drugs; we get the drugs cheaper from Suriname; it come 'back-track' (illegally) and they don't pay duty; we get the drugs cheaper…and when you check the drugs, it's the same work its doing… the Karate does not kill*

fish…but the Bestac kills fish'[93]. (Male, 58 years, owns 6 acres of cultivated land, primary level education, 24 years experience, resides in Region #4).

Illegal import of pesticides and some of the associated dangers of this practice were supported by 6 key informants, but the views of some informants revealed unawareness of current trends. Information from Key informant 1 exemplified the incidence of pervious laws:

> *'There are many illegal chemicals sold to farmers by the dealers…farmers themselves support this illegal activity because the chemicals are sold at a cheaper rate…they (farmers) are told that these chemicals are not appropriate, but they persist and even encourage the dealers in this practice…'*

Key informant 5 however thought that this trade was now restricted and explained:

> *'For the past 1 to 1.5 years the chemical services are no longer offering these chemicals (illegal chemicals) for sale. We have been monitoring them and searching. There is a heavy 'clamp down' (restriction) on illegal trade from across the border. Now we are working with the pesticides personnel from that end (Suriname), so the trade is like from approximately 30% to 5%.'*

But Key informant 10 substantiated farmer MK's explanations, that this illegal trade was simply conducted in a more discreet manner, rather than being restricted. He explained:

> *'Now we do have a problem in that a lot of stuff (agrochemicals) comes across the border from Suriname. The PTCB has done some work in trying to seize it, but it has gone underground, what used to happen before, these guys (dealers) would bring it and have it on their shelves. They don't do that now since the PTCB 'tighten up' (commenced seizing). What they are doing is going directly to the farmer and they keep it in their storage facility. So it is a problem because generics*[94] *are coming out of China and everybody knows that it does not have the quality…The percentage of Active ingredient (AI)*[95] *that they're supposed to have is not there.'*

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[93] This corroborates the concern of key informants in relation to the toxicity of illegal chemicals which the farmers use. For example the Agriculture Manager of Geddes Grant Guyana explained: *They (the farmers) want the stuff from Suriname. Why? Because it is cheap, but they don't know the damage they are doing to the environment, the crops and themselves.'*

[94] Non-original formulations of the products

[95] Active Ingredient (AI) of a chemical is the chemical which will kill the pest, the other ingredients are inert ingredients which are added to the pesticide formulation for purposes other than pesticidal activity such as diluting the pesticide, making it easier to mix or handle or for preservation purposes.(US, EPA: http://www.epa.gov/opprd001/inerts/ and National Pesticide Telecommunications Network (NPTN): http://npic.orst.edu/factsheets/formulations.pdf

Four (4) farmers and local literature[96] substantiated that this trade is still vibrant. An experienced farmer, Roz, explained the procedure of purchasing to me, exemplifying effects of the illegal sale. He elaborated:

> *'There are DC, B and D (agrochemical dealers) at Parika; 3 of them. When you go to buy drugs from them its like when you go into the drug store and ask for a drug like Panadol etc. and they will give it to you; you have to know what it is. Similarly, when you go for a drug for your garden, you have to know how to use it. None of them (sellers) can tell you how to use it or what it is good for. This is one of the problems farmers are reaching (encountering). Most of the drugs (labels) are in Spanish or Dutch, because they come from Suriname and people do not understand it, so they don't know what to use and how to use it.'* (Male, 66 years, owns 7 acres of cultivated land, secondary level education, 30 years experience, resides in Region #3).

Farmer DK substantiated this claim:

> *'…one of my concerns is that they (the importers) are bringing drugs to use in Guyana and I can't understand, sometimes they bring drugs with the label; no English, at least not everybody knows Spanish. How can you know how to use it and those things?'* (Male, 24 years, owns 6 acres of cultivated land, secondary level education, 11 years experience, resides in Region #4).

In my opinion, the persistence of illegal pesticide sale was partially the fault of farmers, who were aware of the illegal nature of this activity but purchased the chemicals because they were less expensive. For instance Farmer MK noted:

> *'The chemical board says any chemical comes in this country without English writing did not come legally...Parika gets a lot of stuff from Venezuela.'* (Male, 58 years, owns 6 acres of cultivated land, primary level education, 24 years experience, resides in Region #4).

However, this farmer's excerpt just previously demonstrated his support for this illegal trade, citing less price and increased potency of the illegal pesticides as advantages. I noted, based on recent newspaper reports, that illegal imports and sale of pesticides are ongoing in Guyana[97].

Various authors link farmers' inappropriate pesticide use with inadequate regulatory systems. Baloch and Haseeb, (1998), in reporting on agrochemical use in Pakistan, mention inadequate pesticide control regulations as one of the reasons for the adverse effects of pesticides. Dasgupta *et al* (2007) note farmers' overuse of pesticides in

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[96] This was substantiated by farmers – RG, MK, DK and Roz. Local literature is located within the appendix 3.
[97] These reports are located within appendix 3.

Bangladesh, within an environment of ineffective implementation of pesticide regulations. Similarly, other literature links farmers' overuse of pesticides with weak regulatory enforcement (SANDEE, 2009).

ii. Inappropriate retailing systems

One of the nine farmers who reported inappropriate retailing systems was farmer CS who highlighted the sale of expired chemicals:

> *'...lot of things when you buy and are using it; at the time when you buy these things...sometimes I buy things and don't even check it. Sometimes when I use it and see like I am not getting the result from it ...I might say; let me check the date, sometimes its expired drugs (pesticides), it done expired for a whole year and I am still using it...'* (Male, 35 years, owns 1.5 acres of cultivated land, secondary level education, 16 years experience, resides in Region #4).

In answer to my disbelief he continued:

> *'That's what I am telling you; sometimes now I am looking out saying alright these things (pests) will die when I spray...but tomorrow I go back it's the same insects watching me there again; but when I check the date now, the thing (pesticide) expired a whole year; its not a month, a whole year.'*

Farmer CS gave a possible reason for the dealers' sale of expired chemicals:

> *'...it's the price; you see everybody is holding for price and these things leave stick up in the shelves (are not sold)...'*

Two (2) other farmers were utilising expired chemicals which they knowingly bought from the dealers and gave full accounts of the details of the sale and reasons for their practice[98].

Farmer MK also corroborated the unscrupulous retailing systems. He explained the dealers' coercion for farmers to purchase chemicals which were substitutes. These substitutes were ineffective or high-priced.

> *'Here is what he (the dealer) will say – as soon as you say white flies and you don't have Carpid[99], he says ''substitute'' and he hands you quickly – ''this will help'' - and don't you want a cure? You will buy the medicine, and he calls a (high) price for it...because he wants to sell it.'* (Male, 58 years, owns 6 acres of cultivated land, primary level education, 24 years experience, resides in Region #4).

[98] These conversations are located in the appendix – 7.2.1 and 7.2.2

[99] Caprid – an insecticide which is commonly use to control the pest, whitefly

Six (6) key informants substantiated farmers' claims of inappropriate retailing systems, but more importantly, their support of these illegal activities. Of these Key informant 1 revealed:

> *'There have been some reports of inappropriate methods of retailing, like no instructions and also in unlabelled containers, but farmers have not been proactive in avoiding these types of sale patterns…rather they support it…it's only when something offends them that they will speak…'*

Key informant 5 corroborated this view:

> *'They (farmers) are supposed to report this (labels not in english language) to us…but you see how it happens, these people (farmers) have a close relationship with their vendors and the vendors tell them how to use it (the illegal chemicals). So they will still buy it and they will tell you that they can't read it and they will not tell us anything, because they know if they tell us we'll move in (seize the chemicals).'*

Key informant 7 also substantiated claims of inappropriate retailing.[100] I also observed that farmers supported these illegal activities.

The Stabroek Newspaper of Guyana reported seizure of pesticides from unlicensed vendors, where inappropriate retailing was evident. Pesticides and other undetermined products were contained in beverage and other unsuitable bottle types.[101] Literature records farmers' support of inappropriate retailing systems for various reasons. Huang *et al*, (2003) reveal the use of 'fake' pesticides which had low quality and lacked the desired effectiveness, among rice farmers of China. The authors note that farmers lacked preference among the various brands of pesticides and linked their overuse practices to the use of low quality pesticides. Matthews *et al*, (2003) in their study on pesticide application in the Cameroon, among farmers of various crops, note farmers' preference for less expensive pesticides, even though these products were less suitable for pest control. Dasgupta *et al* (2007) record the sustained sale of controversial pesticides by Bangladesh pesticide suppliers.

iii. Irregular supply and price of chemicals (including absence of price control)

[100] This account is located within the appendix – 7.3

[101] Stabroek Newspaper, March 20, 2008: http://www.stabroeknews.com/2008/stories/03/20/illegal-chemicals-seized-in-east-coast-exercise/

Fourteen (14) farmers explained the occurrence of irregular supply and price of chemicals, which fostered indiscriminate pricing systems. Of these, farmer Too elaborated:

> *'We use Caprid for the white fly; and we are not getting the Caprid now...the white flies make you have to leave it (crop) because of the medicine[102]. For the last 2 weeks we checked all about - all at chemicals store and so on …we did not get the medicine…when they do bring it now…its $6,000 for a pint…anybody can sell for anything because there is no control over the price…Sometimes a medicine comes and it might be sold for $5,000-$6,000; lets say it gets scarce; it will raise $5,000 more…sometimes they have the medicine and they will tell you that it is scarce, and they tell you they have about 2 bottles and call a high price …you want it so you have to buy it…'* (Male, 43 years, owns 3 acres of cultivated land, secondary level education, 11 years experience, resides in Region #4).

Farmer Yas corroborated this indiscriminate activity:

> *'The Government should hold a higher responsibility for bringing in (importing) these type of chemicals then they could sell it at a cheaper rate. But these people that are selling this thing; they bring a small amount; when it is scarce, their price gone up…They prefer to say they don't have - (they say) ''…why don't you go and check that man there'' (another dealer) …and when you go 'bap' price up'*. (Male, 50 years, owns 8 acres of cultivated land, secondary level education, 15 years experience, resides in Region #4).

Farmers' views of irregular supply and price of chemicals, and indiscriminate pricing systems were substantiated by 7 key informants. For instance Key informant 2 explained:

> *'The import, supply and pricing of chemicals is not governed by the Ministry of Agriculture…at times there seems to be some scarcity and farmers have complained of fluctuation in prices…'*

Key informant 3 noted:

> *'Farmers do complain of chemical prices and scarcity but this is not governed by the MOA; while there may be some investigation, this aspect concerns the importers and dealers…'*

Dealer 4 stated: *'Yes, chemicals (pesticides) are scarce many times...'* while Dealer 9 substantiated: *'It (scarcity) happens a lot, especially in the case of pesticides...'*

Authors link the lack of appropriate regulations and supply of agrochemicals to farmers' overuse practices. In a study on pesticide residue levels in vegetables in

[102] Pesticide

Ghana, Kotey *et al*, (2008), associate inappropriate regulatory pricing and supply of pesticides, with farmers' overuse of these chemicals. The authors note that lower cost and ready availability of older pesticides which are restricted or banned make them attractive for purchase by poor farmers within a system of lax regulations. Similarly, Ntow *et al*, (2006), in their study on vegetable farmers' perceptions on pesticide use in Ghana, explained farmers' use of inappropriately retailed[103] pesticides, which were less suited for pest control and linked this practice to farmers' inability to purchase larger quantities.

7.3.3 Irregular and unregulated marketing systems

Irregular and unregulated marketing systems portrayed an intricate system which supported farmers' overuse. Both export and local marketing systems were unpredictable. Farmers were not assured of sale and price of their produce and this fostered overuse. Farmers believed that overuse of chemicals assured them of a crop which would attain maturity and was marketable. Un-assured markets also encouraged unhealthy competition and promoted deceit among farmers. This mechanism was expressed by 23 farmers and substantiated by 11 key informants.

Two main features of irregular marketing systems were noted. In the case of foreign markets, farmers believed that these markets were assured and there was no need to use excess chemicals to produce crops in a highly competitive and unsure environment. Deterrents to export markets included unattainable quality and irregular sale. Farmers viewed export procedures as tedious, stringent[104] and unstable processes, which involved much investment with possible losses. Hence farmers preferred to supply the local market. This feature was expressed by 15 farmers and supported by five key informants. In the case of local markets, farmers expressed haphazard domestic arrangements where irregularity of these markets was primarily characterised by random sale of vegetables to various middlemen. It was therefore imperative that they produced crops which had marketable features and this required

[103] Pesticides were retailed in smaller amounts in other containers in Ghana; this is also similar in some cases reported for Guyana
[104] Importing countries demand quality standards based on Sanitary and phytosanitary requirements which includes residual testing to determine the levels of agrochemicals in vegetables.

the use of excess chemicals. This facet was indicated by 21 farmers and confirmed by 10 key informants.

i. Export risk and unattainable quality

Of 15 farmers who expressed export risk and unattainable quality for foreign markets, farmer CPG explained:

> *'....you see the people outside (foreign markets) have standards that they tell you from the beginning and you have to meet those standards or you will not get market…but you will get a better profit, because if you know that your goods will be sold then you do not have to fight up to make them grow fast and you don't have to worry about getting them looking big and good; because you already have your market …but with all this 'fight down' (competition) on this (local) market you have to try all things you know*[105] *to make sure you have some type of greens (vegetables) that can look the best in the market….otherwise it's no sale…'* (Male, 62 years, rents 1acre of cultivated land, primary level education, 8 years experience, resides in Region #3).

Farmer Chet's views supported those of farmer CPG:

> *'...it is a lot of work and ... money to make the crops come (grow) how the outside markets (foreign markets) want them, because they are accustomed to a certain quality…I don't mind them wanting quality, that is good, but…a farmer cannot plant and use all that money and 'don't know' (cannot be certain/is not assured) if the things will sell outside (abroad)…'* (Male, 42 years, rents 6.5 acres of cultivated land, primary level education, 4 years experience, resides in Region #3).

My conversation with farmer CP explained farmers' general wariness of export markets, in relation to their overuse practices[106].

Five key informants substantiated farmers' fear of export risk. Key informant 1 indicated:

> *'Some farmers do not get recognition as exporters…they do not reach the required standards because of their preferred traditional methods of planting which produces sub-standard products…'*

Key informant 6 substantiated this belief:

> *'Meeting the required export standards seems to be unattainable for many farmers…'*

[105] This includes the use of excess agrochemicals
[106] This conversation is elaborated within the appendix – 7.4

However, the views of Key informants 3 and 7, respectively, were closer to those conveyed by farmers. Key informant 3 explained:

> *'Many farmers see export arrangements as hassling…they cannot cope with all of the bureaucracy involved… they are also not assured of a price and do not know when they will get paid…'*

The views of Key informant 7 supported those of her colleague:

> *'Many farmers view the export procedure as tedious and unrewarding after all the input which they have to invest to meet required standards…'*

ii. Haphazard domestic arrangements

Twenty one farmers expressed haphazard domestic arrangements, with irregular sale of vegetable produce to unspecified markets. Farmer MK explained the mechanics of this system:

> *'Let me explain; like when this crop has demand, when its scarce, we can decide a price because its scarce – you are the buyer, I am the seller, I will say; like bora, I want $600, the seller will settle for $500 or between $500 to $600. But now like when the crop is cheap; you can't decide a price because he doesn't know what will happen when he goes to the market... that's the thing; the fluctuations in the price for the things; sometimes its 'sky-rocketing' (very high price) that you can't even buy to cook and then all of a sudden everybody has to eat because its ''next to nothing'' (very cheap)* (Male, 58 years, owns 6 acres of cultivated land, primary level education, 24 years experience, resides in Region #4).

Farmer DK substantiated these views:

> *'Right now at Mahaica market…I carried 1 and it was left there; it didn't sell…when you carry them and they are left 'stick up there' (unsold); what you will do with that?'* (Male, 24 years, owns 6 acres of cultivated land, secondary level education, 11 years experience, resides in Region #4).

Ten (10) key informants upheld farmers' views concerning haphazard domestic marketing arrangements. Key informant 1expressed:

> *'Farmers are largely responsible for seeking their own markets. The NGMC is of some help but this is mostly facilitation'.*

Similarly, the Key informant 2 stated:

> *'Farmers generally seek their own market with some export assistance from NGMC…'*

Key informant 3 confirmed:

'Farmers are largely responsible for making contacts with vendors or middle men concerning the sale of their produce'.

The General Manager of NGMC, Guyana corroborated the absence of defined marketing systems and informed:

'GMC, as you would know, is not involved in the purchase and resale of farmers' produce; rather GMC facilitates the marketing process through marketing services which includes match making (linking buyer and seller).'

Authors have associated unregulated marketing systems with farmers' overuse of agrochemicals. Dung *et al*, (2003) describe an unregulated marketing system in Vietnam where the time of harvesting was dependent on vegetable dealers. The authors note farmers' deviation from pesticide use recommendations in this system by harvesting produce immediately after pesticide application to meet market demands. Wilson and Tisdell (2000) link inappropriate pesticide use to problems of market failure, in their report on farmers' persistence of pesticide use despite environmental, health and sustainability costs.

The influence of the support factors (disorganised information systems, compromised agrochemical regulations and irregular marketing systems) on farmers' overuse of agrochemicals, exemplifies elements the rational choice theory, where human beings (actors), when faced with various situations, make decisions which yield the most rewarding results (Boudon, 1998; Denzin, 1990). In this instance, farmers are faced with various situations[107], which they rationalize before making decisions to overuse. Farmers' rational thoughts are exemplified by their explanations and justifications for overuse these chemicals, in situations which could not assure them of reliable information, appropriately priced chemicals and assured markets. Farmers' ability to explain the choices they made in these circumstances also substantiated Reckwitz' (2002) conceptualisation of practices as bodily routine actions which are influenced by mental thoughts. However, literature indicates that while farmers' choices to overuse may yield short-termed befits, long term losses are evident (Thrupp, 1991; TWN, 2010).

[107] Disorganised information systems, compromised agrochemical regulations and irregular marketing systems

7.4 CONTEXTUAL SITUATIONS

Contextual situations were characterised as circumstances or conditions which were tangential to farmers' overuse practices, but not displaying a contingent or support role to overuse. Nevertheless, they were integral for comprehensive explanation of farmers' overuse practices. Pilot interviews revealed that these situations were best known and explained by key informants, who were primarily responsible for the implementation and management of the systems in which these situations operated. Thus for this study, key informants were considered as the authorities for knowledge concerning these situations. While farmers expressed knowledge of some of these situations, this investigation relied on the accounts of key informants for identification, explanation and authenticity of contextual situations. Major contextual situations of farmers' overuse were identified as: Incapable extension services, mismatched strategies/interventions, absence of appropriate policy intervention and adverse marketing conditions.

7.4.1 Incapable extension services

Incapacity of the extension services described a condition of inadequate and tardy services offered by the department. This circumstance was identified by 17 key informants. Major features of this condition included those of understaffing, indicated by eight key informants; uncompetitive salaries, pointed out by five key informants; limited technical capability, mentioned by six key informants; unstructured training beset by budgetary constraints and lack of proper monitoring and evaluation, indicated by six key informants.

i. Understaffing

Eight key informants reported on situations of understaffing, which influenced farmers' overuse behaviour. The following examples are noted.

Key informant 1 explained:

> *'…this department (the CLSS) is equipped with 1/3 of its required staff…we need approximately 462 staff members, but currently operate with 151…'*

Similarly, Key informant 3 revealed:

> *'…the ratio of extension officers to farmers is ridiculous…so the type of monitoring that is required cannot be done…'*

Key informant 7 stated:

> *'…farmers have lost faith in the extension services because at some point they were not getting extension services…this loss of faith is also because of fluctuating quality of the extension service offered…'*

ii. Limited technical capability

Of the six key informants who mentioned limited technical capability of the extension services the Key informant 1 gave a detailed explanation:

> *'The department has suffered and continues to suffer from loss of institutional memory. A large number of extension staff members have retired and there is a gap for experienced workers…the extension officers are not necessarily trained in agrochemical use…our extensions agents are not specialists in agrochemical use but they benefit from some training from time to time as far as possible…mostly by the PTCB and if they are invited like to training by these agents.'*

However, in answering my probe on the regularity of this training which extension agents received, he indicated:

> *'… this (training) is not routine, it's as it come along…'*

Key informant 2 substantiated views of limited technical capability of extension personnel, noting:

> *'The extension officers are not like specially trained in pesticide and fertiliser use, but they learn over time, especially after spending many years in the field…'*

Key informant 5 had a similar view:

> *'Extension agents basically have a diploma. They are not an authority on any particular crop and they are paid to oversee many crops. They are not that good, over 15 years maybe they would be competent…so we have to go back to research…the agent gets his briefing then he can explain to the farmer…so if there is a similar incident he has learnt something, that is experience…'*

In my opinion, since there was '*loss of institutional memory'* as key informant 1 noted, it is questionable how many officers actually remain in the job for an extended period to gain relevant experience and develop the required capability in the area of agrochemical use.

iii. Unstructured training plagued by budgetary constraints and lack of appropriate monitoring and evaluation

The views of the Key informant 2, appropriately explained the situation of unstructured training offered by the extension services which was plagued by budgetary constraints and lack of appropriate monitoring and evaluation. This informant indicated:

> *'Training (on agrochemical use) is based on observations in the field and we gear programmes to address practices that they (the farmers do). They (the farmers) respond to training once it is planned according to how they would have it according to their schedule…We have constraints and some delays especially in demonstrations so we need to plan well in advance because sometimes funds are not available so we might need to collaborate with other people (organisations).'*

I noted severe staff shortages and interviews revealed that the extension service personnel are hardly 'visible'; rendering this service ineffective. Hence it is highly unlikely that observation of practices can be appropriately conducted to assess their representativeness of farmers' behaviour. I also realised, based on interviews, that there was no report or evaluation which assessed farmers' response to training in light of subsequent successes and failures. The views of key informant 3 corroborated my deduction:

> *'…the involvement of farmers whenever we have training suggests that they appreciate the training, but the MOA falls down in monitoring…when farmers leave we do not follow up to clarify and reinforce…they (the farmers) are also much deprived of relevant information…like the much more expensive new chemicals which are more effective, but farmers continue to use the older less expensive chemicals which are not so effective, so they use larger dosages…'*

Key informants 5 and 9 confirmed that budgetary constraints were a deterrent in some instances to dissemination of relevant information to farmers. The former noted:

> *'We also have a news-letter…this is distributed at the training sessions but we do not have the resources to print a large quantity…' 'Training is as required. We have programmes based on budget…we train about 800 farmers per year. That is our training for which we have funds...'*

Key informant 9 explained:

> *'What we find is the extension officers (of the MOA) do not have a budget that they can work with. While they have a budget, they can't spend as they would like to for field days and so on…'*

iv. Uncompetitive salaries

Key informants indicated that uncompetitive salaries of extension officers' reduced the motivation of these personnel to function effectively. The ineffective functioning of extension personnel, negatively affected information dissemination to relevant farmers. Key informant 2 revealed:

> *'Salaries are not at all attractive…this does not motivate staff to work at their best…but the department has been trying…'*

Key informant 3 confirmed this belief:

> *'Well the salaries, you know...I don't have to tell you about that…it is difficult to perform...'*

Key informant 7 agreed that the relatively small salaries of extension agents caused lack motivation in these agents and also encouraged the disrespect of farmers. This informant revealed:

> *'...farmers make money…they know the salaries of government officers and there is lack of respect…'*

While key informant 5 corroborated the issue of unattractive salaries, the view of this officer was divergent:

> *'It's a chicken and egg situation…they (the extension agents) say ''well I'm not paid so how will I deliver?'' They should show their performance first then discuss money…'*

Authors link inadequate extension services to agrochemical overuse. Ntow *et al*, (2006) link inadequate training of farmers with their poor knowledge of pesticide use, including application rates, and note the need for targeted training concerning pesticide use. Kotey *et al*, (2008) associate deficiencies within the extension services to farmers' overuse of pesticides in Ghana. These authors note that farmers' supplies of pesticides from these services were severely limited when compared to other sources. Other literature recommends adequate agricultural training for farmers as a means of reducing pesticide overuse (IDRC, 2000).

7.4.2 Mismatched interventions

The circumstance of mismatched interventions explained a situation where strategies to combat the issues of agrochemical overuse were founded on decisions of unsound investigation or assumptions. These strategies therefore lacked adequate assessment and displayed a high degree of disconnection between the existing reality in the field and the strategy utilised. This circumstance was pointed out by 18 key informants and is supported by main features of: (1) mismatched information dissemination strategy, which is indicated by all (19) key informants and characterised by: 'pilot farm' and 'farmer-agent' instruction, dissemination of inappropriate/non-credible information, and the use of a business oriented information dissemination strategy, especially by agents and dealers and (2) inadequate laboratory services which are mismatched to current needs, which was pointed out by five key informants.

i. Mismatched information dissemination strategy

'Pilot farm' and 'farmer-agent' instruction

Key informants 1 and 2 exemplified mismatched information dissemination strategy. These sources explained that 'farmer-agent' training was the current strategy used for farmer training. The latter source explained:

> *'Some (farmers) need individual attention but the MOA's focus in on group efforts. That (individual attention) is just for cases of emergency. The focus of extension service is on groups…'*

Key informant 6 explained:

> *'…what we will be doing now is equipping people, the groups and so on with simple equipment like a pH meter…we would be doing training with them on how to use it and interpret it…the groups and the extension people will have them readily available…'*

Key informant 7 also stated:

> *'The focus for training I think is now group oriented…in this way more farmers can be reached…'*

It was intended that selected farmers would be trained and these farmers would disseminate their knowledge to their colleagues. But interviews revealed that information was not readily distributed through extension services, farmer groups were not functional and farmers displayed great secrecy in disseminating information. The views of Key informant 3 corroborated my scepticism of these dissemination strategies, as he speculated:

> *'…another thing is that group and this ''farmer agent'' type of training is currently done, but the question is, how effective these strategies are?'*

Business oriented information dissemination strategy

Key informants' explanation of mismatched information dissemination also revealed that agrochemical agents utilised a business-oriented strategy for disseminating information concerning agrochemical use to farmers. While agrochemical agents claimed to be main sources of information to farmers, interviews revealed that dissemination of this information was conducted primarily in the interest of the agents, for the promotion of sales. Key informant 1 noted:

> *'The agrochemical agents are trained and provide training, but this type of training is biased towards sales and does not necessarily represent the interest of the farmer…'*

Similarly, key informant 5explained:

> *'The agent would train their dealers in their particular chemicals so they can give better recommendations. We are not a part of that.'*

Detailed explanations of the 3 main agrochemical agents regarding their strategy of information dissemination to farmer substantiated the views of key informants.[108]

Dissemination of inappropriate/non-credible information

Key informants revealed that even the limited information which was disseminated to farmers was frequently conveyed in a manner which was inappropriate for effective farmer learning. This information was often mismatched and not credible. Key informant 3 explained:

> *'A more dynamic methodology of transfer of information to farmers is required...the information given to farmers does not match the farmers' needs in many instances...the information which we give to farmers needs readjusting to suit their literacy level…'*

Key informant 6 noted:

'Based on the test we would make recommendations…in the absence of the soil tests we tell them to use the general recommendations that we have in the farmer's manual…'

However, my perusal of the farmers' manual indicated that the level of writing was above the average farmers' literacy level. Further, of the 38 farmers interviewed only five were aware of the farmers' manual.

[108] Full conversations are located within the appendix; section 7.5

Key informant 9 explained the process of pest identification and subsequent farmer recommendation which was done by this company.

> *'…we try to meet farmers' needs…if a farmer calls and says I have this problem...we ask them to bring a sample and try to go through it with whatever information we have. We have some books with common vegetables and their diseases and pests. The pests problems are quite simple…than the viral which are more difficult…if we cannot be sure on that one, the broad spectrum chemical will take care of it, because we have no laboratory facilities so it's difficult to identify…'*

Based on this explanation there is therefore no surety that farmers are supplied with the correct information.

ii. Inadequate (mismatched)laboratory services

Key informants' views demonstrated the mismatch between the services currently offered by the pesticides laboratory as opposed to the exiting needs. While the current advice and training offered by this facility is good, there is urgent need for the laboratory to conduct testing of vegetables for chemical residual levels.

Key informant 2 noted:

> *'The pesticide laboratory is functional but services are mainly advice on the safe use of pesticides, like what is required versus what is not required…'*

Key informant 3 shared the same belief:

> *'The laboratory is expected to function in a way that will curb these practices, you know through residual tests…but that seems a little way off...I think staff is problem and I am not sure about the equipment, there may not the relevant ones as yet…''*

The statement Key informant 5 confirmed both of these views:

> *'But as soon as this laboratory becomes functional and we take samples....'*

However, no specific date was supplied for the commencement of residual testing.

7.4.3 Absence of appropriate policy intervention

Absence of appropriate policy intervention described the lack of policy involvement to address the issues of overuse. Specific instances included: (1) the absence of active government control in importation and dissemination of agrochemicals and related information, despite prevailing issues; (2) the presence of a structured system of disseminating information on agrochemical use in the traditional sector, versus an unstructured system in the non-traditional sector; (3) absence of regulation governing the required capability of dealers and extension agents to appropriately inform farmers; and (4) the non-mandatory registration of farmers and maintenance of diaries. All fostered ineffective monitoring.

i. Absence of government control in importation and dissemination of agrochemicals and related information

The observations of Key informant 1 exemplified other informants' views concerning government's lack of involvement in importation and dissemination of agrochemicals. He noted:

> *'Long ago like over 10 years back the Ministry used to have some responsibility in the dissemination of agrochemicals but that is not the mandate of the Ministry now...that is in the hand of the private sector…the PTCB regulates the importation according to what is accepted and prohibited…'*

Key informant 3 explained:

> *'Input suppliers present chemicals to farmers for sale and these suppliers are driven by profit…there is the absence of a strong ''watch dog''*[109] *such as the Ministry of Agriculture in these matters…also a lot of chemicals banned from other countries are approved for here (Guyana); this is hypocrisy…Just imagine with all that is happening, almost anyone can stand at a counter to sell pesticides and fertilisers… farmers are not bound to get registered…some of them do not wish to give their simple details, yet they complain....'*

Similarly, key informant 7 reported:

> *'We (relevant authorities in Guyana) have no proper system of monitoring in place at sea ports and the airport…it might be better to conduct trials on these illegal chemicals rather than banning or dumping them…there is more need for dissemination of related information to the general public…the Ministry of Health (MOH) and MOA need to collaborate to produce health programmes to educate consumers'*

ii. Structured system of disseminating information on agrochemical use in the traditional sector, versus an unstructured system in the non-traditional sector

The views of Key informant 5 represented those of other informants as he revealed a structured system for disseminating information on agrochemical use within the

[109] Monitoring agency

traditional sector, as opposed to a haphazard system within the non-traditional sector. He explained:

> *'Other than the main ones (agrochemical agents) most of the others are linked to GUYSUCO…they are tendering…'*[110] *'We are working with GRDB on a project to do training for GRDB farmers and we developing a Rice training manual…it is an all comprehensive manual including fertiliser application, pest recognition, pesticide categorisation and use and safety in use…We work along with GRDB in the FFS and do pesticide aspect training for them…'*[111]

There was no such system for the non-traditional sector. Key informant 2 indicated:

> *'From time to time we link with the agrochemical agents for staff and farmer-training.'*

I noted however, that no structured training was conducted.

The key informants of 2 agrochemical agents confirmed bias in the conduct of quality control between traditional and non-traditional sub-sectors. Key informant 10 revealed:

> *'We use the relevant authorities in rice or sugar (industries) to test the product. So once GRDB tests the product they will use their extension officers once they are satisfied that it confirms to exactly what we said or the manufacturers said it would do. We would then push it (the product) commercially and their (GRDB) extension officers would also be transferring the technology in the field.'*

Key informant 9 also explained:

> *'We have trials going on with GRDB in this current rice season, it's just a matter of agreeing on the budget….then we work with Guysuco in terms of supplying samples which we think can add benefit to their industry…'*

No similar occurrence was identified within the non-traditional sector. Rather, when key informant 5 was questioned concerning the laboratory which is responsible for quality control of this sub-sector, this source noted:

> *'We are preparing for accreditation…we have nothing in place but we have a bright future…'*

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[110] The Guyana Sugar Corporation (Guysuco) was linked to most of the agrochemical agents who supplied agrochemicals and necessary training for stakeholders

[111] The Guyana Rice Development Board (GRDB) regularly employed the agrochemical agencies to conduct structured training for its stakeholders

iii. Absence of regulation governing the required capability of dealers and extension agents to appropriately inform farmers

The views of key informant 2 supported those of other informants who related the lack of regulatory guidance concerning the qualification of dealers:

> *'There is no law that says what qualification a dealer must have to tell farmers of pesticide and fertiliser practices…I guess it is expected that at least they (the dealers) will know the basics… from experience and some training and so on…'*

Key informant 8 also noted:

> *'We have sales agronomist…they are not expected to be experts but whatever knowledge is required they have the managers as a resource to get that knowledge.'*

iv. Non-mandatory registration of farmers and maintenance of diaries

The explanation of key informant 2 substantiated those of other informants' regarding the non-mandatory registration of farmers. This source related:

> *'Registration (of farmers) is currently not mandatory but plans are currently in place to change that…they (farmers) will soon have to register…'*

Key informant 7 also noted:

> *'It is generally not mandatory that farmers keep a diary but for those farmers which exporters visit this is a necessity…'*

In the absence of records which indicate farmers' general practices, including their use of agrochemicals, it is difficult to establish farmers' inadequacies and provide relevant instruction accordingly.

Literature cites the importance of appropriate government policy to address issues of inappropriate agrochemical use. Tuormaa (1995), in a study on adverse effects of agrochemicals on health, mentions that government policy should be designed to motivate farmers to adopt practices which reduce high use of agrochemicals. Literature also links the development of management technologies to the reduction of pesticide use (IDRC, 2000). Ngowi *et al*, (2007) associate the deficiency of extension instructions and poor pesticide policy with farmers' inappropriate pesticide use, while Palis (1998), in a study conducted on the perceptions of rice farmers, concerning insect control in the Philippines, notes the need for appropriate training strategies to influence farmers' perceptions and subsequent change of high pesticide usage. Baloch and Haseeb, (1998) record the importance of adequate laboratory facilities and corresponding residual testing to ensure the safety of foods with respect to acceptable residual limits, while Kotey *et al*, (2008) note the importance of residual monitoring for production of safe agricultural produce.

7.4.4 Adverse marketing conditions

Characterised by the absence of forecasting and dependable contractual arrangements, adverse marketing conditions and pressures explained the extensive state of unfavourable marketing conditions in both export and local contexts. This situation was indicated by nine key informants. In the case of export markets, four key informants mentioned unfavourable marketing conditions which included the absence of long- term agreements on quotas and prices and quality restrictions by importing countries. These conditions increased competition from other exporting countries. For the local market, four key informants pointed out adverse marketing conditions, explained by the absence of a definite marketing structure, including lack of appropriate forecasting and infrastructure for the sale of vegetables.

The views of key informant 3 exemplified those of other informants and indicated unfavourable export marketing conditions, where conditions of trade were beyond the capacity of the MOA. He revealed:

> *'There is no real marketing forecast in place…farmers are often advised to plant certain crops only to be let down after they have invested so much…but then this is also a function of external marketing conditions…sometimes we (Guyana's exporters) are not very competitive and then there is the case of sanitary and phytosanitary regulations, which is difficult to maintain with all the chemical residues and so on…'*

His conversation indicated cases of rejected export crops, due to overuse practices by farmers.

> *'Residual tests have indicated the presence of chemical residues on farmers' crops…bora (string bean) was one such crop...there have been isolated cases where produce sent overseas was tested and dumped…residue testing was not done here (in Guyana) before they (the crops) were exported…'*

Key informants 2 and 3 indicated the absence of a domestic marketing structure and infrastructure respectively. The former explained:

'Marketing is mainly supported by the NGMC, but as far as I know this is primarily guidance for export and pricing, it does not include like ensuring sale of farmers' produce…farmers have to be proactive in the sale of their produce…a lot depends on the farmers themselves…prices are mostly regulated according to supply and demand.'

Key informant 3 noted:

'Farmers plant and do not even know where they will market their produce, can you blame them sometimes for their actions?...They get desperate sometimes…they need to eat and pay their bills also…they have families to take care of…'

The views of key informants 1 and 7 representative conveyed adverse conditions for both export and domestic markets. Key informant 1 explained:

'We (the Ministry of Agriculture) cannot guarantee farmers a market. New GMC tries to arrange markets for farmers but this is not their mandate. Much of it relates to bilateral agreements between countries and this is highly competitive. Also they (NGMC) cannot sell all of the farmers' produce.'

Key informant 7 noted:

'Marketing is mainly a farmer initiative…GTIS[112] *did have a market-led programme but this was mainly with farmers having money and whose system of production did not pose many problems in finding markets…'*

Literature reveals the absence of regulatory control by the relevant agricultural authorities in both external and internal marketing systems in Guyana. The General Manager of the NGMC indicated:

'The price of farmers' produce in our market today is determined by market forces (demand, supply, quality, delivery, packaging, terms of payment, etc). There is no price control or price fixing that is done by the Ministry of Agriculture of GMC' (SN, 2009a).

Authors confirm the effect of marketing conditions on inappropriate agrochemical practices. Dung *et al*, (2003) indicate farmers' tendency to utilise cheaper and more dangerous pesticides due to market liberalisation. Ntow *et al*, (2006) associate farmers increased use of pesticides with their need to meet consumers' required appearance of produce and attain desired yields of produce.

[112] The Guyana Trade and Investment Support (GTIS) Project, is a joint project of the Government of Guyana and the U.S. Government which provides support to enterprises, private sector organizations, and government institutions to identify new markets for Guyanese products and increase exports to regional and international markets. (http://www.competitiveness.org.gy/implementation/gtis)

The effect of diverse contextual situations (Incapable extension services, mismatched strategies/interventions, absence of appropriate policy intervention and adverse marketing conditions), on farmers' overuse of agrochemicals exemplify Carolan's, (2005) account of Bourdieu's (1997) conceptualisation of a 'field' within the practice theory, where 'fields' may be likened to spheres of specific principles which define conditions for various actions. In this case, the sphere of policy related contextual situations, defines the circumstances within which the farmers overuse actions are encouraged. Carolann, (2005) notes, that fields are contested indicating their temporal nature. Contested fields influence change and allow actors to also change their response to different situations. Similarly, this study proposes in the concluding chapter that a redress of policies which influence change in the contextual situations that influence overuse, is key for motivating change in farmers' overuse of agrochemicals.

7.5 SUMMARY AND CONCLUSIONS: OVERUSE; EXPLAINED BY LINEARITY OR INTERCONNECTEDNESS?

This findings of this investigation challenged what was indicated by previous studies, that farmers' overuse of agrochemicals was due to the single influence of factors such as farmers' land tenure status and education level. Rather, the results of this study indicate that it is the interaction of various factors which encourage, support and provide an enabling environment for farmers' overuse practices. These factors were sufficient to explain the reasons for farmers' practice of overuse, in this study as causes or causal factors for farmers' overuse of pesticides and fertilisers. Causal factors were categorised as contingent, support and contextual factors, based on their role in influencing farmers' practices of overuse, as revealed by interviews. A causal model, which depicts the interactions of the various categories of causal factors is presented in section 7.1 of this chapter.

An example of farmers' causes for overuse, explained by the interaction of carious causal factors or reasons is hereafter exemplified. Farmers assumed and were motivated, based on their observations, that excessive dosages of pesticide and fertiliser were necessary for assured protection of crops against pest attack and increases of crop produce, respectively. These assumptions which were contingent for overuse were strongly supported by disorganised information systems. Within these support systems farmer visits by the extension services were haphazard, or in many instances absent and the disseminated information was abstract and inappropriate. This interaction of farmers' assumptions and a disorganised information system occurred within a context of incapacity of the extension services, where the capability of the department was hindered by issues of understaffing (qualitative and quantitative) due to uncompetitive salaries.

Findings therefore reveal that it is the interconnectedness of contingent, support and contextual factors which explains the reasons for farmers' sustained overuse, rather than the linear effects of single farmer of farm unit factors. Based on this interaction of factors, a matrix[113] was developed which delineates each category of factors but simultaneously demonstrates the interactions of these categories to effect farmers' overuse of agrochemicals. The following chapter which analyses farmers' perceptions concerning their overuse practices presents information which complements and enhances the understanding of farmers' reasons for overuse, explained in this chapter.

[113] This matrix is located within appendix 3.

CHAPTER 8: FARMERS' PERCEPTIONS OF PRODUCTION, ENVIRONMENTAL AND ECONOMIC EFFECTS OF PESTICIDE AND FERTILISER OVERUSE

8.1 INTRODUCTION

> *'Farmers' decisions to adopt a new agricultural technology depend on complex factors. One of the factors is farmers' perception'* Bagheri *et al* (2008, p1384).

> *'While pesticides are generally considered a panacea for farmers' pest concerns, farmers' perceptions and use of the chemicals have not received much attention'* Ntow *et al*, (2006, p356).

The previous chapter examined causes for farmers' agrochemical overuse through identifying and explaining the roles of contingent, support and contextual factors which influenced farmers' overuse practices. According to literature, farmers' perceptions are also key for understanding their decision processes in the practices they adopt. Understanding farmers' reasoning provides guidance for appropriate interventions. Various authors note the significance of farmers' perceptions in formulating strategic solutions to address agrochemical abuse (Dasgupta *et al*, 2007; Insin and Yildirim, 2007; Ntow et al, 2006; Palis, 1998). For instance, in their study on pesticide overuse among fruit and vegetable farmers of Bangladesh, Dasgupta *et al*, (2007, p92) notes that: *'...a clear understanding of farmers' perception of risk and pesticide application behaviour is necessary in the design of any policy intervention.'*

This chapter analyses the perceptions of 38 farmer respondents concerning the potential crop production, environmental and economic effects of their pesticide and fertiliser overuse practices. Evaluation of farmers' perceptions is based on the belief that understanding the farmers' standpoints is significant for discovering knowledge gaps and other factors which affect farmers' thought processes and influence their overuse practices. Understanding farmers' perceptions is therefore an effective tool for formulating meaningful interventions, which can influence farmers' behavioural patterns. In this study, farmers' perceptions revealed some of their key beliefs regarding the effects of their overuse practices, which subsequently influenced their decisions to overuse. While farmers' actions were guided by their beliefs, literature presents standard agronomic[114] guidelines for agrochemical use.

The chapter commences with an explanation of the agronomic approach in which pesticides and fertilisers should be utilised. This explanation, in conjunction with other relevant literature which agronomic perspectives of agrochemical use, is utilised to highlight the similarity and disparity between farmers' beliefs concerning agrochemical use and overuse and the scientific or agronomic approach which is recommended for appropriate use of these chemicals. Analysis of farmers' perceptions primarily reveals deviation from the recommended agronomic practices which guide the appropriate use of these chemicals.

The analysis of farmers' perceptions is presented according the categories and sub-categories investigated: (i) the effects of pesticide and fertiliser overuse and on crop production (growth, yield, crop protection against disease and quality) and (ii) the potential environmental and economic effects of pesticide and fertiliser overuse. In some instances farmers believed and expressed more than one of the main perceptions noted within a specific category. Farmers' beliefs are discussed and correlated with findings from various literary sources; demonstrating both substantiating and conflicting views and simultaneously highlighting corresponding literature from authoritative sources. A detailed tabular account of farmers' perceptions is presented within appendix 4.

Farmers' beliefs concerning crop production (growth, yield, crop protection and quality) revealed firstly, their primary belief that the use of excessive pesticides was not relevant for crop growth, while excessive fertilisers increased the growth rate of crops and caused faster maturity of plants. Secondly, in terms of yield, most farmers believed that the use of excessive pesticides was not relevant to crop yields while using excessive fertilisers was necessary for increased crop yields. Thirdly, in the case of crop protection, most farmers felt that the use of excessive pesticides was necessary for crop protection where the recommended dosages seemed ineffective, while the use

[114] That branch agriculture which specialises in the technology of crop production (including crop growth and development) and soil science: http://en.wikipedia.org/wiki/Agronomy; http://www.ncl.ac.uk/undergraduate/course/D444/Agronomy.

of excessive fertilisers was not of relevance to crop protection. Fourthly, in relation to quality, all respondents believed that excesses of pesticides and fertilisers affected the quality of vegetables, through reduced shelf life.

Regarding environmental effects from overuse, most interviewees believed that the use of excessive chemicals was not likely to result in negative environmental effects because of two main reasons. In the first instance, farmers believed that these chemicals were removed by water sources such as rain or during irrigation of crops, since water from these sources complemented by non-stagnant waterways was capable of washing away any excess chemicals. In the second case, farmers believed that while excessive amounts of pesticides and fertilisers were utilised, these chemicals lacked the required potency to cause environmental harm.

In relation to economic effects of pesticide and fertiliser overuse, marketing was utilised as a proxy for assessing these effects, due to farmers' lack of records. Perceptions revealed the primary belief of farmers, that excessive use of pesticides and fertilisers was more likely to affect export markets causing loss of these markets, but this was not likely for local markets. The main reason cited was the routine testing for chemical residues in vegetables which was conducted by importing countries, but which was absent locally.

This chapter concludes by discussing farmers' perceptions in association with the causes which encouraged farmers' overuse. This discussion sets the stage for preliminary identification of areas for interventions, which are later comprehensively addressed within the final chapter. The following table presents the characteristics of the farmers whose excerpts are utilised within this chapter.

Table 8.1: Specific Interviewees Particulars

Pseudonym	Age (years)	Land Tenure Status	Area Cultivated (acres)	Experience (years)	Education Level*
REGION 3					
JW	52	Rent	4	25	P
VB	24	Rent	2	11	S
Gov	43	Own	1.5	18	P
Sur	29	Rent	4	6	P
RR	26	Rent	2	11	P
CPG	62	Rent	1	8	P
CJ	18	Own	1.5	7	S
REGION 4					
RG	42	Own	3	17	P
LM	39	Rent	4	11	S
Ren	49	Rent	3	20	S
BD	68	Own	1	25	S
MT	65	Rent	5	25	P
JA	56	Rent	9	16	P
DR	61	Own	6	19	S
NW	36	Rent	3.5	7	S
Sub	56	Rent	11	27	P
Ash	40	Rent	3	12	S
Vib	48	Own	16	12	S

Source: Source: Field Survey Data; Guyana – 2008/9
*P – Primary level and lower; S – Secondary level and higher

8.2 An Agronomic Approach to the Utilisation of Pesticides and Fertilisers

This study demonstrates farmers' use of pesticides and fertilisers in an indiscriminate manner based on various causes discussed in the previous chapter 7. While the focus of this investigation is not the agronomic factors which address the appropriate use of agrochemicals, a vast amount of literature explains this scientific manner and role in which these chemicals should be utilised and function respectively, highlighting the appropriate use of these chemicals for achieving maximum effectiveness.

In the previous chapter, causal factors of farmers' overuse of agrochemicals demonstrated that their decisions for the use and subsequent overuse of these chemicals were primarily conducted within a social, rather than agronomic context. But literature indicates that the use of agrochemicals should be ordered by agronomic-based factors such as soil type, soil nutrient status and crop type, in the case of fertilisers and factors of pest type, pest infestation level, appropriate choice of chemical (chemical type), appropriate mixture and application of chemicals, stage of maturity of crop and time and mode of application in the case of pesticides.

Concerning the use of pesticides, literature indicates that the type of pest is one of the main factors which guide the kind of pesticide to be utilised by farmers, as pesticides differ in physiological composition and demonstrate varying levels of efficacy against specific pests. Knowledge concerning the mode of action of different pesticides is important for selection of the most appropriate pesticide to utilise. This is significant for achieving maximum effectiveness against the pest and also for preservation of non-target organisms, including humans (Graham-Bryce, 1977; NSA, N.D.; Willoughby, *et al*, 2004).

The use of pesticides also requires identification of beneficial organisms. If these organisms are present in sufficient numbers, control may be possible without pesticide application. The preservation of beneficial organisms is important in pest control since destruction of these organisms is often the cause of subsequent increase in pest populations (Graham-Bryce, 1977; Oerke, 2006). Spraying pesticides at low levels of pest infestation can cause wastage of these chemicals and also reduce the chances of the pesticide reaching the pest. In some instances prophylactic treatment [115] is recommended, but this is for selective cases such as soil and seed treatment (Graham-Bryce, 1977), and not in the manner practiced by farmers in this study, where chemicals were applied to plants in the absence of pests as preventive treatment. In the presence of beneficial organisms, the preferred type pesticides are those which are least harmful to these organisms (Graham-Bryce, 1977; Newman, 2002; NSA, N.D.; Willoughby, *et al*, 2004: 33).

Pest populations and the severity of damage also guide whether there is need to apply pesticides and the also the amount to be utilised. Where pest populations are below the economic threshold levels[116], there may not be the need to utilise pesticides for pest control. Additionally, the level of pest infestation in relation to the stage of development of the crop is an important guide in ascertaining the possible damage of

[115] Treatment applied before infestation commences

[116] The threshold concept guides the use of pest control measures and the amount or frequency of pesticides to be applied, based on acceptable economic and ecological levels. For example crop losses may be acceptable, not requiring the use of pesticide (Oerke, 2006: 31, 42).

the pest and the need for pesticide application (Graham-Bryce, 1977; NSA, N.D.; Willoughby, *et al*, 2004: 33).

Pesticide resistance is an important issue in the use of pesticides which is directly related to the appropriate choice of pesticide dosages. While chronic pest infestations[117] may require repeated applications, the same pesticides, or pesticides from the same family of pesticides must not be utilised, as this practice fosters pest resistance (Graham-Bryce, 1977; NSA, N.D.; Oerke, 2006). The issue of pest resistance is critical for utilisation of correct dosages. Pest resistance to applications of chemicals often misleads farmers to believe that the pesticide is ineffective, predisposing their actions of overuse, though increased frequencies of applications or higher concentrations of the chemicals. In some instances the use of adjuvants or additives[118] may be necessary to maintain or increase the effectiveness of pesticides, but in this study only 3 farmers recognised this need and utilised adjuvants (Solun, 2003; Willoughby, *et al*, 2004).

Information concerning the persistence or residual action of pesticides is also critical to use of correct dosages as more resistant products exert longer periods of activity against pests. On the other hand, a pesticide of lower persistence is desirable when applications are conducted close to harvesting period (NSA, N.D.; Willoughby, *et al*, 2004). Pesticides are also subjected to more rapid detoxification if applied during sunlight, which reduces their persistence (Newman, 2002). As farmers in this study did not observe this phenomenon, this may be one of the reasons that in some instances, pesticides seemed ineffective in their opinion.

The timing of pesticide application is important for achieving effectiveness of these chemicals. Inappropriate weather and soil conditions are likely to cause drift or direct wash-off of pesticides into the nearby waterways or into the soil. To minimise this risk, applications of pesticides should be avoided during inappropriate weather such as heavy rainfall or windy conditions. The timing of pesticide application is closely connected to the method of application and influences the amount of pesticide which

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[117] Those pest infestations which occur throughout a crop season
[118] Substances which are used in conjunction with pesticides to increase the efficacy of the pesticides

can be drifted away from the area of application (Solun, 2003; Willoughby, *et al*, 2004).

The method of applying pesticides directly relates to dosage rates. Certain types of pesticide application equipment are more suitable for the application of some types of pesticides and also for regulating the required size of droplets. For example, spraying equipment require calibration for appropriate application while some specific types of sprayers or nozzles are recommended for the application of some pesticides, as the droplet sizes regulate the dosages of these chemicals. The speed at which the operator walks while spraying the chemical is also important for dispensing appropriate dosages within the target area (Graham-Bryce, 1977; NSA, N.D.; Solun, 2003; Willoughby, *et al*, 2004). But farmers in this study utilised equipment based on availability, rather than appropriateness, hence the hand operated lever-type knapsack sprayer was mostly utilised. Adjustment of droplet sizes and pace of walking during pesticide application were also not observed by farmers.

Pesticide characteristics such as the mobility and volatility are also important factors which influence the efficacy of pesticides. Mobility and volatility influence the movement of these chemicals from the site of application. The mobility of a pesticide depends on the pesticide formulation and conditions of the application site. The main pesticide characteristics which influence the mobility are water solubility, rate of adsorption into the soil and persistence of the pesticide. Information concerning the mobility of individual pesticides is generally presented on the product label for compliance. The volatility of pesticides indicates their rate of evaporation. Volatile pesticides are those which quickly evaporate if applied during hot and dry weather. These pesticides then redeposit in other locations such as waterways. This risk can be minimised by avoiding the application of volatile pesticides when the air temperature is above 25ºC (Solun, 2003; Willoughby, *et al*, 2004). But farmers in this study did not indicate knowledge of these facts.

In the instance of fertilisers, the main guidelines for use include the soil type, soil nutrient status and crop type. These guidelines in turn provide specifications concerning the type of fertiliser to be utilised, the quantity or rate of application, the timing of application and the method of application (FAO, 2005; TFI, N.D.; Theobald and Talbot, 2002). Literature records that:

> *'Fertilisers applied in an agronomically sound way are critical in achieving maximum crop production, while at the same time reducing nutrient runoff potential and improving water quality'* (TFI, N.D.).

Prior to the use fertilisers, an analysis of the soil type and nutrient status is recommended to ascertain the specific amounts of which nutrients are required for optimal performance. Fertilisers are intended to supply the deficit of nutrients as indicated by the soil analysis. The amounts of each nutrient required provides a guideline to the type of fertiliser, which is best suited to provide these nutrients. In some instances more than one type of fertiliser may be required to supply the nutritional needs of crops. The type of crop and stage of maturity also guides the type of fertiliser which is best suited for efficient growth, as nutritional needs vary according to crop types. The time of application of fertilisers depends on the type and growth stage of the crop, to ensure that the required nutrients are supplied when most needed, for example at growing or fruiting stages (FAO, 2005; Girard: 2010; NCSU, 2002; Nurmakhanova, 2006; TFI, N.D.).

The method of application of fertilisers is also according to the type of fertiliser being utilised. For example granular type fertilisers can be manually applied while liquid types can be applied via irrigation systems. The method of application is important for fertilisers to be in the correct location, for use by plants when required. It is recorded in literature that incorporating inorganic fertiliser with organic fertilisers is useful for preventing nutrient loss by erosion and nutrients being volatised (NCSU, 2002; TFI, N.D.).

However, findings from this study indicate a series of interacting choices which resulted in farmers' overuse of fertilisers. In the absence of appropriate training and guidance, farmers' choices of fertilisers were first influenced by the price and availability of these chemicals, resulting in the use inappropriate types. In instances where farmers chose fertilisers according to the crop type or growth stage of the crop, required dosages were not calculated according to the directions supplied, but rather, based on their observations. In these cases, the lack of desired results was interpreted by farmers as ineffectiveness of the chemical, which necessitated the addition of incremental amounts or dosages. However, authors point out that the use of some fertilisers at high dosages for increased yield (for example nitrogen fertilisers) can result in diminishing and negative returns (Dung *et al*, 2003; Theobald and Talbot, 2002).

While farmers' non-observance of agronomic factors for the use and subsequent overuse of agrochemicals was not the primary focus of this investigation, acknowledgement of the role of these factors in famers' overuse practices, highlight and corroborate some of the main findings of this research, which reveal the need for redress of educational (training) policy concerning agrochemical use. Generally, very few farmers[119] indicated their knowledge of these scientific phenomena, and thus could not apply this knowledge for the conduct of appropriate practices. The following sections of this chapter present farmers' perceptions concerning their overuse practices and discuss these within the context of appropriate use, highlighting the need for redress of educational policy will ideally include targeted and sustained training of farmers in the appropriate use of agrochemicals.

8.3 The Effect of Overuse on Crop Production: Farmers' Standpoints

> *'There is a wide debate on the contribution of pesticides to crop production (e.g., reducing losses)…a large number of literature show that chemical pesticides have significantly reduced pest related crop yield losses. On the other hand, there are also a substantial number of literature that show the negative impacts of chemical pesticides'* (Huang, *et al*, 2003, p19).

In this study farmers' perceptions concerning the effects of pesticide and fertiliser overuse on four aspects of crop production (growth, yields, protection and quality of produce), revealed farmers' tendency to associate pesticide overuse with protection against disease and fertiliser overuse with increased yields. Both forms of overuse were associated with the quality of the produce.

[119] On average, less that 6 farmers for each scientific phenomenon

8.3.1Crop Growth

In the case of crop growth, most interviewees; (21 of 38 farmers), believed that the use of excessive pesticides was not relevant for crop growth. For example farmer Sur noted:

> *'... they (pesticides) would not help the plants to grow faster or give more bearing (fruit)…that is what the fertiliser would do…'*

On the contrary, 9 farmers were of the opinion that excessive pesticides facilitated increased plant growth since their use protected the crops from pests and disease infestations, while eight farmers believed that the use of excessive pesticides could cause decreased growth of plants through pesticide damages to these plants. Findings by Ntow *et al*, (2006) substantiated the views of those farmers who associated excesses of pesticide with increased crop growth. In their study on vegetable farmers' perceptions of pesticide use in Ghana, the authors found that farmers associated increased pesticide amounts with increased plant growth and unnecessarily utilised fungicides to produce excessive vegetative growth in crops. Wilson and Tisdell (2000) note the role of pesticides in enhancing crop plant growth through prevention of pests and diseases; however these authors do not advocate the overuse of pesticides. But while agronomic guidelines indicate the necessity of repeated pesticide applications in cases of chronic pest infestations, overuse is not recommended. Rather, caution to desist from the use of similar pesticides is indicated (Graham-Bryce, 1997; NSA, N.D.; Oerke, 2006).

In relation to fertilisers the most common opinion, expressed by 31 respondents was that excessive fertilisers increased the rate of growth of crops and caused faster maturity of plants. This belief was exemplified by farmer CPG who explained:

> *'…We can use less (fertiliser) but then the plant takes longer to grow, while we are waiting for it to grow another man's own come (matures) already and taking over the market…we need money too…..how long we can wait for it come so as to get money?'*

However, 6 of these farmers believed that this increased growth was accompanied by decreased quality of vegetables which were produced by crops to which excesses of fertilisers were applied. Four (4) farmers opined that excessive fertiliser would damage crops and cause reduced growth, while two farmers felt that excessive fertilisers had no relation to crop growth. One farmer was unsure of any relation between crop growth and the use of excessive fertiliser.

In their study on study on the impact of agrochemical use on productivity and health in vegetable and rice farmers of Vietnam, Dung *et al*, (2003) partially endorse farmers' views in this study concerning increased crop growth through increments of fertiliser. While the authors mention the increased early growth of plants, through increased applications of nitrogen fertilisers, these sources do not recommend overuse. Rather, these writers indicate incidences of pest increase accompanying high nitrogen application and highlight the need for balanced application of nitrogen with other fertilisers. Other authors associate the intensive use of nitrogen fertilisers with negative effects of plant growth through the hindering of seed germination and seedling growth and damage to plant foliage (Brenmer, 1995; Xu *et al*, 1992). This finding strongly supports the views of those farmers who believed that excessive use of fertiliser would result in damaged crops and reduced growth. However, farmers in this study were unable to pinpoint a specific fertiliser which caused this reaction, indicating lack of precise knowledge. Agronomic guidelines indicate the importance of applying fertilisers at the correct time and stage of crop growth to achieve effectiveness (FAO, 2005; NCSU, N.D; Nurmakhanova, 2006).

8.3.2 Crop Yields

Perceptions concerning crop yields in relation to the use of excessive pesticides revealed that most farmers, (25); believed that the use of excessive pesticides was not relevant to crop yields. Farmer LM's views exemplified those of her colleagues:

> *'More pesticide help to keep off pests and like diseases, but that has nothing to do with how much you will get…'*

Giving a similar opinion, Farmer VB noted:

> *'...drugs (pesticides) are not really for the plants to bear...they are for pests and like fungus and that kind of thing...'*

Five (5) farmers felt that the use of excessive pesticides could cause decreased yields through plant damage. An additional five farmers opined that the use of excessive pesticides protected crops from pest and disease infestations and permitted them to produce maximum yield, while one farmer thought that excessive pesticides were needed to control pest population to ensure any yield at all.

Several authors discuss farmers' perceptions and report similar views to those of farmers in this investigation, who believed that the use of excessive pesticides was necessary to ensure appropriate and maximum yields. In their study on Turkish fruit growers' perceptions of harmful effects of pesticides, Isin and Yildirim *et al*, (2007) reveal farmers' preference of too large dosages of pesticides, to guarantee yield of fruits, even while these farmers were knowledgeable of the pesticide instructions. Ntow *et al*, (2006) link farmers' increased use of fungicides and insecticides with their desire for yield of produce. IDRC (2000) associates farmers' increased application of pesticides with their perceptions of increased yield losses when pesticide application was not conducted. Palis (1998) points out Philippine rice farmers' belief that in the absence of spraying pesticides, rice yields would reduce by 20%. In his study on agrochemical use for weed control, Engindeniz (2008) mentions celery farmers' beliefs that more than half of their yield would be lost if agrochemicals were not used to control pests.

Huang *et al*, (2003) indicate that rice farmers' perceptions of yield loss due to pests, directly affect the amount of pesticides they utilised. The authors note that in China, farmers' misperceptions of yield loss often resulted in their overuse of pesticides. Other literature records the impact of pesticides in preventing yield losses but does not encourage overuse. One source mentions that while pesticides do not directly boost yields as in the case fertilisers, pesticides reduce crop losses caused by pests (SANDEE, N.D). However, this source points out that increments of pesticides did not absolutely determine yield increases. Rather, maximum yield was obtained only up to addition a certain amount of pesticides, beyond which there was no yield increase[120] (SANDEE, N.D: 3). Other authors indicate findings of no significant yield increases through pesticide overuse (Dung *et al*, 2003).

[120] A study on farmers' use of pesticides in Nepal and the impact of increased pesticide use on yields indicated that pesticide use made significant contribution to yield by limiting losses but this effect was noted only up to a certain amount of pesticide addition. For instance pesticide application beyond 850 grams per hectare demonstrated no significant extra effect on yield (SANDEE, N.D.: 3).

In relating excessive fertilisers to yields, farmers' perceptions were variable. However, the most expressed opinion was that the use of excessive fertilisers was necessary for increased crop yields; articulated by 27 farmers. Of this group was farmer Ash who stated:

> *'...it (excess fertiliser) makes the plants grow faster and too many insects don't go on them… if you put more you would get more effects; you will get more…'*

Within this category there was much variation of opinions relating negative effects which accompanied increased yields. The two most prominent groups comprised 11 farmers who believed that with increased yields there was decreased quality of produce and six farmers who were of the opinion that there would be shorter bearing period while one farmer felt that the plant would sustain some damage.

Bagheri *et al*, 2008, highlight farmers' perceptions which indicate the use of agrochemicals as the best method for increased crop production and their disbelief that reducing the amount of fertilisers used could lead to feasible production over time. Coinciding with perceptions of some farmers, other literature notes that the use of fertiliser boosts yield; however this was not to be an absolute conclusion in all cases, as yield increases due to fertiliser application were subject to various conditions; for instance, the use of incorrect fertiliser combinations[121] does not necessarily assure yield increments (SANDEE, N.D). Similarly, Tilman *et al*, (2002) record that increased applications of nitrogen and phosphorous fertilisers are effective only to a point after which there is diminishing returns. Farmers were able connect the result of increased yields with fertiliser use but were unable to establish the case of overuse resulting in diminishing returns.

Contrary to the belief of most farmers in this investigation concerning the overuse of fertilisers for increased yields, authors report that the overuse of nitrogen by Vietnamese farmers was accompanied by non-optimal yields and profits. The authors highlight the misconception that more profits can be made from more applications of fertiliser (Dung *et al*, 2003). These writers link farmers' increased use of potassium and phosphorous with increased vegetable yields, but did not support the overuse of

[121] For instance farmers' use of combined amounts of nitrogen, phosphorous and potassium nutrients in a Nepal study did not demonstrate increased yields; indicating a probable case of incorrect combinations.

these fertilisers. Rather, the writers associate the overuse of nitrogen with negative productivity effects and record no significant yield increases where pesticide was overused (Dung *et al*, 2003:47). Additionally, Bremner (1995) associates the foliar application of highly concentrated nitrogen fertiliser with 'leaf burn' and subsequent reduced plant yield. This finding partially substantiates the misconception of a farmer who perceived that increments of fertilisers would boost yields but also damage the plants, and highlights the need for targeted and consistent training. Standard agronomic practices indicate that while incremental amounts of fertilisers may be added for increased yields, this practice eventually increases the soil's susceptibility to erosion (Girard, 2010).

8.3.3 Crop Protection

In relation to crop protection, most (17) interviewees believed that the use of excessive pesticides was necessary in cases where the recommended dosages seemed ineffective or, according to their opinion, when the pests seemed stubborn or the pesticides were 'weak' and the crops were threatened. Farmer CJ was one such farmer who explained this belief:

> *'...Sometimes you spray and by the time you finish (when you have finished spraying) and walk back out of the field them things still alive and moving around on the plants. The drugs them weak (the drugs are weak…you got to spray again sometimes or put some more and even then some of them still come back.'*

Seven (7) farmers felt that the use of excessive pesticides was required when a fast control of pests was required while an additional seven believed that excessive pesticides could be used as preventive action to reduce chances of pest attack. Four (4) farmers believed that excessive use of pesticides was required for general pest control; ensuring that pests were killed, while three felt that the overuse of pesticides did not necessarily offer protection to crops, since in many instances pests returned even after applications of excessive pesticides.

Based on an investigation on perceptions of paddy farmers' concerning technology adoption in Iran, Bagheri *et al*, (2007) report farmers' beliefs that the use of agrochemicals was the best mode of action for use against pests. These results are similar to findings of this study, where the majority of farmers interviewed (17) were convinced that excess pesticide use was necessary for crop protection. Similarly, in a study where high residues levels were found in vegetables in Ghana, authors record the belief of vegetable farmers that higher pesticide dosages were required during instances of heavy pest infestation (Kotey *et al*, 2008). However, literature indicates that the overuse of pesticide may result in pesticide resurgence and resistance, predisposing to yield losses rather that increases (Graham-Bryce, 1977; Oerke, 2006; Wilson and Tisdell, 2000: 2-4).

In terms of farmers' beliefs concerning excessive use of fertilisers and crop protection, two main categories of perceptions were noted. Most farmers (26) were of the opinion that the use of excessive fertilisers was not relevant to crop protection. Farmer Vib exemplified this belief:

> *'...more fertiliser can't help with pests...that* (fertiliser) *is for the plant to grow and bear...them pests need good drugs...'*

Twelve (12) interviewees believed that overuse of fertilisers promoted healthier plant growth and caused plants to be more resistant to pests.

In a study on vegetable and rice farmers' pesticide overuse practices in Vietnam, the authors indicate farmers' views which are partially similar to the two main categories of farmers' beliefs in this study; firstly that excess fertilisers are not relevant for crop protection and secondly, that fertiliser, especially nitrogen compounds, increase vegetative growth. However, these authors highlight that enhanced vegetative growth from intensive fertiliser application predisposes to increased incidences of pests and diseases[122] (Dung, *et al*, 2003). Other writers also mention the proliferation of pests and diseases due to intensive use of nitrogen (Dasgupta *et al*, 2007).

8.3.4 Crop Quality

In relation to quality, it was significant that all 38 farmer interviewees believed that both pesticide and fertiliser overuse negatively affected the quality of vegetable produce. Most of these farmers (33), accepted that the reduced quality was apparent

[122] The increased vegetative growth is attractive to insects and also provides humid conditions which favour the growth of fungi.

by shortened shelf life of vegetables; demonstrated by earlier than expected spoilage of vegetables. For example farmer Gov explained:

> *'Sometimes you cook vegetables and you find plenty of water because it was forced to grow... many vegetables like if you buy and keep for two days, they will melt (disintegrate)…'*

While farmers mentioned other perceived negative effects such as abnormal colour and taste and increased water content of vegetables they were not capable of clearly differentiating which of these effects they believed were the results of excessive pesticides, from those which were caused by overuse of fertilisers. Of the 38 farmers who believed that excesses of pesticides and fertilisers affected the quality of vegetables, by shortened shelf life; ten expressed views of additional negative quality effects: six felt that the taste of the crop was abnormal; three believed that excesses caused abnormal taste and increased water content; while one farmer felt that excessive use caused only abnormal taste of vegetables.

Four (4) technical key informants of this study confirmed that quality of vegetables was indeed affected by the use of excess pesticides and fertilisers, primarily through shortened shelf life, but the incidence of increased water content and altered taste, expressed by farmers was not confirmed. Kennedy (1998, p25) links the use of pesticides to improved quality of produce, through lack of damage by pest and mentions the result as: *'...fruit and vegetables with less surface damage'*. However, the author does not advocate overuse. Rather, he notes that the use of pesticides requires careful application with adherence to recommendations to achieve acceptable MRLs of pesticide residues in food.

It was significant that while all farmers believed that both pesticide and fertiliser overuse negatively affected the quality of vegetable produce, these farmers nevertheless engaged in these practices. This finding was similar to that of Islin and Yildirim, (2007), who report the use of excess pesticides by fruit growers in Turkey to assure the quality of fruits they produced. This finding also correlates with, and can be explained by the contingent factor of farmers' need for a marketable crop, where it is obvious that while the farmers in this study are aware of the negative effects of overuse to crop quality, the desperate need for a marketable crop overrides this knowledge.

While farmers differentiated their views concerning the effects of pesticide and fertiliser overuse in relation to crop production, in the cases of environment and economic effects, farmers' viewed these effects as similar for both pesticides and fertilisers. In early records many repetitions were noted. Hence, in the case of the farmers' perceptions concerning overuse in relation to environment and economic effects, these beliefs are recorded as combined for pesticide and fertiliser, except in cases where farmers were able to distinctly separate their views concerning effects pesticide and fertiliser overuse.

8.4 Overuse and Environmental Effects: Farmers' Perspectives

> *'The environmental implications of the use of agrochemicals in the developing countries are generally ignored. The magnitude of the hazards to the environment and human health is multiplied because of lack of technical knowledge on how to handle agrochemicals. The adverse effects of pesticides, in particular, are very high and long ranging'* (Baloch and Haseeb, 1998, p58).

In this investigation, farmers' perceptions concerning environmental effects of pesticide and fertiliser overuse revealed 6 main categories. The largest category comprised 17 out of 38 farmers whose belief was that excessive chemicals were not likely to cause any negative effects to the environment because of their removal by some type of water source. Specific mention was made of the rain and the practice of regular irrigation having the capacity to 'wash off' excess pesticide and waterways being non-stagnant which caused any excess pesticide and fertiliser to be 'washed away'. Exemplifying this belief was farmer JW who explained:

> *'Well when the rain falls the land is washed and it (excess agrochemicals) must end up (eventually get) into the drain; but it won't do the water in the trench anything, because the water is so plenty (much) and its steadily running (flowing); if it was stagnant water, then we would find problems... it won't affect fish because at the time it reaches from the lane it is gone down (broken down/not effective)...'*

A second category comprised 16 farmers who believed that overuse of pesticides and fertilisers could not pose an environmental threat, since they were not sufficiently potent or toxic to cause any environmental harm. In this category, farmers claimed that the chemicals and residues were mostly in a 'weak' or less toxic state caused by disintegration soon after application to plants (within a few days) or because of an originally 'weak' composition when purchased. For instance, farmer MT noted:

'...but those things (pesticides and fertilisers) they break down after you use them...and the ones we get now not strong like the ones we used to get long ago...when they diluted, they not harmful even if some get into the water and so on ...'

Farmer BD shared this belief:

'...drugs not going to remain too long in the soil or water like that...remember they break down after you use them...the fertilisers too, they must break down after you use them...and remember most of these things are used up the plants already...what might be left is like a small amount...that really can't cause a problem in water or soil...'

Within a third group, eight farmers believed that excessive use of pesticides and fertilisers had adverse environmental effects, where the water and soil were polluted. Farmer RR noted:

'…Well when rain falls heavy we don't use water from the drain in front here, not even to wash wares (dishes) or wash clothes with it, because the drugs and fertilisers 'bound to' (will definitely) wash off into that water. We use rain water.'

Corroborating this belief, farmer Sub explained:

'I sprayed glyphosate there to plant the Boulanger, and when I planted, the glyphosate was still in the land (soil), because the boulanger got small leaves. I know; that's why I pulled them out… I planted bora...it's the same thing so I had to pull out a lot and discard them'.

A fourth category of six farmers were of the opinion that the use of excessive pesticides and fertilisers were not likely to cause pollution, since most of the chemicals applied would act on the pests or plants, hence very little of these chemicals would be left free or as excess within the environment.

An example of this view is noted in farmer RG's explanation:

'I am using (pesticides) when there are pests; so the effect is on the pests; it's like if you keep putting when there are no pests, then where else would it go but into the air, water and so on and then is when you get pollution and all these bad things; if you use the drugs for what they were made for and not put, like some people, just to keep away pests then these drugs will not affect the environment.'

Likewise farmer RR expressed:

'The drugs and fertilisers work on the plants and like for the pests when they are there...but like if you use these things wild[123]...like some people don't wait

[123] Using 'wild' means to use without a cause or not in correct amounts.

to see pests...it's then the extra can get in the water...or like fertiliser stay (remain) in the soil...that is what cause pollution...'

In a fifth category, four famers based their assessment of possible environmental effects on their observations. Within this category farmers believed that negative environmental effects of overuse were not likely, as they had not noticed any evidence such as dead fish or other negative after-effects subsequent to their utilisation of water from nearby waterways for domestic purposes.

For example farmer CJ explained:

> *'…it is not so much more you know…I never see it kill fish. And we usually use the water to wash and so on and nothing never happen.'*

While farmer RR explained that his family did not use water from the drains beside their farming plot during the rainy season for fear that the water was polluted by excess pesticides and fertilisers, he however concluded that he had not noticed any evidence such as dead fish:

> *'...the drugs and fertilisers 'bound to' (will definitely) wash off into that water. We use rain water. But I never see any fishes get killed…'*

A sixth group of two farmers believed that extensive pollution would occur because of overuse and cited cases of water pollution negatively affecting water life (fish and algae) and even the vegetables.

Exemplifying this belief, farmer JA explicated:

> *'…Polluted fish you are eating; polluted vegetables you are eating…this thing Aldrin that used to come long ago is systemic. If you put it in the trench it kills all the algae …We used to put it in the drain to kill ants…because all the ants will die when the water circulates. It is something that kills fish; people do not know; this same thing here; this same caprid too… when it goes into the water watch what happens…and they (other farmers) are saying that it will not damage anything…don't worry with them and what they are telling you. They don't even know...'*

Literature widely addresses the effects of inappropriate agrochemical use on the environment. Engindeniz, (2008) records farmers' views that their agrochemical use practices were not detrimental to groundwater pollution. However, the writings several authors contradict farmers' views of almost immediate degradation of pesticides and fertilisers after application. Huang *et al*, (2003) record that only approximately 20-30% of pesticides are absorbed during application while the remainder is left in the environment. Similarly, Tilman *et al*, (2002) mention the uptake by crops of only 30-50% and approximately 45% of nitrogen and phosphorous fertilisers respectively when applied. The remainder is lost from agricultural fields into the ecosystem, especially waterways.

Various writers clarify that excessive pesticide and fertiliser use cause contamination of both ground and surface water, and air pollution (Bagheri, *et al*, 2008; Dasgupta *et al*, 2007; Engindeniz, 2008; Ntow *et al*, 2006; Tilman *et al*, 2002). Other authors associate the contamination of vegetables and root crops with pesticide overuse (Huang *et al*, 2003) and the destruction of beneficial organisms (Dasgupta *et al*, 2007; FAO, 1995; SANDEE, N.D.; Tuormaa, 1995) with both forms of overuse.

Coinciding with the belief of farmers concerning the persistence of pesticides on plant life and within the soil, Kotey *et al*, (2008) note the possible persistence of pesticide on plant surfaces and in soils for as long as 14 days and 1 year respectively, as exemplified in the case of the pesticide chlorpyrifos. Baloch and Haseeb (1998), in a study of agrochemical use in Pakistan report findings of pesticide contamination of drinking water. Findings by Seth *et al*, (1998) in their research on agrochemical use and residue management in India, reveal the possibility of unused pesticides and their degraded products entering the human body via the food chain and causing health hazards. The authors also record the persistence of pesticide in soil and water, depending on the type of chemical and type of water or soil. These findings substantiate farmers' belief in this study that excess pesticides had adverse environmental effects of water and soil contamination.

8.5 The Economic Effects of Overuse: Farmers' Viewpoints

> *'Pesticides play an essential role in food production…they are perceived by farmers as a component of economic safety against the uncertainties of agricultural production…'* (Guivant, 2001, cited by, Waichman *et al*, 2007, p581).

In my study, marketing potential was utilised as a proxy for potential economic effects (actual gain or loss measured in monetary value) of agrochemical overuse, in the absence of farmers' records. Generally, farmers believed that the use of excessive pesticides and fertilisers caused deleterious marketing effects. However, farmers perceived that these effects were more serious for the export market when compared to the local market, since the former was carefully monitored in terms of chemical residue testing while on the other hand, the local market lacked monitoring. Several farmers cited cases of rejection of produce by export markets. Farmers' perceptions of the economic effects of overuse were categorised within 3 main groups.

The largest farmer category comprised 16 farmers who felt that excessive use of pesticides and fertilisers was more likely to negatively affect export markets and not local markets since residual tests were conducted importing countries, but were lacking in Guyana.

For example farmer Ren explained:

> *'...you see all places like foreign countries they usually test their crops and if they get anything they reject it, but here they don't test…and that is the reason why certain times when Guyana used to export vegetables like bora (string bean), they stopped, because when they (foreign countries) tested it, they found chemicals still inside.'*

Farmer Ash had a similar view:

> *'…it will be worse if the greens (vegetables) have to be exported...that market will not last for long if the people in the other countries test and find that the greens (vegetables) are full of drugs…..they will dump it and then that market is gone...'*

Farmer DR supplied an example:

> *'...when the people tested them (string bean exports); they said that they sprayed with monocrotophous*[124] *and dumped all in the river…they dumped all, too much of poison.'*

A second category of 13 farmers believed that excessive use of pesticides and fertilisers was detrimental for both local and export markets; but again this was more serious in the case of export markets since it could mean possible loss for the country and farmers through the loss of markets and dumping of farmers' produce respectively. In this case farmer CPG's views were exemplary of his colleagues, concerning overuse effects on the export market:

> *'...the vegetables (for export) will not have so much of drugs remember, because then they (the Ministry and relevant authorities) already tell you that*

[124] Monocrotophous is classified according to toxicity by the WHO as a Class Ib (highly hazardous) (FAO, 1997:http://www.fao.org/docrep/w5715e/w5715e04.htm#TopOfPage; Matthews et al, 2003: 712). The pesticide is banned for use on vegetables in Guyana, but farmers continue to use it in a discreet manner.

you cannot put so much…and they (the relevant authorities of importing countries) will test it…that is serious, is everything will dump, outside (foreign countries) is not like here…then farmer in problem, Government in problem and all the news papers investigating…that is a big thing…'

Within the third category, 8 respondents believed that the use of excessive pesticides was detrimental for both local and export markets. Within this category 5 farmers felt this way because residual testing was done for export markets, while an additional 5 cited cases of consumers detecting the negative effects of overuse and avoiding repeat purchases from sale points known to have poor quality vegetables. For example farmer RR stated:

> *'…Well the quality is not good; the things spoil faster and have a bitter taste when you cook them and so when people find out and tell others then you can lose your market. No one from outside (foreign countries) will want to buy low standard things (produce). Or even here you might sell some things of less quality if you sell them cheap, but still, people want quality and if your own spoil fast or aint taste good they wouldn't buy again….'*

Farmer Ash substantiated these views:

> *'...after a while they will notice and people know to avoid the greens (vegetables) that spoil quickly...but then again some people like to buy greens cheaply and so they might still buy...but I think the majority of people like to know that they are eating something with quality…if people are conscious that they're buying this greens from this person all the time and then persons feel sick and go to the doctor and the doctors says its food poisoning….and tells them it's the vegetables that they use and then they know that they buy the greens from this person… it affects your market… that person tells the next one…and the next one and the market gone right down…'*

Coinciding with the perceptions of the majority of farmers in this investigation, studies record the presence of agrochemical residues in foods as a deterrent to export. Kotey et al, 2008 record the rejection of cocoa beans exported to Japan from Ghana, due to the presence of excessive levels of pesticides. The authors also mention local incidences of residue violations for various vegetables; indicating the absence of local residual monitoring and the presence of pesticide residues in vegetables which exceeded 50% of the Codex maximum residue limits (MRLs).

Incidences of residue violations for various locally produced vegetables and the absence of local residual monitoring in Guyana are similar to conditions in Guyana, which were expressed by farmers and key informants. Occurrences of export rejection, due to excess pesticide residue and lack of local residual testing correlate with farmers' views of economic effects of excessive pesticide use in this study. Guyana's Minister of Agriculture emphasised the need for pesticide use in Guyana, to be conducted in compliance with external market requirements (SN, 2007). The Minister explained that the appropriate use of these agrochemicals was important for Guyana's compliance with SPS standards to be competitive exporters of agricultural produce, when the EPA[125] is established (SN, 2008).

Other studies link inappropriate agrochemical use to chemical residues within agricultural produce and highlight the importance of achieving MRLs for export of agricultural commodities. Seth *et al*, (1998) in their study on agrochemical use and residue management in India, mention that the presence of pesticide residues above the stipulated MRL in agricultural produce in India. This was sometimes the result of improper use or deliberate overuse of these chemicals. In their study on agrochemical use in Pakistan Baloch and Haseeb (1998) report findings of pesticide residues in samples of vegetables and note the implications of meeting MRLs of chemicals in agricultural produce for international trade. Kennedy (1998) points out the risk of contaminated food through the use pesticides and advocated that strict attention be paid to the application of pesticides. The author emphasised the observance of withholding periods, in order to achieve recommended MRLs. Dung *et al*, (2003) mention the presence of pesticide residue in vegetables in Vitenam, higher than FAO recommended MRL, which occurred because of very intensive pesticide use. Engindeniz, (2008) substantiates this finding, noting that excessive agrochemicals could result in the presence of unacceptable levels of residues in foods.

8.6 SUMMARY AND CONCLUSIONS: THE INFLUENCE OF FARMERS' PERCEPTIONS ON THEIR OVERUSE PRACTICES

Farmers' perceptions of their overuse behaviour demonstrated 2 main behavioural patterns: paradoxical and consistent; both of which can be explained by the causal factors, analysed in the previous chapter. Paradoxical behaviour was common to all

[125] *'The Economic Partnership Agreement (EPA) is a proposed trade agreement with all European nations which would allow for free trade and the removal of tariffs with regard to goods and services produced in the Caribbean…* (SN, 2008).

categories [126] within which farmers' perceptions were assessed. This illogical behaviour was characterised by instances where farmers' beliefs were divergent to their overuse practices. In these cases, farmers were capable of identifying the negative effects of their practices, but nevertheless continued their overuse practices.

Farmers' contradictory attitude noted in my study correlates with findings reported by authors. In their study on fruit growers' perceptions of the negative effects of pesticides, Insin and Yildirim (2007) note that:

> *'Farmers perceptions had little or no impact on how they selected or applied pesticides, thus the majority of growers used more than recommended…producers' knowledge about the harmful effects of pesticides is not enough to change their behaviour, as their overriding concern is crop damage that leads to economic loss, not health'* (Insin and Yildirim, 2007, p922).

The writers suggest that farmers were unable to translate their awareness into practices due to their lack of knowledge and concern about pesticide effectiveness.

Similarly, a study conducted on agrochemical use in Cole crop[127] growers of Nepal records:

> *'on average, Cole crop growers lose about 2% of production costs...because of their inefficient use of pesticides. Yet, over-use of pesticides is an on-going phenomenon'* even though, as the study reveals: *'a majority of farmers in the study area understand that pesticides are harmful to human health and that they hurt a range of beneficial organisms present in the ecosystem'* (SANDEE, N.D., p3).

The writer suggests that farmers may deliberately apply overdoses of chemicals because of their uncertainty of these dosages or in their quest to prevent the risk of pest attacks.

The paradoxical overuse behaviour of farmers in my study can be explained through an understanding of the causal factors of this behaviour, presented in the previous chapter. While farmers perceive the negative results of their actions, they are

[126] Categories of: crop production, environmental and economic effects

[127] Crops from the genus Brassica are sometimes called *cole crops*, which is derived from the Latin word *caulis*, meaning *stem or cabbage.* Cabbage, cauliflower, broccoli, brussels sprouts and kale make up a group of cool season vegetables known as cole crops. (http://en.wikipedia.org/wiki/Brassica; http://extension.unh.edu/resources/representation/Resource000605_Rep627.pdfhttp://extension.unh.edu /resources/representation/Resource000605_Rep627.pdf)

constrained in amending their inappropriate practices due to a stronger influence from those contingent, support and contextual factors, which initiate, support and encourage these overuse practices, respectively. In this study, the preceding in-depth analysis of the causes for farmers' pesticide and fertiliser overuse, conducted in chapter 7, provides an adequate backdrop for explaining farmers perplexing and sustained inappropriate behaviour of overuse, despite their perceptions of the negative effects of this practice. For example, farmer DK perceived that excesses of pesticide should not be used, but due to his desperation for a marketable crop (contingent factor), in a situation of unsure markets (support factor) his contradictory behaviour is to overuse, in spite of his belief. This farmer indicated that his application of excess pesticide was a last 'desperate' attempt to save his crop, especially in the context on an unsure marketing system.

Similarly, farmer RG perceived various negative effects of applying excesses of fertilisers and pesticide to his crops, but did so anyway. His strange behaviour was more aptly explained by the contingent factor of farmers' assuming dosages based on observations. This farmer explained that while overuse had negative effects, he observed that in the absence of excessive applications, fruit were of smaller sizes and often bore marks (scratches) due to pest attack. This farmer overused despite his belief, since the market demand was for larger fruit (eggplant), which were 'smooth' and bore no marks. The contradictory behaviour of farmers is therefore linked to and explained through the reasons for overuse: that is, the combined interactions of contingent, support and contextual factors.

Consistent behaviour of farmers' in this study is demonstrated where farmers' beliefs were indicative of their lack of knowledge and uncertainty of the effects of their overuse, characterised by their perceptions which were misconstrued or incomplete. In these cases farmers' perceptions of overuse seemed to have direct influence on the practices they adopted. As in the case of their illogical behaviour, farmers' consistent attitude is also explained by reasons for their overuse. In these instances, farmers' overuse practices are consistent with their perceptions that no negative effects occurred from their overuse practices.

Farmers' belief that no negative effects occurred from overuse, is explained by those reasons (factors) which reflect inappropriate information dissemination, Farmers' access of relevant knowledge, influence their perceptions, which in turn influence their behaviour. For instance, authors have linked farmers' agrochemical overuse to their beliefs that these practices were necessary or did not cause harmful effects. Such perceptions were then associated with the lack of inappropriate information dissemination, due to various deficiencies such as inadequate extension services (Palis, 1998: 606; SANDEE, N.D.). Palis (1998) proposes that:

> *'Empirical evidence shows that farmers' perceptions are not influenced by their educational attainment or their farm experience. However, experiential learning –such as learning-by-doing (NES[128] practice) and –learning by-using (FFS[129] or IPM[130] training) – significantly influences the process by which perceptions are changed to make them consistent with scientific knowledge'* (p606).

The author notes that perceptual changes are translated into appropriate practices.

In my investigation, similar findings were noted where farmers' overuse behaviour was consistent with their perceptions that there were no negative effects from overuse, or that overuse was necessary for increased protection and production. These beliefs coincided with the general lack of appropriate information by the extension agencies. For example, farmer Ash believed that excessive pesticide use was okay where there were high pesticide populations, as this was necessary to ensure that the pests were killed. Similarly, farmer LM perceived that once her plants were not burnt, then the amount of fertiliser she utilised was not considered as overuse and would not have negative effects. The following sections of this chapter analyse the major paradoxes and consistencies of farmers' perceptions in tandem with the factors which encourage farmers' overuse. In so doing, preliminary areas for interventions are identified. These are analysed in greater detail within the final chapter.

Farmers' perceptions concerning crop production (growth, yields, crop protection and quality), revealed firstly, their primary belief that the use of excessive pesticides was not relevant for crop growth, while excessive fertilisers increased the rate of growth of crops and caused faster maturity of plants. This perception coincides primarily with

[128] NES – No early insecticide spraying
[129] FFS – Farmers' Field School
[130] IPM – Integrated Pest Management

the contingent factors of farmers' assuming dosages and utilising their experience (discussed in chapter 7, section 7.2). According to farmers' manner of pesticide use over time[131], it was logical for them to assume that pesticides were not associated with crop production, but were solely for disease control. Based on the response of crop plants to incremental additions of fertilisers which the farmers noticed over time, farmers developed confidence that extra additions of fertiliser was directly related to increased growth. Farmers however lacked the relevant technical knowledge that: (1) while pesticides were not directly related to plant growth, their use was associated with increased growth through the prevention of negative pest and disease effects (Wilson and Tisdell, 2000) and (2) extensive growth from fertiliser applications encouraged pests and diseases (Dasgupta et al, 2007; Dung, *et al*, 2003). This finding underscores the need for a 'dual' approach of farmer training which includes both agrochemical and agronomic instruction. This is discussed in the following chapter.

Secondly, farmers mostly believed that the use of excessive pesticides was not relevant to crop yields while the use of excessive fertilisers was necessary for increased crop yields. In the first instance, farmers were again expressing their perception based on assuming dosages and use of their experience. This strategy demonstrated their lack of knowledge that excessive pesticides could negatively affect crop yields in various ways, such as the development of pest resistance and resurgence due to overuse (Wilson and Tisdell, 2000). In the second instance farmers lacked agronomic information that increased yields from increments of fertilisers were consistent only to an optimal point, beyond which no increments were achieved, resulting in higher production costs rather than increases of yields (Dung *et al*, 2003; SANDEE, N.D; Tilman *et al*, 2002). Further, some farmers perceived that the use of excessive fertiliser could damage crop plants but lacked precise knowledge that intensive use of nitrogen fertilisers, results in negative effects to plant growth through retarding seed germination and seedling growth and damaging plant foliage (Brenmer, 1995; Xu *et al*, 1992). Again, these findings highlight the need for targeted training. Based on the lack of knowledge demonstrated, it can be presumed that training should be conducted in various levels and include demonstrations to enhance farmer' understanding.

[131] In the presence or absence of pests and in varying amounts to rid pests

Thirdly, most farmers felt that the use of excessive pesticides was necessary for crop protection in cases where the recommended dosages seemed ineffective, while the use of excessive fertilisers was not of relevance to crop protection. Similar to the previous instances, these perceptions are explained by famers' based on the use of their assumptions and experience, and highlight the need for effective and targeted training.

Fourthly, in relation to quality, all respondents believed that excesses of pesticides and fertilisers affected the quality of vegetables, through reduced shelf life. This perception largely coincided with, and is explained by factors which describe farmers' need for marketable crops and unreliable marketing systems. Farmers were aware of the negative effects of their overuse practices but it seemed they were nevertheless goaded into these practices based on their desperation to have what they considered a marketable crop in the context of an unreliable marketing system. This highlights the need for a structured reliable system of marketing; both locally and export-based, which literature shows is definitely absent in the case of Guyana. This is emphasised in the following chapter.

Regarding environmental effects from overuse, most interviewees believed that the use of excessive chemicals was not likely to result in negative environmental effects because of two main reasons. In the first instance farmers believed that these chemicals were removed by water sources such as rain or when irrigation of crops was conducted during farming. Water from these sources along with non-stagnant waterways was capable of washing away any excess chemicals. In the second case, farmers felt that while excessive amounts of pesticides and fertilisers were utilised, these chemicals lacked the potency required to cause environmental harm. But literature indicates otherwise. Authors point out the pollution effects and persistence of agrochemicals within the environment (Huang et al, 2003; Tilman *et al*, 2002). Dearth of farmers' knowledge concerning the environmental effects of agrochemical overuse in demonstrated. In this case, the need for interagency collaboration[132] in targeted training is obvious. This is also addressed in the concluding chapter.

[132] For example collaboration of the MOA and Environmental Protection Agency (EPA), Guyana

In relation to the economic effects of pesticide and fertiliser overuse, it was the primary belief of farmers that excessive use of pesticides and fertilisers was more likely to affect export markets causing loss of these markets, but this was not likely for local markets. The main reason cited was the performance of routine testing for chemical residues in vegetables conducted by importing countries, but which was absent locally. In this case, farmers' knowledge of the situation is to be clearly commended, as it reflects the present state of agrochemical monitoring within Guyana's non-traditional agricultural sector and confirms that farmers possess technical knowledge concerning the importance of attaining chemical residual limits on marketing of agricultural produce (Baloch and Haseeb, 1998; Engindeniz, 2008; Kotey *et al*, 2008). In this case, the need for targeted policy assessment and intervention is evident, and is elaborated within the following concluding chapter.

An assessment of farmers' perceptions concerning their overuse practices played a key role in explaining both consistent and inconsistent behaviours of farmers' overuse practices. More importantly, this evaluation of farmers' perceptions formed a major link between the factors which explained farmers' reasons for overuse (discussed in the previous chapter) and implications for addressing overuse (elaborated in the following chapter. Farmers' perceptions largely endorsed and enhanced understanding of the reasons established for overuse but also, highlighted areas, primarily for targeted training required to address the problem of agrochemical overuse in Guyana. This key role of understanding and applying perceptions in this study coincides with Elmore and Arcury's belief that knowledge about the perceptions of farm workers are important in developing effective educational materials (Elmore and Arcury, 2001). In keeping with the main aims of this thesis, implications to address the key problem of agrochemical overuse are discussed in the following concluding chapter, in tandem with the main findings of the study, which facilitated identification of the recommended solutions.

CHAPTER 9: CONCLUSIONS AND IMPLICATIONS

9.1 INTRODUCTION

This chapter summarises the main findings about farmers' agrochemical overuse in Guyana and implications to address this on-going problem, together with possible areas for further study concerning the subject. Investigating farmers' practices of pesticide and fertiliser overuse in Guyana revealed the general lack of an enabling environment to initiate, support and facilitate farmers' adoption of appropriate agrochemical practices. This deficiency is strongly supported by the absence of prior concerted-research, a lack of appropriate policies and the use of mismatched interventions to address problems of agrochemical overuse. My study therefore adopted a different approach from that of other studies. This investigation utilised the tenets of the critical realist and practice theories to conceptualise farmers' overuse behaviour. Analysis of data was conducted through the use of a mixed methods strategy and grounded theory approach which identified and subsequently elaborated the causes for farmers' sustained practices of overuse.

This approach enhanced the investigatory leverage of my research. In addition to examining the factual aspects of farmers' overuse, the standpoints of a wide range of informants were sourced and thoroughly analysed to explain overuse. Information concerning the scientific (agronomic) aspects of overuse was complemented with knowledge of the social elements which motivated these practices, since the agents of their occurrence are social actors. The close analysis of agents' views was especially important for discerning and establishing what influenced farmers' continued practice of agrochemical overuse. More importantly, agents' interviews revealed that overuse was a result of the combined actions of contingent, supporting and contextual causal factors.

While in other studies, farmers' actions were seen as the main causes of overuse behaviour, my study revealed that on the contrary, these obvious practices were reactions to deeper reasons which were unobvious and embedded within the support and contextual factors identified in this study. Support and contextual factors of farmers' overuse comprised mainly policy deficiencies and mismatched interventions which were utilised to address overuse.

Although some studies and reports[133] recorded the overuse of agrochemicals in Guyana, the imbalance and absence of appropriate policy has not been associated with farmers' overuse of agrochemicals by any of these studies. Thus, redress of specific policies to tackle the problem of overuse has not been implicated by previous investigations. Implications for addressing overuse arising from this study comprise generally, a reconstructed view of farmers' overuse practices as a 'policy deficiency quandary' and not a 'farmer delinquency problem'. Previous studies have adopted the latter approach. In assessing overuse as a 'policy deficiency quandary' this study suggests a redress of policy concerning agrochemical use in areas of regulatory policy, educational and training policy and marketing policy. This chapter summarises the main findings, and draws upon a few additional quotations and their context to illustrate possible policy dimensions of the findings.

9.2 AGROCHEMICAL OVERUSE: ITS SOURCE AND CONTINUITY IN ARABLE FARMERS OF GUYANA

Interrogating farmers' practices revealed the need for redress in the manner which farmers' overuse practices were previously interpreted and dealt with. Studies and reports which addressed this practice in Guyana, generally viewed overuse as a farmers' problem (Bovell *et al*, 2002; IICA/JIFSAN, 2004; Lall, 2002). While this study acknowledges the need for farmer change, it proposes a different approach based on findings from in-depth qualitative analysis.

Firstly, based on the principles of the practices theory, presented by three practice theorists (Carolan, 2005; Reckwitz, 2002; Schatzki, 1996), the core of any practice is comprised of mental thought and physical action. The physical and obvious action is influenced by the mental thought. Due to the lack of a structured approach, which is devoid of theoretical guidance, previous studies conducted for Guyana concerning agrochemical use have either not acknowledged or not placed emphasis on addressing

[133] Bovell *et al*, 2002; IICA/JIFSAN, 2004; Lall, 2002

the mental aspect of farmers' practices. Farmers' standpoints have been largely ignored. Implications for farmers' behaviours are not formulated based on thorough examination of the farmers' thought process, which can identify the causes for their behaviour. Interventions used to address farmers' overuse behaviour are therefore divergent to the core of the problem.

Secondly, practice theorists have also ascribed importance to an actor's 'habitus' or the sphere of normal and usual activity patterns, within which he or she functions. Actors' 'habitus' influence their behaviour (Carolan, 2005; Reckwitz, 2002; Schatzki, 1996). Again, previous studies on agrochemical overuse have neglected to investigate the farmers' environment and to link the features of their environment to their overuse practices.

In my study, the influence of the farmers' environment in predisposing their overuse practices is highlighted by the role of support and contextual factors in influencing farmers' overuse behaviour. More specifically, it is the understanding of these intricate and often neglected support and contextual factors which form the core of the implications presented in this chapter, for addressing the problem of agrochemical overuse in arable farmers of Guyana.

Based on these findings I propose that implications for addressing farmers' overuse should be guided by the contextual and support factors which are identified within this study as tangential to and supportive of farmers' practices of overuse. The results of this investigation demonstrate that these factors activate farmers' overuse behaviour. Understanding these factors from farmers' standpoints is therefore significant for formulating meaningful solutions which match farmers' point of view and their relevant needs.

Understanding farmers' standpoints in this study was achieved through the use of a critical realist theory, which did not rob from the reality of the situation, but took into account the social dimension of the problem. Farmers' overuse was recognised as a practical or real issue, but utilising a critical realist view, permitted emphasis on farmers as agents. In this way, farmers were seen as the author of their practices and played an important role in identifying and explaining the reasons for their actions.

Principles of the practice and critical realist theories formed the basis for conceptualising farmers' overuse behaviour. This approach revealed that, unlike studies which viewed and addressed overuse as a 'farmer-delinquency problem'; overuse should rather be understood and tackled as a 'policy-deficient problem'. This requires redress in the manner of establishing the reasons for farmers' overuse and subsequently proposing solutions according those reasons identified. The following section presents the conclusions of this study. These are based on findings which indicate farmers' overuse as a 'policy-deficient problem', which caused dilemmas, to which farmers reacted.

9.3 Concluding the Problem of Overuse: Farmers' Dilemma and Reaction

Quantitative results of this investigation revealed that structural factors (such as age, land tenure and source-type of information) were significant to overuse. However, despite demonstrating significance to overuse, the role of these structural factors in influencing overuse could not be explained through quantitative methods. Qualitative results indicated that interpretive factors such as farmers' assuming dosages and depending on their experience for guidance were contingent to their overuse behaviour. However, these contingent factors were not the 'stand alone' reasons for their overuse practices, but they operated within a network which also comprised support and contextual factors. These three categories of causal factors of overuse[134] demonstrated different levels of influence on the farmers' overuse behaviour. Contrary to the 'linear-effect' approach[135] utilised for explaining reasons for farmers' overuse, as suggested by some studies and reports[136], qualitative findings of this study revealed that reasons for farmers' overuse were contained within and explained by the combined action of causal factors.

Principles of establishing causality, explained by Sayer (2000) together with Collier's (1994), account of Bhaskar's interpretation of causation, were utilised to explain the manner in which causal factors interacted to influence overuse. Elaborations on this interaction are discussed within chapter 7 and a matrix which depicts the possible

[134] Contingent, support and contextual factors
[135] For example, citing a single factor such as low education level as a reason for overuse.
[136] Bovell et al, 2002; Chandran, 2006; IICA/JIFSAN, 2004; Lall, 2002

elements of each category and their interactions to effect over use is presented in appendix 3. While other studies linearly link and explain the practice of overuse in relation to single factors such as farmers' education, my investigation acknowledges the presence of these factors as structural factors (existing as farm and farm unit variables), but indicates that the 'essence' of explaining farmers' overuse lies within the interactions of the 3 categories of causal factors identified in this study. Support and contextual factors primarily comprise mismatched interventions and inappropriate or absent policies, respectively.

A study of policies which are relevant to agrochemical overuse and the interventions utilised to address this problem, reveal that these policies and interventions created a dilemma for farmers, to which they farmers reacted. Farmers' reactions were revealed by the contingent factors of overuse, identified in this study. An apt example is the context of the absence of a marketing policy for non-traditional crops (which include the crops under study), together with the support factor of an unregulated marketing system. This environment created a farmers' dilemma of unsure marketing for their crops. Farmers' reactions to this dilemma comprised their engagement in any actions which could guarantee them a market ahead of their competitors, who were other farmer colleagues. These actions were reflected in contingent factors, such as deception of farmers by their own colleagues. Hence, while deception is noted as a contingent factor for overuse, this action was triggered by an environment or the dilemma of unsure marketing; the latter being policy related.

The primary conclusions and reasons for explaining farmers' actions of overuse lie therefore, not within the actual reactions of the farmers, although these are important and should be addressed. Instead, the reasons for farmers' overuse behaviour are positioned in that which triggered the farmers' actions; being the lack of an enabling environment, comprising absent and inappropriate policies, and mismatched initiatives. This finding was primarily revealed by relevant key informants' interviews, together with relevant literature.

Assessment of Guyana's political economy, with respect to the agricultural sector (conducted in chapter 4), revealed that this sector was largely the same as that of colonial and immediate post-independence periods, in terms of its structure and policy.

There is still great bias in favour of traditional crops[137]. The sector is not adequately structured to cope with the current globalised changes which have implications for the cultivation and export of non-traditional crops. Within the present free market system, competitive production is required to secure markets. Policies require updating to address a changing modern external agricultural system. However, there is lack of technological and infrastructural development within the non-traditional sector (Forde, N.D.; Singh, 2005). While the NDS, which is Guyana's highest level of policy planning and instruction, reveals extensive plans for diversification of this sector to address development of the non-traditional sub-sector (NDS, 2001), there is still much bias in favour of the traditional sector. This has been discussed at length in chapter 2.

In the case of agrochemical use and relevant support structure, there is an absence of policies or initiatives to address regulation, training and marketing. Interviews with key informants corroborated these policy deficiencies which were revealed through the assessment of the political economy in chapter 4. Examination of the contextual and support factors indicates that the absence of an enabling environment to promote appropriate agrochemical use is contained within three main categories of policy deficiencies and mismatched interventions. The lack of enabling environment, which triggers farmers' overuse practices is therefore explained and concluded within the following categories of: Regulatory policy, educational policy and marketing policy.

9.3.1 Policy Implications: The Need for Demand and Supply Interventions Which Address the Overuse Problem

In this section, policy implications for this study are addressed within 2 categories of demand and supply side interventions. The former includes the demand for pesticide and fertilisers, the demand for special-type farmer education relating to agrochemical use and the demand for consumer training which can positively influence consumers' desire for and purchase of vegetables which are cultivated in a manner reflecting appropriate agrochemical use. This will in turn influence farmers' choice for correct agrochemical application.

[137] Sugar and rice

Supply side interventions reflect those interventions which suggest the availability of services which can influence farmers' appropriate use of agrochemicals. These include the need for quality control regimes which regulate the content of agrochemical labels and the distribution of agrochemicals including the manner in which instruction is disseminated to farmers. Measures to increase farmers' trust in the information they receive also play an important role in influencing their acceptance of information they receive from authentic sources such as agricultural officers.

Good governance with respect to dissemination of both products (agrochemicals) and services related to the sale of agrochemical is needed as this problem is generally not reflected in other product categories. This need can probably be addressed by copying the manner in which quality control is conducted for other goods and services by the Guyana National Bureau of Standards and Food and Drugs Department, where constant monitoring and testing of other product categories is conducted by these agencies.

In terms of demand side interventions, the need for appropriate pesticides and fertilisers is evident where farmers and agents confirm the scarcity of these products at varying intervals, accompanied by substitution of other products, which may be inappropriate. This is discussed in chapter 7, sections 7.3 and 7.4. Substitution often affects the efficiency of these chemical regarding the purposes for which they are applied. This lack portrays the need for an import and distribution system which adequately caters for the needs of farmers, permitting them to access a consistent supply of appropriate chemicals and also have a choice of various chemical types which are suited to the specific requirements. This intervention also requires joint forecasting of farmers' agrochemical needs, by recognised agents and government officials, which is based on corresponding research.

Interviews also revealed the demand for targeted farmer and consumer training. Within the former, are both intellectual and ethical dimensions. Intellectual issues address those where disparity is revealed in farmers' education level. This is discussed in more detail in chapter 6, section 6.3.2 and chapter 7, section 7.2. These findings suggest the need for farmers training to be conducted at various levels;

utilising methods which are best suited for to ensure farmers' understanding of the information disseminated. These findings also reveal the demand for appropriate and sustained training of government and other extension officials in a manner which ensures their capability to correctly instruct farmers concerning agrochemical use. The implications for targeted farmer training are discussed in more detail within section 9.3.2 of this chapter which deals with Educational and Training Policy.

Appropriate training of extension officials is related to the ethical issue of trust, where because of inappropriate information dissemination strategy farmers have lost trust in the extension services (discussed in chapter 7, section 7.2). There is therefore the need to restore trust in these farmers, even prior to disseminating information. Maybe outreach programmes which allow the regular interaction of farmers with extension agents and focus initially on farmers' interests can be conducted initially. Farmers' should be assured that their interests are being addressed and they are not neglected or exploited.

In conjunction with farmer training, is the need for consumer training in agrochemical use and the possible effects of overuse. Interviews revealed that consumer desires influenced farmers' overuse of agrochemicals (discussed in chapter 7 section 7.3). In this regard, consumers' education can play an important role in farmers' choice of appropriate agrochemical application. If consumers are duly educated concerning the ill effects of consuming vegetables with agrochemical residue, this will influence their purchase patterns. Consequently, if farmers know that consumers are not desirous of purchasing vegetables which are likely to have this residue, this action will positively influence farmers to adopt recommended agrochemical practices.

In terms of supply side interventions, while there are control regimes which address the label content of agrochemicals contained within the Pesticides and Toxic Chemicals Control Act (PTCB, N.D.c), there is need for reinforcement in this area. In conjunction with this is the need for regimes which address the distribution and sale of agrochemicals. Interviews revealed that these chemicals are often distributed by personnel who lack appropriate knowledge for instructing farmers (discussed in chapter 7, section 7.4.Unauthorised sale of chemicals is also reported (chapter 7, section 7.4). But interviews also reveal farmers' collusion with defaulters because o cheaper prices of chemicals sold in this manner. There is therefore the need for strict penalties for perpetrators of these acts and also farmers who support this manner of agrochemical sale.

On the other hand, systems should be established which encourage farmers to adopt correct purchasing procedures. Interviews revealed the need for appropriate information dissemination channels, which take into account the capability of dealers to correctly instruct farmers. A price control system is also required which can encourage farmers to purchase appropriate chemicals, especially in instances where cheaper prices of unauthorised chemicals are an incentive for purchase of inferior products. The lack of, and need for appropriate policy is also discussed in the following section which scrutinises deficiencies in regulatory, educational and marketing policy.

9.3.2 Regulatory Policy: deficiencies and mismatched interventions

Lack of regulatory enforcement regarding the import and sale of agrochemicals is widely described in chapter 7, sections 7.3 and 7.4, through the contextual and support factors which explain absence of appropriate policy intervention and compromised agrochemical regulations, respectively. Laws governing agrochemical trade should ideally be enforced via the monitoring body of the PTCB but enforcement is weak. Five (5) key informants identified human resource and budgetary constraints as the key deficiencies hampering regulatory enforcement of this board. Illegal trade of sub-standard agrochemicals is noted. While seizure of illegal products is conducted, the trade remains 'invisible' and persists in a sophisticated discreet manner (chapter 7, section 7.3).

The following section of a letter from a citizen was published in the Guyana Stabroek Newspapers of July 2010:

> *'I noted the Ministry of Agriculture's recent seizure of backtrack* [138] *Agrichemicals in last Saturday's Stabroek News with a deep sense of expectation…These products are often not safely packaged or properly labelled in English. Sir, there is the need for a well-trained and equipped unit within the PTCCB charged with the responsibility to go after those involved in importing, transporting, storing, selling and using backtrack pesticides and*

[138] Illegally imported

> *toxic chemicals. The present structure and composition of the PTCCB rendered this body impotent to effectively carry out these functions. Such a specialised unit will enable the Board to have sound information gathering and intelligence on the movers and shapers of this underground economy and at the same time develop appropriate strategies to counter this trade'* (SN, 2010).

The PTCB refuted these claims concerning the organisation's inability to monitor the agrochemical trade and replied:

> *'The board has recently conducted a number of enforcement exercises across the country which resulted in the seizures of large quantities of unregistered pesticides…the board is committed to this process and will be intensifying these operations so as to deal with the illegal trans-boundary movement of pesticides'* (SN, 2010a).

However, in addition to literature, interviews revealed that while the board is involved in seizing illegal chemicals, this trade judiciously persists. This is discussed in detail in chapter 7, section 7.3, through the support factor of compromised agrochemical regulations. In August 2010 another citizen penned:

> *'…I also take this opportunity to inform the Pesticides Board that more and more dangerous and illegal chemicals are being sold here on the Essequibo Coast without a relevant licence being issued by the Board'* (SN, 2010b).

In addition to policy deficiency concerning agrochemical trade regulations, there exists the absence of a pricing policy for agrochemicals. As elaborated in chapter 7, section 7.4, the agrochemical trade is private-sector controlled and devoid of price regulations. Farmers are often the recipients of unscrupulous pricing regimes, conducted by dealers.

The combination of unscrupulous pricing and availability of sub-standard chemicals at relatively lower prices (compared to those imported in accordance with regulations from the PTCB), creates a dilemma where farmers are faced with choices to either purchase sub-standard chemicals at lower prices or to choose chemicals of recommended-standard at higher prices. Farmers' reactions are revealed by this study in their choice of lower priced chemicals, even though these chemicals may be with sub-standard. Owing to their choice of sub-standard chemicals, farmers are confronted with chemicals which now appear 'weak' or ineffective, predisposing to overuse. Additionally, farmers use chemicals for which the instructions in a foreign language which they cannot interpret. Farmers' reaction to this dilemma is explained by contingent factors of their assumptions of dosages and uncertainty of information regarding dosages. While focus is generally on the contingent factors, which embody farmers' actions, a redress of regulatory policy is a more foundational approach which will address the cores reasons for overuse and not the readily manifested actions of the farmer.

The establishment of the PTCL is the main initiative to enforce regulations concerning the import and use of agrochemicals, through the testing of illegal chemicals and residues within agricultural produce. But this facility is currently functioning in the capacity of training, rather than both training and testing. On the contrary, quality control monitoring of the main traditional crops is conducted by functional laboratories. While interviews revealed the rejection of Guyana's vegetable produce by importing countries due excessive agrochemical residue limits, this has not been reported for the traditional crops, sugar and rice.

9.3.3 Educational and Training Policy: deficiencies and divergent interventions

Similar to the regulatory policy, guidelines for educating farmers in agrochemical use is largely deficient, revealing absences and bias towards the traditional sector. Detailed delinquencies of these educational policies are revealed by the support and contextual factors of disorganised information systems and incapable extension services, both of which are discussed in detail within chapter 7, sections 7.3 and 7.4, respectively.

While training within the traditional sector is structured and regular, the training of vegetable farmers is irregular. Cases of long term lack of visits and supervision of farmers (abandonment) and the use of selective group training, which is not appropriately monitored, are revealed (chapter 7, section 7.3). Training within the traditional sector is conducted by experts of the main agrochemical agencies represented in Guyana, while training of vegetable farmers lack technical expertise. This training is delivered by extension officers who are not specialists in agrochemical use (chapter 7, section 7.4).

One of the key tools for training exercises, the farmers' register, was not updated for more than five years. Registration of farmers is not mandatory. Bits of information concerning farmers are contained within several departments. Crop reporters have partial registers for farmers within their designated areas. These are mainly hand-written and outdated with no appropriate farmers' contact details (see appendix 4). The extension officers have partial registers for their designated areas (see appendix 4). For both groups of staff (crop reporters and extension officers), registers were not forthcoming from more than half of the staff members, which instilled doubt within me (the researcher) concerning their very existence. The website of the NGMC has partial registers for farmers of certain crops but these are by no means representative of the farmer population (NGMC, N.D.c). The PTCB has lists of farmers from previous training programmes conducted by this agency, but these lists merely comprise farmers who were trained for several exercises conducted by this agency (PTCB, 2008). For the purposes of this study, paid census was conducted within the 2 study regions.

Perusal of the National Development Strategy and the mandate of the Crops and Livestock Support Services within the Ministry of Agriculture, reveal the absence of a regulatory mechanism to address specific agrochemical training, despite the ongoing problem of overuse. There is no regulation which stipulates the required technical expertise of personnel who disseminate information concerning agrochemical use. Interviews revealed that even the limited information which farmers received was often inappropriate and abstract, not suited to their needs (chapter 7, section 7.4). Moreover, farmers' perceptions; discussed in detail within chapter 8, primarily reveal a series of partial facts and understandings and misconstrued beliefs which highlight the lack of appropriate instruction.

Farmers' lack of regular structured information and receipt of inappropriate information, contributed to another main farmers' dilemma. Farmers were confronted with the predicament of finding an appropriate information source. Should there be dependency on traditional sources (other farmers, dealers, shop attendants) or experience? Should the information they received be disseminated?

The farmers' decisions varied but were reflected in the contingent factors of their dependence on their experience for decisions on dosages, in the absence of extension services, Farmers' decisions were also reflected in the contingent factor of deception, where farmers resorted to deceiving their colleagues and were also deceived by dealers, in the absence of appropriate information. Additionally, in the absence of relevant information farmers assumed dosages based on their observations after applications of chemicals.

The non-specific intervention to address the appropriate use of agrochemicals, revealed by key informants of the MOA and IICA primarily comprises training in Good Agricultural Practices. This training is conducted as a collaborative effort between IICA and the MOA. However, training is not mandatory, except for farmers who export their produce. Also, no structured programme for this training was available.

9.3.4 Marketing Policy: deficiencies and lack of interventions

Similar to the instances of regulatory and educational and training policies, irregularities were also detected in the case of marketing policies to address agrochemical use. An assessment of Guyana's political economy, in relation to the agricultural sector, conducted in chapter 4, reveals the absence of advocacy with respect to marketing of non-traditional agricultural produce. This is highlighted by the change of NGMC's role, from that of a purchaser of farmers' produce during the 1980s, to one of a marketing facilitator in 2007. The marketing corporation now mainly provides export guidance for farmers. Within this system, farmers are not guaranteed any market for their produce, as was the case of the previous system. The support factor of irregular and unregulated marketing systems, discussed in chapter 7, section 7.3, reveals a system of un-assured markets and haphazard marketing which farmers encounter. The contextual factor of adverse marketing conditions, discussed in chapter 7, section 7.4 indicate the absence of forecasting and pricing agreements. The absence of price control systems also cause farmers to have no guaranteed prices for their produce. The general manager of the NGMC confirmed the absence of marketing advocacy and pricing systems for non-traditional produce (SN, 2009a).

The lack of adequate policy to deal with marketing, accompanied by the absence of un-assured markets and pricing systems, fostered unhealthy competition among farmers and presented another major farmers' dilemma. In these circumstances farmers were faced with various questions. Should they not overuse chemicals and risk losing crops or have other farmers present 'better looking' crops than theirs? Should they share the information they acquired and run the risk of having other farmers' also produce crops which were marketable and thus increase market competition? Should they hide this information and increase their marketing possibilities by reducing competition for their produce and thus have a chance of increased prices?

The farmers' decisions in this dilemma are reflected in contingent factors which explain their desperation to have a marketable crop and deception of colleagues. In the case farmers' desperation, these agents utilised excesses of agrochemicals even in instances where they knew this was inappropriate practice, to combat the problem of un-assured sales. In the instance of deception, farmers in this unsure marketing situation were willing to deceive colleagues in an effort to reduce competition and increase chances of sale for their produce.

No specific intervention to address farmers' dilemma of un-assured markets and prices has been identified. However an initiative, the 'Grow More' campaign was launched in 2006 by the NGMC in collaboration with the MOA to encourage increased production and targeted export of non-traditional crops using a market-led approach (SN, 2010c; SN, 2008a). Up to recently however, this initiative has been heavily criticised by farmers for not achieving its goals and causing them to suffer losses. The Stabroek Newspaper of September 6, 2010, analysed farmers' explanations concerning the effects of the 'Grow More' campaign:

> *'In Berbice, Worrell Lewis left 2000 boulanger plants alone, planning to cut them down. "The price ain't right", he explained. "$1000 can't pay you".'*
>
> *'Growing production has resulted in gluts in the local market with farmers having no place else to turn to sell their produce. Export of fruits and vegetables is still to take off in a major way. Although farmers acknowledge that gluts are sometimes seasonal, some said they have responded to appeals to grow more but the markets have not materialized.'*
>
> *'...in the almost four years since the Grow More Food campaign began and a number of initiatives started, many farmers- identifying markets as very critical to them, said that they have seen little change in this regard. They still battle the gluts in the local market and sometimes prefer to leave the crops to rot in the fields. The prices offered by the middle-men who buy from them are too low to make it worthwhile'* (SN, 2010d).

Similarly the Stabroek Newspaper of September 13, 2010, reported the following farmers' views of this initiative:

> *There is a need for more markets, farmers stressed. "The local market can't take up the amount of produce that people plant," Sarju said. "The amount of farm that the Minister of Agriculture tell people ah grow, it ain't gat no market for am," said Persaud. "Grow the food is nice but you nah get the price*[139]*," he added. The low price for their produce is one of the main concerns for farmers…There is "no kind of market foh tek off your goods,*[140]*" he said, adding that it is more work but less money.*
>
> *Ramnarine Ramotar of Big Baiboo said he was not affected much. He explained that he was ill and was not doing much farming. However, he noted that he normally planted the same acreage for the local market. "Me nah grow nothing for export because me nah get market,*[141]*" he said, adding that if they source an overseas market, they can definitely grow more'* (SN, 2010e).

Recent literature of September, 2010 confirms the absence of marketing policy for non-traditional crops and also reflects the confused state of marketing explained by farmers' interviews and their subsequent actions of desperation and deception. While the 'Grow More' campaign encourages production, recent news included the following excerpt, which indicates controversial policies:

> *'The Agriculture Ministry will be more aggressive in seeking export markets, Minister Robert Persaud pledged yesterday, though he said if farmers don't have markets they should not plant and ultimately an agro-industrial base will be the salvation for the sector…He said that previously, production was focused on but now farmers should secure the market before they produce. "If you don't have the market, don't plant," Persaud said. He said the role of government is to facilitate and provide support and that is what it will be doing… we have to plan," Persaud said, adding that this is where the New GMC and the extension system has to work; advising farmers based on the market needs.*
>
> *It will also require a change on farmers' part, he said, telling them that they have to move away from an attitude of believing that it is somebody else's problem or it is for government to solve'* (SN, 2010f).

Farmers indicated that the agencies which they are advised to consult are inaccessible and do not conduct regularized visits to them. This irregular service was also confirmed by key informants and is discussed in detail in chapter 7, sections 7.3 and 7.4.

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[139] This is interpreted as: *'The amount of crops that the Minister of Agriculture told people (farmers) to grow, there is no market for them...Growing the food is nice, but you don't get the price...'*

[140] This is interpreted as: *'There is no market for your produce...'*

[141] This is interpreted as: *'I am not growing anything for export because there is no market...'*

Based on findings and preceding arguments it is concluded that contingent factors for farmers' overuse those of farmers' assumptions of dosages, dependence on their own experience, their desperate need for a marketable crop and deceptive attitudes to other colleagues. However, a wider picture emerges, where the reasons for farmers' expression of these contingent factors is the lack of an enabling environment which can initiate, support and facilitate farmers' adoption of appropriate practices. The key reason for farmers' overuse of pesticide and fertiliser is therefore the lack of this enabling environment which is capable of promoting and sustaining appropriate agrochemical use practices. The main elements of this incompetent environment are identified as: Deficiencies, absences and mismatched interventions in 3 key policy areas: regulatory policy; education and training policy and marketing policy. Redress of the elements which comprise this incompetent environment should therefore be the focus of attention for the development of an atmosphere which is conducive to farmers' adoption of appropriate agrochemical use practices. Implications for this study therefore focus on the redress of regulatory, education and training and marketing policy and interventions within the agricultural sector.

9.4 Implications for Policy Reformation to Address Agrochemical Overuse

Literature identifies an imbalance of policy in Guyana's agricultural sector, with bias for traditional crops (EC, 2006; Forde, N.D.; Singh, 2005). While policies for agrochemical use do not lie primarily within the purview of the agricultural sector[142]; there is provision for inter-sector collaboration (NDS, 2001). Furthermore, activities of the agricultural sector have been implicated within policy and other writings, for their capability to cause environmental distress through the use of agrochemicals (EC, 2006; NDS, 2001). Though not widely recorded, farmers' overuse practices are well known among technical personnel, as indicated by key informants. Imports of illegal chemicals and unscrupulous pricing systems persist. Many other ills concerning the import, distribution and use of agrochemicals are recorded within the media and include inappropriate retailing (chapter 7, section 7.3).

[142] According to policy, agrochemical use is primarily under the purview of the Environmental Protection Agency (EPA): http://www.epaguyana.org/; http://www.ndsguyana.org/document.asp (5.IV)

In spite of this knowledge, the import and distribution of agrochemicals is still private-sector governed. Agents remain the authorised importers and distributors. While agents are required to adhere to stipulations set out by the PTCB, the physical presence of the PTCB staff is not required at the import exercise. Porous borders of the country permit a vibrant illegal agrochemical trade between Guyana and her neighbouring countries, Brazil, Suriname and Venezuela. These acts are substantiated by literature (SN, 2004), farmers (chapter 7, section 7.3) and key informants. For instance, Key informant 10 revealed:

> *'We do not get into areas like Lethem or the North West because they are not heavily into vegetable farming and Lethem would get their stuff (chemicals) from Brazil and the North West they get a lot of stuff from Venezuela'.*

Key informant 5 stated:

> '*Now we are working with the pesticides personnel from that end (Suriname), so the trade is like from approximately 30% to 5%'.*

Addressing the deficiency of appropriate regulatory mechanism concerning agrochemical use cannot begin with the farmer. While the private sector can play a role in the import and distribution of agrochemicals, policy which addresses active government involvement is required. For example, the private sector can retain some aspects of import and distribution, but under careful government monitoring. Alternatively, import and distribution should be government-controlled. Twenty one (21) farmers called for government intervention in the regulatory mechanism of agrochemical distribution. For example farmer Chr noted:

> *'The Government should hold a higher responsibility for bringing in (importing) these type of chemicals; then they could sell it at a cheaper rate…these people that are selling this thing; they bring a small amount; when it is scarce, their price gone up.'*

There is also the need for improved border surveillance to combat the illegal imports of agrochemicals, which are often sub-standard. This may require targeted collaborative efforts between the Customs agency and PTCB and also stricter penalties for persons found engaging in these practices. The current penalty of seizure of illegal agrochemicals does not seem effective enough to deter this practice.

In terms of education and training policy, training of farmers in agrochemical use is not specified for any agency. The PTCB is mandated to monitor the quality, sale and use of pesticides and other toxic chemicals in the interest of stakeholders and also to educate on the use of pesticides and other toxic chemicals. As part of its mandate, the PTCB conducts training for farmers and other agricultural stakeholders in appropriate pesticide use (PTCB, N.D.a; SN, 2010a). While policy if fully set out concerning pesticides through regulations contained within the Pesticide and Toxic Chemicals Act, there is absence of precise policy regarding the use of fertilisers. The overuse of fertilisers seems to be generally downplayed and rarely mentioned except when there is suspicion by the average consumer.

It is implicit that since the Ministry of Agriculture houses a training unit for farmer and staff education, then training should encompass aspects of agrochemical use. Various agencies of the ministry have indicated limited involvement in training farmers on agrochemical use. The CLSS collaborate with the IICA agency to provide instruction to farmers concerning agrochemical use, through training on GAPs[143]. The CLSS and the national research institute, NARI, both provide information concerning fertiliser use to farmers[144], but interviews reveal that these services are spontaneous and untargeted.

Additionally, there is no law which addresses the technical capability of personnel who disseminate information concerning agrochemical use. Agrochemical agents generally distribute imported agrochemicals to a wide cross section of dealers. But there is no law which dictates the technical capability of dealers, who are often the advisors of farmers. Farmer and key informants' interviews and my own observations indicate the incompetency of agents in many instances to give advice concerning agrochemical use. Further, interviews reveal that the extension agents are not specialists in the area of agrochemical use and are also not the recipients of organised training (chapter 7, section 7.4).

Against the preceding background, there exists an obvious policy gap concerning regulations which govern farmer and technician training in agrochemical use. Results from this study reveal the urgent need for specific training which targets agrochemical use. Agencies should have precise mandates which address specific aspects of training,

[143] Information sources from key informants of the MOA and IICA
[144] Information sources from key informants of the MOA

as implicit connotations can foster delinquency. Training should be conducted by authorised personnel and be sustained; guided by regular feedback. The issue of the farmers' register is pertinent to policy concerning training. It is unsure how officials conduct appropriate training in the absence a farmers' register. Effective and sustained training will require monitoring of trainees, which definitely necessitates a regularly updated farmers' register. Additionally, farmer registration and record keeping should be mandatory, if farmer instruction is to be effective.

Analysis of farmers' perceptions in chapter 8 reveals their lack of education concerning appropriate agronomic procedures which have implications for agrochemical use. This finding suggests the need for a dual approach training which informs on both agrochemical use and also corresponding agronomic procedures. The partial knowledge of agronomic facts which concern agrochemical use and corresponding misconstrued beliefs expressed by farmers also implies the need for targeted training at different levels reinforcement, for example through demonstration and evaluation of the effectiveness of training programmes.

Concerning policy to address marketing, it is clear that no agency fully addresses the issue of farmers' marketing of non-traditional crops. As pointed out in chapter 2, marketing of the traditional crops, sugar and rice is conducted by established agencies, and includes negotiations for price and quantities. This study reveals the absence of an informed and regularised marketing system for non-traditional crops, indicating the need for an established system of marketing for these crops. While farmers can be proactive, appropriate policy is required for their guidance. Within the present circumstances a clear direction is needed for farmers to follow. While this expertise is beyond the scope of this thesis, implications include the following : a reverse of the role of the marketing corporation from 'facilitator' to 'purchaser'; buying farmers' produce for subsequent retail; the establishment of a structured marketing system, including appropriate physical infrastructure where buyers and sellers are clearly identified, with inclusion of systems of traceability and price control, which assures the farmer of a 'least' income, rather than face the devastating possibility of no income after cultivation and harvest.

While the foregoing implications have been suggested to address the problem of pesticide and fertiliser overuse investigated in this study, as in any other study, there were limitations to the scope of this investigation. The proposed areas are therefore recommended for further exploration of the farmers' agrochemical overuse. Firstly, similar studies can be conducted for other crops, to enhance targeted interventions, including training. Secondly, a more participatory approach can be adopted, where the researcher resides at farmers' plots for periods of time which are sufficient to fully observe farmers' behaviour and take part in their decision making. This will enhance the understanding of farmers' choices to adopt overuse practices. Thirdly, once policy implications are implemented, studies which involve repeat visits to farmers can be conducted, to assess the impact of these implementations on changes in farmers' behaviour.

This study concludes that the causes of farmers' overuse of agrochemicals in Guyana are embedded within and explained by the absence of targeted policy and the use of mismatched interventions to address this persistent dilemma. The key to discovering the causes for this persistent behaviour was uncovered through in-depth analysis and clear understanding of the factors which triggered farmers' decisions to adopt these practices. Such understanding revealed that comprehensive redress of existing policies and interventions which target agrochemical use is pertinent for the alleviation and possible cessation of farmers' overuse behaviour.

APPENDICES

APPENDIX 1: Research Information Documents and Data Collection Instruments

A1.1 Interviewees' Consent Form

Consent Form

Survey Questionnaire for Investigation of Farming Practices

Introduction:

This study is being conducted for my PhD thesis and investigates some of the types of activities or practices which farmers conduct and why they choose these practices.

As a farmer you would know that you do lots of things in farming; like preparing the land before planting and adding different types of substances to help the plants grow and prevent diseases. These things that you do are what I call farming practices in my study. I would like to find out more about some of the practices you do; like what type of fertiliser or manure you use, what you use to keep off pests and prevent diseases and other questions like these. I am very interested in knowing how and why you choose these kinds practices and will also ask you some questions about yourself; which will help me to understand the choices you make. You are free to tell me anything else about how you do farming.

The information you give to me will not be shared with anyone else unless you agree. This information will be stored on my computer but your names will be removed. You are free to take part or not, but I hoping that you will do so, since this a very important study which can provide both of us with much information on farming; especially in understanding the choices you make. If you wish, at the end of the study I can tell you what I found.

Is there anything else you would like to know about this study?............................

Are you willing to take part in this interview?.......................

Signature /Mark: ....   Date: ..../.........../....................

A1.2 SED – Risk Assessment Form

School of Environment and Development
Risk Assessment

Head of School:	Clive Agnew on 0161-275 3654
Geography Safety Adviser (SSA):	Roger Braithwaite on 0161-275 3644
IDPM Safety Adviser	Willy McCourt
Planning Safety Adviser	Mark Baker
Architecture Safety Adviser	Simon Guy

Purpose

The purpose of this risk assessment is to establish the safe working procedures to be followed that are not already covered in the Schools (3) generic risk assessments. The risk is identified for each relevant hazard category and the appropriate control measure(s) are described.

Activity:	*Please provide details*
Geographical location(s):	*Please provide details*
Agreed by HoS date ****	To be reviewed ****

Declaration

I/We, the undersigned, have assessed the proposed procedure and its associated hazards and declare that the risks will be controlled by the control methods listed. I/We will plan the procedure in enough detail to assess the potential hazards and to reduce the associated risks to the lowest possible level.

All participants in the procedure have been informed of these control measures. The risk assessment will be re-assessed whenever there is significant change, or at least annually.

Name of responsible person	
Signed:	
Date:	
Name of tutor/adviser (if appropriate)	
Seen by HoS/SSA/deputy-SSA	
Date	

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RISK ASSESSMENT USING HAZARD CHECKLIST

The possible hazards involved in the field course are listed on pages 3-7 according to the following categories:

1) FEASIBILITY OF PROJECT (Feasibility)
2) RISKS INHERENT IN SITE (Sites)
3) RISKS INHERENT IN WORK (Work)
4) ORGANISATION OF THE PROJECT (Organisation)
5) CONDUCT OF PROJECT (Conduct)

You should go through the list of hazards under each category and check those relevant to the planned fieldwork. Most items will not be relevant. You then go to page 8 and perform the actual risk assessment (Assessment). This involves listing the possible **hazards** and outlining **control measures** for each identified **hazard** so that the **risk** is **as small as possible**. For example, missing the plane is a possible hazard but the risk is small if all participants receive a timely and clear itinerary of the planned travel. If, despite this, young Jason still misses the flight it is not the fault of the organiser.

Some of the hazards involve major control measures. For example, item 3.2.1 "Chemical hazards" is a major hazard if you are using chemicals or are exposed to them. The appropriate control measure "Observe COSHH" regulations is concise to write but requires a lot of work to implement and must be fully documented.

Many hazards will only arise on serious expeditions to the Arctic or while climbing Mount Everest, but you should be aware that fieldwork can expose people to novel hazards. For example, we are all used to traffic as an everyday hazard but walking around in large groups, or carrying unwieldy equipment, may involve exceptional traffic hazards.

Dealing with other people can be very hazardous, especially in private space, and social scientists have to be just as careful in their risk assessment as environmental scientists.

A certain common sense is required in judging which hazards have to be addressed explicitly. For example, field course participants can use public transport or chartered vehicles and rest assured that their health and safety concerns are covered by the transport provider. However, if you rent a vehicle and drive it yourself you have to operate it properly and, under University regulations, you can only drive a vehicle with students if you have passed an approved minibus course.

If in doubt please consult with the Discipline Safety Advisor. The main thing is that risk assessment should be an active process and not a conditioned ticking of boxes.

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HEALTH AND SAFETY PLANNING CHECKLIST

1. FEASIBILITY OF PROJECT

No.	General Area	Specific Issue	Relevant?
1.1.1	Access	Travel arrangements	
1.1.2	Access	Permission to work on site	
1.1.3	Access	Provision for disabled	
1.1.4	Access	Availability of assistance	
1.1.5	Access	Accommodation	√
1.1.5	Access	Insurance	
1.2.1	Fitness	Pre-expedition training	
1.3.1	Training	Navigation	
1.3.2	Training	First-aid	
1.3.3	Training	Languages	
1.3.4	Training	Interpersonal skills	
1.3.5	Training	Hygiene/health education	
1.3.6	Training	Specific skills	√
1.4.1	Health	Health questionnaire	
1.4.2	Health	Medical/dental check-up	
1.4.3	Health	Vaccinations (especially tetanus)	
1.4.4	Health	First-aid kits	
1.4.5	Health	Sterile packs	
1.5.1	Staffing	Staff to student ratios	
1.5.2	Staffing	Deputising arrangements	
1.5.3	Staffing	Competence of all leaders	

School of Environment and Development
HEALTH AND SAFETY PLANNING CHECKLIST

2. RISKS INHERENT IN SITE

No.	General Area	Specific Issue	Relevant?
2.1.1	Physical hazards	Extreme weather	√
2.1.2	Physical hazards	Mountains and cliffs	
2.1.3	Physical hazards	Glaciers, crevasses, ice falls etc	
2.1.4	Physical hazards	Caves, mines and quarries	
2.1.5	Physical hazards	Forests including fire hazards	
2.1.6	Physical hazards	Freshwater	
2.1.7	Physical hazards	Sea, seashore, tides, currents etc.	
2.1.8	Physical hazards	Marshes and quicksand	
2.1.9	Physical hazards	Roadside	√
2.2.1	Biological hazards	Dangerous animals	√
2.2.2	Biological hazards	Dangerous plants	
2.2.3	Biological hazards	Pathogenic micro-organisms	
2.3.1	Chemical hazards	Agrochemicals and pesticides	√
2.3.2	Chemical hazards	Dusts (COSHH)	
2.3.3	Chemical hazards	Chemicals on site (COSHH).	√
2.4.1	Man-made hazards	Machinery and vehicles	
2.4.2	Man-made hazards	Power lines and pipelines	
2.4.3	Man-made hazards	Electrical equipment	
2.4.4	Man-made hazards	Insecure buildings	
2.4.5	Man-made hazards	Slurry and silage pits	
2.4.6	Man-made hazards	Attack on people and property	
2.4.7	Man-made hazards	Military activity	
2.4.8	Man-made hazards	Alcohol abuse	
2.5.1	Environment	Pollution	√
2.5.2	Environment	Disturbance of ecosystems	√
2.5.3	Environment	Waste minimisation	√

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HEALTH AND SAFETY PLANNING CHECKLIST

3. RISKS INHERENT IN WORK

No.	General Area	Specific Issue	Relevant?
3.1.1	Training	Navigation	
3.1.2	Training	Survival/rescue	
3.1.3	Training	First-aid	
3.1.4	Training	Specialist training	
3.2.1	Chemical hazards	COSHH assessment	
3.3.1	Biological hazards	COSHH assessment	
3.3.2	Biological hazards	Animals	√
3.3.3	Biological hazards	Plants	
3.4.1	Personal safety	Risk of attack	
3.4.2	Personal safety	Routine communication	
3.4.3	Personal safety	Communication in emergency	

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HEALTH AND SAFETY PLANNING CHECKLIST

4. ORGANISATION OF THE PROJECT

No.	General Area	Specific Issue	Relevant?
4.1.1	Personal safety	Travel documents	
4.1.2	Personal safety	Next of kin and G.P. noted	
4.1.3	Personal safety	Medical problems noted	
4.1.4	Personal safety	Appropriate authorities informed	√
4.2.1	Catering	Provision of food	√
4.2.2	Catering	Hygiene	
4.2.3	Catering	Potable water	√
4.2.4	Catering	Food preparation and storage	
4.2.5	Catering	Fuel for cooking	
4.3.1	The group	Leader	
4.3.2	The group	Chain of command	
4.3.3	The group	Staff to student ratios	
4.3.4	The group	Personal relationships	
4.3.5	The group	Size of working groups	
4.3.6	The group	Responsibilities for work	
4.3.7	The group	Accommodation	
4.4.1	The individual	Lone working avoided?	√
4.4.2	The individual	Adequate/appropriate clothing?	√
4.4.3	The individual	PPE provided?	
4.4.4	The individual	Trained and fit?	√
4.5.1	Equipment	Fit for purpose?	√
4.5.2	Equipment	Used properly?	
4.5.3	Equipment	Well maintained?	
4.5.4	Equipment	Repairable on site?	
4.5.5	Equipment	Need to duplicate?	

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HEALTH AND SAFETY PLANNING CHECKLIST
5. CONDUCT OF THE PROJECT

No.	General Area	Specific Issues	Relevant?
5.1.1	Local conditions	Weather forecast	
5.1.2	Local conditions	Local knowledge/rules	
5.1.3	Local conditions	Farming practices	√
5.1.4	Local conditions	Itinerary and return times	
5.1.5	Local conditions	Appropriate permission sought	
5.2.1	Transport	Appropriately licensed driver(s)	√
5.2.2	Transport	Correctly maintained	√
5.2.3	Transport	Correctly loaded	√ life jackets
5.2.4	Transport	Appropriate spares	
5.2.5	Transport	Seat belts	√
5.2.6	Transport	Fuel	
5.2.7	Transport	Maps and navigation aids	
5.3.1	The Group	Present and correct (roll calls)	
5.3.2	The Group	Correctly equipped (PPE etc.)	
5.3.3	The Group	First-aid kit/emergency eqpt.	
5.3.4	The Group	Survival aids	
5.3.5	The Group	Group size and supervision	
5.4.1	Working Practices	Lone working avoided?	√
5.4.2	Working Practices	Communication systems	
5.4.3	Working Practices	Buddy system or lookouts	
5.4.4	Working Practices	Provision of shelter	
5.4.5	Working Practices	Safety lines, harnesses etc.	
5.4.6	Working Practices	Safe working systems	
5.4.7	Working Practices	Permit to work	
5.4.8	Working Practices	Workers trained and fit (according to University Occupational Health)?	
5.4.9	Working Practices	Limitation of working time	
5.5.1	Emergencies	Communication	
5.5.2	Emergencies	Protection of remaining party	
5.5.3	Emergencies	Evacuation	
5.5.4	Emergencies	Recovery of casualties	
5.5.5	Emergencies	Chain of command	

RISK ASSESSMENT

List the significant hazards identified (use 5-point check list on pages 4-8) and detail control measures to minimize or eliminate risk

No.	Significant hazard	Control Measures
1.1.5	Accommodation	For work in rural areas where extended stay is required, accommodation will be sought in established hotels or guest houses. Privately controlled accommodation will be avoided.
1.3.6	Specific skills	Skill for research techniques will be accomplished through appropriate training modules, additional training (for example workshops/seminars/conferences) and pilot practice.
2.1.1	Extreme weather	In cases of flooding, work within these areas will be rescheduled until conditions are suitable for work. Work will continue in other areas.
2.1.9	Roadside	
2.2.1	Dangerous animals	Care will taken not to enter premises without permission; to be alert for necessary signs; to ask questions even where it may seem safe and avoid animals known to be dangerous.
2.2.2	Dangerous plants	Care will be taken not to handle or come into contact with known dangerous plant material or those which are unknown.
2.3.1	Agrochemicals and pesticides	Care will be taken not to handle or come into contact with agrochemicals and pesticides which are known to be dangerous or those which are unknown. Handling will be avoided.
2.3.3	Chemicals on site (COSHH).	Care will be taken not to handle or come into contact with chemicals which are known to be dangerous or those which are unknown. Handling will be avoided.
2.5.1	Pollution	Cases of pollution will be examined as part of the research but examined in a manner to avoid any negative health effects. Handling will be avoided.
2.5.2	Disturbance of ecosystems	Disturbances of ecosystems will be examined as part of the research but examined in a manner to avoid any negative health effects. Handling will be avoided.
2.5.3	Waste minimisation	Cases of waste disposal will be examined as part of the research but examined in a manner to avoid any negative health effects. Handling will be avoided.
3.3.2	Animals	Care will taken not to enter premises without permission; to be alert for necessary signs; to ask questions even where it may seem safe and avoid animals known to be dangerous.
4.1.4	Appropriate authorities informed	The most relevant authorities (for example the Ministry of Agriculture) will be informed of the exercise.

4.2.1	Provision of food	Food will be prepared and taken or bought from established businesses.
4.2.3	Potable water	Water will be taken to all rural areas.
4.4.1	Lone working avoided?	Work will be conducted during the more busy hours of the day and care taken to either avoid lonely areas or visit these areas accompanied
4.4.2	Adequate/appropriate clothing?	Appropriate clothing for visits to rural farming districts will be utilised
4.4.4	Trained and fit?	Prior pilot visits and surveys and interview will be conducted
4.5.1	Fit for purpose?	Prior pilot visits and surveys and interview will be conducted
5.1.3	Farming practices	Through preliminary pilot visits, acquaintance will farming practices will be acquired.
5.2.1	Appropriately licensed driver(s)	It will be ensured that all drivers contracted are licensed; where this cannot be ascertained, public transport will be utilised.
5.2.2	Correctly maintained	As far as is possible, a check will be conducted for vehicle maintenance; for example, ascertaining a document of vehicular fitness.
5.2.3	Correctly loaded	It will be ensured that all modes of transport are not overloaded; in the instance of transport on water; it will be ensured that life jackets are utilised.

OTHER INFORMATION

ATTACH LIST OF FIELDWORK PARTICIPANTS AT END OF DOCUMENT

ATTACH COPIES OF ANY DOCUMENTS AND/OR HANDOUTS GIVEN TO FIELDWORK PARTICIPANTS

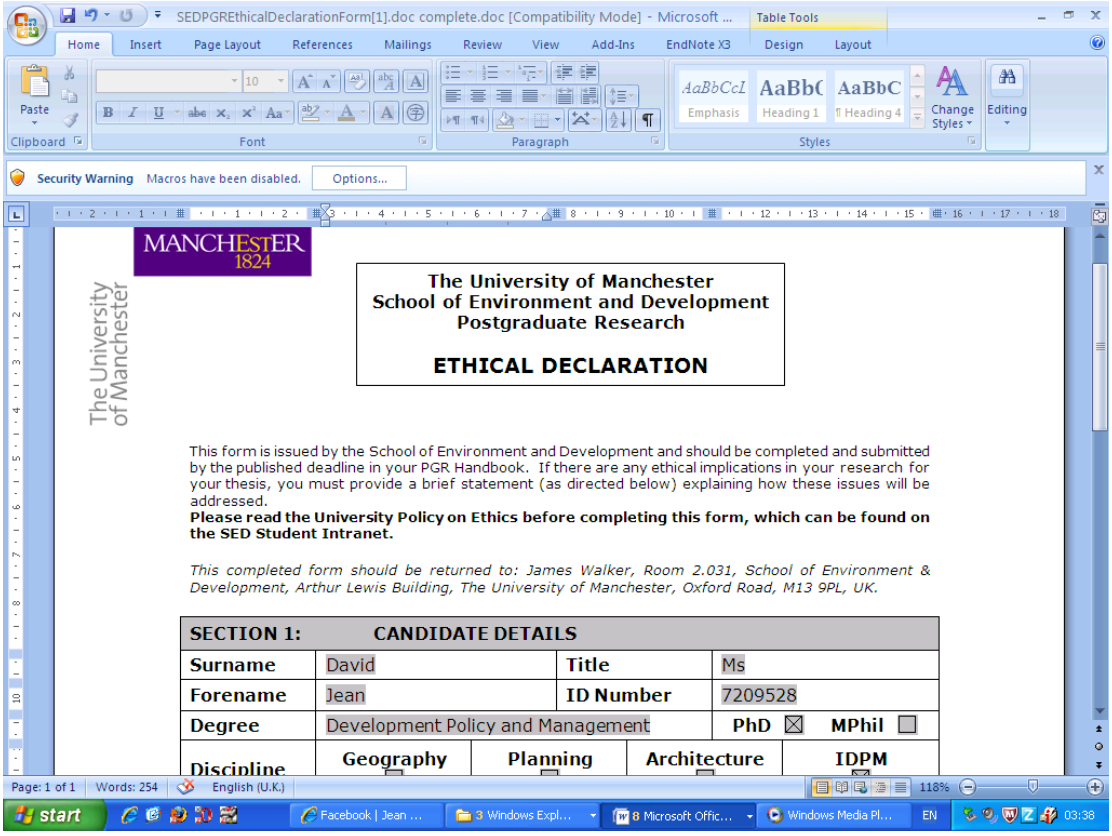
ATTACH ITINARY OF TRIP, INCLUDING FLIGHT NUMBERS AND TIMES OF FERRIES ETC

GIVE ADDRESSES, PHONE NUMBERS, NAMES OF CONTACT PERSONS AND DATES FOR ANY ACCOMODATION USED

ATTACH ANY OTHER ASSESSMENTS MADE IN CONNECTION WITH THIS COURSE, COSHH ASSESSMENTS ETC

GIVE ANY COMMENTS BELOW

A1.3 Ethical Declaration Form



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Postgraduate Research

ETHICAL DECLARATION

This form is issued by the School of Environment and Development and should be completed and submitted by the published deadline in your PGR Handbook. If there are any ethical implications in your research for your thesis, you must provide a brief statement (as directed below) explaining how these issues will be addressed.
Please read the University Policy on Ethics before completing this form, which can be found on the SED Student Intranet.

This completed form should be returned to: James Walker, Room 2.031, School of Environment & Development, Arthur Lewis Building, The University of Manchester, Oxford Road, M13 9PL, UK.

SECTION 1:	**CANDIDATE DETAILS**				
Surname	David	**Title**	Ms		
Forename	Jean	**ID Number**	7209528		
Degree	Development Policy and Management		**PhD** ☒	**MPhil** ☐	
Discipline	**Geography**	**Planning**	**Architecture**	**IDPM**	

Ethical Issues for Research on Investigating Pesticide and Fertiliser Overuse

The general research question for this investigation is 'What are the reasons for pesticide and fertiliser overuse in some arable farmers in the Guyana context, 2000-2010?'

Some of the data required for answering this research question constitutes sensitive information in various instances. Farmers will be asked questions which will generate information both of a general nature and concerning specific farming practices they conduct. Some queries are based on pesticide use, fertiliser use and occupancy status, among others. Various agencies within Guyana are endowed with the mandate for exercising law on various areas of query encompassed by this study. The following gives a background and indication of some specific areas which constitute sensitive information and how these will de managed.

The Pesticides and Toxic Chemicals Board in Guyana, falls under the purview of the Ministry of Agriculture, Guyana and has the mandate for 'making arrangements and providing facilities for controlling the manufacturing, importing, transporting, storing, selling, using and advertising of pesticides and toxic chemicals' (Pesticides and Toxic Chemicals Control Board, Board profile). Regulations under The Pesticides and Toxic Chemicals Control Act, 2000, specify rules for pesticide use.

The Lands and Survey Commission of Guyana has the mandate to 'to survey and map the land and water resources of Guyana, to be custodians of all public lands and administer these effectively in the national interest, and to provide land-based information to a broad range of public and private sector entities and interests' (Government of Guyana, Lands and Survey Commission, Guyana: Mission Statement, Scope, Key Responsibilities). Included in the scope of this agency are specific duties to 'review, file and record application, approvals, issuance, renewals, transfers, cancellations and surrenders of land titles and leases'; 'survey, sub-divide and demarcate publicly-owned to facilitate issue of title to farmers, entrepreneurs and other developers' and 'co-ordinate with other agencies concerned with land-based resource management (Guyana Geology and Mines Commission, Guyana Forestry Commission, Central Housing and Planning Authority and Environment Protection Agency, etc.) with the objective of ensuring orderly and sustainable occupancy and use of lands'; one such agency being the Ministry of Agriculture.

The Environmental Protection Agency (EPA) of Guyana has the mandate to 'promote, facilitate and coordinate effective environmental management and protection; and the sustainable use of Guyana's natural resources'. This agency was established under the Environmental Protection (EP) Act of 1996 (Environmental Protection Agency - EPA). The Environmental Protection Act, No.11 of 1996, Part IV requires that all project developers of specified projects listed in its fourth schedule or those projects which may significantly affect the environment apply to the EPA for an Environmental permit. The EPA collaborates with the relevant sector is responsible for review and assessment of applications (EPA, 2010).

Apart from the above regulatory mechanisms, farmers are also advised concerning good and recommended practices regarding pesticide, fertiliser and tillage, via the National Agricultural Research Institute (NARI) and the Ministry of Agriculture

(MOA); especially through the and the Crops and Livestock Support Services of MOA. In this investigation farmers will be asked questions concerning their pesticide use, fertiliser use. Based on regulatory mechanisms, divulgence of some practices may reveal instances of offences against the law or required practices; for example inappropriate pesticide use or illegal land occupancy (squatting); hence comprising sensitive information; which if revealed may constitute evidence against farmers.

In light of the above discussion, prior to the survey and interviews, farmers will be assured of anonymity and confidentially of the information they divulge; unless they consent otherwise. While ideally, interviews will be recorded via audio and video tape recorders, this will be conducted only where consent of respondents is obtained. In those cases where consent is not granted, notes will also be taken through the use of a field diary. Observations will also be recorded via photographs. Additionally, participants will be informed of their right to withdraw from the process if requested. However, signing if a consent form does not seem appropriate in this instance for two main reasons: first, some farmers may be illiterate, constituting an uncomfortable situation in an already sensitive environment and second, signing forms for some farmers may seem indicative to them of committing themselves to some situation which may have undesirable or binding commitments on their behalf. Thus, a signed statement from the researcher, assuring farmers of anonymity, confidentiality and withdrawal rights, which can be read to farmers and left in their possession seems more applicable and will utilised for this research.

A1.4 Survey Questionnaire

Survey Questionnaire for Investigation of Farming Practices

Introduction:

This study is being conducted for my PhD thesis and investigates some of the types of activities or practices which farmers conduct and why they choose these practices.

As a farmer you would know that you do lots of things in farming; like preparing the land before planting and adding different types of substances to help the plants grow and prevent diseases. These things that you do are what I call farming practices in my study. I would like to find out more about some of the practices you do; like what type of fertiliser or manure you use, what you use to keep off pests and prevent diseases and other questions like these. I am very interested in knowing how and why you choose these kinds practices and will also ask you some questions about yourself; which will help me to understand the choices you make. You are free to tell me anything else about how you do farming.

The information you give to me will not be shared with anyone else unless you agree. This information will be stored on my computer but your names will be removed. You are free to take part or not, but I hoping that you will do so, since this a very important study which can provide both of us with much information on farming; especially in understanding the choices you make. If you wish, at the end of the study I can tell you what I found.

Is there anything else you would like to know about this study?............................

Are you willing to take part in this survey/interview?.......................

Signature /Mark: ....   Date: ..../…......./....................

Household ID:........................

Person ID:............................

Crop ID:................................. (Bora – 1; Boulanger – 2)

GENERAL AND DEMOGRAPHIC INFORMATION

1. Date of survey: ....
2. Farmer's name: ....
3. Location: ....Region.........................
4. Contact: Telephone no.............................. Email address: ....
5. Mailing Address: ....
....

FARMER CHARACTERISTICS

6. **Gender**: Male................ Female: ....

7. **Ethnicity (1)** Amerindian **(2)** African Ancestry **(3)** Indian Ancestry **(4)** Portuguese Ancestry **(5)** Chinese Ancestry **(6)** Mixed **(7)** Other

8. **Farmer's Age Group: (1)** <20 **(2)** 20-30 **(3)** 31-40 **(4)** 41-50 **(5)** >50

9. **Farmer's Education: (Education Level) (1)** Tertiary* **(2)** Secondary **(3)** Primary **(4)** Other

* - Beyond secondary; to include skill training, college, university

10. **Farmer's Experience: (Number of years involved in farming): (1)** <5 **(2)** 5-10 **(3)** 11-15 **(4)** >15

Income

11. **Income Source:** Is farming your only source of income? (1) Yes (2) No

12. If No, how many sources of income do you have? (1) (2) 2 (3) 3 (4) >3

13. **Household members income (Additional members earning income)**

Household member	**Income Group (G$ per month)**	**Source of income**
Farmer	<40,0000	
	41,000-50,000	
	51,000-60,000	
	61,000-70,000	
	>70,000	
Other member	<40,0000	
	41,000-50,000	
	51,000-60,000	
	61,000-70,000	
	>70,000	
Other member	<40,0000	
	41,000-50,000	
	51,000-60,000	
	61,000-70,000	
	>70,000	

Supplemental Income (Investment)

14. Does income from sources other than the farm go towards investment on the farm? Yes…. No…..

    If Yes, name the other source(s)? ....

Affiliation to Farmer Organisation

15. Are you a member of any farmers' organisation or group? Yes ……No……

If yes; please give the name of the organisation or group:

………………………………………………………......................................

FARM CHARACTERISTICS

16. **Farm Size: Total Farm land size (acres):** (1) <5 (2) 5-10 (3) 11-15 (4) 16-20 (5) >20

17. **Area Cultivated: Total Farm land size (acres) under cultivation:** (1) <5 (2) 5-10 (3) 11-15 (4) 16-20 (5) >20

18. **Farm's Management type: (Who manages the farm?)** (1) Owner (2) Paid Management (3)Unpaid/Family management (4) Other........................

19. **Management role of each adult:**

Adult	**Role**

20. **Farm Employees:**

(i) Number of Permanent employees: ....

(ii) Number of Casual employees: ....

(iii) No. of times per year casual employees are taken: ....

21. **Farmer's Tenure Status:** (1) Owner (2) Rent/Lease (3) Family (4) Squatter (5) Other ....

Credit

22. Do you take credit to conduct farming activities? .... (1) Yes...... (2) No

23. If no - WHY?...

24. If yes - Where do you access credit from and why?

Credit Access	**Why?**
Commercial Bank	
IPED	
Relative	
Cooperative	
Farmers' Organisation	
Other	

25. Do you face constraints in accessing credit? Yes……… No……..

If yes, what types of constraints do you face in accessing credit?
………
………
………

Market

26. **Which market do you sell to? Local.................... Export...................**

27. **How accessible are markets to you? (Accessibility): (1)** Very accessible (2) Accessible (3) Fairly Accessible (4) Not Accessible

28. **What type of constraints do you face in accessing market?**

……

……

……

INFORMATION CONCERNING PESTICIDE USE

(A) Accessibility

29. How accessible are pesticides to you? (Ease of Access): **(1)** Very accessible (2) Accessible (3) Fairly Accessible (4) Not Accessible

(B) Education/Information

Source:

30. Where do you get general information concerning pesticides? (**Main Information Source):** (1) Extension agent (2) Pesticide Dealer/Seller (3) Other Farmer (4) Farmers' Organisation/Group (5) Other Source…………………………………

31. Why do you choose this source?
…………………………………………………………………………………………………
…………………………………………………………………………………………………

Frequency

32. How often do you receive information concerning pesticides and their use? (times per month) (**Information concerning pesticides (times per month):** (1) 1 (2) 2 (3) >2

Relevance

33. How relevant do you think this information is assisting you to understand pesticides and their use? **(Relevance):** (1) Very Relevant (2) Relevant (3) Fairly Relevant (4) Not Relevant

Content

34. What does this information include? ………………………………………………………………………………………….
…………………………………………………………………………………………………….
…………………………………

Ease of access

35. How easy is it for you to access to information concerning pesticides and their use? **(Ease of Access):** (1) Very Easy (2) Easy (3) Fairly Easy (4) Not Easy

Ease of Understanding

36. . How easily do you understand the information you receive? (**Ease of Understanding)**
(1) Very Easy (2) Easy (3) Fairly Easy (4) Not Easy

37. What do you think (if anything) would assist you in understanding information concerning pesticides more?

....

....

Pesticide Practices

38. Use: Types, Concentration, Frequency

Pesticide Name/Type	Concentrations Used/How mixed	Frequency of Application	Stage of Growth (of plant)	Remarks

39. Where do you get pesticides? (Pesticide Source): (1) Extension agent (2) Pesticide Dealer/Seller (3) Other Farmer (4) Farmers' Organisation/Group (5) Other Source..................................

40. Why do you choose this source? ....

41. Where do you get specific information on how to use these pesticides? (Information Source): (1) Extension agent (2) Pesticide Dealer/Seller (3) Other Farmer (4) Farmers' Organisation/Group (5) Label/instructions on Container (6) Other Source.................................

42. Why do you choose this source?
………………………………………………………………………………………………
………………………………………………………………………………………………

43. **Which of the following factors help you to decide how much pesticide you must use? And** how important is this factor in helping you decide?

Factor	Importance
Gender	
Ancestry	
Age	
Education	
Experience	
Income	
Member of Farmer Organisation	
Farm Size	
Area of crops cultivated	
Management Type of the Farm	
Number of Employees	
Access to Credit	
Market Access	
Type of Market	
Accessibility of chemical	
Accessibility of information	
Price of the chemical	
Source of chemical	
Source of information	
Understanding the use of chemical	
Other	

1 - Very important; 2 – Important; 3 - Moderately important

Practices Rotation:

(1) Yes……… **(2) No………**

INFORMATION CONCERNING FERTILISER USE

(A) Accessibility

44. How accessible are fertilisers to you? **(Ease of Access): (1)** Very accessible (2) Accessible (3) Fairly Accessible (4) Not Accessible

(B) Education/Information

Source

45. Where do you get information concerning fertilisers? (**Main Information Source):** (1) Extension agent (2) Pesticide Dealer/Seller (3) Other Farmer (4) Farmers' Organisation/Group (5) Other Source.......................................

46. Why do you choose this source?

……………………………………………………………………………………………………
…………………………………………………………………………………………………….

Frequency

47. How often do you receive information concerning fertilisers and their use? (times per month) (**Information concerning pesticides (times per month):** (1) 1 (2) 2 (3) >2

Relevance

48. How relevant do you think this information is assisting you to understand fertilisers and their use? **(Relevance):** (1) Very Relevant (2) Relevant (3) Fairly Relevant (4) Not Relevant

Content

49. What does this information include? ....

....

....

Ease of Access

50. How easy is it for you to access to information concerning fertilisers and their use? **(Ease of Access):** (1) Very Easy (2) Easy (3) Fairly Easy (4) Not Easy

Ease of Understanding

51. How easily do you understand the information you receive? (**Ease of Understanding)**
(1) Very Easy (2) Easy (3) Fairly Easy (4) Not Easy

52. What do you think (if anything) would assist you in understanding information concerning fertilisers more?

……………………………………………………………………………………………………
……………………………………………………………………………………………………

(C) Fertiliser Practices

53. Use: Types, Concentration, Frequency

Fertiliser Name/Type	Concentrations Used/How mixed	Frequency of Application	Stage of Growth (of plant)	Remarks

54. Where do you get fertilisers? (Fertiliser Source): (1) Extension agent (2) Pesticide Dealer/Seller (3) Other Farmer (4) Farmers' Organisation/Group (5) Other Source..................................

55. Why do you choose this source?
....
....

56. Where do you get information on how to use these fertilisers? (Main Information Source): (1) Extension agent (2) Pesticide Dealer/Seller (3) Other Farmer (4) Farmers' Organisation/Group (5) Label/instructions on Container (6) Other Source................................

57. **Which of the following factors help you to decide how much fertiliser you must use? And** how important is this factor in helping you decide?

Factor	**Importance**
Gender	
Ancestry	
Age	
Education	
Experience	
Income	
Member of Farmer Organisation	
Farm Size	
Area of crops cultivated	
Number of Employees	
Access to Credit	
Market Access	
Type of Market	
Accessibility of chemical	
Accessibility of information	
Price of the chemical	
Source of chemical	
Source of information	
Understanding the use of chemical	
Other	

1 - Very important; 2 – Important; 3 - Moderately important

58. Is there any other information concerning your use of pesticides and fertilisers that you would like to tell me about?
....
....
....

59. Is there any other information concerning you use of pesticides and fertilisers that you would like to tell me about?
…………………………………………………………………………………………………
…………………………………………………………………………………………………

Thank you for your time and patience.

A1.5 Interview Schedules

Part 1- THE FARMER

Farmers' Interview Schedule for Investigation of Farming Practices Pesticide and Fertiliser Overuse

(1) ESTABLISHING REASONS/CAUSES

Objectives

(i)Establishing and analysing the factors which influence farmers' overuse of pesticides and fertilisers

(ii) Verifying how these factors occurred and their link to overuse practices and how they (factors) interlink to influence these practices

Use a broad structure to permit farmers to express their various motivations for adopting the practices under study.

Establishing and analysing the factors which influence farmers' overuse of pesticides and fertilisers

1st Phase – Each Interview approx 1.5 hr

PRELIMINARY OR 'SCOPING' INTERVIEWS (1ST Session of interviews – to identify factors, establish friendship and gain farmers' confidence)

1. How long have you been farming?
2. What is your farming experience like?
3. What types of problems do you experience?

   (If no problems are mentioned concerning agrochemical use)

   Then probe

4. What types of problems do you experience in relation to your use of pesticides and fertilisers?

   OR

5. Can you explain to me how you use pesticides and fertilisers?

(Taped Interviews with Notes)

Verifying how these factors occurred and their link to overuse practices and how they (factors) interlink to influence these practices

2nd Phase – Follow-up (2nd session of interviews) - Probe of Themes/Factors Identified in the first session of interviews

Each Interview approx 2-2.5 hrs

(A) Specific information (to verify factors and understand the manner in which these factors worked to Influence Overuse)

Main Themes	Sub-Themes	Questions
Farmers Assuming Dosages		You mentioned that you watched (observed) how the plants grew and this would tell you how much pesticide/fertiliser to use. Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?
Farmers' uncertainty of the information they received		You mentioned that sometimes you are not sure about the information on the label or what someone has told you. Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?
Farmers' depending on their experience		You mentioned that you sometimes depended on your experience to decide the amount of pesticide/fertiliser you used? Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?
Farmers' need for a marketable crop to survive (Desperation/Survival)		Why do you really think you have to add more of pesticide and fertiliser that the label indicates?
Farmers receiving distorted information based on self interest and deception of the sources	(i)dealers disseminating misinformation	You mentioned that sometimes the information you received from the dealers was incorrect. Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?
	(ii)cases of farmers maintaining secrecy concerning dosage rates and other information	You mentioned that sometimes other farmers hid information from you. Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?
	(iii) farmers misguiding their colleagues	You mentioned that sometimes other farmers would give incorrect information to you. Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?

Main Themes	Sub-Themes	Questions
Disorganised information systems	*(i)Abandonment*	You mentioned that extension agents rarely visit you. Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?
	(ii)Dissemination of inappropriate or abstract information	You mentioned that you did not understand the information you received from the dealers and extension agents. Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?
	(iii)Selectivity	You mentioned that only some farmers were visited by extension workers and were selected to attend seminars and workshops. Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?
Compromised agrochemical regulations	*(i)Pervious and inappropriate law or regulation*	You mentioned that chemicals you bought sometimes had instructions in another language. Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?
	(ii)Inappropriate retailing systems	You mentioned that the pesticides/fertilisers were sometimes sold to you in containers with no labels or no instructions were given to you. You mentioned that the pesticides/fertilisers were sometimes expired. Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?
	(iii)Irregular supply and price of chemicals (including absence of price control)	You mentioned that the prices for pesticides and fertilisers were not stable. Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?
Irregular and unregulated marketing systems	*(i)Export risk and unattainable quality*	You mentioned that is was difficult to access the export market. Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?
	(ii)Haphazard domestic arrangements	You mentioned that the local marketing system was confusing. Please tell me some more about this? How does this influence/determine the amount of pesticide/fertiliser that you would use?

(B) CHECKING FACTORS REVEALED BY SURVEY ANALYSIS

1. Land tenure- How differently would you use pesticides and fertilisers if you owned/rented the land you cultivate (plant on)? **Probe** – would you use more or less pesticide/fertiliser if you…

   Sensitive cases: *How do you think land tenure influences the amount of pesticide/fertiliser that you use? Explain to me please (use for other factors)*

2. Area cultivated- How differently would you use pesticides and fertilisers if you cultivated more land? (for interviewees who cultivated 5 and less acres of land) **Probe** – would you use more or less pesticide/fertiliser if you…

   Area cultivated- How differently would you use pesticides and fertilisers if you cultivated more land? (for interviewees who cultivated more than 5 acres of land) **Probe** – would you use more or less pesticide/fertiliser if you…

3. Age- How differently did you use pesticides and fertilisers when you were younger? (for 45 years old and above). **Probe** – did you use more or less pesticide/fertiliser if you…

   Age- How differently do you think you would use pesticides and fertilisers when you are older? (for less than 45 years old). **Probe** – do you think that will you use more or less pesticide/fertiliser if you…

4. Education level – How differently do you think you would use pesticides/fertilisers if you were more/less educated? **Probe** – do you think that will you use more or less pesticide/fertiliser if you…

5. Credit - How differently do you think you would use pesticides/fertilisers if you accessed (took) credit? **Probe** – do you think that will you use more or less pesticide/fertiliser if you…

(C) CHECK THAT THESE QUESTIONS ARE ANSWERED

1. How do you (know) decide whether (if) you should use pesticides/fertilisers?

2. How do you (know) decide how much (the amount) of pesticide that you should use?

3. How do you (know) decide how often (many times) you should apply the pesticide?

4. In your own way explain to me why you feel that you have to sometimes use more than the amount of pesticide that is stated on/recommended by, the label instructions?

OR (For more sensitive cases)

5. In you own words explain to me why you feel it is important/necessary to use the amount of pesticide that you use?

(Follow up if questions 4 or 5 do not yield all of the desired information)

6. What do you think about the amount of pesticide you use?

7. Do you think it is enough, not enough or too much? Why do feel so? Any

(Notes taken for the 2nd phase of interviews)

(2) INVESTIGATING FARMERS' PERCEPTIONS CONCERNING PESTICIDE AND FERTILISER OVERUSE

(i) Perceptions concerning the effects of pesticide and fertiliser overuse on crop production (yield, protection against disease and quality)

1. How do think the amount of pesticide you use will affect your crop yield?

Follow-up – Do you think that if you increase the amount of pesticide this will increase the amount of crop (yield) that you will get/harvest?

2. How do feel the amount of pesticide you use affects protection against disease?

Follow-up – Do you think that if you increase the amount of pesticide this will increase protection against pests and diseases?

3. How do think the amount of pesticide you use affects the quality of your produce?

Follow-up – Do you think that if you increase the amount of pesticide this will cause you to have better quality crops/produce?

- **Perceptions concerning the potential environmental and economic effects of pesticide and fertiliser overuse**

(ii) Environmental Effects

1. Do think the amount of pesticide you use will have any bad/adverse environmental effects?

2. Do you think these effects are significant/important? Explain to me please.

3. **Follow up -** Do you still think that while although there may be negative/bad environmental effects, you still have to use that amount or more of the pesticides? Why?

(iii) Economic Effects

1. Do think the amount of pesticide you use will have any economic effects?

OR

2. Do think the amount of pesticide you use will have any effects on the market you sell to?

3. Do you think these effects are significant/important? Explain to me please.

4. **Follow up -** Do you still think that while although there may be negative/bad economic effects, you still have to use that amount or more of the pesticides? Why?

CONCLUSION/VERIFICATION OF PERCEPTIONS (MAKE SURE THESE QUESTIONS ARE ANSWERED)

1. What do you think are some of the effects of the amounts of pesticide/fertiliser that you use? Explain (on crop production, environment and economic effects)

2. Is there anything else you would like tell me concerning your use of pesticides/fertilisers?

NB. The study is important for general planning of programmes and more specifically guidance for planning and execution of extension services. The study enables greater depth of understanding why farmers made certain choices.
Programmes can then be designed to respond to the specific causes/reasons for these choices/decisions, rather than speculations.

Part 2 – THE KEY INFORMANT

Key Informants' Interview Schedule for Investigation of Farming Practices – Pesticide and Fertiliser Overuse

Objectives

(1) Establishing and analysing the wider contextual factors which influence farmers' overuse of pesticides and fertilisers

(2) Verifying contingent and support factors mentioned by farmers

(3) ***Establishing how contextual factors occurred and their link to overuse practices and how they (factors***) interlink with contingent and support factors to influence these practices

Each Interview – approximately 2-2.5hrs

(1) Establishing and analysing the wider contextual factors which influence farmers' overuse of pesticides and fertilisers

(i) Preliminary Conversation (establishing the wider contextual factors which influence farmers' overuse) **(Notes Taken)**

In my interviews farmers mentioned some factors which influenced their overuse of pesticides and fertilisers such as having to assume dosages, using their experience, not being sure of their produce would be sold, and so on.

However, before we discuss those factors I would like to ask what do you think are some of the wider contexts which influence farmers' overuse of pesticides and fertilisers?

(ii) *Identifying how Contextual Situations worked to influence farmers' overuse of pesticides and fertilisers***. (Notes taken and Interviews taped where permission was granted)**

Explain to me the kind of services you offer to farmers with respect to agrochemical use.

(Listen for shortcomings/flaws mentioned in these services, which affected farmers' overuse)

- In the case of training- listen and probe for scope, content, regularity, relevance and quality of information and how topics and farmers were identified.

- In the case of services (laboratory and marketing) – listen for functioning with respect to types of services they were expected to offer (laboratory – any testing?; marketing – any structured arrangement or facilitation?)

(2) Verifying/Corroborating contingent and support factors mentioned by farmers

Contingent Factors

Question	Factors	Question
Farmers conversations indicated that	they assumed dosages based on observations, since there was no one to tell them	what are your views on this?
	Their uncertainty of the information they received from sources, like other farmers and even extension agents and dealers	
	depending on their own experience in the absence of appropriate sources	
	Their desperate need to have a crop which can be sold caused them to overuse	
	They received distorted and deceptive information which caused their overuse	

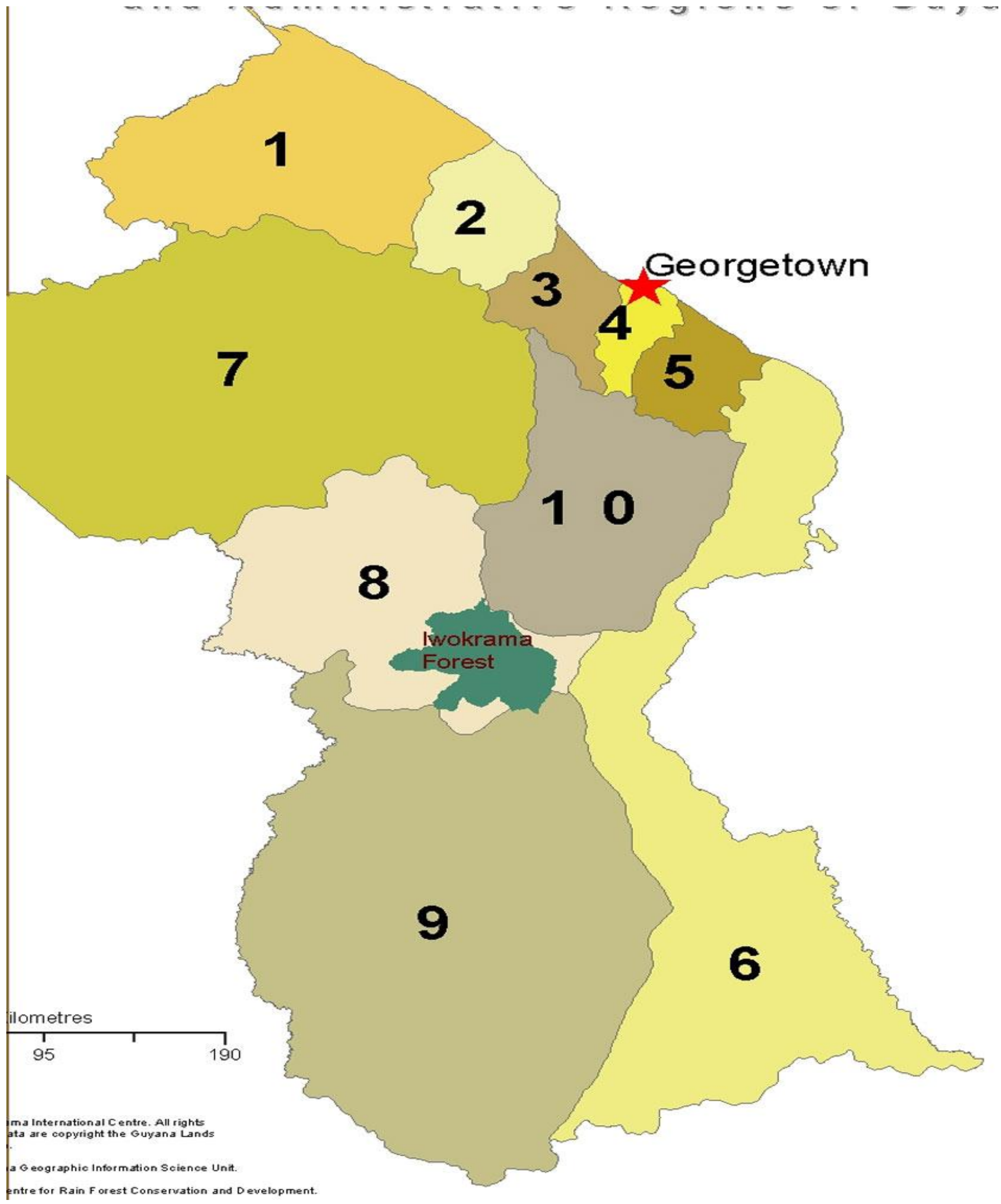
Support Factors

Question	Factors	Question
Farmers conversations indicated that	Disorganised Information systems contributed to their overuse – like seeing no one, inappropriate information and selectivity of visits and invitations to functions	what are your views on this?
	Compromised agrochemical regulations, such as illegal imports, labelled with foreign languages, retailing with no labels, expired chemicals and price fluctuations contributed to their overuse	
	Irregular and unregulated marketing systems such as unreliable and stringent export markets and confusing local marketing arrangements contributed to their overuse	

(3) Establishing how contextual factors occurred and their link to overuse practices and how they (factors) interlink with contingent and support factors to influence these practices

- Through thorough review of Interviews

A1.6 Map of Guyana Showing Study Locations



Source: Guyana Guide http://www.guyanaguide.com/admin_reg.html

Map of Guyana, Showing Study Regions (Regions 3 and 4) among other Regions

APPENDIX 2: Tables of Quantitative Analysis and Commonly Used Agrochemicals

Table A2.1: Descriptive Statistics of Continuous Variables

Variable	Range	Maximum	Minimum	Mean*
Age (years)	50.0	68.0	18.0	42.0
Specific Area Cultivated (acres)	18.0	19.0	1.0	5.0
Experience* (years)	53.0	60.0	7.0	31.0

Source: Source: Field Survey Data; Guyana – 2008/9
N=229; *Figures are rounded

Table A2.2: Farmers' Credit Information

Credit Status, Access and Reasons	Frequency	%
Accessed Credit		
Commercial Institution	18	8
Friend or Relative	9	4
Total	27	12
Did not access Credit		
Fear of repayment	120	52
No collateral	37	16
Uncomfortable	45	20
Total	202	88

Source: Source: Field Survey Data; Guyana – 2008/9
N=229

Table A2.3: Common Pesticides Utilised by Farmers of the Study Population

Pesticide		Group	% use in farmer population
Brand Name	Active Ingredient (AI)		
Admare	Imidacloprid	Insecticide	25
Amidor	Methamidophos	Insecticide	53
Caprid	Acetamiprid	Insecticide	98
Dipel	Bacillus thuringiensis	Insecticide	67
Fastac	Cypermethrin	Insecticide	78
Hyperkil	Cypermethrin	Insecticide	78
Inithion/Malathion	Malathion	Insecticide	86
Karate	lambda-cyhalothrin	Insecticide	88
Caratax	Lambda-Cyhalothrin	Insecticide	90
Lannate	Methomyl	Insecticide	89
Monitor	methamidophos	Insecticide	45
Inisan/ Monocrotophous	Monocrotophous	Insecticide	65
Padan	Cartap Hydrochloride	Insecticide	45
Pegasus	Diafenthiuron	Insecticide	50
Pestac	Cypermethrin	Insecticide	65
Regent	Fipronil (or phenylpyrazole)	Insecticide	35
Torpedo	Chlorpyrifos/Cypermethrin	Insecticide	48
Tracer	Spinosad	Insecticide	24
Triazophos	Triazophos	Insecticide	96
Vydate-L	Oxamyl	Insecticide	90
Thionil	Propanil	Herbicide	85
Gramoxone	Paraquat	Herbicide	89
Aminex	2,4-D	Herbicide	15
Kocide	Copper Hydroxide/ Hexazinone	Fungicide	24
Carbendazim	Carbendazim	Fungicide	58
Cuprosan	Zineb	Fungicide	78
Banrot	Etridiazol/Thiophanate methyl	Fungicide	84

Sources: Field Survey Data; Guyana – 2008/9; Pesticide and Toxic Chemicals Board, Annual Report, 2009: 32-36; Pesticide Safety and Other Pesticide Information, N.D.; The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification 2009 (IPCS/IOMC, 2010); List of pesticides use in Trinidad and Tobago, (AnalChem, N.D.).
N=229

Table A2.4: Common Fertilisers Utilised by Farmers of the Study Population

Fertiliser Group	Type	% use by survey population	% use by interview population
Nitrogen Based Fertilisers			
NPK Compounds	15-15-15	89	100
	Urea	90	100
Phosphorous Based Fertilisers	Triple Super Phosphate) TSP	68	84
Potassium Based Fertilisers	Potash	38	32

Source: Source: Field Survey Data; Guyana – 2008/9

Table A2.5: Variance of Results: Farmers' reports compared to actual situations

Variable	Options	Reported Result (%)	Actual Result (%)
Rotation	Practices	16.6	1.7
	Does not practice	83.4	98.3
Market type	Export	1.7	5.2
	Domestic	98.3	94.8

Source: Source: Field Survey Data; Guyana – 2008/9
N=229

Table A2.6: Factors Explaining Pesticide Overuse in farming Units of Combined String Bean and Egg Plant Production - Regression analysis including the variable Region

VARIABLE	MODEL 1		MODEL 2	
	(B, Exp(B)	p	(B, Exp(B)	p
Region				
- Region 3	(ref. category)		(ref. category)	
- Region 4	0.143, 1.154	0.685	-0.307, 0.736	0.435
Age (years)	-0.167, 0.846	0.063	- 0.192, 0.825	0.046
Age²	0.002, 1.002	0.088	0.002, 1.002	0.052
Credit				
- Access	(ref. category)		(ref. category)	
- Did not access	-1.566, 0.209	0.016**	-1.266, 0.282	0.056
Experience (Years as % of age)	0.001, 1.001	0.919	0.013, 1.013	0.393
Area Cultivated (acres)	0.339, 1.404	0.015**	0.412, 1.510	0.005*
Area Cultivated²	-0.013, 0.987	0.102	-0.017, 0.983	0.047
Land Tenure				
- Own	(ref. category)		(ref. category)	
- Rent	0.457, 1.579	0.196	0.695, 2.004	0.075
Education level				
- Secondary and above	(ref. category)		(ref. category)	
- Primary and below	0.328, 1.388	0.313	0.130, 1.139	0.704
Information Source/Type				
- Label instructions			(ref. category)	0.012**
- Extension Worker			-0.205, 0.814	0.734
- Fertiliser Dealer			1.520, 4.573	0.002*
- Other Farmer/Farmers' Group			0.561, 1.752	0.258
- Experience/None			-0.482, 0.618	0.462
Constant	4.370, 79.023	0.030	3.517, 33.693	0.106

Source: Source: Field Survey Data; Guyana – 2008/9
N= 229 farms
Notes:
B = coefficients (the sign of the coefficients are important); Exp(B) = Odds ratio

Model 1: Both Age² and Area Cultivated² were included in the model, while Information Source/Type was excluded
Model 2: Information Source/Type was included; this variable acted as a control.
* p<0.01
**p<0.05
***p<0.001

Table A2.7: Factors Explaining Fertiliser Overuse in farming Units of Combined String Bean and Egg Plant Production - Regression analysis including the variable Region

VARIABLE	MODEL 1		MODEL 2	
	(B, Exp(B)	p	(B, Exp(B)	p
Region				
- Region 3	(ref. category)		(ref. category)	
- Region 4	-0.069, 0.934	0.841	-0.504, 0.604	0.224
Age (years)	-0.084, 0.919	0.309	- 0.093, 0.912	0.291
Age²	0.001, 1.001	0.484	0.001, 1.001	0.420
Credit				
- Access	(ref. category)		(ref. category)	
- Did not access	-1.239, 0.290	0.032**	-0.902, 0.406	0.128
Experience (Years as % of age)	-0.005, 0.995	0.697	0.006, 1.006	0.707
Area Cultivated (acres)	0.161, 1.175	0.219	0.191, 1.210	0.171
Area Cultivated²	-0.005, 0.995	0.500	-0.007, 0.994	0.425
Land Tenure				
- Own	(ref. category)		(ref. category)	
- Rent	0.114, 1.121	0.739	0.122, 1.129	0.761
Education level				
- Secondary and above	(ref. category)		(ref. category)	
- Primary and below	1.046, 2.847	0.001*	0.801, 2.228	0.020**
Information Source/Type				
- Label instructions			(ref. category)	0.004*
- Extension Worker			0.722, 2.058	0.284
- Fertiliser Dealer			2.059, 7.835	<0.001
- Other Farmer/Farmers' Group			1.112, 3.041	0.061
- Experience/None			0.969, 2.635	0.083
Constant	3.055, 21.216	0.100	1.620, 5.053	0.420

Source: Source: Field Survey Data; Guyana – 2008/9
N=229 farms

Notes:
B = coefficients (the sign of the coefficients are important); Exp(B) = Odds ratio

Model 1: Both Age² and Area Cultivated² were included in the model, while Information Source/Type was excluded
Model 2: Information Source/Type was included; this variable acted as a control.
* p<0.01
**p<0.05
***p<0.001

Table A2.8: Results of Qualitative Check of Factors which were significant to Overuse in Quantitative Analysis

Significant Factor	Question	No. of farmers Indicating Possible Change	
Land tenure	Land tenure- How differently would you use pesticides and fertilisers if you owned/rented the land you cultivate (plant on)? **Probe –** would you use more or less pesticide/fertiliser if you…	**Owned (0)** No change	**Rented (0)** No change
Area cultivated	Area cultivated- How differently would you use pesticides and fertilisers if you cultivated more land? (for interviewees who cultivated 5 and less acres of land) **Probe –** would you use more or less pesticide/fertiliser if you… How differently would you use pesticides and fertilisers if you cultivated less land? (for interviewees who cultivated more than 5 acres of land) **Probe –** would you use more or less pesticide/fertiliser if you…	**More land (0)** No change	**Less land (0)** No change
Age	Age- How differently did you use pesticides and fertilisers when you were younger? (for 45 years old and above). **Probe –** did you use more or less pesticide/fertiliser if you… How differently do you think you would use pesticides and fertilisers when you are older? (for less than 45 years old). **Probe –** do you think that will you use more or less pesticide/fertiliser if you…	**Younger (1 farmer used more)** Only 1 farmer indicated change	**Older (0)** No change
Education level	Education level – How differently do you think you would use pesticides/fertilisers if you were more/less educated? **Probe –** do you think that will you use more or less pesticide/fertiliser if you…	**More Educated (1 farmer indicated he would possibly use less)** Only 1 farmer indicated change	**Less Educated (0)** No change
Credit	Credit - How differently do you think you would use pesticides/fertilisers if you accessed (took) credit? **Probe –** do you think that will you use more or less pesticide/fertiliser if you…	**Accessed Credit (0)** No change	**Did not access credit (0)** No change

Generally, farmers did not indicate any change of their overuse behaviour if the circumstances of these significant factors were to change.

Table A2.9 (a): Prevalence of Pesticide and Fertiliser Overuse in Study Units of String Bean and Egg Plant Cultivation; breakdown by Response per Interviewer

Prevalence		Breakdown by Response per Interviewer (%)*			
		Researcher	Research Assistant 1	Research Assistant 2	Total
Overuse	Pesticide	24	23	22	69
	Fertiliser	22	20	24	66
Not Overuse	Pesticide	12	9	10	31
	Fertiliser	11	10	13	34

Source: Field Survey Data; Guyana-2008/9
N=229 farms
*Figures are rounded

Table A2.9 (b): Deaths Registered By External Causes; Guyana - 2006 to 2008

External Causes	2006	2007	2008	Average
Accidental Poisoning by and Exposure to Noxious Substances	1	2	1	1

Source: Ministry of Health, Statistics Unit – Statistical Bulletin, 2008

Table A2.9 (c): Cross-tabulation Results of Pesticide and Fertiliser Overuse by Gender

Gender	Overuse (%)	
	Pesticide	Fertiliser
Male	87	89
Female	13	11
Total	100	100

Source: Field Survey Data; Guyana-2008/9
N=229 farms
*Figures are rounded

Table A2.9 (d): Cross-tabulation Results of Pesticide and Fertiliser Overuse by Tenure Status

Tenure Status	Overuse (%)	
	Pesticide	Fertiliser
Own	40	42
Rent	60	58
Total	100	100

Source: Field Survey Data; Guyana-2008/9
N=229 farms
*Figures are rounded

Table A2.9 (e): Cross-tabulation Results of Pesticide and Fertiliser Overuse by Area Cultivated

Area Cultivated (acres)	Overuse (%)	
	Pesticide	Fertiliser
<5acres	61	65
5-10 acres	26	24
11-15 acres	8	7
>15 acres	5	4
Total	100	100

Source: Field Survey Data; Guyana-2008/9
N=229 farms
*Figures are rounded

Table A2.9 (f): Cross-tabulation Results of Pesticide and Fertiliser Overuse by Experience

Experience (Years)	Overuse (%)	
	Pesticide	Fertiliser
3-5	11	13
6-10 acres	27	27
11-15 acres	25	23
>15 acres	37	37
Total	100	100

Source: Field Survey Data; Guyana-2008/9
N=229 farms
*Figures are rounded

Table A2.9 (g): Cross-tabulation Results of farmers' Pesticide and Fertiliser Overuse: Source-type of Information by categories of Education

Education Level	Source-type of Information accessed by Farmers (%)					
	Label/ Instructions	Extension Agent	Pesticide Dealer/Seller	Other Farmer/Farmers' Group	Experience/ None	Total
Secondary and higher	41	8	31	13	7	100
Primary and lower	33	11	30	20	6	100

Source: Field Survey Data; Guyana-2008/9
N=229 farms
*Figures are rounded

APPENDIX 3: Interviewees (Key Informants and Framers') Particulars, Interviewees Support Conversations and Integration of Causal Factors

A3.1 Key Informants' Particulars

Table1: Key Informants' Particulars

Key Informants (Identification Number)	Particulars	
	Designation	**Agency/Location**
1	Chief Crops and Livestock Officer	Ministry of Agriculture (MOA), Guyana
2	Chief Training Officer	Crops and Livestock Support Services (CLSS), MOA
3	Technical Manager	CLSS, MOA
4	Head of Plant Quarantine Division	CLSS, MOA
5	Registrar (Head)	Pesticides and Toxic Chemicals Board (PTCB), Guyana
6	Director	National Agricultural Research Institute (NARI), Guyana
7	Agricultural Health Specialist	Inter-American Institute for Cooperation on Agriculture (IICA), Guyana
8	Vegetable Manager	Caribbean Chemicals Limited Guyana (Agrochemical Agent)
9	Manager	Agri-centre Department, Associated Industries Limited (AINLIM) Guyana (Agrochemical Agent)
10	Agriculture Manager	Geddes Grant Guyana (Agrochemical Agent)
11	Agrochemical Dealer 1	Mahaica, Region 4
12	Agrochemical Dealer 2	Mahaica, Region 4
13	Agrochemical Dealer 3	Ann's Grove, Region 4
14	Agrochemical Dealer 4	Ann's Grove, Region 4
15	Agrochemical Dealer 5	Cove and John, Region 4
16	Agrochemical Dealer 6	Enmore, Region 4
17	Agrochemical Dealer 7	Parika, Region 3
18	Agrochemical Dealer 8	Parika, Region 3
19	Agrochemical Dealer 9	Parika, Region 3

Table2: Farmer Interviewees Particulars

NO.	Pseudonym	Age (years)	Tenure	Area Cultivated (acres)	Experience (years)	Education Level*	Type of Interview Record
	REGION 3						
1	**JW**	**52**	**Rent**	**4**	**25**	**P**	Taped and Notes
2	**Bud**	**65**	**Rent**	**3**	**30**	**P**	Taped and Notes
3	VB	24	Rent	2	11	S	Taped and Notes
4	**Gov**	**43**	**Own**	**1.5**	**18**	**P**	Taped and Notes
5	Sur	29	Rent	4	6	P	Taped and Notes
6	Faz	34	Rent	3	8	P	Taped and Notes
7	**RR**	**26**	**Rent**	**2**	**11**	**P**	Taped and Notes
8	**VN**	**24**	**Rent**	**4**	**4**	**P**	Taped and Notes
9	**MX**	**37**	**Own**	**3**	**14**	**P**	Taped and Notes
10	**CP**	**28**	**Own**	**2.5**	**11**	**S**	Notes
11	**Chet**	**42**	**Rent**	**6.5**	**4**	**P**	Notes
12	**Roz**	**66**	**Own**	**7**	**30**	**S**	Taped and Notes
13	RR	67	Own	2	34	P	Taped and Notes
14	**CPG**	**62**	**Rent**	**1**	**8**	**P**	Taped and Notes
15	Sukh	64	Rent	4.5	25	P	Taped and Notes
16	CJ	18	Own	1.5	7	S	Notes
17	Roh	34	Rent	4	14	P	Notes
	REGION 4						
1	**CS**	**35**	**Own**	**1.5**	**16**	**S**	Taped and Notes
2	MrA	50	Own	5	20	S	Taped and Notes
3	**RG**	**42**	**Own**	**3**	**17**	**P**	Taped and Notes
4	**LM**	**39**	**Rent**	**4**	**11**	**S**	Taped and Notes
5	Ren	49	Rent	3	20	S	Taped and Notes
6	KB	39	Rent	2.5	17	S	Taped and Notes
7	BD	68	Own	1	25	S	Taped and Notes
8	MT	65	Rent	5	25	P	Taped and Notes
9	JA	56	Rent	9	16	P	Taped and Notes
10	DR	61	Own	6	19	S	Notes
11	**Too**	**43**	**Own**	**3**	**11**	**S**	Taped and Notes
12	NW	36	Rent	3.5	7	S	Taped and Notes
13	**Sub**	**56**	**Rent**	**11**	**27**	**P**	Taped and Notes
14	Chand	34	Rent	6	10	P	Taped and Notes
15	**MK**	**58**	**Own**	**6**	**24**	**P**	Taped and Notes
16	**DK**	**24**	**Own**	**6**	**11**	**S**	Taped and Notes
17	**Yas**	**50**	**Own**	**8**	**15**	**S**	Taped and Notes
18	**Chick**	**47**	**Own**	**4**	**19**	**S**	Taped and Notes
19	Ash	40	Rent	3	12	S	Taped and Notes
20	Kowl	49	Own	8	19	S	Notes
21	**Vib**	**48**	**Own**	**16**	**12**	**S**	Taped and Notes

P – Primary level and lower; S – Secondary level and higher
Bold- Indicated farmers whose excerpts are used in chapter 7

A3.2 Illegal Trade and Sale of Pesticides in Guyana

Example 1: Toxic chemical board seizes illegal pesticides

The Pesticides and Toxic Chemicals Control Board confiscated a number of unregistered pesticides during recent inspection and enforcement exercises carried out in regions 2, 3,4,5,6 and 10. The Ministry of Agriculture yesterday said the seizures are in keeping with the Board mandates of eradicating the importation, sale and use of illegal pesticides. In photo are some of the illegal pesticides recently seized by the Board. (Ministry of Agriculture photo)

Source: Stabroek Newspaper, Guyana. July 24, 2010:
http://www.stabroeknews.com/2010/media/photos/07/24/toxic-chemical/

Example 2: Illegal chemicals seized in east coast exercise

Pesticides and Toxic Chemicals Control Board inspectors this week seized a number of repackaged and improperly labelled products during an inspection exercise conducted at a number of premises on the East Coast of Demerara.

A press release from the Office of the Registrar of Pesticides and Toxic Chemicals said that all of the products seized were from unlicenced vendors, including a pharmacy at Logwood.

The products included Grassknife, Karatine, Roundup, Dragnet, 2,4-D, Monocrotophos, Malathion, Drexel, Diazinon, Glyphosate, Cutlish, Weedkiller, and Farmizone along with a substantial amount of undetermined products stored in drink and pharmaceutical bottles.

And a number of labels were also seized for these products. The release also said that some of the chemicals which were repackaged are Igran, Round-up, S-Metalchlor and Merlin, but these are only imported by the Guyana Sugar Corporation and the entity has been informed of this development.

The Board noted that the use of drink and other kinds of bottles is a breach of the Pesticides and Toxic Chemicals (Control) Act 2000 (No.13 of 2000) and its associated regulations, as well as offering for sale pesticides and toxic chemicals without a vending licence.

The Board also reiterated that it is an offence punishable by law to offer for sale chemicals which are not properly packaged and without the requisite licence.

Meantime the Board is calling on members of the public to notify the authorities via telephone 220-8880/8838 of such illegal activities.

The Board also advised that use of sub-standard formulations can result in ineffective pest control operations and lead to the development of pest resistance to pesticides.

It was also pointed out that substandard formulations may contain chemicals which can increase the toxicity of the pesticides to mammals and other non-target species, including humans.

And they may also contain degradation products, some of which are known to be more toxic than parent compounds, the release concluded.

Source: Stabroek Newspaper, Guyana. March 20, 2008:
http://www.stabroeknews.com/2008/stories/03/20/illegal-chemicals-seized-in-east-coast-exercise/

Example 3: Pesticides board needs well-equipped unit to tackle backtrack chemicals

Dear Editor,

I noted the Ministry of Agriculture's recent seizure of backtrack Agrichemicals in last Saturday's Stabroek News with a deep sense of expectation.

I write this letter to congratulate the Hon. Minister of Agriculture and his officers for this operation that was timely but long overdue and which should be done frequently.

I also take the opportunity to advise that these operations should be more robust and sustained throughout the Agriculture belt where backtrack chemicals account for 53% of the market share in 'Agri-chemicals' sales. These products are often not safely packaged or properly labelled in English.

Sir, it is grossly unfair to pressure the legitimate businesses to pay 3% of the overall cost of its imports to the Pesticides and Toxic Chemicals Control Board (PTCCB) while the backtrackers continue to operate with relative freedom and contribute nothing to the Government's coffers to aid in national development. These backtrack smugglers pay no income tax.

Sir, there is the need for a well-trained and equipped unit within the PTCCB charged with the responsibility to go after those involved in importing, transporting, storing, selling and using backtrack pesticides and toxic chemicals.

The present structure and composition of the PTCCB rendered this body impotent to effectively carry out these functions.

Such a specialised unit will enable the Board to have sound information gathering and intelligence on the movers and shapers of this underground economy and at the same time develop appropriate strategies to counter this trade.

Finally, how can this body continue to pressure the legitimate chemicals dealers for compliance with its sometimes harsh and needless regulations and requirements, when the `backtrack' business continues to 'Dance in the Rain" with relative freedom? The Pesticides Board is bureaucratic, unreasonable and requires unnecessary data on well-established chemicals.

Sir, we sincerely hope that this recent exercise was not the case of the state propaganda machine being at it again. After all we are in silly season, its election time again.

Yours faithfully,
L.H. Semple
West Berbice
Farmers Committee

Source: Stabroek Newspaper, Guyana. July 31, 2010:
http://www.stabroeknews.com/2010/letters/07/31/pesticides-board-needs-well-equipped-unit-to-tackle-backtrack%e2%80%99-chemicals/

A3.3 Farmers' informed use of expired chemicals

Example 1

The following conversation I had with farmer MX exemplified his knowledgeable use of expired chemicals.

Interviewer: *'Have you ever purchased* (chemicals) *and find that the date is past?'*

MX: '*Yes.'*

Interviewer: *'You realise what I'm asking? Have you ever purchased at any time and find that the expiry date is past?'*

MX: '*The drugs expired? Yes…I can send you now…Look, there are 2 stores at the backdam here (in the village).'*

Interviewer: *'But would you use it?'*

MX: *'Look there are 2 stores – X and Y; you go, maybe they might suspect (be suspicious); but you ask them for Deferential; just tell them that you want to see a bottle, and you will see how long it has expired – I'm serious, not joking.'*

Interviewer: *'So would you use it; put it on your plants?'*

MX: '*Yes, yes, I would use it…that is why some of the drugs don't work (are not effective) as some of the people say; they are expired (farmer's wife). Look there is a drug for fungus; right there I saw it…When I go (went) it had expired already; the drugs were there so long that even the packets are burst (destroyed), and I still bought it, because I have use for it -If you don't have mother you have to use grandmother –* (A saying which means you have to make use of whatever is available to you, in the absence of what is ideal). *'…Yes I have to buy it because something is better than nothing…at least if you buy it, if it can't work full, it will work half and if it can't work half it work quarter percent..'* (laughs).

Interviewer: *'But that is not good enough; you know that is not good enough.'*

MX: *'Yes but what are you going to do if you don't buy it?'*

Interviewer: *'And are you paying the same price for it?'*

MX: (avoids answering the question) *'The deferential had expired quite a long time; that has expired about 2 years…'*

Interviewer: *'Two years?'*

MX: *'Yes, but I have to use it because that is the only thing so far that controls diamond-back reasonably and powder-back flies; a fine powdered back fly that damages Boulanger and diamond back eats cabbage – that's the only thing that works a little reasonably and no matter it is expired, I have to buy and use it.'*

Interviewer's Assistant: '*Do they sell it for the same price?'* - (my assistant noted that he did not answer the question the first time)

MX: '*Or even more'*. (higher price)

Interviewer: '*No – I can't believe this'*.

(Entire interview is recorded)

Example 2

The following part of conversation I had with farmer Sur is a second example of farmers' knowledgeable use of expired chemicals.

Interviewer: *'...in buying do you think you would buy any that is expired?'*

Sur: (indicates No)

Interviewer: *'So you always check?'*

Sur: *'Yes. The dealer sells expired drugs but if they are expired they tell you and they don't sell it for the normal price.'*

Interviewer: *'Ok. So if it's expired you will get it for less?'*

Sur: *'Yes. If you use like 1 ml per can you put 2 or 3 ml per can, because it's expired already.'*

Interviewer: *'Ok, but they would tell you before?'*

Sur: *'Yes they would tell you.'*

(Recorded conversation)

And later after the official interview while just casually taking pictures

Interviewer: *'But this expired drugs that you use, how effective you think this can be?'*

Sur: *'Well it might not work as the good one*[145] *might work, but at least it is what we can get for now so we use it until we can get the right one…the one with the right date…'*

Sur's wife: *'At least that is better than using nothing…'*

Interviewer: *'But what effects you feel using that can have?'*

Sur: *'Well the only thing is that we have to use more because remember it has expired already…so if we use the same amount it might not kill the pests…'*

Interviewer: *'So you see it working for you?'*

Sur: *'Well not like the one that is not expired but at least it keep the pests away for a while…'*

Interviewer: *'How do you know that you must use more when it's expired?'*

Sur: *'They tell you at the shop sometimes, but sometimes you think for yourself too…because is its expired then it cannot be as strong…'*

Interviewer: '*Is it a specific type of chemical that is expired?'*

Sur: *'I bought deferential lately and it was expired but sometimes we get others too…like pestac and pilarking…some I can't remember but its different types…'*

[145] The good one refers to the chemical which is not expired

A3.4 Key Informants' Account of Inappropriate retailing

The Key informant of the Research Institute's substantiated claims of inappropriate retailing.

> *'First of all they (the farmers) should not be using it (expired chemical) the reason being that once it's expired, the effectiveness of that thing would be considerably reduced...I would suspect that once things are expired they would loose the effectiveness of the chemical. If that's the case they (the farmers) might not see the results, like by using 1 ml per gallon, they might want to add more, like - Oh , this thing is expired-…they might want to add more of that chemical and since its not effective you might find a lot getting into soil water…pesticides obviously degrade and you know that some of the degraded products are even toxic sometimes than the actual parent…so sometimes they might end up using something that is even more deadly…but I want to suspect when they buy these things they don't want to get rid of them. That is a dangerous practice.'*

A3.5 Farmers' Comparison of Export and Local Market Conditions: The choice of local markets in relation to overuse

Farmer CP had just indicated to me that if crops contained excess of chemicals they taste and other features of quality will be negatively affected.

Interviewer: *'…these effects that you just told me; like different taste and so on… do think they can affect our export market…?'*

CP: *'Well no other country will want that type of greens (vegetables); it's only we here in this country will buy those things and not complain. As soon as people from outside (foreign countries) see the quality of them greens, they don't want them. But that is if they will reach, they might spoil before they reach and they got to dump them. That's why I am not planting for export; I don't want to hear that the crops get dumped; because someone will have to compensate me'.*

Interviewer: '*But if they have the quality they will not get dumped'.*

CP: *'That quality they wish is hard to get, because remember we got to use what we can get'.*

Interviewer: *'The fertiliser?'*

CP: *'The fertiliser and the drugs. Sometimes both of them you got to use what you can get. When rice crop start again, watch what will happen to fertiliser; the rice farmers will buy 'how many' (a large amount of) bags and the shop will 'make styles on' (be reluctant to sell to) who want small amounts; so you have to use what you can get. It's worse for the drugs, because as soon as you find something that can work and everybody rushes for it, the price will raise (increase) by 2 and 3 times. This is what farmers are facing'.*

Interviewer: *'And do you think that too much of drugs will affect the quality of the greens (vegetables) too?'*

CP: *'Yes. Too much of drugs might be worse than too much fertilisers, because the greens (vegetables) might look good and when you eat them you get sick; you get diarrhoea and all kinds of 'bad feelings' (ill feelings/feelings of illness), but people don't think what is the cause, they just go to the doctor and collect some medicine. Sometimes you might remember what you eat and know what is happening; but most people just don't try to remember if they ate anything funny or where they got it from.'*

Interviewer: *'And do you think putting too much of drugs can affect sales on the market too?'*

CP: *'Well not so much our own market in this country, we don't really examine what we eat; but if we export those things, they will stop buying from us. That is why the Ministry I think or NARI; ....you might know; they got to 'be behind' (have to closely* *monitor) those who planting to send outside (to export), to make sure that they do the right thing.'*

Interviewer: *'The right thing...?'*

CP: '*Like make sure they use the right drugs and not too much and all that, like not spraying just before they pick too; …or it's this country that will get the blame (will be blamed). Those people who taking the goods (importing) wouldn't leave their country to come here looking for farmers; they will blame the country and who responsible for sending it. Then we would not get to export (Our exports will be stopped). Imagine if it's hard (difficult) already and some of these goods are going out (being exported) what will happen if we lose the few markets we have?'*

Interviewer: 'What do you think will happen?'

CP: *'Farmers will have to find other work (jobs); because all of those goods cannot be sold on our local market; they will be left there; farmers will have to do something else if they want to mind themselves and their family. How much of these greens (vegetables) can we eat? Where is the money to but rice, sugar and other things, if the greens can't be sold?'*

A3.6 Conversations of Agrochemical Agents Exemplifying a Business Oriented Strategy

Example 1

The Manager of the Agri-centre Department, Associated Industries Limited (AINLIM) Guyana explained:

> *'There are gaps in terms of the service like the East Bank route to Linden we don't service there normally because there are not many persons who will buy to redistribute.'*
>
> *'Along the routes I told you we have an extension agent who normally goes out and do demonstrations of new products as well as try to advise farmers how to use existing products or to look at what pests or disease problems they have and try to fit a solution that we have. We offer that service and it's of no direct cost to the farmer. This is a full time employee and he will have to visit each area at least once per month. What we try is do; it's a little marketing tactic; we go out and promote our products and people go and ask for them by the name so we get our products sold. So we find that we have to do this in order to drive sales...but it's ongoing…we are in the process of developing our plan for the next financial year which will be from October to September.*
>
> *'So every year we pull the team together and decide what strategies we need to employ, what are the products we need to work with. The sales persons drive this process as well, like if there is something that needs to be done outside of the plan. They would tell us there is this area and they are not getting to sell this product because it needs a little promotion. We would call the extension guy, work out a protocol of how we would approach it and he goes in (to the area).'*

Similar explanations of the Vegetable Manager of Caribbean Chemicals Limited Guyana and the Agriculture Manager of Geddes Grant Guyana were elaborated

Example 2

The Vegetable Manager of Caribbean Chemicals Limited Guyana elaborated:

> *'Basically we provide advice and we do a television programme. The advice is more to do with amounts (of agrochemicals) and we have planting guides. We do not only talk about chemicals but general agronomic practices, the principle being that there is no sense in using chemicals if you are using bad agronomic practices. It is not in our interest to sell chemicals to someone who is using poor agronomic practices because basically they would not be a return customer. Our business is almost entirely return customers. Most people have been farming for some time and they intend to be farming for*

some time so what is critical is not just to make a particular sale but to keep a customer. So our philosophy is to provide agronomic advice.'

'So for example if we are introducing a new product for rice, the rice manager will explain to them; this is the product, this is how it works, this is how we sell the product, in terms of vegetables I will do the same saying, ''these are the vegetable products, this is what they do, this is how you market them and who you market to.'' So it's really a kind of unusual setup that our front line people are more sales oriented than technical, although they must have some technical knowledge.'

Example 3

The Agriculture Manager of Geddes Grant Guyana revealed a similar tactic for the company he represented.

'In terms of support and stewardship towards farmers what we do, we have an agronomist in the field. Geddes Grant is ISO certified so we do a lot of customer briefs…We visit our farmers and distribution centres to see how they are getting along with the products.'

'Added to that at least once or twice per year technical persons come down on visits and we take them to the Parika back dam where they would interact with farmers at to (concerning) how they are finding the products and get first hand feedback as to what is happening.'

'So these are the kind of activities that we try to do for our products that we put on the market. We try to do these kinds of follow-up and training for the persons that use them.'
'…we have our local agronomist who goes out to attend to farmers. There is a commercial sting to it too; we try to garner some sales but we work that way in providing support for them (farmers)…'

A3.7 Pesticide and Fertiliser Overuse Matrix: Interactions of Contingent, Support and Contextual Factors to Influence Pesticide and Fertiliser Overuse

Table 1

Contingent Factors	Support Factors	Contextual Factors
Farmers assuming dosages	(1) Disorganised Information Systems - Selectivity - Dissemination of inappropriate/abstract information - Abandonment - Unsystematic or haphazard Information Channels	(1) Incapable extension services - Understaffing - - uncompetitive salaries - limited technical capability (Extension Agents; both Government and private sector (agents and dealers) are not agrochemical specialists - unstructured training beset by budgetary constraints and lack of proper monitoring and evaluation (2) Mismatched strategies/interventions which displayed a high degree of disconnection between the existing reality in the field and the strategy utilised. (i) <u>Mismatched Information dissemination strategy and Guidance</u>: - (Group/Pilot Farm and 'Farmer-Agent' Instruction) - Inappropriate/non-credible information - Business oriented information strategy (Agents) - Inappropriate - Non-credible and abstract information (ii) <u>Inadequate Laboratory services</u> (mismatched to current needs)

Source: Field Survey Data; Guyana – 2008/9

Table 2

Contingent Factors	Support Factors	Contextual Factors
Farmers depending on their experience	(1) Disorganised Information Systems - Selectivity - Dissemination of inappropriate/abstract information - Abandonment - Unsystematic or haphazard Information Channels	(1) Incapable extension services - Understaffing - uncompetitive salaries - limited technical capability (Extension Agents; both Government and private sector (agents and dealers) are not agrochemical specialists - unstructured training beset by budgetary constraints and lack of proper monitoring and evaluation
Farmers' need for a marketable crop to survive	(1) Irregular and unregulated marketing systems - Export Risk and Unattainable Quality - Haphazard Domestic Arrangements	(1) Adverse marketing conditions - External marketing conditions (including changes in trade regulations and Sanitary and Phytosanitary measures) - Also internal/local markets - not sure of commodities would be sold; also unsure of prices

Source: Field Survey Data; Guyana – 2008/9

Table 3

Contingent Factors	Support Factors	Contextual Factors
Farmers receiving distorted information based on self interest and deception of information sources (in the case of pesticide overuse)	(1) Irregular and unregulated marketing systems - Export Risk and Unattainable Quality - Haphazard Domestic Arrangements	(1) Adverse marketing conditions - External marketing conditions (including changes in trade regulations and Sanitary and Phytosanitary measures) - Also internal/local markets - not sure of commodities would be sold; also unsure of prices
	(2) Disorganised Information Systems - Selectivity - Dissemination of inappropriate/abstract information - Abandonment - Unsystematic or haphazard Information Channels	(2) Incapable extension services - Understaffing and - uncompetitive salaries - limited technical capability (Extension Agents; both Government and private sector (agents and dealers) are not agrochemical specialists - unstructured training beset by budgetary constraints and lack of proper monitoring and evaluation
	(3) Compromised Agrochemical Regulations - Pervious and inappropriate law or regulation establishment and enforcement - inappropriate retailing systems - irregular supply and price of chemicals	(3) Absence of appropriate policy intervention - (Lack of active Government control in importation and dissemination of agrochemicals and related information despite prevailing issues) - Structured Traditional System/Unstructured non-traditional system with respect to agrochemical use - (no regulation governing the required instruction/qualification/capability or of dealers to appropriately inform farmers) - non-mandatory registration of farmers and maintenance of diaries (ineffective monitoring)

Source: Field Survey Data; Guyana – 2008/9

Table 4

Contingent Factors	Support Factors	Contextual Factors
Farmers' uncertainty of the information they received	(1) Disorganised Information Systems - Selectivity - Dissemination of inappropriate/abstract information - Abandonment - Unsystematic or haphazard Information Channels	(1) Incapable extension services - Understaffing and greatly reduced scope of coverage - uncompetitive salaries - limited technical capability (Extension Agents; both Government and private sector (agents and dealers) are not agrochemical specialists - unstructured training beset by budgetary constraints and lack of proper monitoring and evaluation (2) Mismatched strategies/interventions which displayed a high degree of Disconnection between the existing reality in the field and the strategy utilised. **(i)** Mismatched Information dissemination strategy and Guidance: (Group/Pilot Farm and 'Farmer-Agent' Instruction) Inappropriate/non-credible information Business oriented information strategy (Agents) Inappropriate - Non-credible and abstract information
	(2) Compromised Agrochemical Regulations - Pervious and inappropriate law or regulation establishment and enforcement - inappropriate retailing systems - irregular supply and price of chemicals	(3) Absence of appropriate policy intervention - (Lack of active Government control in importation and dissemination of agrochemicals and related information despite prevailing issues) - Structured Traditional System/Unstructured non-traditional system with respect to agrochemical use - (no regulation governing the required instruction/qualification/capability or of dealers to appropriately inform farmers) - non-mandatory registration of farmers and maintenance of diaries (ineffective monitoring)

Source: Field Survey Data; Guyana – 2008/9

APPENDIX 4: Summary of Farmers' Perceptions Concerning the Effects of Overuse on Crop production and Potential Environmental and Economic Effects

Table A4.1: Farmers' Perceptions Concerning the Effects of Overuse on Crop production (A)

Category	Farmers' Perceptions	No. of farmers	(%)
(1)CROP PRODUCTION			
(i) GROWTH			
Growth - Pesticide	the use of excessive pesticides were not relevant for crop growth	21	55
	excessive pesticides facilitated increased plant growth ,since their use protected the crops from pests and disease infestations	9	24
	the use of excessive use of pesticides could cause decreased growth of plants through damages caused to these plants from excessive use of pesticides	8	21
Growth – Fertiliser	excessive fertilisers increased the rate of growth of crops and caused faster maturity of plants	31	82
	increased growth was accompanied by decreased quality of the vegetables produced by such crops to which excesses of fertilisers were applied	6	16
	excessive fertiliser would damage crops and cause reduced growth	4	11
	excessive fertilisers had no relation to crop growth	2	5
	unsure of any relation between crop growth and the use of excessive fertiliser	1	3
(ii) YIELD			
Yield – Pesticide	the use of excessive pesticides was not relevant to crop yields	25	66
	the use of excessive pesticides could cause decreased yields through plant damage	5	13
	the use of excessive pesticides protected crops from pest and disease infestations and permitted them to produce maximum yield	5	13
	excessive pesticides were needed to control pest population to ensure any yield at all	1	3
Yield – Fertiliser	the use of excessive fertilisers was necessary for increased crop yields	27	71
	- with increased yields there was decreased quality of produce	11	29
	- there would be shorter bearing period while	6	16
	- the plant would sustain some damage	1	3
	excessive fertilisers increased yields and size of crop produce	5	13
	excessive fertilisers increased yields and appearance of produce	1	3
	excessive fertilisers increased yields, size and appearance of produce	2	5
	the use of excessive fertilisers increased only the size of crop produce	5	13
	excessive fertilisers increased only sizes and appearance and size of produce	2	5

Source: Field Survey Data; Guyana – 2008/9
N= 38

Table A4.2: Farmers' Perceptions Concerning the Effects of Overuse on Crop Production (B)

Category	Farmers' Perceptions	No. of farmers	(%)
(iii) PROTECTION			
Protection - Pesticide	the use of excessive pesticides was necessary in cases where the recommended dosages seemed ineffective	17	45
	use of excessive pesticides was required when a fast control of pests was required	7	18
	excessive pesticides were seen as preventive action to reduce chances of pest attack	7	18
	excessive use of pesticides was required for general pest control, ensuring that pests were killed	4	11
	the overuse of pesticides did not necessarily offer protection to crops from pest attack since in many instances pests returned even after application of excessive pesticides	3	8
Protection - Fertiliser	the use of excessive fertilisers was not of relevance to crop protection	26	68
	overuse of fertilisers promoted healthier plant growth and caused plants to be more resistant to pests	12	32
(iv) QUALITY			
Quality – Pesticide and fertiliser	both pesticide and fertiliser overuse negatively affected the quality of vegetable produce	38	100
	- reduced quality was apparent by shortened shelf life of vegetables; demonstrated by earlier than expected spoilage of vegetables	33	87
	- the taste was abnormal	6	16
	- excesses caused abnormal taste and increased water content	3	8
	- excessive use caused only abnormal taste of vegetables	1	3
Quality - Fertiliser	abnormal taste and excesses of water content were effects	2	5
	negative quality effects were abnormal colour and increased water content	1	3
	abnormal taste was exclusive to excessive fertilisers	1	3
Quality - Pesticide	abnormal smell and taste of vegetables was caused by pesticide overuse	1	3

Source: Field Survey Data; Guyana – 2008/9
N= 38

Table A4.3: Farmers' Perceptions Concerning the Environmental and Economic Effects of Overuse and Sample Farmers' Registers

Category	Farmers' Perceptions	No. of farmers	(%)
(2) ENVIRONMENT	excessive chemicals were not likely to cause any negative effects to the environment because of their removal by some type of water source	17	45
	overuse of pesticides and fertilisers could not pose an environmental threat, since they were not that potent or toxic to cause any environmental harm.	16	42
	excessive use of pesticides and fertilisers had adverse environmental effects where the water and soil could become polluted	8	21
	the use of excessive pesticides and fertilisers were not likely to cause pollution, since most of the chemicals applied would be were acting on the pests or plants, hence very little of these chemicals would be left free or as excess within the environment	6	18
	negative effects of overuse to the environment were not likely as they had not experienced any evidence such as dead fish or negative after effects after the utilising water in nearby waterways for domestic purposes	4	11
	extensive pollution would occur and cited cases of water pollution negatively affecting water life (fish and algae) and even the vegetables	2	5
	pollution of environment would occur but only if the excessive pesticides and fertilisers were added consistently over a long period of time, like several years	1	3
	pollution of waterways occurred by growth of excess vegetation in the waterway which was due to overuse practices	1	3
	pollution of the environment occurred if the containers were inappropriately disposed of	1	3
	unsure whether overuse would cause any environmental effects	1	3
(3) ECONOMIC	excessive use of pesticides and fertilisers were more likely to cause loss of export markets since tests were conducted, but in the case of local markets this was not likely to happen	16	42
	- disinterest of local consumers in matters pertaining to overuse with more interest in prices	9	24
	- the absence of traceability and monitoring, including residual testing on local markets	8	21
	excessive use of pesticides was detrimental for both local and export markets; but this was more serious in the case of export markets	13	34
	- consumers' initial unawareness of the negative effects of overuse but later becoming concerned if they detected abnormal symptoms	8	21
	- citing cases of rejection of vegetable produce by importing countries	4	11
	- residual test being conducted for export markets by importing countries, but absent for local markets	4	11
	- consumers' interest being more inclined to the price of commodities compared to the quality and lack of traceability, respectively	2	5
	excessive pesticides was detrimental for both local and export markets	18	21
	- residual testing was done for export markets	5	13
	- consumers detecting the negative effects of overuse and avoiding repeat purchases from sale points known to have poor quality vegetables	5	13
	- cases rejection of exported produce by importing countries had occurred because of excessive residual limits of agrochemicals	1	3

Source: Field Survey Data; Guyana – 2008/9
N= 38

A.4.5 Sample of Crop Reporter's Farmers' Register

FARMER'S REGISTER
NAME OF VILLAGE ....La - Jalousie....
REGION # ..3.

MINISTRY OF AGRIC
PLANNING DEPARTM
REPORTING OFFICE

Name of Farmer	Farmer's Address	Farm Address	Total Acreage	Crops	Acres Cultivated	Yield/ Acre
1 Dhamraj						
Puran	La-Jalousie	La-Jalousie	1.00	Bora tomatoe Poie		
				cucumber boulanger		
				ochro pepper celery		
				eshallot corilla	1.00	
2 Sundar Puran	La-Jalousie	La Jalousie	1.00	Bora tomatoe Poie		
				eshallot celery		
				boulanger corilla		
				cucumber ~~Poie~~		
				Pachoie pepper	1.00	
3 Roopan						
Chandradat	La-Jalousie	La-Jalousie	1.00	Bora tomatoe		
				eshallot cellery		
				cucumbe boulanger		
				Pepper Pachoie		
				Poie corilla	1.0	

A.4.6 Sample of Extension Officer's farmers' Register

AMES	ADDRESS		ACRAGE CULT.	CROP TYPES.
I WASHINGTON	DOUTCH FOUR	1	1.5	OCHRO PEPPER, SQUASH CUCUMBER
EY ANDREWS Contact person	TWO FRIENDS	2	0.5	CUCUMBER, SQUASH, CELER
N WILSON	TWO FRIENDS	3	2.0	CUCUMBER, SQUASH, CEL
NKLIN DONDAS	ANNS GROVE	4	0.5	Poi, OCHRO.
IN CLEMENSON	ANN'S GROVE	5	0.5	OCHRO, Pepper, Carilla
AVOE ANDERSON	ANN'S GROVE	6	0.5	Bora, Ochro
EY DENNY	TWO FRIENDS	7	0.5	Celery
THONY COLLINS	ANN'S GROVE	8	1.5	Passion fruit, Squash, Poi.
TH ANDREWS	TWO FRIENDS	9	2.0	Ochro, Squash
MOND JOHNSON	ANN'S GROVE	10	1.5	Banana, Plantain, Papaw
DWELL JONES	ANN'S GROVE	11	2.0	Squash, Cucumber, Och
STON STANIFORD	ANN'S GROVE	12	1.5	Ochro, Pack choi.
RICK COLLINS	ANN'S GROVE	13	1.5	Squash, Ochro.
AVELT DANIELS	ANN'S GROVE	14	1.0	Passion fruit.
VELL BERKSHIRE	TWO FRIENDS	15	1.5	Plantain Cassava.
RICK SPENSOR	ANN'S GROVE	16	0.5	Cucumber.
C BILLY	TWO FRIENDS	17	2.0	Poi, Bannana, Broad leaf th
IN SOSO	TWO FRIENDS	18	0.5	Poi, Ochro
ELY CLERK	TWO FRIENDS	19	1.5	Banana, plantain, Cassa
TRICK SAM	DOUTCH FOUR	20	0.5	Cassava, Banana.
ISTON ANDERSON	ANN'S GROVE	21		
BARNS	ANN'S GROVE	22	4.0	Mangoes
IPH CHAMBRIDGE	ANN'S GROVE	23	1.5	Carilla. Cucumber, Boulanger, Sq
Y STANFORD STANIFORD	ANN'S GROVE	24	0.5	Pack choi, bora
FITT WICKHAM	ANN'S GROVE	25	0.5	Bora, Carilla, Poi.
AL ROOPNARINE	CLONBROOK	26	2.0	Pepper, Cucumber, Squash

APPENDIX 5: Photographic Documentation of Fieldwork

Farmer RG's dependence on his 'experience' for dosages (he uses 3-4 'corks-full') instead of 2 teaspoons
Source: Field Survey Data; Guyana – 2008/9

Farmer Ash's assumption of dosages (he pours from the bottles)
Source: Field Survey Data; Guyana – 2008/9

Farmer KB's use of Distorted Information from a friend- the young plants in his nursery has been destroyed by pests due to the use of inappropriate chemicals
Source: Field Survey Data; Guyana – 2008/9

Farmer Ren's desperation for a marketable crop – his crop is destroyed by overuse of pesticide (caprid) to ensure that all whiteflies are killed.
Source: Field Survey Data; Guyana – 2008/9

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