Economics of Wetland Cultivation in Zimbabwe:

Case Study of Mashonaland East Province

University of Fort Hare
Together in Excellence

A Dissertation Submitted in Fulfilment of the Requirement for the Degree of Master of Science in Agriculture (Agricultural Economics)

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Declaration

I, the undersigned, hereby certify that, unless specifically indicated to the contrary in the text, this thesis is the result of my original work and that I have not previously submitted it to any University for a degree.

Dated: ……………………………………… Day of …………………………………….2009

…………………………………………………………………………….

Amon Taruvinga

Dedication

Dedicated to;

(a) NGOs

(b) Traditional Leaders

(c) Environmental Policy Analysts

(d) Provincial & District Environmental Managers

(e) Environmental Management Agency (EMA) Zimbabwe

(f) Rural Communities (Wetland Cultivators & Non Cultivators)

(g) Agricultural/Natural Resources/Environmental/Developmental Economists

WHO BELIEVE IN "**GREENING THE GDP"** THROUGH UNLOCKING THE HIDDEN HARVEST IN **WETLANDS** SO AS TO MEET THE NEEDS OF THE PRESENT RURAL COMMUNITIES WITHOUT COMPROMISING THE ABILITY OF FUTURE GENERATIONS TO MEET THEIR OWN NEEDS

"In the Face of Poverty, Wetlands are Lifelines"

-Working for Wetlands (WW) 2009 -

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Abstract

Wetlands are stocks of natural resources limited in supply, in the middle of unlimited human wants with multiple uses to society, presenting an economic problem in as far as their rational and sustainable use is concerned. To that end, conflicting recommendations have been forwarded regarding wetland cultivation as a possible land use across the globe and from within the same regions. On one extreme, wetland cultivation has been linked to degradation of wetlands with pure wetland conservation as the prescribed viable and sustainable land use option to society. Closer to reality, partial wetland conversion to crop land has been found compatible with wetland bio-diversity; implying that partial wetland cultivation is the prescribed wetland use option viable and sustainable to societies, a dictum mainly claimed by rural communities.

With that conflicting background and based on the "Safe Minimum Standard" approach, a ban on wetland cultivation was maintained in several early environmental policies in Zimbabwe as a basis for legislative protection of wetlands, a position that is still legally binding in current statutes. Contrary to that, rural communities have responded by invading wetlands as a coping strategy in pursuit of the claimed values of wetland cultivation, further conflicting with standing policies. This scenario has managed to "lock" and is currently locking the claimed 1,28 million hectares of wetlands in Zimbabwe in a "legal-operational impasse", at a cost to the entire nation since no meaningful investment is possible in wetlands when there is a legal conflict.

Viability of wetland cultivation is therefore questionable, which warrants further investigation towards appraising wetland cultivation as a possible land use in rural areas. The connection between wetland cultivation and household food security also requires further exploration with the implicit goal of quantifying the claimed value attached to wetland cultivation. For purposes of regularising wetland cultivation in the event of a significant contribution of wetland cultivation to humanity, socio-economic factors influencing households to participate in wetland cultivation become necessary towards crafting of wetland cultivation transfer user rights. From a policy realm, such an analysis would provide an economic body of evidence to support the economic pillar under sustainable development

that should be fused in an accommodative manner to the environmental pillar of wetland ecology and the social pillar before a policy shift can be imagined.

In an effort to appraise and explore the economic body of evidence as the economic pillar behind wetland cultivation from a sustainable development point of view amid conflicting recommendations, a case study of Mashonaland East Province in Zimbabwe was conducted to investigate the economics of wetland cultivation. Using *Gross Margin Model*, the *Return per Dollar Variable Costs Invested* and the *Net Present Value* approach, profitability of wetland cultivated crops was estimated. To further quantify the viability of wetland cultivation, the contribution of wetland cultivation to household food security was investigated using *Kendall`s tau_b* and *Spearman`s rho* non parametric correlation models for estimation of the systematic relationship that could exist. Using *Cross Tabulation* association and directional measures, the significance and direction of the systematic relationship postulated by correlation models was quantified. Building on these analyses the actual contribution of wetland cultivation to household food security was deduced using the *Relative Risk Estimate – Odds Ratio* approach. The study went on to estimate factors capable of influencing participation of households in wetland cultivation for purpose of policy guidance in the event of transfer of wetland cultivation user rights to communities using a *Binary Logistic Regression* model.

The study concludes that wetland cultivation under rural setting was profitable, with a significant positive linear correlation to household food security to such an extent that wetland cultivators were more than twice food secure than non wetland cultivators at net food security level of households. Household head age, distance to wetland area and availability of wetland restrictive measures were chief factors capable of positively influencing participation of households in wetland cultivation. Household head education, amount of livestock units and household size were negatively related to participation. The study therefore calls for promotion of partial wetland cultivation from a rural setting through lifting of the technical ban in wetland cultivation as currently contained in the environmental legal framework of Zimbabwe.

Caution however should be taken in crafting transfer user rights amid mixed perceptions from society and general scarcity of wetlands in relation to potential demand from society. The negative relationship between participation and household head education as well as the young households further casts a bleak future for wetland cultivation as a possible land use option in Zimbabwe. The study recommends targeted awareness campaigns to correct current mixed perceptions in societies regarding wetland cultivation and grouping of communities in wetland cultivation schemes to accommodate the potential shortage that can cause scramble and conflict.

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Abbreviations

BCEF	Business Coefficient Expansion Factor
$CaCl_2$	Calcium Chloride
CEC	Cation Exchangeable Capacity
CSO	Central Statistics Office
ESP	Exchangeable Sodium Percentage
Ex Ca	Exchangeable Calcium
Ex Mg	Exchangeable Magnesium
Ex Na	Exchangeable Sodium
GB£	Great Britain Pound
GDP	Gross Domestic Product
GFSI	Gross Food Security Index
GI	Gross Income
GM	Gross Margin
GO	Gross Output
Ha	Hectares
IIED	International Institute for Environment and Development
IUCN	International Union for Conservation of Nature and Natural Resources
MC	Multiplier Coefficient
MODAM	Multiple Objective Decision Support Tool for Agro-ecosystem Management

NFSI	Net Food Security Index
NPV	Net Present Value
NR	Natural Region
pH	Hydrogen Potential
RO	Rational Option
SADC	Southern African Development Community
SE	Standard Error
SMS	Safe Minimum Standards
SPSS	Statistical Package for Social Scientists
TAE	Total Adult Equivalents
TEB	Total Exchangeable Bases
TGM	Total Gross Margin
TP	Total Production
TVC	Total Variable Costs
UMP	Uzumba Maramba Pfungwe
US$	United States Dollar
USD	United States Dollar
ZK	Zambian Kwacha

Chapter One (1)
Introduction and Background Information

"The alternative extremes of wetland conservation or wetland conversion in total to agriculture can have devastating effects on rural livelihoods. Conservation leads to loss of access to land for "hungry" season cultivation, while total conversion leads to loss of natural products and hydrological functions"

……………….Maconachie et al. (2008)

1.0 Introduction

Wetland economics presents a widely contested area in as far as its best land use option to society is concerned. Rukuni *et al.* (2006) acknowledge that conflicting conclusions regarding wetland cultivation have been forwarded across the globe and from within the same regions, making it difficult for end users to subscribe to any of the available recommendations. In countries where such recommendations were used, conflicts have been noted between policy makers and societies, a typical case of Zimbabwe; where government maintains a ban on wetland cultivation amid a massive invasion of wetlands by society, an observation noted by Mutambikwa *et al*. (2000). As earlier on noted by Barbier *et al.* (1996), the confusion seems to emanate from the initial definition of wetlands. The term, according to Barbier *et al.* (1996), refers to an array of inland, coastal and marine ecosystems, which share a lot of things in common, meaning different things to different people because of the enormous variety of wetland types and the problems of defining their boundaries.

The Ramsar Convention on Wetlands of International Importance (Article 1.1) defines wetlands as water body systems such as marshes, ferns, peat lands, pans, swamps, streams and lakes, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres, also acknowledged by Chopra and Adhikari (2004), Guveya (2000) and Barbier *et al.* (1996).

The broadness associated with trying to define wetlands presents further challenges in trying to prescribe sustainable land use options, as can be witnessed in conflicting conclusions inferred regarding wetland cultivation. In an effort to streamline wetlands into classes for land use capabilities, several categorizations were proposed to which the following classification, as generally used in southern Africa, shall be used as the working definition in this study. Bullock (1992a) established that in southern Africa wetlands were generally known as *vleis* (*Afrikaans*), *dambos* (*Chichewa*), *matoro / mapani* (*Shona*) or *amaxhaposi* (*Ndebele*), meaning inland wetland systems excluding riverine, coastal and marine systems. It is this form of wetland system that shall be deemed to mean wetland in this study as conventionally used in southern Africa.

The true economic value of wetland cultivation to society remains an over-generalized and a highly contested area, whose potential is mainly claimed by some communities who directly benefit from them. Unfortunately, these claims lack appropriate economic valuation to provide documented economic evidence to support an economic premise for wetland cultivation. Tempted by these "claimed values", rural communities have managed to invade wetlands conflicting with standing policies that restrict wetland cultivation (Mutambikwa *et al.*, 2000). Legal restrictions originated from the idea that wetland catchments were thought to act as hydrological reservoirs, storing water in the rainy season and releasing it through evapo-transpiration from wetland surface in dry season stream flow (Whitlow, 1985; Bullock, 1992b; McFarlene, 1995). Wetland cultivation was therefore thought to cause a reduction in dry season river flow and general wetland degradation, (Rattray *et al.*, 1953; Elwell and Davey, 1972; Whitlow, 1985; Owen *et al*., 1995; Bullock, 1995).

Lately, research has indicated that there is no significant link between wetland cultivation and the claimed degradation as widely and conventionally believed (Bullock, 1992b; McFarlene, 1995; Owen *et al*., 1995; McCartney, 2000; Constantin *et al*., 2003). Based on these findings Bullock (1995) and McFarlene (1995) challenged the existing legal framework and called for a revision of some clauses that restricted cultivation of wetlands. Unfortunately, these ecological findings failed to influence a policy shift, which continued and is currently skewed in favour of pure wetland conservation at the expense of cultivation, as contained in the Zimbabwean *Environmental Management Act*, of 2002 and the Zimbabwean *Environmental Management (Environmental Impact Assessment and Ecosystems Protection) Regulations*, (*Statutory Instrument 7)*, of 2007. As Whitlow (1985) rightfully suggests that, there is need to reassess the role of wetlands in peasant farming particularly since overgrazing and trampling by livestock were the major causes of erosion in wetland areas rather than cultivation. There is therefore a need to provide an economic valuation of wetland cultivation under a clear and an unambiguous analysis reflecting the true economics of wetland cultivation to society.

Wetland cultivation and pure wetland conservation in principle compete for the scarce wetland area in rural areas of Zimbabwe estimated to be 262 000 hectares, approximately 0,67% of the total surface area of the country (Mharapara, 1995). Wetland cultivation must therefore compete economically with pure wetland conservation, which is the current legally binding wetland land-use option, if it is to be accepted as an alternative land-use in wetland economics. To that end survival of wetlands depends on whether society considers them to be assets or liabilities. Of interest in the policy realm is assessing the economic value that local communities living adjacent to wetland areas assign to wetland cultivation, given that some people potentially consider wetland cultivation as a public good while others consider it as a public bad. If the economic value of wetland cultivation is significant, then it would imply that wetland cultivation might be economically enhanced through devolution of wetland cultivation user rights to local communities.

The real issues are whether there exists a significant economic value in wetland cultivation so as to warrant conversion of wetlands to cropping land. Also of importance is the potential of this value to address household food security, implying whether the claimed wetland cultivation value is capable of addressing the broader welfare economics of households. Lastly, are socio-economic factors that influence farmer`s participation in wetland cultivation critical for the devolution of wetland cultivation user rights to societies. In pursuit of the three pillars of sustainable development (social, economic and environmental), a comprehensive environmental policy review would require contributions from the three slants of sustainable development before a policy shift can be influenced. To that end an economic body of evidence providing the economics of wetland cultivation to society is part of the critical information required by policy makers before any policy shift can be imagined. Otherwise current *status quo* defines and justifies the current legal position amid several calls from ecologists to reverse restrictive clauses enshrined in current environmental statutes[1].

1.1 Background Information

This section presents a brief summary of background information pertaining to wetland utilization in southern Africa with special reference to Zimbabwe. Areas covered in this section include, coverage of wetlands and population distribution, agronomic potential of wetlands, myths and facts behind wetland cultivation and legal background of wetland cultivation and its implications.

1.1.1 Coverage of Wetlands and Population Distribution

International Union for Conservation of Nature and Natural Resources (IUCN) (1994) estimates that 13% of the Southern African Development Community (SADC) is made up of wetlands, the bulk of which is found in areas inhabited by approximately 60% of the population. Figure 1.1 indicates an estimated distribution of wetlands in Zimbabwe, Angola, Zaire, Zambia, Malawi, Mozambique and Tanzania (Bell *et al*., 1987).

In essence, understanding wetland economics would go a long way towards crafting sustainable wetland policies because this approach would give an estimated value as well as socio-economic factors influencing their cultivation by society hence an indication of the overall economic efficiency of various competing uses of wetland resources (Barbier *et al.*, 1996).

[1] Zimbabwean Environmental Management Act of 2002 and the Zimbabwean Environmental Management (Environmental Impact Assessment and Ecosystems Protection) Regulations, (Statutory Instrument 7), of 2007

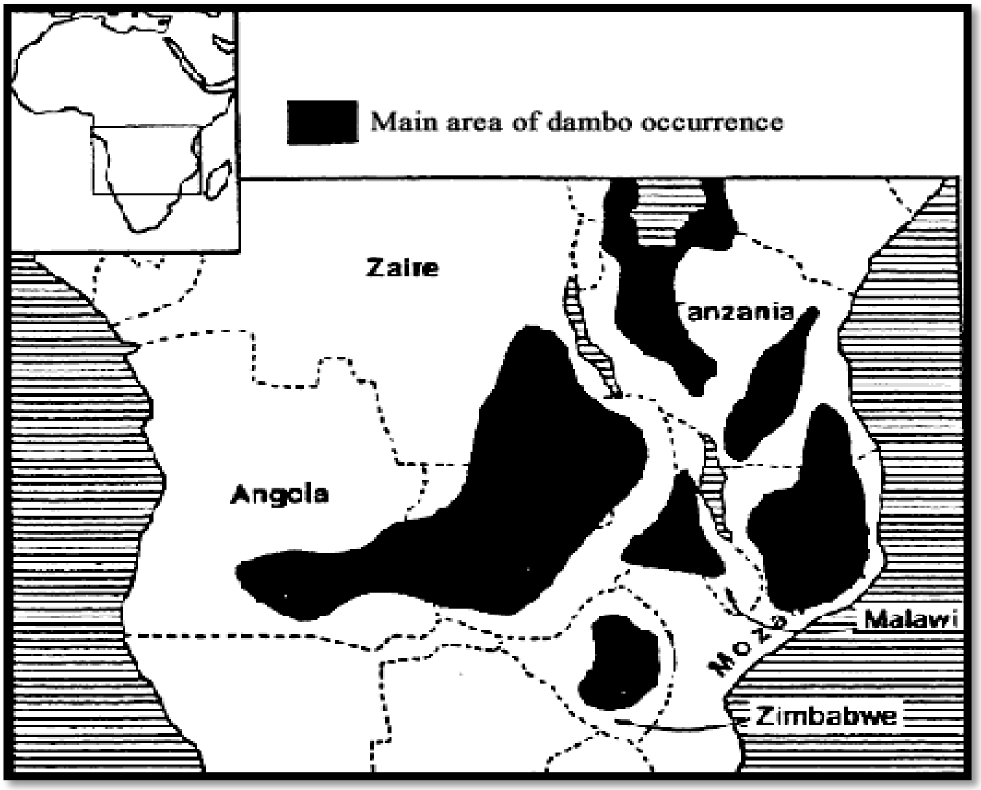

Figure 1.1: *Dambo* Distribution in Southern Africa

Source: Bell et al. (1987)

Mutambikwa *et al*. (2000), estimates that 3,5% of the total surface land area of Zimbabwe is covered by wetlands accounting to 1,28 million hectares. Mharapara (1995) reported that of the wetlands in Zimbabwe, 262 000 hectares is found in rural[2] areas accounting to approximately 0,67% of the total surface area of the country. Thomas (1992), estimated that approximately 42% of the total surface land area of Zimbabwe is purely communal. Fifty five percent of the national population is estimated to reside in communal areas (Central Statistics Office (CSO), 2002). The above statistics portray a significant interaction between wetlands and society, whereby more than half of the country`s population share scarce wetland resources estimated to cover 0,67% of the country`s surface land area accounting to 262 000 hectares (Mharapara, 1995).

[2] The majority of Zimbabwean rural areas are purely defined in communal areas; implying rural areas comprise a bigger subset of the communal area.

Bradley and McNamara (1993) noted that 74% of Zimbabwe`s communal areas are predominantly in regions of low agricultural potential, dominated by poor soils and low unpredictable rainfall. The majority of people from these areas engage in rain fed agriculture, which is largely insecure in terms of sufficient and sustainable food supply (Bradley and McNamara, 1993). The above statistics indicate that more than half of Zimbabwe`s population resides in rural areas, where an estimated 262 000 hectares of wetland area is located.

Although not evenly distributed across all rural areas, figures indicate general scarcity of wetland area either for pure wetland utilization or cultivation in relation to available potential users of that land class. Figure 1.2 indicates land classification in Zimbabwe clearly showing communal areas stretches, most of them located in agro-ecological position IV and V, close to National Parks areas.

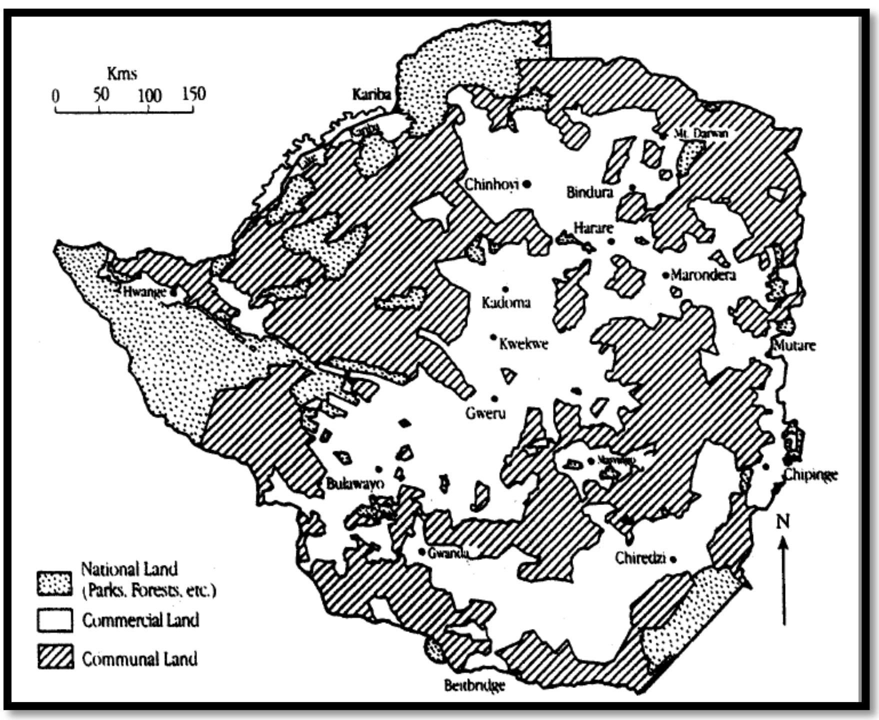

Figure 1.2: Land Classification in Zimbabwe

Source: Child (1995), figure 3, page 16

Superimposing the map of *dambo* distribution by Bell *et al.* (1987) in Figure 1.1, to the land classification map by Child (1995), Figure 1.2, would clearly indicate a scenario where the bulk of wetlands in Zimbabwe are located in the commercial land area. Only a fraction of wetlands would stretch into communal areas[3] (Mharapara, 1995).

1.1.2 Agronomic Potential of Wetland Cultivation

Muzenda *et al.* (2001) acknowledge that high water tables in wetlands makes planting of crops possible throughout the year giving farmers a double cropping advantage over upland cropping. Location of communal areas in Zimbabwe, as can be picked from Figure 1.2, is purely defined in marginal areas where rainfall is very unpredictable and poorly distributed across the season. Child (1995) established that of the total communal land in Zimbabwe more than three quarters is located in low rainfall regions IV and V, where the potential for crop agriculture is limited, same sentiments are shared by Bradley and McNamara (1993). Figure 1.3 indicates an insert photo of a typical wetland in Goromonzi communal area during the dry season (August, 2009), but indicating water table above ground level.

Water Table of Wetlands

Wetlands have high water tables

This is true throughout the year

Making it possible for double cropping and early planting from August onwards when heat units are still high as acknowledged by Muzenda *et al.* (2001)

Figure 1.3: High Water Table of Wetlands

Source: Research photo gallery, (2009)

[3] The superimposed distribution of *dambos* into the communal areas of Zimbabwe covers more of the eastern side of the country than the western side. This is in agreement with estimates by Bullock (1995), who noted that the bulk of the 262,000ha of wetlands estimated to be in communal areas are more defined in Mashonaland East province.

If wetlands exhibit a high water table, as depicted in Figure 1.3, in communal areas, whose uplands[4] face frequent moisture shortages, from a plant-water-requirement point of view, wetlands are comparatively superior and have a significant potential for crop cultivation in communal areas (Muzenda *et al.*, 2001). Based on land equivalent ratio principles, available moisture in wetlands throughout the year makes double cropping possible, a significant shortfall factor in uplands. Mathematically from a hectare of wetland area, farmers are capable of having more than two harvests per year, while only one unguaranteed harvest is possible in uplands.

Early planting (September and October), in conjunction with high moisture content available in wetlands, gives plants a heat unit advantage thereby providing a conducive environment for plant growth. Early planting has a bearing on yields, especially for hybrid varieties (Muzenda *et al.*, 2001). Crops require maximum cumulative heat units, which are more pronounced during the months of August, September and October, for them to fully expose their genetic potential as manifested in yields. To that end, wetland cultivators are more likely to reap maximum genetic potential yields on early planted crops possible with wetland cultivation than late planted crops, generic to uplands where plantings wait for the onset of natural rains that normally come in December.

By this time heat units will be very low and growing period left in the season would have been limited. In support of wetland cultivation, Rukuni *et al*. (2006) reports that researchers studying *dambos* in Zimbabwe found that yield per unit of land and water were approximately twice as high as in formal irrigation systems. Similar conclusions were earlier on inferred by Makombe *et al*. (2001), who observed that dry-land cultivation was the main alternative production system of communal smallholders, but was only one tenth as productive as *dambos*.

In the event that wetlands can provide such moisture during these critical periods in the phenology of a plant, wetlands have a significant agronomic future in communal areas than dry-lands (Rukuni *et al.*, 2006 and Makombe *et al.*, 2001). Figure 1.4 shows an early planted wetland

[4] Uplands in this study shall be confined to mean communal dry-land fields whose production relies on natural rains.

Zea mays crop (Mutoko wetlands)[5] taking advantage of heat units and high moisture available in wetlands. This *Zea mays* crop was planted in October when uplands were still dry. Taking advantage of high moisture content as a result of high water table in wetlands and high heat units during the month of October this crop was able to grow fast and by mid December, the crop was already flowering as shown in Figure 1.4.

Figure 1.4: Wetland *Zea mays* Crop from Mutoko Wetlands; October Planted

Source: Research photo gallery, (2009)

During the same time, (mid December) dry-land crops in the same region (Mutoko district) were still at 60cm height as shown in Figure 1.5[6]. Farmers could not plant during the month of October because it was still dry. First rains in this area were received during the last week of November when this crop was planted. By mid December the crop was almost at knee height. This crop was more likely to face several growth problems ranging from moisture stress during the January dry spell, further offsetting the pollen to silk synchronization process crucial for pollination (de Jong *et al.*, 1993). Low heat units are likely to retard the growth rate of this crop.

[5] The insert photo was taken from sampling Unit A; specifically wetlands from Mutoko District during mid December

[6] The insert photo was taken from sampling Unit A; specifically wetlands from Mutoko District during mid December

In essence the expected yield of this crop is likely to be very low compared to the wetland crop that was planted in October.

Figure 1.5: Upland *Zea mays* Crop from Mutoko Uplands; End of November Planted

Source: Research photo gallery, (2009)

Beadle (1981) postulated a significant drop in yields from swamps with respect to time as a result of a decline in fertility making the agronomic potential of wetlands very questionable based on soil fertility. In contrast, Maclean *et al.* (2003b) disputed this postulation indicating that it was a rare scenario to notice a substantial decline in crop yields as a result of continued wetland cultivation. Given the biomass volume of wetlands in terms of grass species that can survive under wetlands in respect to their moisture and nutrient affinities, Maclean *et al.* (2003b) argues that it does not make any academic and logical sense to expect wetland cultivated crops to deplete nutrient and moisture status of wetlands faster than the grass species endemic to wetlands, an observation echoed by Rukuni *et al.* (2006).

Ideally, wetland cultivation would allow more wetland nutrient and moisture recharge than grass species endemic to wetlands. Figure 1.6 shows typical wetland vegetation during winter when upland land classes fail to sustain grass species. The insert photo was taken from sampling unit

A[7], as explained in Chapter 3 to follow, specifically wetlands from Murewa district. High biomass volumes as can be seen from Figure 1.6 are common under wetlands, indicative of high grass species that Maclean *et al.* (2003b) and Rukuni *et al.* (2006) postulate to have higher affinities for both water and nutrients in comparison to wetland cultivated crops. It is based on this logical understanding that it would be strange to expect cultivated crops to deplete nutrient status of wetlands.

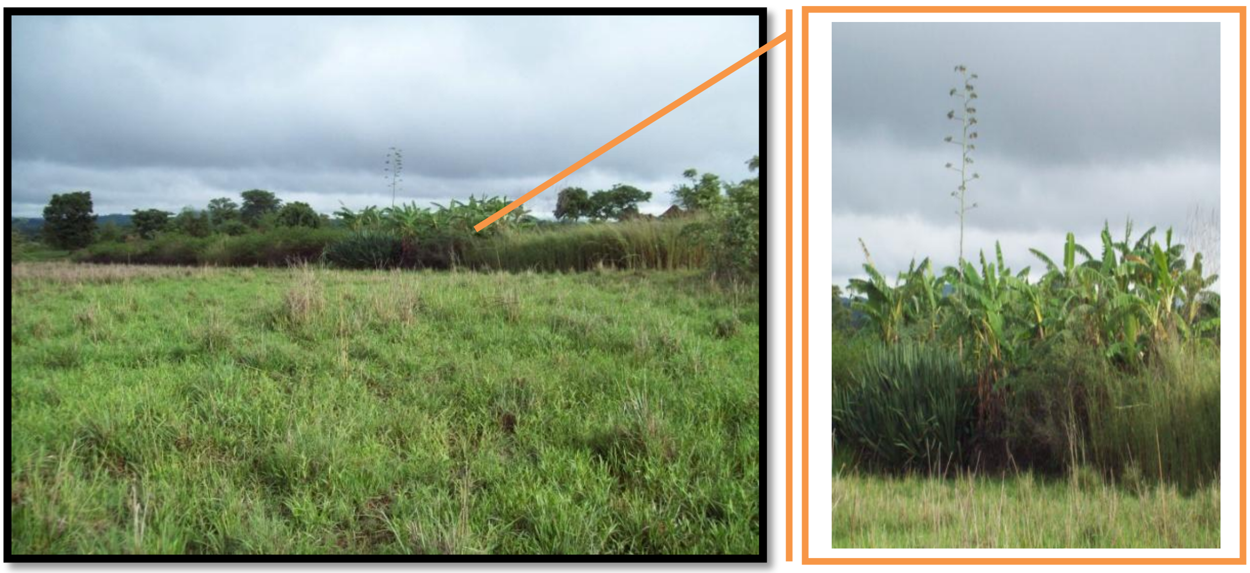

Figure 1.6: Wetland Biomass Volume and Expected Nutrient and Water Affinities

Source: Research photo gallery, (2009)

From a nutrition point of view, wetland soils receive nutrients from top hamper[8] material during winter and leached nutrients from uplands during summer (de Jong *et al.*, 1993). The elevation of wetlands makes them recipients of all deposits from uplands (Mharapara, 1995). De Jong *et al.* (1993) noted that through the assimilative capacity of wetlands, such land classes are capable of converting toxic substances into beneficial nutrients provided deposits should not surpass the assimilative capacity.

[7] Cultivated wetlands from Murehwa, Mutoko and UMP

[8] Dead grass material during winter that is allowed to decay and decompose adding organic matter to soils underneath

Effective depth of the wetland facet was denoted by "1" implying a deep depth in the range above 1,5m. Effective depth gives the depth of the soil which provides a medium for root growth and returns water and nutrients. There were no factors hindering or limiting cultivation within the plough zone indicating that the agricultural potential of the soil was very high. Top soil texture comprised of greater than 40% clay and less than 45% sandy denoted by "F" indicating clay soils more or less similar to Type I Blocky Soils from *Murehwa* Communal Area by Whitlow (1994) as explained in Chapter 3 section 3.2.1 that follows. Permeability was severely restricted denoted by "2", due to high clay content levels. Materials limiting effective depth comprised of horizons showing signs of regular water logging severely restricted in permeability denoted by "M_2".

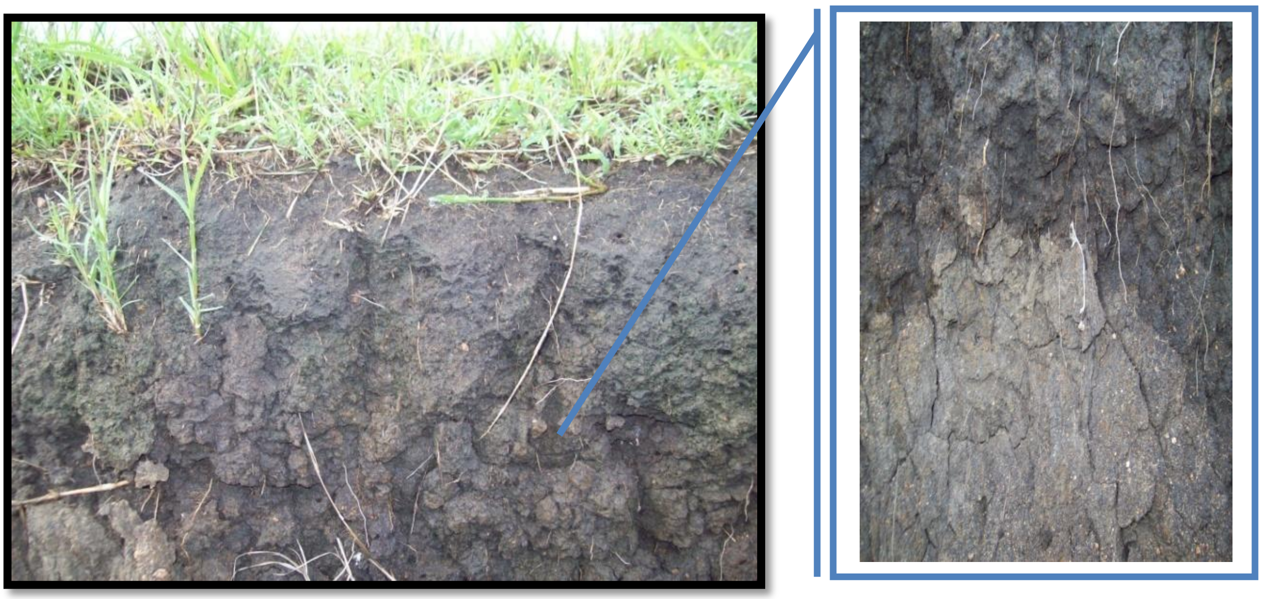

Figure 1.7: Typical Wetland Soil Profile

Source: Research photo gallery, (2009)

Based on the *Mansel* colour chart used, soils indicated very dark grey (10 YR 3/1) to dark yellowish brown (10 YR 4/4) colours denoted by "9", corresponding to a soil catena from *Chikwaka* Communal Area by Whitlow (1994) as explained in Chapter 3 section 3.2.2 that follows. Slope was within the "A" class indicating slope within 0 – 2%. There was no apparent erosion within the entire land facet. Elements of wetness were apparent, denoted by 'W_3'.

1.1.3 Myths and Facts behind Wetland Cultivation

Several schools of thoughts have emerged in as far as compatibility of wetland cultivation to wetland ecology is concerned. On one extreme there exists a general perception linking wetland cultivation to reduced dry season river flow and general degradation (Rattray *et al*., 1953; Elwell and Davey, 1972; Whitlow, 1985; Owen *et al*., 1995; Bullock, 1992a). This school of thought was disputed given that latest research found no significant link between wetland cultivation and the claimed degradation and reduced dry season river flow, (Whitlow, 1985; Bullock, 1992b; McFarlene, 1995; Owen *et al*., 1995; McCartney, 2000; Constantin *et al*., 2003). A safe limit on the extent of *vlei* cultivation was considered to be 10% of the catchment area or 30% of the *vlei*, whichever is smaller, (Bell *et al*., 1987; Bullock, 1995 and Owen *et al*., 1995).

Figure 1.8 presents a diagrammatic presentation of a sustainable approach to wetland cultivation with limits so as to harmonize wetland cultivation and wetland ecology. With those new findings, Bullock, (1995) and McFarlene, (1995) challenged the existing legal framework[9] and called for a revision of some clauses that restricted cultivation of wetlands.

[9] The Water Act of 1972 (amended 1976 and 2002): The Natural Resources Act of 1941 and the Public Streams Protection Regulation of 1952, (all repealed in 2002 by the Environmental Management Act of 2002 and Statutory Instrument Number 7 of 2007 which still maintains the ban in wetland cultivation)

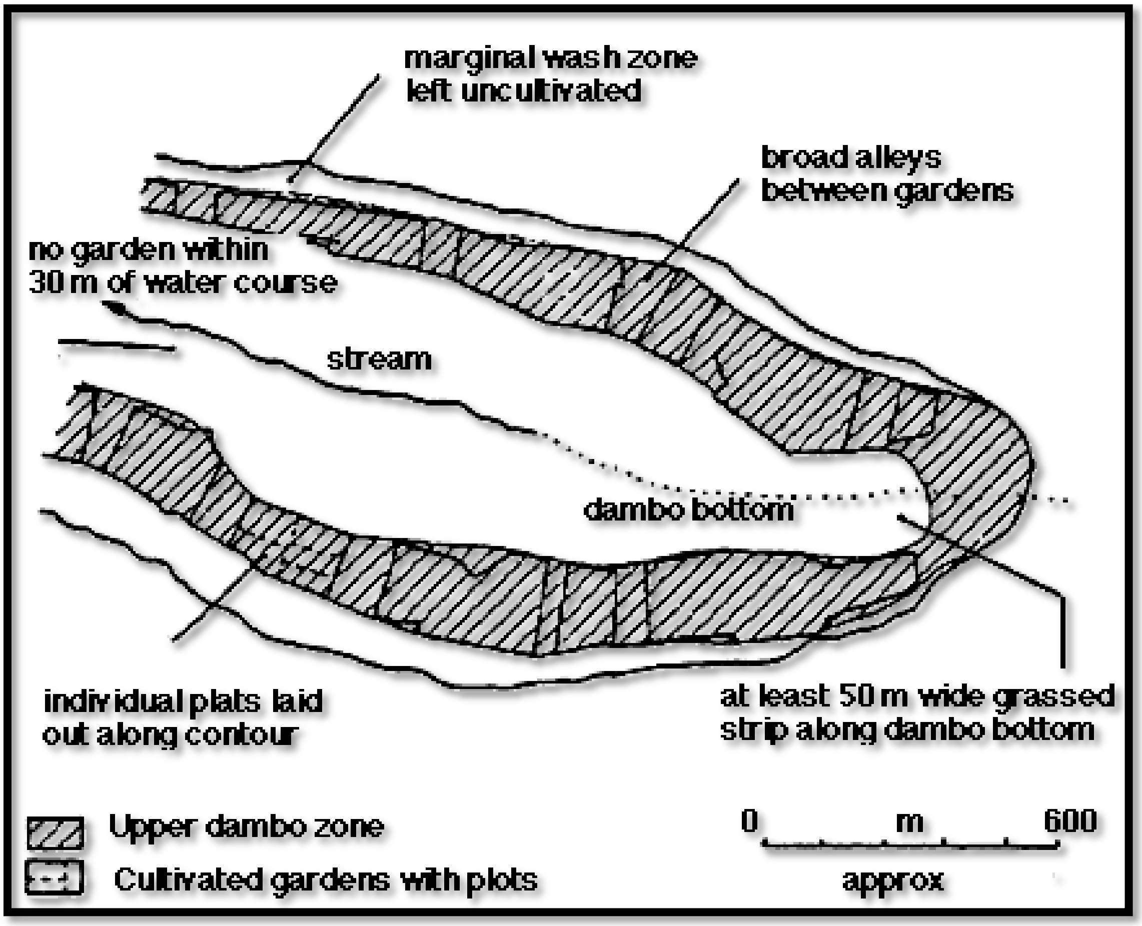

Figure 1.8: *Dambo* Land Use Recommendations

Source: Bell et al. (1987)

1.1.4 Legal Background and Implications

Several pieces of legislation were put in place, amended and repealed in as far as use and conservation of wetland is concerned in pre and post independence Zimbabwe. Based on the Safe Minimum Standards (SMS)[10] approach, a ban on wetland cultivation was maintained in several early statutes[11] and is currently maintained in current statutes[12] as a basis for legislative protection of wetlands but has not been supported by more recent hydrological investigations

[10] Fear of the unknown principle

[11] Natural Resources Act of 1941 and the Public Streams Protection Regulation of 1952 and the Water Act of 1972

[12] Environmental Management Act of 2002 and Statutory Instrument Number 7 of 2007

(Whitlow, 1985; Owen *et al*., 1995; Bullock, 1995; McFarlene, 1995; McCartney, 2000; Mutambikwa *et al*., 2000; Constantin *et al*., 2003).

Legal restrictions have therefore prevented realization of the potential of these seasonally waterlogged lands *(vleis)* through various prohibitive measures enshrined in the legislature based on the conventional belief and the general perception that wetland cultivation would lead to its degradation. Bullock (1995), supported by Muzenda *et al*. (2001), acknowledges that contrary to policy objectives rural communities have been cultivating wetlands at an increasing rate although such activities are deemed illegal in the strictest interpretation of legislation. This view was also supported by Ellis-Jones and Mudhara, (1995) and Mutambikwa *et al*. (2000), who noted that the bulk of wetlands in Zimbabwe, were subjected to cultivation in pursuit of high moisture content and rich organic matter endemic to this land class. Mutambikwa *et al*. (2000) observed that in reality the legislation is not enforced and wetland cultivation was widespread.

Figure 1.9 indicates the general picture of wetlands in Mashonaland East Province. Farmers realizing the potential of these land classes and challenges in uplands of poor nutrition and low moisture have managed to invade wetlands even if such practices are deemed to be illegal. Even in other provinces, wetlands are under intensive cultivation, especially in communal areas. In practice, available policy seems to have failed to stop wetland cultivation in Zimbabwe, but policy makers still maintain a ban on wetland cultivation despite widespread cultivation of wetlands by society.

Figure 1.9: Wetland Cultivation is Widespread despite Restrict Policies

Source: Research photo gallery, (2009)

1.2 Problem Statement

Wetlands are complex and multifunctional ecological systems whose direct and indirect contributions to human welfare are not obvious (Campbell and Luckert, 2002). This scenario has presented a long-standing debate between communities and policy makers in Zimbabwe. Communities subscribe to the notion of wetland conversion to cropland against a pure conservation stance by the government. Policy makers have maintained a legal restriction on wetland cultivation despite presentation of scientific ecological evidence that disputed the feared degradation of wetlands as caused by its cultivation, as contained in the Zimbabwean *Environmental Management Act*, of 2002 and *Statutory Instrument No. 7*, of 2007. On the other hand, rural communities have responded by illegally invading wetlands as a coping strategy, especially in arid regions where cropping is limited (Ellis-Jones and Mudhara, 1995 and Mutambikwa *et al*., 2000).

Of the 1,28 million ha of wetland estimated to exist in Zimbabwe, its efficient use is currently locked up in a “legal-operational impasse”, that could be costly to a nation like Zimbabwe, which has a domestic comparative advantage in agriculture[13]. No meaningful investment can be expected from wetland cultivation when there is a legal conflict. This impasse is likely to persist and worsen if these two land use options (wetland cultivation and pure wetland conservation) are not viewed from an economic point of view as an economic problem. Maintaining the *status quo*, would be more dangerous since any preferred option is associated with an economic cost (opportunity cost) to society. To that end the decision as to what use to pursue amid competing possibilities from an economic point of view can only be made if these gains and losses are properly analyzed and evaluated. Implying that, an economic valuation of wetland cultivation may be a partial panacea and the required "unlocking key" to this long-standing debate, to the benefit of both stakeholders.

1.3 Research Impasse

Authorities differ greatly in as far as the best land use option ideal for society in wetlands is concerned. On one extreme, a number of authors share the conclusion that pure wetland conservation is the best economic land use option for rural communities (Hanley and Craig, 1991; Maclean *et al.*, 2003a). On the other hand several authors subscribe to the school of thought of converting some portion of wetlands to crop land (Thiessen, 1975; Rukuni *et al.*, 2006; Makombe *et al*., 2001; Seyam *et al*., 2001). A third group which seems to be indifferent also exists. This group shares the view that there is no hard and fast conclusion but rather a case by case analysis of wetlands since wetlands are heterogeneous. Price fluctuations of specific wetland cultivated crops were also noted to be critical in determining profitability of wetland cultivation (Baltezore *et al*., 1989; Kramer *et al*., 1994; Ralph *et al*., 1998; Simonit, Cattaneo and Perrings, 2005). This study therefore seeks to evaluate the economic position of wetlands in Zimbabwe based on a case study of Mashonaland East Province.

[13] Zimbabwe has a total land area of about 39 million hectares of which 33.3 million hectares are suitable for agricultural purposes and the remaining 6 million hectares have been reserved for national parks, wildlife reserves and urban settlements (Child, 1995)

1.4 Operational Research Objectives

The broad objective of this study was to investigate the economics of wetland cultivation in Zimbabwe. In pursuit of this objective, the study focused on the following specific objectives;

1) To assess viability of wetland cultivation,
2) To assess the potential of wetland cultivation to address household food security and
3) To investigate factors that influence households to participate in wetland cultivation.

1.4.1 Operational Research Questions

1) Is wetland cultivation viable?
2) Does wetland cultivation address household food security?
3) What are the factors that influence households` participation in wetland cultivation?

1.4.2 Hypothesis

1) Wetland cultivation is a viable venture
2) Wetland cultivation addresses household food security
3) Household size, household head gender and household head education are other factors that influence households` participation in wetland cultivation

1.4.3 Thesis Statement

In light of the above, the underlying thesis of this work is that wetland cultivation has a significant economic value capable of addressing smallholder household food security.

1.5 Justification of Study

The rationale of the valuation is based on the fact that although society understands intuitively that wetlands are significant this may not be enough if ever people are to ensure their wise use (Barbier *et al.*, 1996). Campbell and Luckert (2002) noted that although it could be obvious that wetlands are complex and multifunctional, it is not obvious how the numerous goods and services provided by these wetlands affect human welfare. In essence, it may be meaningful to convert wetlands; whereas to others, it may be essential to ‘hold on’ to these wetlands in their natural state. To that end economic valuation provides a necessary tool to assist with the difficult decisions involved, from an economic point of view. Viewed in this context wetland utilization would be presented as an economic problem whereby a decision to leave wetlands in their natural state or convert them into cropping lands has implications to society in terms of values gained or lost. Put in other words, Barbier *et al*. (1996), acknowledges that the main objective of valuation in assisting wetland management decisions is generally to indicate the overall “economic efficiency” of various competing uses of wetland resources.

The ultimate objective *per se*, would be a rationale allocation of wetland resources to improve human welfare. The goal of this research is to assist planners and decision-makers with increasing the input from economic valuation in decision-making pertaining to wetland utilization. This poses a further challenge to agricultural economists to investigate the claimed benefits and potential of wetland cultivation to address smallholder household food security, especially given the fact that;

(a) an area of 1,28 million ha occupied by wetlands in Zimbabwe is indeed large enough to warrant investigations into its economic potential,
(b) high transport cost and poor infrastructure development in communal areas inhibiting distribution of food to these areas, imply that any available option to increase rural food productivity would be a sustainable food security policy,
(c) low cost and non technical irrigation systems possible with wetland cultivation would also be more user friendly, adaptable, cheap and sustainable than high cost and mechanized irrigation systems currently imposed on rural areas by African governments who ironically claim to lack capital resources,
(d) the rate at which rural communities are “invading” wetlands as droughts persists in southern Africa is increasingly presenting continued conflict with standing policies

(e) retardation and loss of interest by researchers in further research in appropriate and sustainable wetland cultivation methods after policy makers failed to acknowledge contribution of the scientific research in the field of wetland cultivation, and

(f) the confusion that exists, between communal farmers and extension service providers who remain indifferent (as government employees) in as far as offering technical advice on sustainable wetland cultivation or inhibit farmers from cultivating wetlands given that all of them (farmers) seem to have entered wetlands using the backdoor system deemed to be illegal according to current regulations.

By providing a means for measuring and comparing the various benefits of wetlands, economic valuation can be a powerful tool to aid and improve wise use and management of global wetland resources. It is based on the above issues that an evaluation is needed from an economic point of view as an economic body of evidence justifying the economic rationale of wetland cultivation to a nation.

1.6 Thesis Delineation and Assumptions

This section shall focus on delineation of the study in line with set specific objectives to avoid generalization. Operational assumptions shall also be highlighted in this section for purposes of clarity.

1.6.1 A statement of the Limits to the Project

This study will concentrate on the economics of wetland cultivation to society (**economics component**), not the impact of wetland cultivation to wetlands (**ecological compatibility**).

1.6.2 Assumptions

The following assumptions shall be maintained in this study based on current evidence from wetland ecology studies.

- Wetland cultivation is compatible with wetland ecology.

    - Provided cultivation covers 10% of the total wetland catchment area, or 30% of the wetland area as defined by the highest flood level of the wetland under consideration with the rule of thumb of considering which ever ratio that gives the smallest area (Bell *et al*., 1987; Bullock, 1995 and Owen *et al*., 1995).

These assumptions are based on several wetland ecology studies conducted in Zimbabwe and in Africa, by the following authors, (Whitlow, 1985; Bell *et al*., 1987; Owen *et al*., 1995; Bullock, 1992b; McFarlene, 1995; McCartney, 2000; Mutambikwa *et al*., 2000; Constantin *et al*., 2003). To that end this research is a follow up study from an economic point of view towards quantifying the economic value attached to wetland cultivation and its meaning to the broader welfare economics of rural communities.

1.7 Organization of the Study

Chapter 1 presents the introduction and the background of the research study specifically looking at wetland utilization and conservation in southern Africa with particular reference to Zimbabwe. **Chapter 2** reviews literature on wetland cultivation as practised across the globe, with special emphasis on the best wetland use option ideal and sustainable to societies, viability of wetland cultivation and its agronomic potential, potential of wetland cultivation to address household food security and factors influencing households` participation in wetland cultivation.
Chapter 3 highlights the road map to the study area starting with the provincial location with respect to specific districts from which respondents were selected. Major issues highlighted in this chapter include; agro-ecological survey summary of the study area, soils, geology geomorphology, hydrology and demographic data of the study area. **Chapter 4** outlines the research design for purposes of explaining how the study was conducted. Also discussed in this chapter are the methods and analytical tools used for data analysis.

Chapter 5 presents and discusses preliminary results based on descriptive statistics. The implicit goal at this stage was to ascertain whether conclusions could be made based on descriptive analysis pertaining set operational objectives. **Chapter 6** presents and discusses the results based on inferred findings with regards to statistical models used to estimate conjectured hypotheses. The absolute goal at this stage was to confer any obtained relationship with some degree of confidence. **Chapter 7** wraps up the study by presenting the research summary, conclusions, recommendations and areas of further study.

Chapter Two (2)

Literature Review

"An understanding of the socioeconomic value of wetlands is crucial when deciding on conservation and development priorities related to land use ...."

......................Lannas and Turpie (2009)

2.0 Introduction

This chapter reviews literature presented on valuation of environmental goods and services with special reference to wetland cultivation. Concepts reviewed include issues on the best wetland use option sustainable to societies, viability of wetland cultivation and its agronomic potential, potential of wetland cultivation to address household food security and factors influencing households` participation in wetland cultivation. Due to variation in degree of importance put to wetlands by different societies across the globe, the above mentioned concepts were reviewed under the following categorization as follows; Zimbabwean, African and global case studies.

A special section was reserved for review of analytical models used in valuation of natural resources to gain more understanding of various approaches to environmental valuation. The chapter also covers a brief summary of research insights and the current research impasse leading to indications in current research gaps to which this study aims to bridge. The chapter concludes by a logical conceptual framework build from the concept of sustainable development, trying to link household behaviour based on wetland cultivation to sustainable wetland management at household level fully exposing the role of policy in sustainable wetland management.

2.1 Zimbabwean Perspective of Wetland Cultivation

This section focuses on case studies regarding wetland cultivation in Zimbabwe, exposing concepts of ideal wetland use options for societies, viability of wetland cultivation and its agronomic potential, contribution of wetland cultivation to household food security and socio-economic factors influencing participation in wetland cultivation at household level.

2.1.1 Ideal Wetland Use Option for Societies

In an effort to establish the ideal and sustainable wetland use option for rural societies, Rukuni *et al.* (2006) noted that conflicting conclusions regarding wetland cultivation have been forwarded across the globe and from within the same regions, making it difficult for end users to subscribe to any of the available recommendations. Rukuni *et al.* (2006) went on to suggest that cultivation on the *dambo* with indigenous methods[14] was environmentally sustainable, with no possibilities of drying up the *dambo*, or reducing downstream flows[15].

Rukuni *et al.* (2006) argued that since gardens[16] do not consume more water than native vegetation on the *dambos*, an observation by Maclean (2003b), as explained in Chapter 1 section 1.1.2, the water that is not used by the crops flows through to other fields or to a stream below the field as the main reasons why wetland cultivation was sustainable. To that end, Rukuni *et al.* (2006) concluded that, *dambo* cultivation was less damaging, in terms of erosion and water releases than dry-land cultivation of the watershed above the *dambo* and further stressed that impacts on habitat and wildlife appeared to be relatively benign.

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[14] In this study indigenous methods implied no deep drains or mechanical pumps

[15] A view that was conventionally and currently shared in Zimbabwe forming the basis of a legal ban in wetland cultivation as contained in the Natural Resources Act of 1941 and currently maintained in the Environmental Management Act of 2002, and Environmental Management (EIA and Ecosystems Protection) Regulations, Statutory Instrument 7 of 2007.

[16] Gardens comprise the dominant land use style in wetlands in Zimbabwe

Earlier, Makombe *et al*. (2001) had evaluated the potential of *Bani*[17] systems as a smallholder irrigation development strategy in Zimbabwe. From the study, Makombe *et al*. (2001) established that, due to high costs of infrastructure development of conventional irrigation systems and the prevalence of general pessimism based on the current low level of performance of the already existing projects in terms of financial, managerial and environmental objectives, it was imperative to evaluate smallholder irrigation systems under farmer management as an alternative and/or complementary irrigation development strategy. Makombe *et al.* (2001) compared and evaluated the socio-economic characteristics and the technical efficiency of the *Bani* system to the formal systems and made recommendations for its development.

The substance of the whole debate emanated from early conflicting schools of thought regarding compatibility of wetland cultivation and wetland ecology, where on one extreme of these theories existed a general perception linking wetland cultivation to reduced dry season river flow and general flora and fauna degradation of wetlands, (Rattray *et al.,* 1953; Elwell and Davey, 1972; Whitlow, 1985; Owen *et al.,* 1995; Bullock, 1995) as explained in Chapter 1 section 1.13. This perception was widely shared and to a greater extent influenced earlier environmental policies in Zimbabwe that restricted wetland cultivation, a position that is still technically maintained in current Zimbabwean environmental statutes (Rukuni *et al.*, 2006).

This triggered significant research by ecologists in an effort to ascertain the claimed correlation between wetland cultivation and reduction in dry season river flow and general flora and fauna degradation of wetlands. These hydrological studies established that there was no significant link between wetland cultivation and reduced dry season river flow and general degradation as widely believed (Whitlow, 1985; Bullock, 1995; McFarlene, 1995; Owen *et al.,* 1995; McCartney, 2000; Constantin *et al.*, 2003). To accommodate cultivation in wetlands Bell *et al.*, (1987), Bullock, (1995) and Owen *et al.,* (1995) recommended a safe limit of wetland cultivation in the range of 10% of the catchment area or 30% of the *vlei* with a rule of thumb of recommending whichever ratio is smaller as the ideal ecological limit. With those findings, Bullock (1995) and McFarlene, (1995) challenged the existing legal framework calling for a

[17] A Shona name for wetlands as used in Zimbabwe

revision of clauses that banned cultivation of wetlands as explained in Chapter 1 section 1.1.3. To that end available literature on wetland cultivation in Zimbabwe supports partial wetland conversion into crop land as the ideal and sustainable wetland use option for societies.

2.1.2 Viability of Wetland Cultivation and its Agronomic Potential

Efforts to establish viability and agronomic potential of wetlands in Zimbabwe were undertaken by several authorities. Rukuni *et al.* (2006) reports that researchers studying *dambos* in Zimbabwe found that yield per unit of land and water were approximately twice as high as in formal irrigation systems. Similar conclusions were inferred by Makombe *et al*. (2001) who discovered that dry-land cultivation was the main alternative production system of communal smallholders, but was only one tenth as productive as the *dambos*. To that effect Makombe *et al*. (2001) noted that southern African policy makers were rethinking the potential for "wise use" of *dambos* in response to evidence of the economic contributions and benign environmental effects of *dambos*.

From a conceptual point of view, Rukuni *et al.* (2006) and Makombe *et al*. (2001) managed to expose the overall technical and cost efficiency in wetland irrigation to the advantage of rural farmers. Also of importance from the studies was the productivity advantage of wetlands deemed to be around ten times higher than the dry-land cultivation system dominant in rural areas. In other words, there seem to be a significant economic value attached to wetland cultivation, capable of addressing smallholder household food security provided that there is a "wise use" of these wetlands. In support of the agronomic potential and viability of wetland cultivation in Zimbabwe, Muzenda *et al.* (2001) acknowledge that high water table in *vleis* makes multiple plantings of crops possible throughout the year to the advantage of the farmer who can reap multiple yields compared to single yields possible with uplands. Based on available literature from Zimbabwe the agronomic potential of wetlands is high and capable of influencing viability of wetland cultivation as a possible land use option in rural areas.

2.1.3 Contribution of Wetland Cultivation to Household Food Security

Not much has been done towards quantifying the contribution of wetland cultivation to household food security. Based on available limited literature (Thiessen, 1975) on the importance of *dambos* in the agrarian economics of the peasant-farming sector of Zimbabwe, conclude that there was a positive relationship between the area of *dambo* cultivation by individual families and their socioeconomic well-being. Diminutive insights can be drawn implying further studies are required. This research by Thiessen (1975) was one of the earliest studies in the field of wetland cultivation in Zimbabwe, which triggered research in wetland hydrology and degradation in an effort to provide an ecological view point of compatibility of wetland cultivation to wetland ecology as explained in section 2.1.1.

2.1.4 Socio-economic Factors Influencing Households` Participation in Wetland Cultivation

Not much has been done towards exploring socio-economic factors that influence households` participation specifically in wetland cultivation in Zimbabwe. However, a few limited studies have also been done on factors that influence households` decision to participate in conservation programmes of natural resources. In this section, such studies were used as proxy literature capable of giving insights on how household characteristics are capable of influencing behaviour of society on utilization of natural resources. A study by Muchapondwa (2003) on assessing the potential of local communities to manage wildlife in Zimbabwe, noted that younger and highly educated household heads were more likely to view local wildlife management as a public bad. The implied message from this study has implications on careful articulation of policy crafting for mixed perceptions may dominate societies, making it difficulty to propose blanket recommendations. With this limited literature, a need therefore arises to investigate socio-economic factors that influence households` participation in wetland cultivation at country level to give an insight on society`s perceptions in as far as wetland cultivation is concerned.

2.1.5 Insights from Literature

There is a wide consensus based on case studies from Zimbabwe (Rukuni *et al*., 2006 and Makombe *et al.,* 2001) on the fact that there is a significant agronomic potential and possibly viability of wetland cultivation in rural areas. The claimed economic value attached to wetland cultivation however; seems to have been based on explicit[18] costing without taking cognizance of implicit costs[19] in the name of opportunity cost of wetland cultivation to societies, so as to come to a correct value of wetland cultivation as a preferred economic land use in wetlands.

Also, the real significance or contribution of this economic value to household food security remains unclear and over generalised. The available single study by Thiessen (1975) over generalized this relationship and further assumed that since an economic premise was confirmed the link was so obvious as it were to conclude that wetland cultivation has a significant contribution to the border welfare economics of society. More detailed studies are therefore required to investigate the relationship between wetland cultivation and household food security towards appraising wetland cultivation as a possible land use option to rural communities. Of interest is also the fact that no single study from Zimbabwe attempted to explore socio-economic factors that influence participation of households in wetland cultivation for purposes of understanding society`s perceptions regarding wetland cultivation. This presents a gap in literature that can cause policy failure in the event of crafting wetland cultivation devolution user rights to communities significantly capable of causing errors of commission and omission in policy formulation.

2.2 African Perspective of Wetland Cultivation

In this section, the African perception of wetland cultivation is explored. Frantic efforts were made to establish the ideal, viable and sustainable wetland use option, contribution of wetland cultivation to household food security and socio-economic factors influencing participation in

[18] Direct costs that a firm is contracted to pay such as wages, rates and production inputs

[19] Costs that the resources could earn in their next best alternative use

wetland cultivation by African societies based on case studies drawn from different African countries with a special bias to southern and central African countries close to Zimbabwe.

2.2.1 Ideal Wetland Use Option for Societies and Viability of Wetland Cultivation

Many studies relevant to viability and ideal wetland use options to societies have been carried out as can be noted from the following case studies. Barbier *et al*. (1993) conducted a partial valuation of competing wetland use options in the *Hadejia* – *Jama* floodplains in northern Nigeria. The rationale of the study was to assess the economic importance of the *Hadejia-Nguru* wetlands with the sole objective of investigating the opportunity cost to Nigeria of its loss. By estimating some of the key direct use values wetlands provide to local people through exploitation of these resources (crop production, fuel-wood and fishing), Barbier *et al*. (1993) were able to quantify the value people attach to the wetland.

Downstream wetland area was under threat from an upstream irrigation project. Using a partial valuation approach, Barbier *et al*. (1993) showed that floodplain agricultural, fishing and fuel-wood's net benefits were much more substantial than the net benefits of an upstream irrigation project, which was diverting water from the wetlands. Barbier *et al*. (1993) estimated that net present value of agricultural, fishing and fuel-wood benefits from the wetlands was N253 to 381 (US$ 34 to 51) per hectare (in 1989/90 prices), while the net present value of benefits from diverting stream-flow to the irrigation project were only N153 to 233 (US$ 20 to 31) per hectare. Barbier *et al*. (1993) concluded that the economic importance of wetlands means that there will be an economic loss (an opportunity cost) associated with any scheme that leads to degradation of the floodplain system, for example by diverting water away from floodplain system.

In this study, Barbier *et al*. (1993) presents a typical example that clearly indicates the value society is willing to place on wetland cultivation and utilization. The study combines wetland cultivation to other wetland resource flow benefits (fuel-wood and fishing) making it different from this research study. From an analytical point of view, net present value (NPV) of the two competing land use options seem to have been calculated using explicit costs only. Imputing the implicit costs in the model could have been more appropriate, in bringing the real economic value of these land use options. Nevertheless, including the opportunity cost will simply reduce the value but not change existing standpoints. If wetland cultivation and other resource flow benefits to society can outweigh benefits of a planned irrigation project, wetland cultivation can play a significant role in rural peasant agriculture, sometimes worth exploring as supported by case studies from Zimbabwe.

Based on a study in Madagascar on evaluating tropical forests, Kramer *et al*. (1994) noted that development projects in which large forest areas are protected or converted to other land uses, such as agriculture or grazing for livestock, have often failed to take into account the impacts on people with traditional rights to forests. In this study, Kramer *et al*. (1994) focused on environmental valuation of forest development and conservation projects attempting to answer questions such as: Is the value of a park with a buffer zone greater than one without? What is the appropriate level of compensation for local people who are unable to continue their forest extraction activities because of a reserve? How much are foreign tourists willing to pay to visit national parks in developing countries?

The objective was to adapt several valuation methods for use in economic analysis of a conservation project, in particular, to examine the use of several valuation tools for assessing the benefits and costs of establishing a new national park. Results suggested that an annual compensation of approximately US$100 per household was required where such compensation could be made in the form of education, health facilities, and alternative income-earning enterprises in the buffer zone or other development activities. These compensation costs appeared to be a significant part of the true cost of implementing protected area projects and should be built into project design at an early stage. Kramer *et al*. (1994) concluded that without adequate compensation and active cooperation of local residents, natural resource management projects were most likely to fail. The study brings in the idea of sustainable development where developmental projects should not be considered based on their environmental benefits alone, but rather on economic, social and environmental merits.

Seyam *et al*. (2001) conducted a simple and rapid approach analysis towards valuation of the Zambezi wetlands in southern Africa. The objective of the research was to apply a simple approach to valuing wetlands at a river basin scale level. The approach took into account the frequent problem of limited data availability and allowed a rapid assessment of wetland values. For each wetland considered in the study, an inventory of production and information functions was made. The marginal values of products from floodplain subsistence agriculture were estimated based on the average production value of both rice and maize, which represented the main crops in terms of area cropped. Using the exchange rate of 1990 (37 ZK = 1 USD), the average production value of both crops was estimated at 214 USD/ha/year.

Seyam *et al*. (2001) concluded that flood recession agriculture was the main contributor to the total economic value of wetlands in the Zambezi basin. Seyam *et al*. (2001) further acknowledged that total use value of the 10 wetlands was 145 million USD/year equivalent to 4,7% of Zambia's GDP in 1990 which was US$3120 million. With flood recession agriculture as the main contributor to the total economic value of wetlands in the Zambezi basin and this value being equivalent to 4,7% of Zambia's GDP as at 1990 prices, this shows a significant contribution of wetlands cultivation that warrants further investigations at country level.

Maclean *et al*. (2003a) undertook an economic valuation of goods derived from papyrus swamps in southwest Uganda. Uganda wetlands had undergone considerable decline over the last thirty years as a result of clearance for agriculture and over – use of wetlands resources. The case of Uganda is typical of marginal areas of southern African countries, where rainfall is very erratic and poorly distributed across the season. Soils are typically sand from granite rock inherently poor and crop production is risky. Wetlands are also available in these areas with Zimbabwe having a total of 262 000 hectares of wetland in its communal areas (Mharapara, 1995). In this study Maclean *et al*. (2003a) examined the effects of papyrus harvesting and swamp reclamation on the net present value (NPV) of papyrus fringing "Lake *Bunyonyi"* in southwest Uganda. The value of harvested papyrus, crops and fish obtained from the swamps were modelled in relation to swamp area, using a production function approach. Parameter values were estimated from interview data. Results indicated that the net present value (NPV) of swamps was maximized when between 27-33% of the swamp was utilized for harvesting, but when optimal cultivation levels were less than 2%. Maclean *et al.* (2003a) acknowledged that Ugandan wetlands were under severe threat as a result of intensive pressure to convert them or over-use their resources, often under the premise that this benefits local people. However, results from this study differ greatly to the general norm; instead results indicated that conserving significant proportions of the swamp maximized its net present value (NPV). These findings lend support to the premise that conserving biodiversity has an economic basis.

The same views were recently echoed by Lannas and Turpie (2009) based on a study to evaluate the provisioning services of wetlands in Lesotho and South Africa. The objective of the study was to describe and compare the use and values of the provisioning services of the two wetlands and their possible contribution to livelihoods of surrounding communities. Lannas and Turpie, (2009) noted that the main use of the wetlands by both communities was for grazing. Other provisioning services like wildlife hunting and cultivation were minor and did not generate significant income to households (Lannas and Turpie, 2009). These findings are however not new in the literature, Beadle, (1981) postulated significant drops in wetland yields further casting a bleak future on the agronomic potential of wetlands as an ideal land use option in rural areas.

2.2.2 Contribution of Wetland Cultivation to Household Food Security

Umoh (2008) undertook a study of evaluating contribution of wetland farming to household food security in Nigeria. The author noted that farmers cultivate wetlands to satisfy household food need and for the sale of produce to supplement their incomes. Umoh (2008) established that wetland farming contributed more than 56% of total food supply to the household compared to 33% from uplands implying that wetland cultivation was important in achieving household and indeed national food security of Nigeria. Similar conclusions were shared by Kambewa (2005), who noted that wetland cultivation was very important for people`s livelihoods based on a study to evaluate access to and monopoly over wetlands in Malawi. These studies share the same conclusion as Thiessen (1975) that was conducted in Zimbabwe; however more studies are required from different rural settings to substantiate the potential of wetland cultivation to address household food security.

2.2.3 Socio-economic Factors Influencing Households` Participation in Wetland Cultivation

Zidana *et al*. (2007) undertook a case study to establish factors influencing cultivation of the Lilongwe and Linthipe river basins in Malawi. Using logit analysis, Zidana *et al.* (2007) concluded that household size, main occupation, education, market availability and land holding size were important parameters in influencing farmers to engage in river bank cultivation. Kapanda *et al.* (2005) also evaluated factors affecting adoption of fish farming in wetlands in Malawi and noted that household head gender had a negative influence, while household head age and livestock ownership had a positive influence on adoption rate by respondents. This area of study is new in literature implying more studies might be required at country level to assist policy crafting.

2.2.4 Insights from Literature

Barbier *et al*. (1993), Seyam *et al*. (2001) and Kramer *et al*. (1994) agree on an economic premise for wetland cultivation as a viable land use option ideal for societies. This was in support of results from case studies conducted in Zimbabwe, although based on explicit costing. Contrary to the widely shared conclusion, Beadle (1981) doubted sustainability of wetland cultivation based on the feared loss of nutritional status of wetland soils. Further casting a bleak future for wetland cultivation, Maclean *et al*. (2003a) discovered a positive relationship in pure wetland conservation than in cultivation based on a case study conducted in "Lake *Bunyonyi"* in southwest Uganda. Similar conclusions were also noted by Lannas and Turpie (2009) who discovered that wetland cultivation did not significantly contribute towards livelihoods of communities.

Conflicting conclusions, as noted by Rukuni *et al.* (2006), therefore dominate the issue of wetland cultivation in Africa where on one extreme authorities agree on partial wetland conversion into crop land as the ideal, sustainable and viable wetland use for societies while on the other extreme authorities call for pure wetland conservation. Based on available limited literature, the meaning of the economic premise inferred by authorities who support partial wetland conversion was further linked to household food security by Umoh (2008) and Kambewa (2005). They noted a significant contribution of wetland cultivation to the broader welfare economics of rural societies. A detailed analysis of this relationship was also pursued by Seyam *et al*. (2001) linking this value to Zambia's GDP[20].

A new dimension of assessing socio-economic factors that influence participation of households in wetland cultivation was introduced by Kapanda *et al.* (2005) and Zidana *et al*. (2007). It is worth pursuing at country level to establish society`s perceptions in as far as wetland cultivation is concerned. Conflicting recommendations in as far as viability and ideal wetland use options at rural levels is concerned, provides a research impasse indicating a significant gap in the literature. Limited literature on the contribution of wetland cultivation to household food security and socio-economic factors influencing wetland cultivation at household level further presents gaps in literature of wetland cultivation economics. The holistic implication is confusion to end users (policy makers and society) who fail and become hesitant to subscribe to any forwarded recommendations (Rukuni *et al.*, 2006).

2.3 Perceptions on Wetland Cultivation at a Global Glance

This section brings in the global perception on wetland cultivation towards understanding how other societies value wetland cultivation. Case studies on ideal wetland use option and the potential viability of wetland cultivation were considered. Socio-economic factors capable of influencing wetland cultivation were also reviewed in this section.

2.3.1 Wetland Use Option for Societies and Viability of Wetland Cultivation

Baltezore *et al.* (1989) undertook an economic analysis of draining wetlands in Kidder County, North Dakota. Baltezore *et al*. (1989) acknowledged that wetland drainage was a highly controversial issue especially in the United States, appreciating the fact that wetland drainage was often a rational decision by individual landowners, though it could involve external costs to

[20] Gross Domestic Product

society that exceeded landowners` benefits. The purpose of the study was to estimate the potential profitability of draining wetlands for agricultural production under various cost/price situations. Using a linear programming model, Baltezore *et al*. (1989) analyzed variations in net revenues across a range of avoidance[21] and drainage costs. Other variables incorporated in the analysis were production costs, field productivity levels, and commodity prices. Using three agricultural commodity price options for wheat and barley including historic country average, August 1987 forward contract, and government target prices, the authors analyzed the profitability of wetland cultivation. The analysis was based on a short - and long-run farm-level planning horizons.

Baltezore *et al*. (1989) concluded that factors affecting drainage returns were drainage costs, expected crop production expenses, yields and prices, which were different for each wetland. With that in mind drainage decisions, according to the authors, were supposed to be made on a wetland-by-wetland basis, implying that there was no room for generalizing about the profitability of converting wetlands to cropland because each wetland has a different return to drainage. With special reference to wetlands in Kidder Country, North Dakota, revenues generated from short-run, long-run and no-drainage cost alternatives showed that if a farmer does not amortize or spread his drainage costs for the given year over five years, he would appear better off not draining. However, extending the analysis for the short-run drainage cost alternative over more than one year may lead to positive net returns. Wheat production was profitable assuming amortized and no-drainage cost alternatives; however, barley revenues still did not recover both production expenses and drainage costs, suggesting that drainage was profitable if only wheat was grown. This conclusion is almost similar to results presented by Ralph *et al.* (1998), stressing that there were several factors that determined the profitability of wetland cultivation.

Ralph *et al*. (1998) estimated the potential of wetland conversion for crop production and the associated economic consequences in United States of America. Using data on wetland hydrology and potential agricultural productivity for nearly 50 000 wetland sample points

[21] Avoidance costs in this research were the added expense of farming around wetlands.

aggregated to make regional and national estimates of wetland area, the authors modeled the data in an effort to delineate area that could be profitably drained for crop production. Ralph *et al*. (1998) claimed that the site-specific data they used allowed them to draw regional and national conclusions based on potential agricultural productivity of a representative sample of actual wetlands rather than using country average productivity or other assumptions that may obscure important variations in resource quality.

Using two extreme possibilities the authors estimated the area that could be converted to agriculture on the extreme high conversion and extreme low conversion scenarios. The decision of wetland conversion based on this study was coined on the expected profits from the conversion, which Ralph *et al*. (1998) calculated as expected value of returns from conversion, assuming no feedback effects on prices and costs from increased production due to the wetland conversion would occur. Ralph *et al*. (1998) concluded that the economic effect of wetland conversion on the farm sector depends on how much area is converted, type of crops planted and the prices on offer to farmers from the product market. Ralph *et al*. (1998) noted a scenario where a fall in market prices would send signals to producers to reduce area under production and *vice versa*. On the extreme high conversion case, wetland conversion to crop production was found to be profitable on an estimated 13,2 million acres.

Simonit *et al.* (2005) undertook an economic modelling of the hydrological externalities of agriculture in wetlands in *Esteros del Iber`a*, Argentina. This study considered the hydrological externalities of agricultural production in one freshwater wetland: the *Esteros del Iber`a* (the wetlands of *Iber`a*) in north-eastern Argentina. In particular, the study develops a model of rice production that incorporated the hydrological services provided by the wetland, and controls for the hydrological effects of other significant economic developments in the region. Results indicated a strong two-way interaction between economic and natural processes. Expansion of rice production within certain ‘in-wetland’ districts (such as Mercedes) positively feeds back into the growth of the wetland, whilst expansion of production in other districts (such as San Martin and Santo Tom`e) had the opposite effect.

Kaechele (2005) evaluated a multifunctional wetland system of the conflict between farmers and nature conservationists in the lower Odra Valley National Park, in Germany. The author noted that the establishment of expansive nature conservation areas was among the most important measures for maintaining bio-diversity. Kaechele (2005) acknowledged that, of late, these areas have increasingly been established in agrarian regions, leading to conflicts between farmers and nature conservationists. In the context of the, Lower Odra Valley National Park an economic approach for achieving a comprehensive understanding of the divergent objectives of participants was introduced. Calculations were made with support of the MODAM modeling system (Multiple Objective Decision Support Tool for Agro-ecosystem Management).

The conflict between farmer and natural conservationist stakeholder groups in the Lower Odra Valley National Park was used as a case study in order to highlight a possible methodological approach that makes the conflict more transparent. Kaechele (2005) noted that the existing conflict traces back to a land use concept submitted by the National Park, which shall be referred to as “nature conservation” scenario in this review. In pursuit of the IUCN provisions, nature conservationists wanted to set aside substantial amounts of farmland and restricted land use for the remaining area. Kaechele (2005) noted that the concept was in line with the requirements of maintaining bio-diversity but did not take into account the farmers` concerns leading to a conflict of interests.

This conflict also exists in the Zimbabwean context where the latest statutes that govern natural resources empower the Minister of Environment and Tourism in subsection (1) of section 113 of the Environmental Management Act to declare any wetland to be an ecologically sensitive area and to impose limitations on development in or around such area. Following this scenario, Kaechele (2005) noted that, 42 farmers lost up to 50% of their land and on average the loss of farmland summed up to seven percent or 27 ha per farm. On the other hand, farmers were interested in a solution that warranted a minimum standard of bio-diversity conservation, but providing as much income as possible.

Farmers` vision of the lower Odra region therefore differs extremely from what nature conservationists preferred. The income effects were measured by the loss of gross margin of individual farms and aggregated all farms to create the Total Gross Margin (TGM) loss. MODAM was used for the analysis of interdependencies between economic and ecological objectives in agricultural land use in this case-study. Several scenarios of various national park concepts were analyzed. A nature conservationist-defined scenario resulted in an income loss 2.5 times greater than the compensation payment amount available. While a farmer-favoured scenario resulted in an income loss considerably less than the subsidy limits. Kaechele (2005) concluded that establishment of nature conservation areas does not automatically increase the demand for public funds, but requires a skilful reallocation of the existing funds for agro-ecological programs. Ideally, this could lead to win-win solutions for all the stakeholders involved.

Hanley and Craig (1991) conducted a partial valuation of alternative uses of peat bog in Northern Scotland. Unique plants forming a significant habitat for birds dominated the 400 000 hectares of wetland area. The area has also been subjected to conversion from its natural state to planting of pines and spruce in block plantations. This scenario is very common to rural wetlands in Zimbabwe, where a bulk of these pieces of land have been subjected to cultivation in pursuit of high moisture content and rich organic matter endemic to these soils (Ellis-Jones and Mudhara, 1995; Mutambikwa *et al.*, 2000).

The overall impact of the conversion in this case study, according to Hanley and Craig (1991), has been increased sedimentation and erosion, disruption of water and soil regimes as well as habitat disturbance. However, the authors seem to have over generalized and used convectional knowledge to conclude these environmental degradation issues as being caused by this conversion. In total contrast to this school of thought, Whitlow (1985), Rukuni *et al.* (2006), Bullock (1995), McFarlene (1995), Owen *et al*. (1995) and Mutambikwa *et al*. (2000) in the Zimbabwean context noted that wetland cultivation has no significant link to its degradation, as generally preserved and traditionally purported in various literature.

In an effort to assess the tradeoffs between the competing land uses, Hanley and Craig (1991) conducted a partial analysis to compare the alternative of conserving the peat bog area in its natural state against converting it to block plantations. Wetland cultivation can be viewed as a competing land use option proxy to block plantations in this case. Obviously, trade-offs exist between the two competing land use options (conserving wetlands in their natural state against converting them to crop land).

Hanley and Craig (1991) calculated the net benefits of tree planting by determining the profits from an infinite cutting and replanting rotation. Gross revenues from each clear-felling amounted to GB£5 921 (US$ 10 517) per hectare (1990 prices), and these were then combined with initial establishment and replanting costs at a 6% discount rate. The resultant net present value was negative, at minus GB£895 (US$ 1 590) per hectare, implying that without external (government) support to the plantation project there would be no economic motivation in planting trees as a commercial venture, before even factoring in the opportunity cost attached to conversion. Revenues from horticulture produce can be calculated using the gross margin model and projected to a five or ten year period then discounted to capture the net present value in the case of wetland cultivation.

Hanley and Craig (1991) concluded that conserving the wetland in its natural state was indisputably the preferred land use option. For purposes of clarity, the authors calculated the benefits of maintaining the wetland in its present state to reinforce the conclusion that conserving the area was optimal using a contingent valuation survey. The contingent valuation survey used was aimed at assessing regional residents' willingness-to-pay for conserving the area by asking whether they would be willing to contribute a one-time amount to a trust fund established to conserve the area. As there is always a natural bias by residents within the vicinity of a wetland area to forward arguments in favour of their immediate benefits at the expense of benefits accruing to distance society, using a contingent valuation survey that caters for regional residents was more of a noble idea by the authors to overcome this natural bias. However, the only practical limitation of this approach would be its use in developing countries to which Zimbabwe is included, where environmental importance is still undervalued because society normally places such valuation as inconsequential to them.

Mean willingness-to-pay in this study was estimated at GB£16,79 (US$ 30) per household. By extrapolating the average willingness-to-pay over the entire regional population, and expressing this on a per hectare basis, the net present value of conserving the area was estimated to be GB£327 (US$ 580) per hectare, contrasting with the negative figure of minus GB£895 (US$ 1590) per hectare calculated for converting peat bog areas to block plantations. By adding the opportunity cost as a cost to conversion so as to give the full economic picture of the costs of resorting to plantations, the authors` new net present value of converting the area to plantations was negative £1222 (US$ 2170) per hectare. Hanley and Craig (1991) seem to have assumed that by converting the peat bog area to a plantation area could mean total deprivation of all environmental goods and services that are normally available under an undisturbed situation. This is however an extreme scenario, which could exaggerate the opportunity-cost of conversion there-by leading to a wrong conclusion. Although a negative net present value was recorded for the plantation option, such an exaggeration would send a wrong signal to future studies in favour of the conservation approach at the expense of conversion.

2.3.2 Socio-economic Factors Influencing Households` Participation in Wetland Cultivation

Siribuit *et al.* (2008), based on a study of socio-economic conditions affecting small farmers` management of wetlands in Thailand, noted that education of household head, amount of livestock and income from wetland products had a positive influence to households` participation in wetland resource management activities.

2.3.3 Insights from Literature

Two schools of thoughts emerge from the global perspective contrasting to the generally agreed premise from African countries. On one extreme, pure wetland conservation is the agreed economic wetland use option. This conclusion is also shared by some authorities based on case studies from Africa, (Maclean *et al.,* 2003a; Lannas and Turpie, 2009). On the other extreme, several authors agree that there is no hard and fast conclusion on economic value of pure wetland conservation or wetland cultivation but more of wetland situation based conclusion. No similar conclusions were inferred from Africa, implying a new dimension worth exploring from an African perspective. Limited literature still dominates areas of contribution of wetland cultivation to household food security and socio-economic factors influencing participation in wetland cultivation at household level.

2.4 The Assessment Framework for Economic Valuation of Wetlands

Economic valuation can be defined loosely as an attempt to assign quantitative values to goods and services provided by environmental resources, whether or not prices are available (Barbier *et al*., 1996). The same authors went on to suggest that in economic principles, economic value of any good or service is generally measured in terms of what society is willing to pay for the commodity, less what it cost to supply it. Under a scenario where environmental resources simply exist, providing society with products and services at no cost, the willingness to pay alone gives the true value of that product or services whether or not society makes any payment at all (Barbier *et al*., 1996). Barbier *et al*. (1996), suggested a three-stage process of evaluating wetlands as a true "economic assessment" of wetland values. The authors emphasized the reflection of the true 'willingness to pay' by society to wetland benefits. This valuation process, according to Barbier *et al*. (1996), involves three stages of analysis as follows;

- ***Stage 1****:* In stage one, the core intention would be to define the problem in question and choosing the correct economic assessment approach.
- ***Stage 2***: Stage two entails defining the scope and limits of the analysis and the information required for the chosen assessment approach.
- ***Stage 3***: The last stage would be to zero-in on defining data collection methods and valuation techniques required for economic appraisal, including any analysis of distributional impacts.

These stages are similar to the approach proposed by International Institute for Environment and Development (IIED) in 1994. IIED (1994) further suggests that three expansive categories of issues are of relevance to the economic analysis of wetlands. In this study, the partial valuation approach was used as explained in section 2.4.1.

2.4.1 Partial Valuation

Under partial valuation, assessment of two or more alternative wetland use options will be the primary objective. Examples under this scenario includes; whether to divert water from the wetlands for other uses or to convert/develop part of the wetlands at the expense of other uses. In this study, partial valuation approach was used to assess the economic value of converting wetlands to cropping land. Barbier *et al*. (1996) suggests that once the system and analytical boundaries are defined, further analysis is needed to determine the basic characteristics of the wetland being assessed with the main objective of 'valuing' these characteristics. Figure 2.1 summaries the categorization of wetland uses when translating the characteristics of wetlands into economic terms.

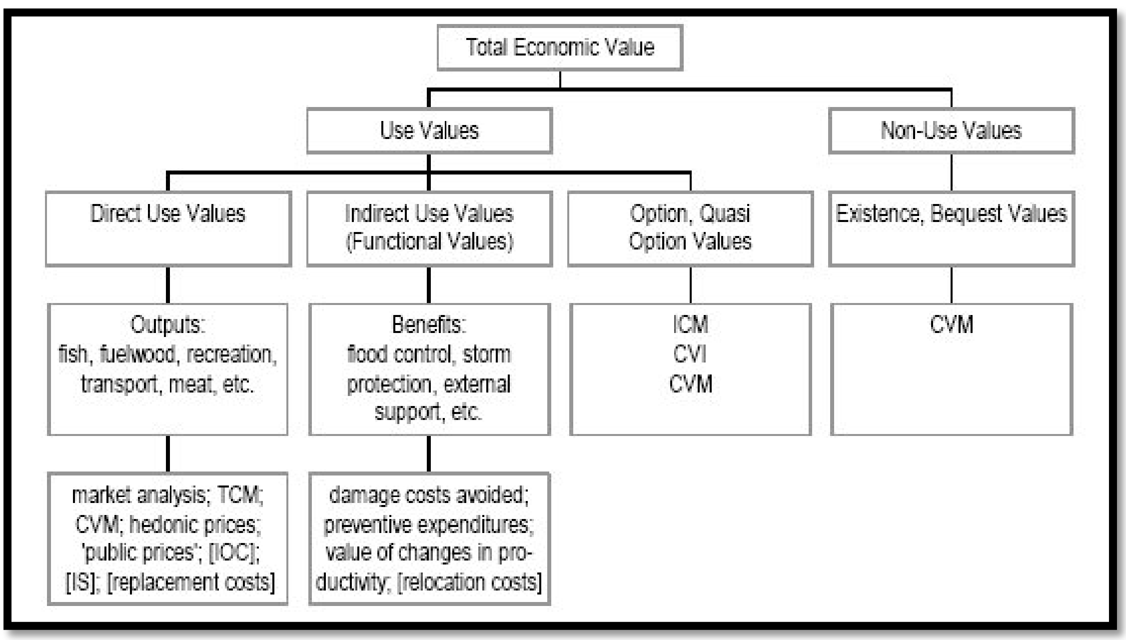


Figure 2.1: Wetland Valuation Techniques

Source: Barbier (1989)

The next step will be to determine the type of value connected with each of the wetland system's structural components, functions and attributes. Barbier (1989) suggests categorization based on "direct use" values (the values derived from direct use or interaction with a wetland's resources and services); "indirect use" values (the indirect support and protection provided to economic activity and property by the wetland's natural functions, or regulatory 'environmental' services); and "non-use" values (values that are not derived from current direct or indirect uses of the wetlands).

For the direct user values of wetlands in this case wetland cultivation products, market analysis was recommended as a proxy measure to investigate the economic value of wetland cultivation (Barbier, 1989). This is possible through calculating the gross margin budgets of wetland cultivated crops and the net present value of wetland cultivation. Maclean *et al*. (2003a) used the same approach based on an economic valuation of goods derived from papyrus swamps in southwest Uganda as explained in section 2.3.1.

2.5 Research Impasse and Current Gaps in Literature

Wetland economics presents a widely contested area in as far as its best land use option to society is concerned. Conflicting conclusions have been forwarded as noted by Rukuni *et al.* (2006). A number of authorities share the conclusion that pure wetland conservation is the best economic land use option for rural communities amid an equal share of authorities who subscribe to the notion of converting some portion of wetlands to cropland. A conservative school of thought also exists where authorities in this category share the view that there is no hard and fast conclusion but rather a case-by-case analysis of wetlands since wetlands are heterogeneous. Price fluctuations of specific wetland cultivated crops were also noted as critical in determining profitability of wetland cultivation.

The available economic body of evidence on the economics of wetland cultivation is not conclusive, hence not user friendly to recipients who comprise policy makers and society. Amid these conflicting conclusions, policy makers in Zimbabwe have been hesitant to lift a ban on wetland cultivation, despite an ecological compatibility premise inferred by ecologists. On the other hand, rural communities still claim a significant economic value in wetland cultivation as the main reason why they continue to cultivate wetlands when statutes restrict such activities. From a policy realm, in the event of transfer of wetland cultivation user rights to households, a clear picture of factors influencing participation in wetland cultivation is critical. Ideally, understanding the influence of various household socio-economic factors on participation in wetland cultivation at household level becomes the first necessary entry point. This is critical for purposes of targeting, for awareness campaigns or devolution of user rights for wetlands are scarce in relation to populations in rural areas. This study therefore seeks to bridge the current gaps through appraising viability of wetland cultivation and linking the claimed value in wetland cultivation to household food security. For policy guidance the study further explores the factors that influence participation in wetland cultivation at household level.

2.6 Conceptual Framework

In this conceptual framework, a scenario where the free forces of supply and demand are too weak to influence allocation and utilization of wetlands to society is modelled. The concept of market failure is appreciated as a practical reality especially in wetlands, since they exhibit low excludability and high rivalry elements. No rights exist that can avoid an individual from using wetlands and also use by individuals affects use by others. These are critical elements of common pool resources. Classical economics postulates that the best way to allocate these resources is through the collective action since they are external to the price mechanism, mainly caused by the excludability and rivalry nature of common pool resources in this case wetlands.

Collective action in the name of policy becomes the ideal pathway to be followed towards allocation and use of wetlands. Government plays a critical role at this stage, as the legitimate body entrusted by society to craft polices in the event of a market failure as witnessed in wetland utilization. The concept of sustainable development remains the ideal conceptual model to be consulted in crafting a sustainable wetland utilization policy. The conceptual framework modelled in this study presents two possible pathways a government can follow towards drafting a wetland policy and the resultant effect to status of wetlands. The voice of society is modelled alongside the participatory approach, as the key driver of policy drafts capable of serving the status of wetlands.

The idea of sustainable development grew from numerous environmental movements in earlier decades and was defined in 1987 by the World Commission on Environment and Development (*Brundtland Commission, 1987*) as:

> *"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*.

In wetland economics the sustainable development concept would imply that; sustainable wetland management follows a pathway that meets the needs of present generations without compromising the ability of future generations to meet their own needs. This entails a threesome approach where the three pillars of sustainable development are fully justified in an accommodative manner which filters synergistic effects back to the core pillars of ecological integrity of wetland as the environmental base; society as the residents of the environment and economics as activities to be introduced by society (wetland cultivation) in the environment (wetland area) to provide goods and services for current societies without compromising the future needs of upcoming societies from the same environment (wetland).

Presented with such a dilemma to allocate and use wetlands, a government can consider a conceptual framework with two pathways to follow as shown in the conceptual framework (Figure 2.2). The model accepts that utilization of wetlands is a policy issue that requires a government to craft a policy. The model`s role is therefore to present possible pathways and their effects to society and status of wetlands. A rational (sustainable) pathway entails consulting the three pillars of sustainable development through engaging each pillar as follows;

Social pillar: Society should be involved in defining the scope of wetland management in a participatory approach from problem identification through policy crafting to policy implementation. The process should also further empower societies to make decisions on how wetland management should be done, for they are the ones who will be using the resource. Socio-economic factors that surround participation in wetland cultivation should also be investigated since they give direction and guidelines towards crafting wetland cultivation devolution user rights.

Ecological pillar: Ecological models should give scale of utilization which falls within the compatibility levels so as to maintain wetland ecosystems functioning when ever cultivation is introduced. Minimum and maximum cultivation threshold should be clearly defined to give guidelines on how to utilize wetlands.

Economic pillar: Economics of wetland cultivation should also give directions on profitability of various wetland cultivated crops and its contribution to the broader welfare economics of society. Profitability of wetland cultivation based on set ecological thresholds in terms of areas deemed compatible is critical.

An environmental policy that respects the above pillars is deemed sustainable and is likely to be supported by society since society feels they were consulted and the policy they are receiving is a result of their ideas not mere policies imposed on them. In essence, society`s marginal utility is increased, which the conceptual framework model postulates to send a strong signal towards conservation of wetlands by the same society. Societies are likely to guard wetlands using local conservation structures without external monitoring by government agencies further cutting government expenditure, because the policy is a creation of society`s ideas. Ownership elements created through participatory policy crafting are conjectured to change attitudes of societies that are skewed in favour of conservation of wetlands, a critical element that defines the current and future status of wetlands of a nation, capable of making wetlands meet the needs of current generations without compromising the ability of future generations to meet their own needs.

Conceptual Framework

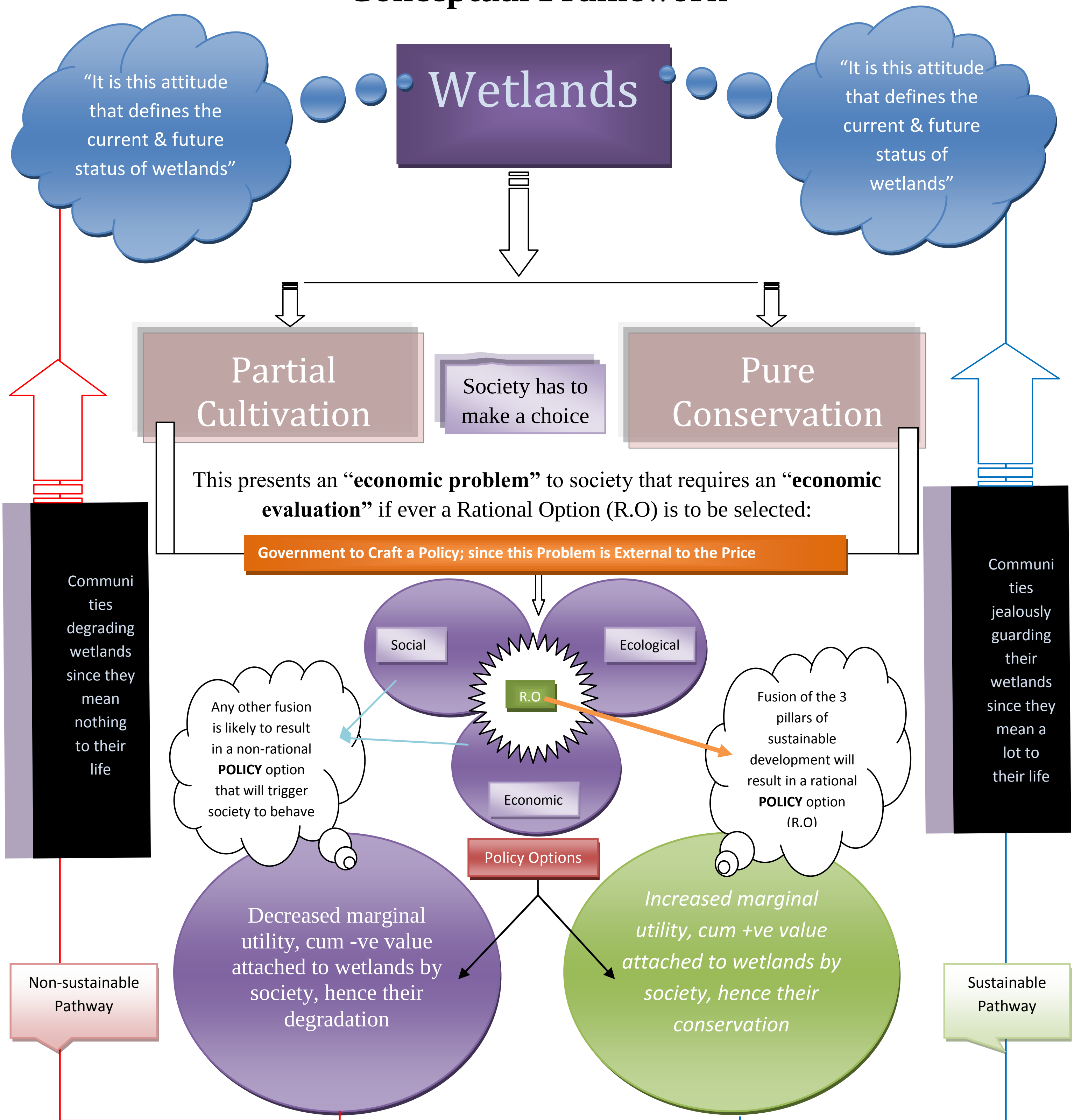


Figure 2.2: Conceptual Framework *Source: Modified from the Sustainable Development Concept by Brandtland Commission (1987)*

Closely related to the sustainable pathway exists three lucrative possibilities a government may be tempted to pursue as shown in Figure 2.3.

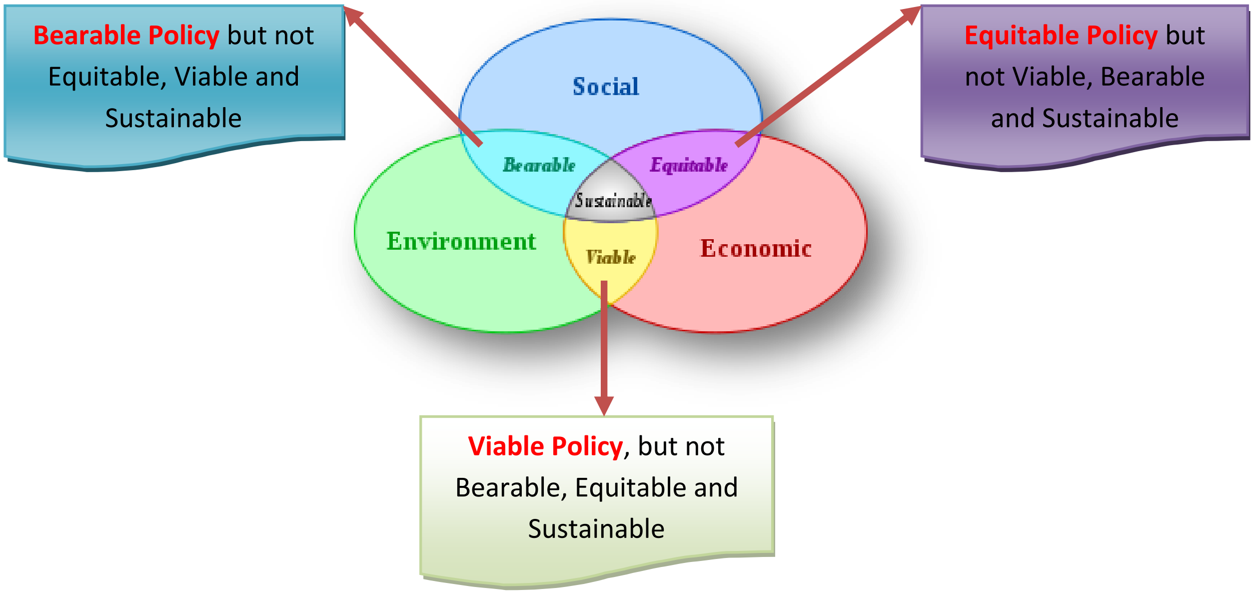


Figure 2.3: Non-rational Policy Options

Source: Modified from the Sustainable Development Concept by Brandtland Commission (1987)

(a) ***Bearable policy*** entails a policy crafted and based on balancing environmental and social aspects of sustainable development. This choice is not equitable, viable and sustainable. Ideally, it falls in the non rational pathway.

(b) ***A viable policy*** is also possible mainly based on environmental and economic aspects of the sustainable development concept. Although viable the policy is not bearable, equitable and sustainable, again it falls into the non-rational pathway.

(c) Lastly, ***an equitable policy*** can be considered based on fusing social and economic aspects of the sustainable development concept. The danger of this policy is that it is not viable, bearable and sustainable.

All these policy options including extreme considerations[22] fall in the non-rational (non-sustainable) pathway. Net effect of these pathways provides policies with errors of commission and omission, lacking sustainability. As a result, the policy bears little social desirability, environmental compatibility and economic rationale. The conceptual framework model postulates that this scenario sends a decreased marginal utility to wetlands from society culminating in a low if not negative value attached to wetlands by society hence their degradation. This behaviour changes the attitude of society to a situation where society sees wetlands as valueless natural resources with little relevance to humanity. This attitude is likely to define the current and future status of wetlands of a nation in a non-sustainable way, which compromises the needs of the current generations and further compromises the ability of future generations to meet their needs from the same wetlands.

With full understanding of complications in policy crafting and several dimensions and approaches used, this study offers a user friendly policy crafting approach based on sustainable development concept, where three critical pillars of sustainable development interact to give a sustainable development pathway. The conceptual framework clearly shows the need for a compromise if ever a sustainable pathway is to be followed, where a policy should not be purely defined along ecological, economic or social principles, but rather a balance of the three pillars. In this study, the economic pillar is investigated towards adding economic knowledge of wetland cultivation to policy formulators.

2.7 Chapter Summary

Studies reviewed indicated conflicting recommendations with regards to wetland cultivation as a possible land use in rural areas. Also not much has been done towards appraising the actual contribution of wetland cultivation to household food security. The same is true to socio-economic factors influencing participation of households in wetland cultivation. To that effect available literature remains insufficient and non - user friendly to policy makers and society, a possible reason for the current legal – operational impasse in Zimbabwe. The use of sustainable

[22] A policy based on purely environmental, social or economic principles

development models in evaluating wetland use options seem also to have been neglected significantly contributing to the current conflict, given that the available recommendations lack the accommodative approach critical for sustainable development. In essence, more country specific studies are required to explore the economics of wetland cultivation, from viability via welfare implications to possible crafting of transfer user rights from a policy perspective.

Chapter Three (3):

Description of Study Area

"...................13% of Southern African Development Community (SADC) is made up of wetlands, the bulk of which is found in areas inhabited by approximately 60% of the population"

............................IUCN (1994)

3.0 Introduction

In this chapter, a detailed review of the geographical location of the study area is presented as a road map to the study area starting with the country location map, to the provincial location map and specific districts within Mashonaland East Province specifically those districts to which this study was done. Figure 3.1 indicates Mashonaland East Province in relation to the country of

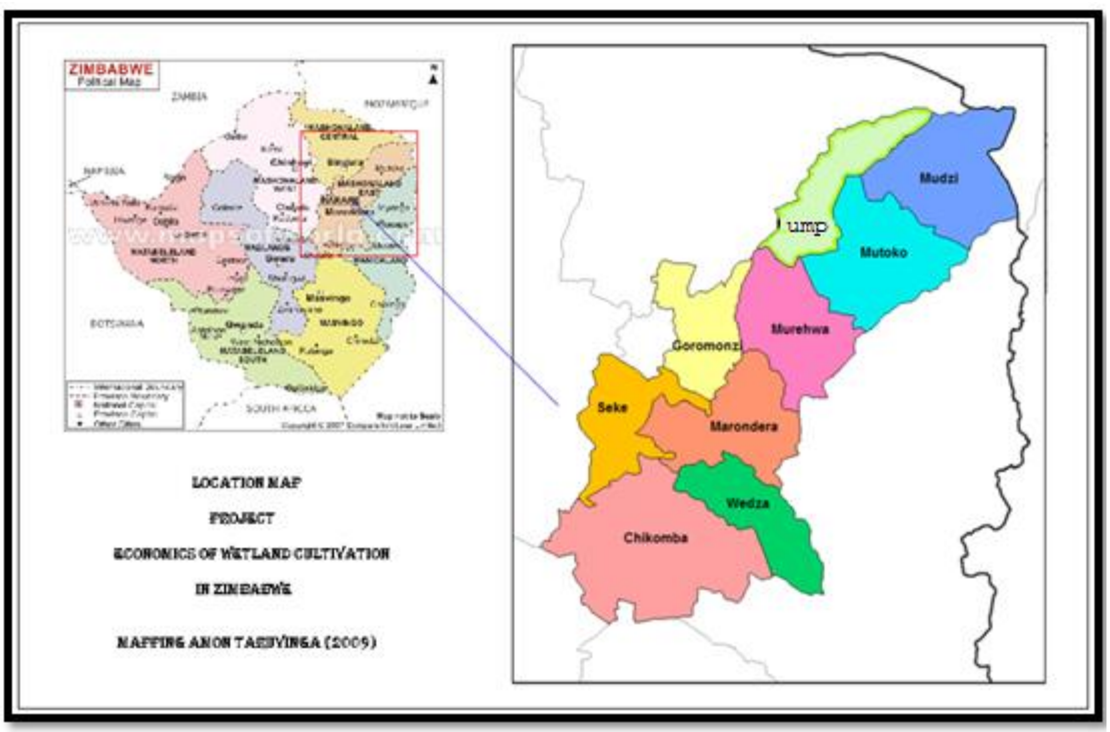


Figure 3.1: Location Map: Mashonaland East Province

Zimbabwe. A detailed agro-ecological survey summary of the province with special reference to study districts was also conducted concentrating on climatic conditions, soils, geology, geomorphology, hydrology and demographic data of the study area.

The entire province has a total surface area of 32 230km^2 and a population of 1 127 413 according to Central Statistics Office (CSO) (2002) and Utete (2003). In terms of administrative districts the province has a total of nine districts, viz: Chikomba, Goromonzi, Marondera, Mudzi, Murehwa, Mutoko, Uzumba Maramba Pfungwe (UMP), Seke and Wedza (Utete, 2003). Mashonaland East Province lies in agro-ecological regions IIa to IV suitable for intensive crop farming, dairy, horticulture and production of small grains (Utete, 2003). The following sections concentrate of detailed description of specific study areas to which this research was conducted based on the three (3) categorised sampling units as explained in Chapter 4, section 4.3 and Figure 4.1 to follow.

3.1 Description of Specific Study Areas

3.1.1 Sampling Unit A

Sampling unit "A"[23] comprised of three districts in the province, namely Mutoko, UMP and Murehwa. Mutoko is located 160km from Harare, the capital city of Zimbabwe, along the Harare - Nyamapanda highway. A national tarred road passes through the Mutoko growth point linking Mutoko to Harare and Nyamapanda boarder post to Mozambique. CSO (2002) estimated that the entire district had a population of 132 268 people and 29 administrative wards with a sex ratio[24] of 92,05 implying more females (52,07%) than males (47,93%). Utete (2003) noted that the entire district was wholly communal with no commercial farms.

[23] Cultivated wetlands from which respondents were randomly selected within Mutoko, Murehwa and UMP districts

[24] Sex ratio according to CSO, (2002) was defined as the average number of males per 100 females: a number above 100 therefore indicates an excess of males over females while a ratio below 100 depicts the opposite.

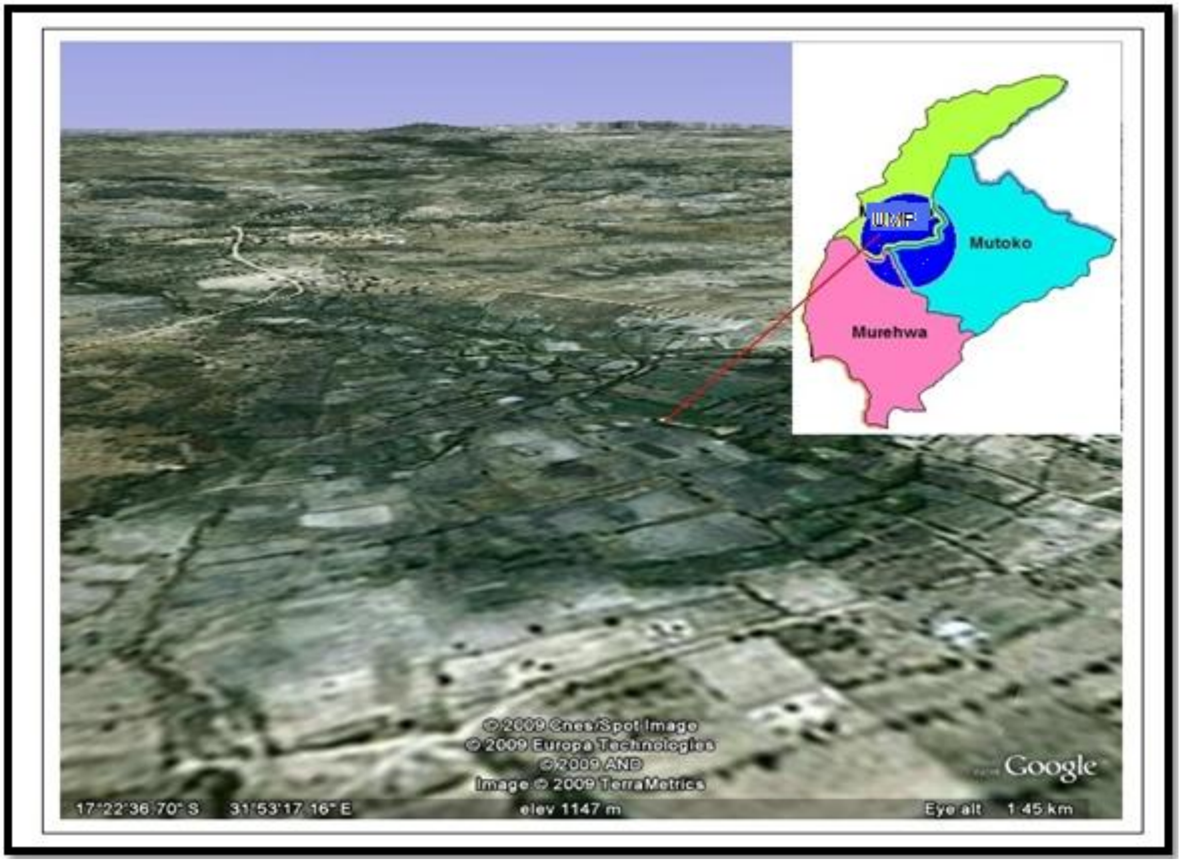


Figure 3.2: Uzumba Wetlands; Sampling Unit "A"

Local farmers used the Mutoko growth point as the local market place for their horticulture products with several market places scattered at business service centres across the whole district. The bulk of the produce from farmers was marketed at *Mbare Musika* in Harare. CSO (2002) noted that agriculture was the main economic activity with 74,67%[25] share, followed by mining and construction with 3,43% share.

Murehwa lies 85km from Harare along the same Harare – Nyamapanda highway. Murehwa district`s location is strategically bordered by two highways; Harare – Nyamapanda to the north and Harare – Mutare to the south. This set up makes the district accessible from Marondera town for farmers who are geographically located to the south. The entire district has some commercial farms, especially in Macheke area, and a stretch of communal area along the Harare -

[25] Of all economic activities available to residence of Mutoko district agriculture comprised 74,67%, implying that agriculture was the dominant economic activity in the district.

Nyamapanda highway. CSO (2002) estimated that the entire district had a population of 162 167 and 30 administrative wards with a sex ratio of 92,75. Main economic activities in the district were agriculture with 71,4% share, services with 8,26% share and manufacturing with 4,54% share (CSO 2002). Although the main economic activity was agriculture, a significant contribution of the services and manufacturing sectors was noted.

UMP is geographically located 176 km from Harare, 91km from Murehwa along the Murehwa - Madecheche highway. According to Utete (2003), the entire district is wholly communal with no commercial farms. Mutawatawa growth point hosts the dominant market place for local farmers. To the extreme north, Chitsungo and Nyanzou business centres host Pfungwe communal area farmers. Nhakiwa and Tamutsa business centres, host Uzumba communal farmers to the south. Northern farmers from this district also make use of Shamva and Rushinga markets in Mashonaland Central Province, while southern farmers access Mutoko and Murewa markets. CSO (2002) estimated that the entire district had a population of 104 336 with 15 wards and a sex ratio of 91,53. CSO (2002) noted that agriculture was the main economic activity with 80,34% share, followed by mining and construction with 5,23% share implying that agriculture was the dominant economic activity for UMP citizens with a minor contribution from the mining and construction sectors. The agro-ecological setting of the study area, despite being in three different districts, shared the same climate. To that respect a composite agro-ecological survey summary was considered as follows;

3.1.2 Agro-ecological Survey Summary

Sampling unit "A" was defined in agro-ecological regions, IIb and III. Daily ambient temperatures were very high with maximum summer temperatures of $35^{o}C$ and a minimum of $11^{o}C$ with no incidence of frost (Ministry of Agriculture, 2009). Rainfall was very erratic with annual average of 700mm per annum, most of it occurring between December and January as shown in Figure 3.3a. This was poorly distributed across the growing season making rain fed crop culture a very risky venture. Figure 3.3 "a" and "b" summaries temperatures and rainfall of this area based on averages from Ministry of Agriculture district data-base.

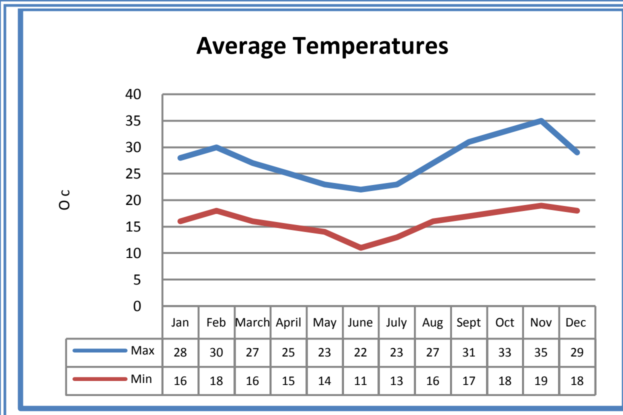


Figure: 3.3a: Average Temperature (Sampling Unit A)

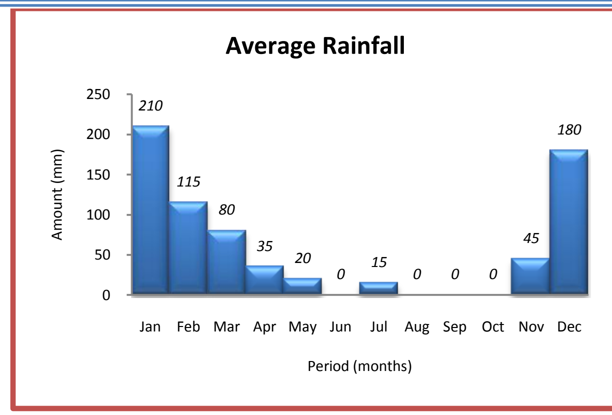


Figure: 3.3b: Average Rainfall (Sampling Unit A)

Source: Ministry of Agriculture (2009)

Minimum temperatures fluctuated between 11^{o}C in June and 19^{o}C in November, a clear indication of a hot area with no incidences of frost. Maximum temperatures ranged from 22^{o}C in June to 35^{o}C in November. These are good temperatures for plant growth if supported by adequate moisture, because they give a heat unit advantage to crops. Also, lowest temperatures were above the "biological zero"[26] temperature (10^{o}C) of most horticultural crops implying that there was no period to which farmers were restricted to crop production because of lower temperatures. Unfortunately, the corresponding rainfall status of the area as shown in Figure 3.3b was very erratic and poorly distributed, with December and January as the main rainfall months. Crops introduced in December would by February face moisture stress, a critical factor to the success of dry land agriculture in this area.

3.1.3 Sampling Unit B

Sampling unit "B"[27] comprised of three districts in the province, namely Goromonzi, Murehwa and Marondera as shown in Figure 3.4. Goromonzi is a rural community in Zimbabwe 32km

[26] Minimum temperature for plant growth to which any figure below that plants will stop to grow.

[27] Cultivated wetlands from which respondents were randomly selected within Murehwa, Goromonzi and Marondera districts

south-east of Harare. Goromonzi hosts Ruwa town to the south and Juru growth point to the north. Its proximity to Harare gives local farmers an advantage for they are linked to the biggest national market for their produce. Locally farmers utilize Ruwa town and Juru growth point as trading centres. Ruwa town has a total of 11 wards with an estimated population of 23 681 (CSO, 2002).

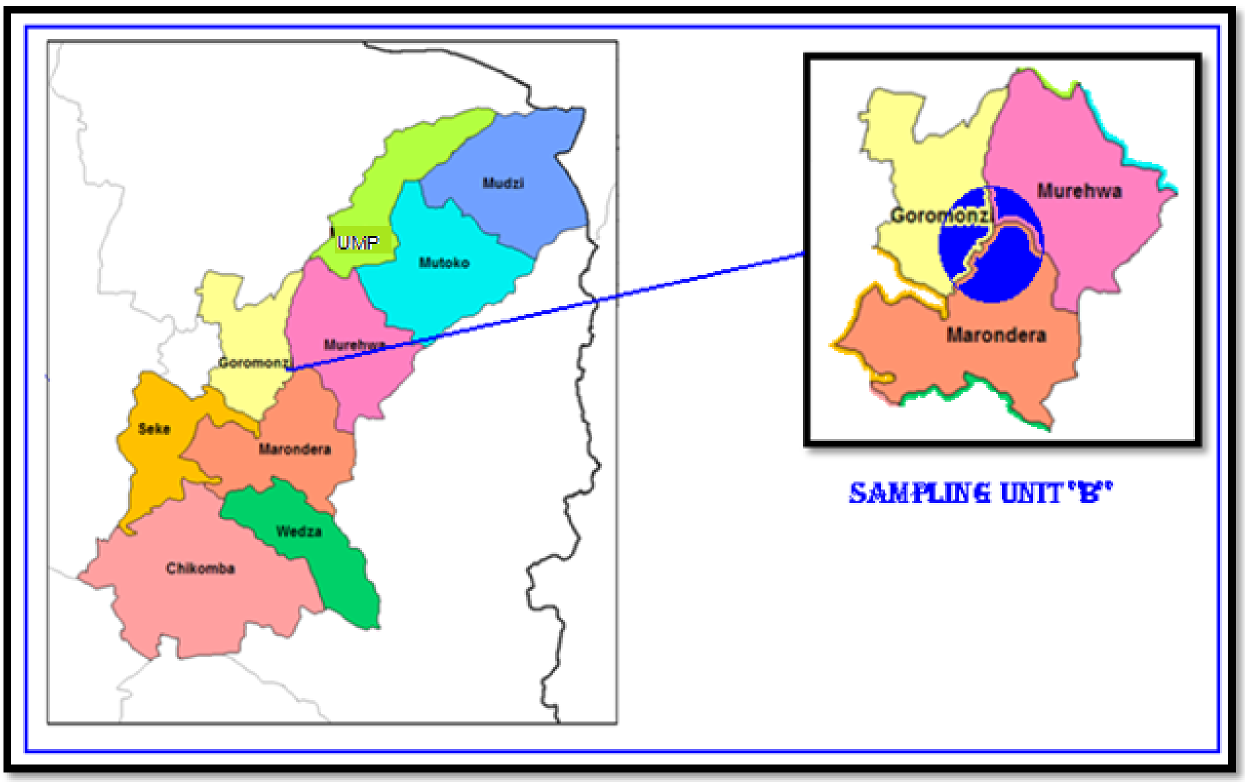


Figure 3.4: Sampling Unit "B"

With regards to sex ratio (97,78), Ruwa had more females (50,56%) than males (49,44%). The entire district covered an area of 91km^2 with an estimated population of 154 263 and a total of 25 wards (CSO, 2002). The district sex ratio (98,97) remained skewed more towards females than males. Goromonzi district had a mixed set up in terms of communal and commercial farms (Utete, 2003). Main economic activities in Ruwa were services with 18,14% share, manufacturing with 17,6% share and agriculture with 9,71% share, (CSO 2002). In terms of the entire district (Goromonzi) the main economic activities, according to CSO (2002), were agriculture with 58,66% share, services with 11,67% share and mining and construction with

5,58% share. Although the main economic activity was agriculture, a significant contribution of the services and manufacturing sectors was noted especially from Ruwa.

Marondera is located about 72km east of Harare with an estimated population of 102 830 and a sex ratio of 101,17 implying there are more males (50,29%) than females (49,71%) (CSO, 2002). Marondera town is strategically located along Harare - Mutare highway and also linked to Murehwa to the north eastern side and Wedza to the south. The district is defined in a mixed set up of commercial farming area and a communal area across the entire district (Utete, 2003). The district hosts Marondera urban with an estimated population of 51 847 and 11 wards with a sex ratio of 87,34 (CSO, 2002). Main economic activities in Marondera Urban were services with 20,06% share, manufacturing with 16,44% share and agriculture with 7,83% share (CSO 2002). In terms of the entire district (Marondera), the main economic activities, according to CSO (2002), were agriculture with 74,46% share, manufacturing with 3,78% share and law and society with 2,94% share. Figure 3.4 shows this sampling unit in relation to the entire province.

Murehwa district was also part of Sampling Unit “B” as shown in Figure 3.4 and part of Sampling Unit “A” as shown in Figure 3.2 indicating the complex nature of natural resources (wetlands) when they are defined with respect to administrative boundaries.

3.1.4 Agro-ecological Survey Summary

Sampling unit “B” was defined in agro-ecological regions, IIa, IIb and III. The daily ambient temperature of this area was moderately high with maximum summer temperatures of 26^{o}C and a minimum of 1^{o}C with some incidences of frost during peak winter periods (Ministry of Agriculture, 2009). Rainfall was good with annual average of 967mm per annum, most of it occurring between October and February as shown in Figure 3.5b. This was evenly distributed across the growing season making rain fed crop culture a successful venture. Figure 3.5 “a” and “b” summaries temperatures and rainfall of this area based on averages from Ministry of Agriculture district data-base.

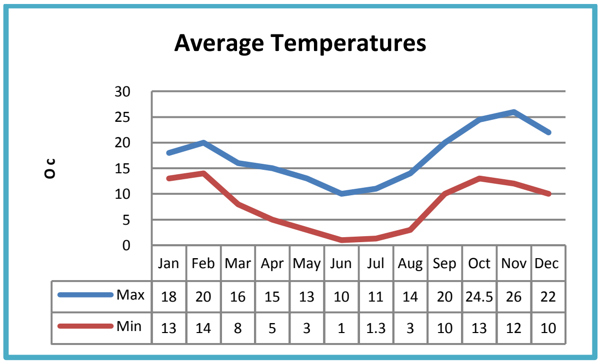


Figure: 3.5a: Average Temperature (Sampling Unit B)

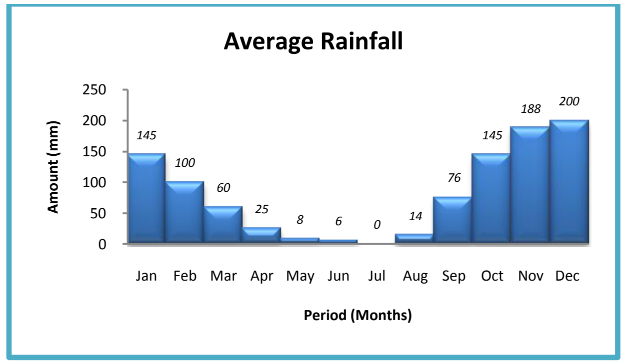


Figure: 3.5b: Average Rainfall (Sampling Unit B)

Source: Ministry of Agriculture (2009)

Temperatures indicated that the study area was a cold region, where minimum average temperatures ranged from 1^{o}C to 14^{o}C and maximum average temperatures from 10^{o}C to 26^{o}C as shown in Figure 3.5a. Frost challenges were pronounced especially in wetlands facing east and south east, (direction of trade winds). Rainfall of the study area seemed to be good, in the sense that by September some rains were received to enhance early plantings followed by a continuous supply of natural rains as shown in Figure 3.5b, capable of giving most crops an adequate growing period.

3.1.5 Sampling Unit C

Sampling unit "C"[28] comprised of four districts in the province, namely Seke, Marondera, Wedza and Chikomba as shown in Figure 3.6. Seke is located 55km from Harare. This district comprises both commercial farms around Beatrice area and communal areas towards Marondera. The district hosts Chitungwiza town giving farmers a comparative advantage in terms of market. CSO (2002) estimated district population to be around 76 923 with 21 wards and sex ratio of 102,63 implying more males (50,65%) than females (49,35%). CSO, (2002) noted that agriculture was the main economic activity with 65,49% share, followed by services with 9,01% share implying that agriculture was the dominant economic activity for Seke citizens with a notable contribution from the service sector.

[28] Cultivated wetlands from which respondents were randomly selected within Seke, Marondera, Wedza and Chikomba districts

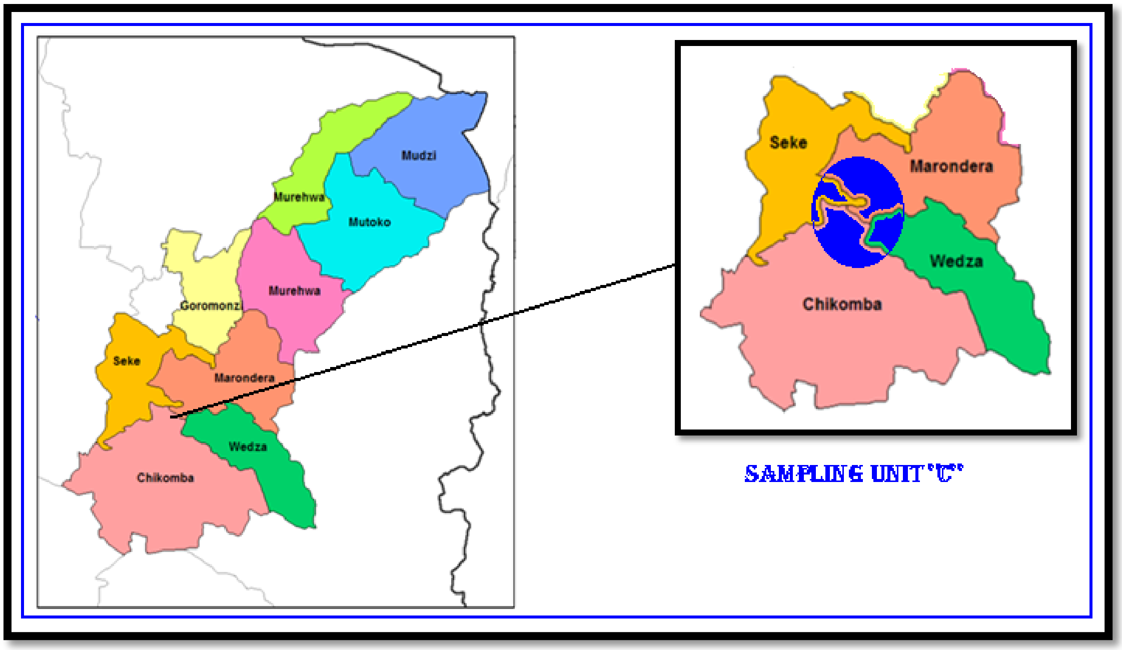


Figure 3.6: Sampling Unit "C"

Wedza is located 76km south east of Harare defined in a mixed set up of communal and commercial farming (Utete, 2003). Hwedza growth point provides farmers with an opportunity to trade their produce. The growth point is well networked by a tarred road to Harare, Marondera and Rusape. CSO (2002) noted that agriculture was the main economic activity with 76,98% share, followed by services with 6,19% share implying that agriculture was the dominant economic activity for Wedza citizens with a notable contribution from the service sector. The entire district had 14 administrative wards and a total of 70 677 people were estimated to reside in Wedza with a sex ratio of 91,94 (CSO, 2002).

Chikomba is located 100km south of Harare; where to the south the town is linked to Masvingo, to the north the town is linked to Harare and to the south eastern direction the district is linked to Nharira. The district enjoys a mixed set up of communal and commercial farming area mainly for cattle ranching (Utete, 2003). Main economic activities in Chikomba were agriculture with 74,6% share, services with 7,13% share and education with 3,42% share (CSO 2002). Chikomba hosts Chivhu town to the advantage of farmers in terms of a market. Chikomba had a total of 30 wards and a total population of 120 248 with a sex ratio of 90,37 indicative of more females (52,53%) than males (47,47%) (CSO 2002).

3.1.6 Agro-ecological Position and Survey Summary

Sampling unit "C" was defined in agro-ecological regions, IIa, IIb and III. The daily ambient temperature of this area was high with maximum summer temperatures of 32^{o}C and a minimum of 0^{o}C with high incidences of frost during peak winter periods as shown in Figure 3.7b (Ministry of Agriculture, 2009). Rainfall totals were good with an annual average of 967mm per annum, most of it occurring between October and February as shown in Figure 3.7a. This was evenly distributed across the growing season making rain fed agriculture a viable option. Figure 3.7 "a" and "b" summaries temperatures and rainfall of this area based on averages from Ministry of Agriculture district data base.

This study area (Sampling unit "C")[29] was defined in a high rainfall zone with high temperatures during peak summer periods and very low temperatures during peak winter periods as shown in Figure 3.7b. The growing period in this area (September to February) was frequently supported by high rainfall months of the year as shown in Figure 3.7b, corresponding to high temperature periods of the year.

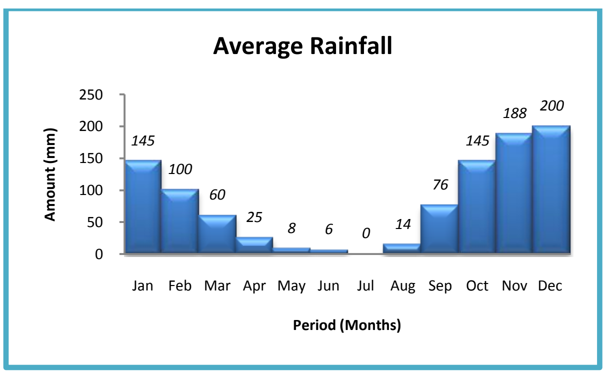


Figure: 3.7a: Average Rainfall (Sampling Unit C)

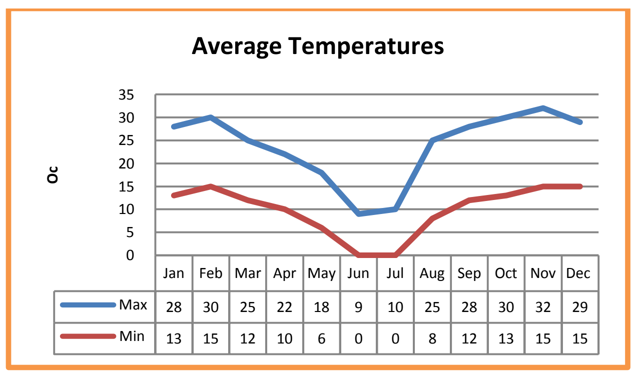


Figure: 3.7b: Average Temperature (Sampling Unit C)

Source: Ministry of Agriculture (2009)

29 Cultivated wetlands from which respondents were randomly selected within Seke, Marondera, Wedza and Chikomba districts

Winter periods registered very low temperatures (0^oC) especially in the wetlands, implying selecting horticultural crops that tolerate low temperatures was mandatory for successful winter wetland cultivation.

3.2 Wetland Pedology

From a general point of view, wetland soils differ widely in their texture, depth, profile, nutrient status, stability and workability, to the point that many variants of this are found within and between *dambos* in close proximity (Mharapara 1995). Mkwanda (1997), building from earlier observations, noted that variations were in three dimensions; top to bottom of *dambo*, perpendicular from edge to centre of *dambo* and the diagonal from the edge to the centre and bottom. In essence, Mkwanda (1997) acknowledges that any attempt to classify *dambos* according to soil types can only be on broad terms as follows;

1. Sandy, shallow acidic *hydromorphic* soils with rocky impermeable layers underneath
2. Sandy, medium to deep *sodic hydromorphic* soils with semi-impermeable clay layers underneath
3. Variants of 1 and 2 with sandy clay loams at various levels of the profile and in different proportions.
4. Heavy clay with top black soils and variants of gray and white clayey material at various stages of weathering.
5. Unstructured *hydromorphic* soils with a thick peaty or matt of organic matter at different stages of decomposition and growth.

Nyamapfene (1991) suggested that classification of wetlands according to their nutrient status would broadly place sandy *dambo* soils derived from granitic material in a class of low fertility, while *dambo* soils derived from the clay forming parent materials would be placed in the class of fertile soils. A scenario Mkwanda (1997) postulated to be influenced by the location of a wetland in respect to rainfall amounts, which cause leaching of nutrients in and out of the system. To that end wetlands have been generally assumed to be inherently fertile compared to uplands, although the above observation by Nyamapfene (1991) does not necessarily support that school of thought. It is as a result of this generalization that rural communities in Zimbabwe have invaded wetlands in pursuit of the claimed nutrient status of wetland soils.

3.2.1 Pedological Context of *Dambos* in Mashonaland East Province

Thompson and Purves (1978) established that *dambo* soils in this area were classified as *fersiallitic* soils driven from granite rocks. Pursuing this further, Whitlow (1994) observed that such soils were dominated with clay minerals with *kaolinite* but also including small proportions of *smectite* or *montmorillonite*. Table 3.1 presents a typical soil catena on granite gneiss based on a study conducted by Whitlow (1994), in Murehwa district of Mashonaland East Province, which shall be used in this study to generalize the entire soil catena of all study areas.

Table 3.1: Soil catena on granite gneiss in the *Chikwaka* Communal Area

Position on Catena	**Top Soil Features (0 – 10 cm)**	**Sub Soil Features (100 – 110 cm)**
1. Ridge Crest	Dark brown (10 YR 3/3) sandy soil; dry	Brown (7,5 YR 4/4) clayey sand; moist
2. Upper Slope	Brown (10 YR 4/3) sandy soil; dry	Brown (7,5YR 4/4) sandy loam; moist
3. Mid to Lower Slope	Dark greyish brown (10 YR 4/2) sandy soil; dry	Yellowish brown (10 YR 5/4) coarse sandy soil; mottled with soft concretions; moist
4. *Dambo* Margin	Very dark greyish brown (10 YR 3/2) humic sandy soil; moist	Greyish brown (10 YR 5/2) clayey sand; mottled with water table at 50cm ferricrete at 75 cm
5. Dambo	Very dark grey (10 YR 3/1) humic clayey sand; very moist	Dark yellowish brown (10YR 4/4) sandy clay strongly mottled with water table at 85 cm

Key: Codes in brackets are Mansell Soil Colour Chart Codes

Source: Whitlow (1994), page 11

3.2.2 Categorization of Dambo Mineralogy

Whitlow (1994) argues that research in hydrology of *dambo* in Malawi and Zimbabwe has shown that the *smectitic* clays within *dambo* are formed *in-situ* in the valley sites. Earlier works by Thompson and Purves (1978) suggested that elements are leached from the inter fluves and are transported down slope in two forms of runoff, the shallow through flow removes the Si and Al and the deeper circulating ground water carries mainly bases. It is as a result of precipitation of these elements, according to Thompson and Purves (1978), especially in the valley sites, mainly as a result of dry season evaporation and neo-formation of clay that leads to formation of *smectitic* clays within *dambos in-situ* (Whitlow, 1994).

On acidic parent materials in Zimbabwe, Thompson and Purves (1978) generalize that *smectite* clays were formed typically in the low- lying wetter depressions within the *dambo,* restricted to *dambos* formed on *mafic* rocks. However, based on a much more specific field study, Whitlow (1994) argues that *dambo* clays comprise varying proportions of *kaolinite* and *smectite* along with sand fraction of quartz and orthoclase feldspar. Whitlow (1994) went on to categorize and compare two predominant *dambos* properties in Murehwa Communal Area as shown in Table 3.2.

According to Whitlow (1994), Type I soils were more common in Murehwa wetlands characterized by blocky *humic* topsoil with a weak crumb structure overlying a coarse blocky dark, grey sand clay or clay horizon up to 0,5m depth. Generally, this is underlain by a more massive dark greyish brown clay or *saprolite* (Whitlow, 1994). To a lesser extent Type II soils were also available in Murewa area, according to Whitlow (1994), which were generally shallow, slightly *humic* sandy clay topsoil overlying a well developed columnar sandy clay horizon yellowish brown in colour and up to 1m depth.

Of notable interest are pH levels of the two soil profiles, especially within the plough zone; 4.7 for Type I and 3.9 for Type II. These are purely acidic levels that require a lot of liming to accommodate most horticultural crops that can perform well under neutral conditions. This explains the reason why a lot of farmers were liming their plots as explained in Chapter 5, section 5.1.

Table 3.2: Comparison of *dambo* soil profiles in Murewa Communal Area

Soil Property	**Type I Blocky Soil**			**Type II Columnar Soil**		
Depth (cm)	**0 – 10**	**40 – 50**	**65 – 80**	**0 – 10**	**40 – 50**	**85 – 100**
% Organic	37	-	-	29	-	-
% Gravel	0	0	0	0	9	10
% Sand	46	32	34	61	46	43
% Silt	19	11	11	14	6	6
% Clay	35	57	55	25	49	51
pH ($CaCl_2$)	4.7	5.5	5.6	3.9	5.0	6.9
Ex Ca (meq%)	184	186	109	33	22	81
Ex Mg (meq%)	76	97	61	19	22	81
Ex Na (meq%)	5	4	3	2	3	7
TEB	267	288	174	54	49	170
CEC	303	361	358	66	81	183
ESP	1	10	8	25	38	39

Key: *Ex: Exchangeable bases milli-equivalents per cent (meq%); TEB: Total Exchangeable Bases; CEC: Cation Exchangeable Capacity; ESP: Exchangeable Sodium Percentage*

Source: Whitlow, (1994), page 12

The clay content levels[30] were ideally good with a corresponding good cation exchange capacity[31] for Type I profile although low levels were pronounced under Type II profile. From a

[30] Clay content levels of soils define the potential of soils to adsorb essential cations and anions for plant growth; implying that soils with high level of clay content are by default rich and sand soil poor.

[31] Cation exchange capacity defines the rate at which adsorbed cations can be transferred from the soil colloids to plants hence plant growth cum productivity.

production point of view Type I soils are inherently fertile and ideal for crop production. Type II soils still remain good in comparison to uplands currently under production in rural areas. To that end wetland invasion by rural communities in the study area remains justifiable and logical based on nutritional merits of the soils capable of improving productivity of farmers.

3.3 Wetland Hydrology

Wetland hydrology is dependent on the processes that take place in the catchment area, given that wetlands receive incident rain, catchment run-off and seepage from catchments (Mkwanda, 1997). Murwira (1997) argues that the importance and significance of any of these input sources to the hydrological status of the *dambo* is variable and dependent on several factors to include; (a) infiltration rates both in catchment and *dambo*, (b) *dambo* size, (c) ratio of *dambo* size, (d) catchment size, (e) rainfall amount, (f) timing of rainfall event in respect to season and (g) location.

Mkwanda (1997) suggested that a useful classification of wetlands based on the hydrology would be the groundwater level (wetness) of the *dambo* especially during the critical stages of its utilization cycle. Building on this argument, Mkwanda (1997) further categorized critical periods into stages during time of (a) land preparation, (b) crop establishment or crop harvest noting that this would vary within *dambos*, between *dambos* and between seasons but capable of giving an average picture based on average expected seasons. Earlier works towards classification of *dambos* intended for cultivation, according to Mharapara (1995), were categorically based on three factors as follows;

1. (I): Water table on or above the surface (free water) in October (end of the dry season) for the greater proportion of the *dambo*
2. (II): Water table down to a maximum of 50 cm below surface (moist soils with dry surface) in October for the greater proportions of the wetlands
3. (III): Water table down to beyond 50 cm below surface (dry soil in plough zone) in October for the greater proportion of the wetlands

The wetland hydrological setting of the study area was generally synchronized to match the above classification by Mharapara (1995) as follows; in sampling unit “A” (Mutoko, Murehwa and UMP) the bulk of the wetlands under study were located in agro-ecological region III with just a few in agro-ecological region IIb. Based on physical observations, water table levels of all the wetlands under study were down to a maximum of 50cm below surface (moist soils with dry surface) in October for the greater proportion of the wetland area, fitting well to category two (II) of wetlands based on Mharapara`s (1995) classification. This was also true of wetlands from sampling unit “B” (Murewa, Goromonzi and Marondera) although broadly the area was defined in agro-ecological position IIa, IIb and III.

Sampling Unit “C” (Seke, Marondera, Hwedza and Chikomba) was defined in agro-ecological regions; IIa, IIb and III. The bulk of the wetlands under study were located in agro-ecological region IIb. Based on physical observations, water table levels for the bulk of wetlands located in region IIb were on the surface in October for the greater proportion of the wetland area, tallying with Mharapara`s (1995) category one (I) of wetlands. Water plays a significant role in crop production[32] to such an extent that its absence is capable of restricting crop production. This is true under uplands, dry-land cultivation during winter and early summer seasons where crop cultivation is restricted. Invasion of wetlands by communities in rural areas remains logical in pursuit of moisture content that is always available throughout the year.

3.4 Wetland Geology and Geomorphology

Nyamapfene (1991) acknowledged that a wide range of geological materials occur in Zimbabwe and most of these are igneous and metamorphosed igneous rocks which occupy about 65 % of the land area. Sharing the same view Mharapara (1995) acknowledge that granites were the most dominant geological materials in the *craton*, accounting for 46% of the area. Building on earlier conclusions, Mkwanda (1997) noted that materials of sedimentary or *aeolian* origin were common mainly in the northern and northwestern parts of the country accounting for 25 % of the land area.

[32] Nutrient uptake in soil solution form and several enzymatic and cell functioning of plants crucial for plant survival

In an effort to link geology and geomorphology to agricultural soils, Nyamapfene (1991) acknowledged that complexes of metamorphosed basaltic and andesitic lavas and sediments, although less extensive in area than the other formations, are an important feature of the Zimbabwean geology, giving rise to the agriculturally important red soils. Nyamapfene (1991) went on to highlight that *mafic* rocks give rise to formations rich in ferromagnesian minerals and thereby giving rise to red and yellowish red clays in well drained positions.

Linking geomorphology to wetlands, Nyamapfene (1991) noted that the majority of *dambos* in Zimbabwe have geological characteristics of the Basement Complex, which is largely comprised of the igneous and the metamorphic rocks. Sharing the same view, Mkwanda (1997) warns that a smaller but significant amount is also associated with the Kalahari sands and Karoo sandstones in addition to the Basement Complex as noted by Nyamapfene (1991). Both geologies, according to Mkwanda (1997), give rise to sandy or sandy loamy soils. In addition to available knowledge, Mkwanda (1997) further endorsed that a very small percentage of the *dambos* were associated with the *doleritic* geologies that give rise to clayey soils.

Whitlow (1984b) estimated that *dambos* covered 3.6% of the land area of Zimbabwe and that approximately 84 % of these occur on gneiss and intrusive granitic rock. Mashonaland East Province wetlands, specifically wetlands from Murehwa communal area, were broadly linked to granitic geomorphology, a general conclusion forwarded by Whitlow (1984b). To that end, wetland geomorphology of the study area was defined as occurring on gneiss and intrusive granitic rocks giving rise to soils characterized by blocky *humic* topsoil with a weak crumb structure overlying a coarse blocky dark, grey sand clay or clay horizon up to 0,5m depth for the bulk of wetlands and a limited occurrence of soils characterized by shallow, slightly *humic* sandy clay topsoil overlying a well developed columnar sandy clay horizon yellowish brown in colour and up to 1m depth based on studies of *dambo* mineralogy by Whitlow (1994).

3.5 Wetland Climate

Rainfall has a major influence on *dambo* formation and development and hence their occurrence in Zimbabwe is closely related to the rainfall distribution patterns (Mkwanda, 1997). Building on Mkwanda`s (1997) conclusions, Murwira (1997) noted that areas with the highest concentration of wetlands (Central plateau) closely resemble the areas that receive the highest rainfall on comparable geologies and topography. Earlier on Mharapara (1995) had observed that *dambo* development was brought about by the movement and accumulation of soil aggregates, solutes, and organic matter from the catchment areas to the lower areas by water. Concurring with Mharapara (1995), Mkwanda (1997) further noted that the movement is either on the surface through run-off or subterraneously through seepage of excess water. It therefore follows that the higher the rainfall is, the higher is the frequency of such movement and hence the higher the rate of *dambo* development (Mkwanda, 1997).

In respect to rainfall, Mkwanda (1997) suggested that *dambos* in Zimbabwe could be classified as (a) high, (b) medium and (c) low rainfall area *dambos*, where such locations would broadly coincide with the NR I and II ("a"; high), III ("b"; medium) and IV and V ("c"; low) respectively. Murwira (1997) noted that such a classification would have direct input into the management of water as the major variable. Mkwanda (1997), on a different approach, suggested an alternative assessment that would focus on the level of development of the *dambo* brought about by the action of rain water.

Comparable *dambos* in the high rainfall areas, according to Mkwanda (1997), would be more advanced in their development than those in lower rainfall areas in respect of profile formation/destruction. In this respect, terminologies such as (a) developed (high), (b) medium (medium) and (c) young (low) could be used for such classification. To that end, sampling units "A" (Mutoko, Murehwa and UMP) and "B" (Murehwa, Goromonzi and Marondera) would be technically classified as "medium wetlands" since they are located in medium rainfall areas and in terms of their profile formation/destruction are also defined as medium. Wetlands from sampling unit "C" (Seke, Marondera, Wedza and Chikomba) would be defined as "developed –

high wetlands" given that they are geographically located in high rainfall areas and their profile formation/destruction would be expected to be highly developed due to high rainfall.

Adding a new dimension in wetland climate, Mkwanda (1997) noted that frost causes damage to most crops and wetlands were more susceptible to its occurrence than uplands since they accumulate cold air pockets due to their hollow formations. In agreement to this observation Murwira (1997) deduced that *dambos* facing east and southeast (the direction of the trade winds) tend to be more susceptible than those facing other directions. Ideally, those facing other directions are sheltered from the cold winds and also benefit from the afternoon sun as endorsed by Mkwanda (1997). Mkwanda (1997) suggested a review of wetland classification based on frost incidences into (a) frost free and (b) frost prone zones an input that would provide guidelines for crop selection and cropping patterns for wetland areas. With this new wetland climate dimension, wetlands from sampling unit "A" would categorically be defined as frost free wetlands and those from sampling unit "B" and "C" as frost prone wetlands.

3.6 Chapter Summary

Agriculture was the dominant economic activity of the entire population within the sampling frame (CSO, 2002). Interestingly, wetlands from the sampling frame indicated a lucrative agronomic potential as defined by soils, geology, climate and hydrology. A significant population interacted with wetlands, a crucial factor that could address rural livelihoods in the event that wetland cultivation is viable and capable of addressing household food security. To fully enhance this dream a supportive legal framework would be necessary to regularize wetland cultivation.

Chapter Four (4):

Research Method and Design

4.0 Introduction

This chapter focuses on the research design in an effort to explain how the study was conducted. The chapter is arranged in such a way that research design was presented first giving details of the research techniques used in the study. This was followed by a section on methodologies and research instruments that were used to gather different types of data used in this project. The chapter concludes by discussing the sampling procedure, data sources, characteristics and the statistical techniques that were used.

4.1 Research Design

The following research techniques were used in this study;

- Case Study
- Evaluative / Appraisal

A case study technique, according to Hofstee (2006), is a research design approach that examines a single case in a tightly structured way, towards testing a hypothesis about the case itself as well as gaining principles that can be extrapolated to similar cases. In this study, a case study approach was used to capture detailed knowledge on the economics of wetland cultivation as perceived by residents from Mashonaland East Province.

An evaluative approach seeks to come to a conclusion about the effects or success level of some happening or intervention (Hofstee, 2006). In this study, an evaluative approach was used to complement the case study technique through appraising wetland cultivation as a possible land use option. Wetland cultivation was also considered as proxy to an intervention to which its contribution to household food security was assessed using this technique.

4.2 Methods and Research Instruments

The study was carried in two major phases. In phase one, the main objective was to obtain a series of qualitative data in as far as wetland utilization was concerned. The main approach at this level was through participatory rural appraisal surveys. Interviews with key informants from a technical level to grass root level was the main method used to gather information. Phase two of the study was dominated with a much more substantive baseline survey targeting both qualitative and quantitative data. Baseline survey captures events as they are on the ground for future referencing. This included data on;

(i) Demographics of the household,
(ii) Cropping activities
(iii) Socio-economic status of the households

A questionnaire as shown in annexure 1 was used as the main instrument to gather data pertaining to the above-mentioned information.

4.3 Sampling frame

The proposed study encompassed all wetland areas in Mashonaland East Province as the sample frame. Primary sampling units were taken as wetlands under cultivation. From this frame three wetland areas (“A”; “B” and “C”) were selected based on the following criteria as indicated in Figure 4.1;

1) The wetland area should be under cultivation,

    - Only cultivated wetlands were considered since the study was targeted to explore the economics of wetland cultivation.

2) Wetland area should have been under cultivation for at least five years,

   - A fluctuation in yields emanating from decline in soil fertility was the major feared factor in sustainability of wetland cultivation by earlier scholars like Beadle (1981).
   - To that end, heavily cultivated wetlands were considered to capture the effect of decline in soil fertility.

3) The cultivated wetland area must cover at most 10% of the catchment area or at most 30% of the vlei area,

   - Only wetlands that were cultivated within the above set limits were considered so as to comply with ecological set compatibility requirements, by Bullock (1995) and Owen *et al*. (1995).
   - For simplicity the 30% limit was considered where wetland plots within one sampling unit were supposed to be within the 30% limit of the entire wetland area measured to the highest flood level of the wetland.

Since wetland areas do not respect ward or district boundaries, implying they can stretch from one ward to another and from one district to another the following categorization (A, B & C) was done to denote sampling units, within the entire sampling frame as shown in Figure 4.1.

4.3.1 Sampling Procedure for the Baseline Survey

Using stratified systematic sampling based on wetland cultivation status of the initial sample, two homogeneous mutually exclusive strata were created (stratum “A”; “**Wetland Cultivators**”: n = 145 and stratum “B”; “**Non Wetland Cultivators**”: n = 144) for independent analysis. Stratification entails dividing the population into homogeneous, mutually exclusive groups called strata where independent samples are selected from each stratum with the sole objective of reducing sampling error.

4.3.2 Sampling Size

From each of the sampling units (A and B) 100 families/households were randomly selected for direct questioning, using the "in-person interview" approach. For sampling unit "C", 89 households were selected to give a total of 289 respondents. Table 4.1 summaries the distribution of respondents with respect to their cultivation status.

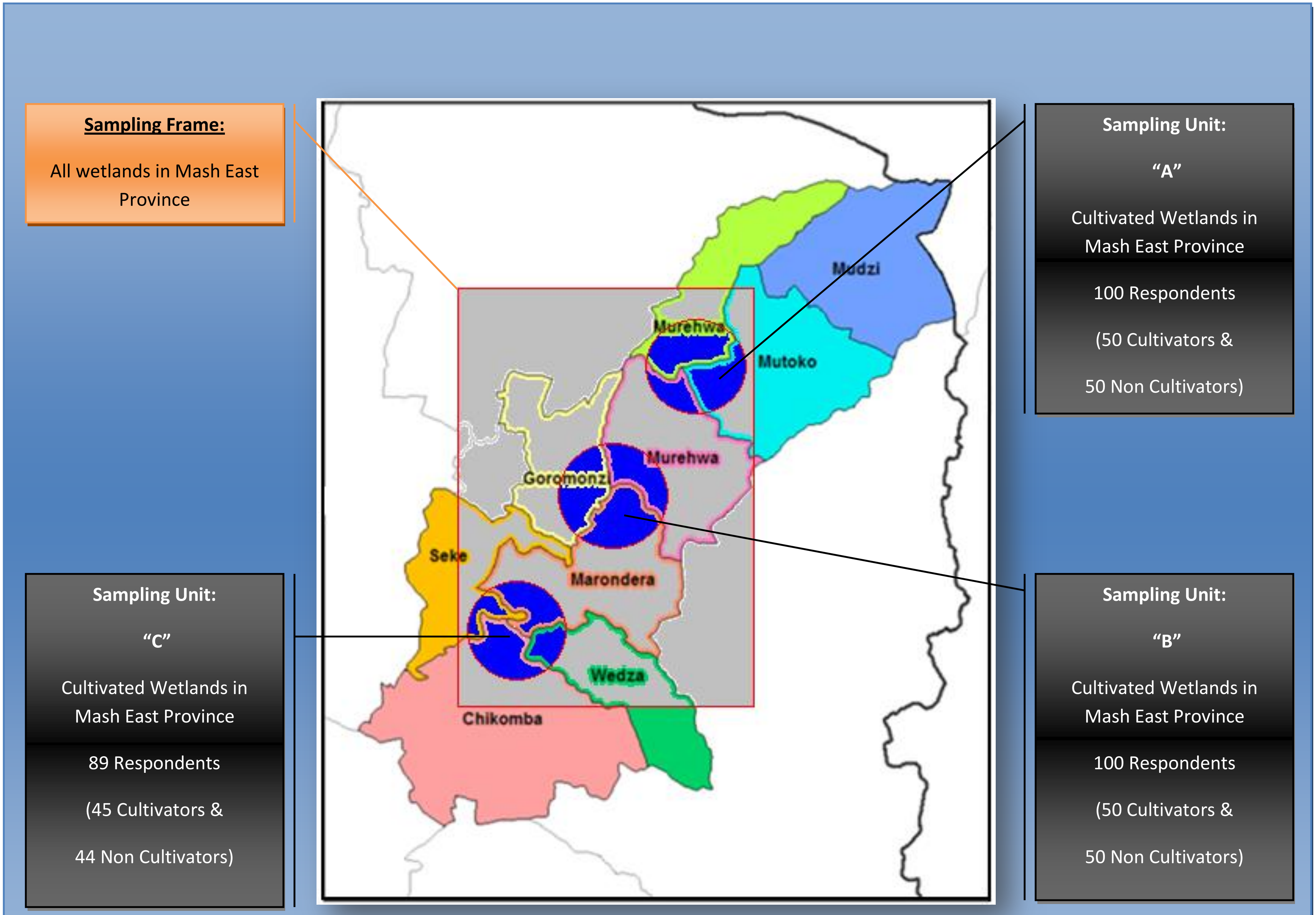


Figure 4.1: Sampling Frame; All Wetlands in Mash East Province

Table 4.1: Distribution of respondents with respect to wetland cultivation status

Sampling Units	Wetland Cultivation Status of Respondents				%Total
	Cultivators	%	Non Cultivators	%	
A	50	50%	50	50%	100%
B	50	50%	50	50%	100%
C	45	51%	49	49%	100%
Households Totals	**145**		**144**	**Total Households n = 289**	

- From sampling unit "A" a total of hundred (100) households were selected comprising of fifty cultivators (50%) and fifty non cultivator (50%) households.
- Fifty cultivators (50%) and fifty non cultivator (50%) households were randomly selected from sampling unit "B".
- Lastly forty five cultivators (51%) and forty four non cultivators (49%) were randomly selected from sampling unit "C".
- In total one hundred and forty five cultivators were selected from the three sampling units against one hundred and forty four non cultivators summing to two hundred and eighty nine households.

The entire sample considered was distributed as follows in terms of the stratification considered;

One hundred and forty five cultivators constituted 50,2% of the entire population selected and one hundred and forty four non cultivators constituted 49,8% of the entire population selected as shown in Table 4.2.

Table 4.2: Distribution of respondents within the entire sample

Distribution of respondents with respect to wetland cultivation status			
Strata	**Number of Households**	**Percentage**	**Characteristics**
Stratum (1)	145	50.2%	Cultivators
Stratum (2)	144	49.8%	Non cultivators
Total	**289**	**100**	

4.3.3 Enumerator Selection and Training

Five enumerators were selected on merit from a possible ten, all of which had received graduate training in agriculture, applied environmental science, rural sociology or geography from various Universities in Zimbabwe. All enumerators chosen were resident in Mashonaland East Province at the time of the study and fluent in the local language. This team was trained over five days so as to familiarize themselves with the different sections of the questionnaire. On the fourth day, a pre-testing exercise was conducted at one of the study sites. Each enumerator managed to interview at least five households. The last day was for brain storming and reflections on different sections of the questionnaire, based on pre-test results. Several adjustments to the questionnaire were done and skills on how to approach households were also highlighted.

4.3.4 Justification for sample size and location

Of the estimated 262 000 hectares of wetland area in Zimbabwe`s communal areas, the bulk of it is geographically located in Mashonaland East Province (Bullock, 1995). The obvious assumption made here is the fact that the more wetlands they are in an area, the more they are utilized, especially in rural areas where they mean coping strategies for cropping. Therefore a better representation of the value of wetland cultivation could be estimated in these areas. This is further supported by the fact that UMP, Murehwa and Mutoko districts are the dominant suppliers of the country`s main market (*mbare musika*) of fresh horticultural crops from wetlands.

From an ecological sustainability point of view, Whitlow`s (1980; 1983; 1984a; 1984b; 1985) studies of wetland cultivation compatibility were done in Mashonaland East Province in Murehwa district. As a follow up study in respect to those findings and bearing in mind that wetlands were heterogeneous, this study was more site specific biased so as to maintain assumptions of compatibility of wetland cultivation as one of the arguments to support the conclusion of this study. As a reminder, Whitlow (1985) did conclude that there was no significant link between wetland cultivation and its degradation, which was further supported by Bullock (1995), Owen *et al.* (1995), MacFarlene (1995) and lately by McCartney in 2000 and Constantin *et al.* (2003). To that effect since wetlands are not homogeneous, as noted by Mharapara (1995) this study was expected to be site specific to wetlands from Mashonaland East Province.

4.4 Analysis

Data was entered and managed in Statistical Package for Social Scientists (SPSS) version 17.0. Majority of the analysis which included the following analytical techniques was done using a combination of SPSS and Microsoft EXCEL;

1. Viability of wetland cultivation was estimated using the following approaches;

- Gross Margin Models
- Net Present Value Model

2. Potential of wetland cultivation to address household food security was estimated using the following approaches;

- Net and Gross Food Security Index
- Non Parametric Correlation Models (*Kendall `s tau_b* and *Spearman`s rho*)

- Cross Tabulation (*Pearson Chi-Square*, *Goodman & Kruskal tau*, *Somer`s d*, *Cramer`s V* and Relative Risk Estimate – *Odds Ratio*)

3. Factors affecting households` participation in wetland cultivation were estimated using the following approach;

- Binary Logistic Regression Model

4.4.1 Gross Margin Model

Gross margin, (GM) is the difference between total sales commonly known as gross income, (GI) and total variable costs (Johnson 1992). Johnson (1992) defines gross income as a product of output and price calculated as shown in equation 1. Variable costs are mainly operational costs that vary with changes in scale of operation, to include most of the inputs like, fertilizers, seed, chemicals, transport, causal labour and land preparation as denoted in equations 2.

$$\boldsymbol{GI = (P\ x\ Y\ x\ A)} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 1$$

Where;

GI = Gross Income measured in monetary value (US$)

P = Prevailing Market Price measured in monetary value (US$)

Y = Yield of the produced commodity measured in metric tonnes per hectare (t/ha)

A = Area under production measured in hectares (ha)

$$TVC = \sum_{x=1}^{n}(x_1; x_2 \dots \dots \dots .. x_n) \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots . . \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots 2$$

Where;

TVC = Total Variable Costs measured in monetary value (US$)

x_1 = First variable costs to be used during the production phase

x_n = The last variable cost to be used during the production phase

$$GM = (GI - TVC) \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots . \dots \dots \dots \dots \dots \dots 3$$

Where;

GM = Gross Margin measured in monetary value (US$)

GI = Gross Income measured in monetary value (US$)

TVC = Total Variable Costs measured in monetary value (US$)

Based on the assumption that fixed costs lie in the range of thirty percent (30%) of the entire production costs and they can also be incurred even if business is not operating[33], the gross margin value can be used as a reliable estimate of viability of an enterprise (Johnson, 1992). In other words the gross margin value is the amount that a farmer is left with after paying off all the operational costs incurred during the production phase. Enterprises with higher or positive GMs are deemed viable by rule of thumb.

The return per dollar variable costs invested (GM/$VC or GI/$VC) in wetland crops can be used as the business coefficient expansion factor, (multiplier coefficient) compared against the minimum commercial threshold to establish the business buoyancy of wetland-cultivated

[33] The classical shutdown principle

crops. The Return / $VC invested in wetland cultivation gives the business coefficient expansion factor (BCEF), which is the rate at which the business expands as it operates. Any figure above 1 is by default ideal, but for serious commercial production an expansion factor equal or above 2.5 is considered ideal, to send profit signals in favour of any crop that enjoys such an expansion factor (Johnson, 1992). Equation 4 presents the calculation procedure.

$$\boldsymbol{MC = \left(\frac{GM}{TVC}\right)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.4$$

Where;

MC = Multiplier Coefficient

GM = Gross Margin

TVC = Total Variable Cost

In this study the gross margin model was used to capture wetland production details for wetland plot holders and to infer partial enterprise viability. This model was extended to a whole farm model to capture the entire wetland production details for all wetland cultivators selected using approaches highlighted in equations 1 to 3. Using the multiplier coefficient approach as contained in equation 4, relative potential of wetland cultivation was estimated as a possible land use option compared to the commercial threshold as suggested by Johnson, (1992). Produced gross margins were further used in measurement of project worthiness using the net present value (NPV) approach.

4.4.2 Net Present Value Model

Lin and Nagalingam (2000) defined Net Present Value (NPV) as the present value of net cash flows. Ideally, it is a standard method for using the time value of money to appraise long-term projects (Baker, 2000). Principally, NPV measures the excess or shortfall of cash flows in present value (PV) terms once financing charges are met, calculated as shown in equation 1 (Lin and Nagalingam, 2000).

$$NPV = \sum_{t=0}^{N} \frac{Ct}{(1+r)^t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..1$$

Where;

t = time of cash flow

N = total time of the project

r = discount rate (the rate of return that could be earned on an investment in the financial markets with similar risk)

Ct = net cash flow (the amount of cash, inflow minus outflow) at time *t*

Lin and Nagalingam (2000) noted that under the NPV model each cash inflow/outflow is discounted back to its present value (PV) a process that will produce the NPV after summing up the cumulative PVs as contained in equation 1. The discount rate to be used plays a crucial role to the overall predictive power of the NPV model (Baker, 2000). In this study, a variable discount rate was used with higher rates applied to cash flows occurring further along the wetland cultivation time span as suggested by Baker (2000).

In financial theory, NPV is an indicator of how much value an investment or project adds to the value of the firm (Lin and Nagalingam, 2000). Since NPV is an indicator of how much value an investment or project adds to the firm, in this context NPV of wetland cultivation shall be deemed to mean how much value wetland cultivation adds to society. Critical limits for rejection or acceptance of a land use project will be decided on the following cut off points;

1) For mutually exclusive alternatives, the one yielding the higher NPV should be selected

2) For independent projects any positive NPV is accepted

Lin and Nagalingam (2000) summarized the cut off points as follows:

- NPV > 0: The investment would add value to the firm hence the project may be accepted.

- NPV < 0: The project would subtract value to the firm hence the project should be rejected

- NPV = 0: The project would neither gain nor lose value for the firm, an indifferent stance should be considered bearing in mind that the project adds no monetary value implying considerations to be based on other non monetary strategic merits.

4.4.3 Net and Gross Food Security Index

Gross Food Security Index (GFSI) and the Net Food Security Index (NFSI) are partial indicators of food security status of households (Guveya, 2000), calculated as shown in equations one (1) and two (2). According to Guveya, (2000), Gross Food Security Index (GFSI) is an indicator of whether the household will have enough food to last until the next harvest season, had the household not sold any of its grain.

$$\boldsymbol{GFSI = \left[\left(\frac{TP}{R}\right).100\right]} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..1$$

Where;

1) GFSI = Gross Food Security Index

2) TP = Total Production defined by total grain production (maize and sorghum)

3) R = Requirement given by multiplying total adult equivalents (TAE) by minimum annual grain requirement of an average adult (155kg)

- If GFSI is 100%, production will be equal to requirement and the household is food self-sufficient but has no surplus to sell.

➢ If GFSI > 100%, the household is food self-sufficient and food secure.

➢ If GFSI < 100%, this does not mean that the household is food insecure because the household might be earning enough from off-farm activities to buy supplements.

Net Food Security Index (NFSI) is an indicator of whether, after selling, the household will have enough food for consumption to last until the next harvest (Guveya 2000).

$$\boldsymbol{NFSI = \left[\left(\frac{S}{R}\right).100\right]} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Where;

1) NFSI = Net Food Security Index

2) S = Surplus given by production minus sales

3) R = Requirement given by multiplying total adult equivalents (TAE) by minimum annual grain requirement of an average adult (155kg)

➢ If NFSI = / > 100%, this means that the household retains sufficient food to meet its household requirements till the next harvest.

➢ If NFSI < 100%, this means that the household does not retain enough grain to last until the beginning of the next season.

In this study wetland cultivators and non-cultivators were assessed in terms of their food security status based on the above estimation. Effectively respondents were further categorized into wetland cultivator food secure or wetland cultivator non food secure, and non wetland cultivator food secure or non wetland cultivator non food secure. The above categorization was split into two to indicate the distribution based on gross and net food security status of households. These were used as dummy variables to assess whether there is any significant relationship between wetland cultivation and food security status.

4.4.4 Correlation Models

For purposes of estimating, the potential of wetland cultivation to address household food security two non parametric correlation models were used to establish whether there exists a relationship between wetland cultivation and food security. Specifically, the two-tailed *Kendall`s tau_b* and the *Spearman`s rho* analyses were computed which provide correlation coefficients that indicate the strength and direction of the linear relationship. *Kendall`s tau_b*`s estimation is based on the probability of concordance minus the probability of discordance (Daniel 1990 and Abdi 2007). The test statistic is given by the following expression;

$$\tau = \frac{S}{\frac{n(n-1)}{2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where;

S = difference between P (the number of pairs in natural order) and Q (the number of pairs in reverse natural order)

τ = relative measure of the extent of the disagreement between the observed order of the Y observations and the two orderings that represent a perfect correlation between the X and Y rankings.

n = the number of (X, Y) observation (ranks)

In order to obtain S and consequently τ , Daniel (1990) suggested the following steps;

1. Arrange the observations (Xi, Yi) in a column according to the magnitude of the X`s, with the smallest X first, the second smallest second, and so on. This arrangement will present the X variables in a natural order.

2. Compare each Y value, one at a time, with each Y value appearing below it. This procedure will present the pair of Y values in a natural order if the Y below it is larger than the Y above and a reverse natural order if the Y below is smaller than the Y above.

3. Let P be the number of pairs in natural order and Q the number of pairs in reverse natural order.

4. $S = P – Q$; that is S in Equation 1 is given by the difference between P and Q.

A total of $\binom{n}{2} = \frac{n(n-1)}{2}$ possible combinations of Y values can be made in this manner. If all the Y pairs are in natural order, then;

$P = \frac{n(n-1)}{2}, Q = 0, S = \left[\frac{n(n-1)}{2}\right] - 0 = \frac{n(n-1)}{2}$ this would give equation 2;

$$\boldsymbol{\tau} = \frac{\frac{\boldsymbol{n(n-1)}}{\mathbf{2}}}{\frac{\boldsymbol{n(n-1)}}{\mathbf{2}}} = \mathbf{1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Indicating perfect direct correlation between the rankings of X and Y. On the other hand Daniel, (1990) showed that if all the Y pairs are in reverse natural order, then;

$P = 0, \; Q = \frac{n(n-1)}{2}, \; S = 0 - \left[\frac{n(n-1)}{2}\right] = -\frac{n(n-1)}{2}$, to give equation 3;

$$\boldsymbol{\tau} = \frac{-\frac{\boldsymbol{n(n-1)}}{\mathbf{2}}}{\frac{\boldsymbol{n(n-1)}}{\mathbf{2}}} = -\mathbf{1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

This would indicate a perfect inverse correlation between the X and Y rankings. Thus τ can not be greater than, +1 or smaller than -1. Daniel (1990) noted that τ could be viewed as a relative measure of the extent of the disagreement between the observed order of the Y observations and the two orderings that represent a perfect correlation between the X and Y rankings. The strength of the correlation is given by the magnitude of the absolute value of τ. This approach was used to estimate the possible association between wetland cultivation and household food security the later estimated by the relative gross and net food security index of households as acknowledged by Guveya (2000) earlier on explained in section 4.4.4.

Spearman`s rho

Pearson correlation is unduly influenced by outliers, unequal variances, non-normality, and nonlinearity (Daniel, 1990). An important competitor of the Pearson correlation coefficient is the *Spearman's rank correlation coefficient*. This latter correlation is calculated by applying the Pearson correlation formula to the ranks of the data rather than to the actual data values themselves. Daniel (1990) noted that by so doing, many of the distortions that plague the Pearson correlation are reduced considerably.

Pearson correlation measures the strength of the linear relationship between *X* and *Y*. In the case of nonlinear, but monotonic relationships, a useful measure is *Spearman's* rank correlation coefficient, *Rho,* which is a *Pearson's* type correlation coefficient, computed on the ranks of *X* and *Y* values (Daniel, 1990). It is computed by the following formula:

$$\boldsymbol{rho} = \frac{[\mathbf{1-6}\ \sum(\boldsymbol{di})^{\mathbf{2}}]}{[\boldsymbol{n}(\boldsymbol{n}^{\mathbf{2}}-\mathbf{1})]} \quad \text{...}\mathbf{1}$$

Where;

d_i is the difference between the ranks of X_i and Y_i.

n = the number of (*X*,*Y*) observation (ranks).

r_s = +1, if there is a perfect agreement between the two sets of ranks.

r_s = - 1, if there is a complete disagreement between the two sets of ranks.

Abdi (2007) and Daniel (1990), warns use of correlation models to infer causality based on possibilities of spurious and wrong-way causation generic in several variables. Based on this understanding any relationship inferred by correlation models in this study was treated as a systematic relationship. Further tests were therefore necessary to cross check the established relationship supported by logical inference before causality was claimed as recommended by Abdi (2007). The following section describes several tests of association and directional measures that were used in this study to cross check the systematic relationship obtained under correlation models.

4.4.5 Cross Tabulation

This is a type of a bivariate analysis that involves testing whether a relationship or an association exists between two categorical variables only so that the direction of association is made obvious (Norusis, 2004). Cross tabulation presents several tests of association, directional and symmetrical measures. In this study, the following statistical tests were used to cross check the systematic relationship between wetland cultivation and household food security inferred by correlation models towards quantifying the established systematic association with the aim of establishing the potential of wetland cultivation to address household food security using non parametric models: *Pearson Chi-Square*, *Goodman & Kruskal tau*, *Somer`s d*, *Cramer`s V* and Relative Risk Estimate – *Odds Ratio*).

1. Existence of association between wetland cultivation and household food security was estimated using *Pearson Chi-Square* test of association as a follow up cross check measure to quantify the systematic relation inferred by correlation models.

2. Significance cum strength of association was cross checked by the *Goodman & Kruskal tau* and *Cramer`s V* test.

3. Direction of association was cross checked using *Somers'd* test.

4. Relative food insecurity status of respondents cum potential of wetland cultivation to address household food security was therefore inferred using the Relative Risk Estimate – *Odds Ratio* approach, after a close analysis of the systematic hint inferred by the non parametric correlation models.

Using the systematically stratified samples created based on wetland cultivation status of the initial sample, (stratum "A"; "**cultivators**": n = 145 and stratum "B"; "**non cultivators**": n = 144) and the further categorized sample based on food security status of respondents, relative risk of food insecurity between cultivators and non-cultivators was estimated using the *Relative Risk Estimates - Odds Ratio* approach at 95% confidence interval to give conclusive evidence to infer potential of wetland cultivation to address household food security. The *Odds Ratio* measures the association between presence/absence of a factor and the occurrence of an event (Norusis, 2004). This approach was used to estimate the degree of association between wetland cultivators and non-cultivators and the occurrence of food insecurity at both gross and net level of analysis.

4.4.6 Binary Logistic Regression

The binary logistic model was used to estimate households` socio-economic factors that influence participation in wetland cultivation among wetland cultivators and non cultivators to which wetland cultivation status of households was taken as the dependent variable. Seven predictor independent variables were regressed against the binary dependent variable of wetland cultivation status of households. Households' participation in wetland cultivation was based on an assumed underlying utility function of attaining household food security from wetland cultivation. According to this theory, households were conjectured to participate more in wetland cultivation if the utility obtained from participation exceeds that of non-participation. The binary logistic regression model as specified in equations, one (1) to five (5), according to Kidane *et al.* (2005), was used to determine factors affecting households` participation in wetland cultivation.

$$\phi_i = E\left(\gamma_i = \frac{1}{\chi_i}\right) = \frac{1}{1 + \ell^{-\left(\beta_i + \sum_{i=1}^{k=n} \beta_{ij} \chi_{ij}\right)}} \quad \text{.. (1)}$$

ϕ_i = is the probability of household (i) being a cultivator

γ_i = is the observed wetland cultivation status of the household

i, χ_{ij} = are the factors determining wetland cultivation status for households

i and β_j = stands for parameters to be estimated.

By denoting $\beta + \sum_{j=1}^{k=n} \beta_{ij}$ *as* Z, equation (1) can be written to give the probability of wetland cultivation status of household (*i)* as:

$$\phi_i = \mathrm{E}\left(\gamma_i = \frac{1}{\chi_i}\right) = \frac{1}{1 + \ell^{-Z_i}} \quad \text{.. (2)}$$

From equation (2) the probability of a household being a wetland cultivator is given by $\left(1-\phi_i\right)$ which gives equation (3) as follows;

$$(1-\phi_i) = \frac{1}{1+\ell^{Z_i}} \quad \text{......} \quad (3)$$

According to Kidane *et al.* (2005) the odds ratio would therefore be, [i.e. $\phi_i / \left(1-\phi_i\right)$] as given by equation (4);

$$\left(\frac{\phi_i}{1-\phi_i}\right) = \frac{1+\ell^{Z_i}}{1+\ell^{-Z_i}} = \ell^{Z_i} \quad \text{......} \quad (4)$$

The natural logarithm of equation (4) gives rise to equation (5);

$$Ln\left(\frac{\phi_i}{1-\phi_i}\right) = \beta + \sum_{j=1}^{k=n} \beta_{ij} + \varepsilon_i \quad \text{......} \quad (5)$$

4.4.6.1 Description of Variables Specified in the Model

This section focuses on a description of the variables specified in the logistic regression model. Using conclusions inferred from other studies and empirical findings from the study area, the *a priori* influence of various household characteristics was estimated.

a) Household size

Household size was measured by the number of family members in the household. Household size would be expected to determine the labour force available to cultivate in the dry-lands and wetlands. Zidana *et al.* (2007) revealed that a positive relation between wetland cultivation and household size was possibly caused by lack of access to land leading households with large family sizes to invade wetlands in search of land for cultivation. Based on these findings, a positive correlation was expected. However, in the event that pressure of household size to wetland produce is likely to be higher than the labour benefits likely to be enjoyed by large household sizes, a negative correlation would be possible. To that end either a negative or a positive correlation between household size and wetland cultivation was expected as shown in Table 4.3.

b) Household head sex

Men and women engage in different activities at household level as defined by the African historical cultural domain. Household head sex was conjectured to influence type of activities likely to be engaged by female or male headed families in as far as wetland cultivation was concerned. Earlier studies showed that wetland cultivation was apparently a gendered activity in some areas. Chinsinga (2007) noted that wherever wetland cultivation competes for time and attention with seemingly lucrative alternatives, it becomes predominantly a feminine activity. Households headed by females were therefore expected to participate in wetland cultivation more than male headed households, for males would rather focus on field crops (Chinsinga, 2007), implying a negative correlation as shown in Table 4.3 denoted as follows; (1 if male: 0 if female) to represent this predictor variable.

c) Household head education

Wetlands are complex ecosystems whose direct and indirect contribution to humanity is not obvious (Campell and Luckert, 2002). Education in that respect helps people to appreciate more values of wetlands. In essence, as noted by Muchapondwa (2003), education would make it easier for households to comprehend negative externalities and passive user values of natural resources. Ideally, decisions pertaining to wetland utilisation are expected to be influenced by education level of households. Intuitively, a positive correlation was expected for this variable measured by the level of education attendance of the household head as shown in Table 4.3.

The legal conflict behind wetland cultivation presents another scenario where the risk averseness common to educated people would influence educated households heads to distances themselves from wetland cultivation. Similar effects were also earlier on observed by Zidana *et al.* (2007) reporting a negative relationship between river bank cultivation and education as mainly caused by less access to non farm incomes by uneducated households, hence resorting to river bank cultivation. Based on the foregoing arguments, either a positive or negative effect was expected.

d) Household head age

Wetlands are state-lands in Zimbabwe, their legal ownership remains on Rural District Councils in which such pieces of land are geographically located. Village heads are empowered to monitor management of wetlands through the Zimbabwean Traditional Leaders' Act and the Zimbabwean Communal Lands and Forestry Produce Act. To that end rural communities collectively use wetlands as a public common pool good. Those with fields stretching into wetlands have managed to claim ownership of wetlands in proximity to their fields although not legally supported.

Such temporal ownership has grown to levels where at local level communities have agreed to allocate wetlands in relation to household field position. Age as measured by the actual number of years of the household head plays a vital role in terms of land ownership cum wetland utilization in rural areas, where older household heads are expected to have better access to land than younger heads because younger men either have to wait for a land distribution or have to share land with their families. A positive correlation was therefore expected between age and wetland cultivation similar to conclusions inferred by Kapanda *et al.* (2005).

e) Number of livestock units[34]

Livestock units as measured by the total number of livestock units per household was conjectured to have an influence in as far as participation in wetland cultivation by households was concerned. More attention was given to large ruminants (cattle, sheep, goats and donkeys) that utilize wetlands as grazing areas. A mixed expectation was conjured where, on the one hand, conversion of wetland into crop lands would reduce grazing area for households with large livestock units, hence this would influence the way such household would consider wetland cultivation.

[34] 1 Livestock Unit = 500kg live mass

On the other hand, livestock specifically cattle and donkeys are sources of draught power in rural areas crucial for land preparation, a crucial element in land preparation under wetland cultivation and synergies that exists between the two variables (use of livestock manure in crops, vegetable gardens and fish ponds) as observed by Kapanda *et al.* (2005).

f) Distance to wetland area

Wetland cultivation was also expected to be influenced by the distance between households` fields in relation to wetland location as measured by the actual kilometres between the two variables. To that end the more distant the fields are from the wetlands, the drier are uplands implying the moisture content of the soil is only limited to summer seasons when there are natural rains (Peters, 2004). To that effect upland farmers are more likely to face high chances of crop failure than their counterparts with fields stretching into wetlands.

As a coping strategy up-land farmers are more likely to venture into wetland cultivation to complement upland yields. Contrary to this scenario households with fields far from wetlands would find it more difficult to access wetlands due to pressure from households with fields near wetlands in relation to scarcity of wetlands in rural areas. Naturally, either a positive or a negative effect was expected.

g) Availability and enforcement of wetland cultivation restrictive measures

Laws supported by statutory instruments, provides the legal basis for controlling activities, through setting the *modus of operandi*, standards and penalty levels. In Zimbabwe, the Environmental Management Act provides the legal basis for management of wetlands. At local level chiefs, head-man and village heads use different wetland restrictive strategies to control wetland cultivation. By default, all wetland areas in Zimbabwe are restricted in as far as cultivation is concerned based on the national legal framework. What differs therefore is enforcement depending on areas.

With that background, categorization of areas based on low, medium and high enforcement levels was used as a standard measure to assess the influence of availability and enforcement of wetland restrictive measures to participation in wetland cultivation with the implicit goal of evaluating the effectiveness of available polices. Under normal circumstances availability and enforcement of laws that restrict wetland cultivation within an area or within a country is expected to be associated with a decline in engagement of such activities (wetland cultivation) as citizens respond to set rules.

Regardless of availability and enforcement of these measures, Mutambikwa *et al.* (2000) noted that widespread wetland cultivation was an indication of a conflict between society and policy makers. To that end, either a positive or a negative effect was expected. Table 4.3, summarises variables specified in the binary logistic model with wetland cultivation as the dependent variable and their expected signs.

Table 4.3: Description of variables specified in the model

Acronym	*Description*	*Type of Measure*	*Expected Sign*
Dependent Variable			
PARTINWETCUL:	**Whether a household participates in wetland cultivation**	**Dichotomous Response (1 if yes: 0 if no)**	
	Explanatory Variables	**Dummy (1 if yes: 0 if no)**	
1)HHSZE	Household Size	Number of family members in a household	- / +
2)HHHSX	Household Head Sex	Gender of household head (1 = male; 0 = female)	- / +
3)HHHED	Household Head Education	U=Uneducated; P=Educated to Primary level; S=Educated to Secondary level; T=Educated to Tertiary level (U=0; P=1; S=2; T=3)	- / +
4)HHHAG	Household Head Age	Actual number of years	+
5)AMTLU	Amount of Livestock Units	Actual number of livestock units per household	- / +
6)DISTWA	Distance to Wetland Area	Kilometres from end of fields to wetland banks: (<1km = 1; 1-3km=2; >km=3)	- / +
7)AEWCRM*	Availability and Enforcement of Restrictive Measures	Law enforcement levels within areas (L=1; M=2; H=3) (L=Low; M=Medium; H=High)	+

*(AEWCRM) = Availability and Enforcement of Wetland Cultivation Restrictive Measures

4.5 Chapter Summary

Wetland cultivation economics sums up several economic concepts critical for purposes of inferring the economic position of wetland cultivation as a land use option. The first concept as highlighted in this chapter is on viability. Before considering the welfare implications and policy angles of implementing wetland cultivation, viability of specific wetland cultivated crops was deemed necessary. To that effect several enterprise viability measures were recommended as shown in Table 4.4 and explained earlier.

The welfare implication in the name of household food security was also deemed necessary towards explaining economics of wetland cultivation to society. Several tests of association were also recommended as shown in Table 4.4 for purposes of estimating the association between wetland cultivation and household food security. Lastly, economics of wetland cultivation was defined from a policy angle in an effort to understand socio-economic factors that could influence participation of households in wetland cultivation. Understanding these factors was deemed necessary for crafting of practical people centred wetland cultivation user rights as well as identification of areas for targeted educational campaigns. Table 4.4 summaries the research objectives, questions, hypothesis and the statistical tests used to dispute or support conjecture hypotheses in this study.

Table 4.4: Summary of research objectives and analytical framework

Objective	Question	Hypothesis	Analytical Tools
To assess viability of wetland cultivation	Is wetland cultivation viable?	Wetland cultivation is viable	Gross Margin Net Present Value
To assess potential of wetland cultivation to address household food security	Does wetland cultivation address household food security?	Wetland cultivation addresses household food security	Correlation Cross tabulation
To investigate determinants of farmer wetland use choice	What are factors that influence farmer`s participation in wetland cultivation?	Household size and household head education are other factors that influence farmers` participation in wetland cultivation	Binary Logistic Regression

Chapter 5 (Five)

Results: Descriptive Findings

5.0 Introduction

This chapter presents research findings based on descriptive results from selected respondents. In broad terms the chapter summaries descriptive findings of the viability of wetland cultivation and it's potential to address household food security. Household characteristics of respondents were also explored with the objective of trying to establish their potential influence to the final farmer wetland use choice.

5.1 Viability of Wetland Cultivation

Viability of wetland cultivation was investigated against the null hypothesis that wetland cultivation is not viable; hence there was no significant economic evidence to warrant conversion of wetlands into croplands. Empirical findings from the study area indicated that the following horticultural crops were commonly grown by all wetland cultivators; (a) tomatoes, (b) cabbage, (c) sugarcane, (d) green mealies, (e) onion, (f) and potatoes, as shown in Figure 5.1.

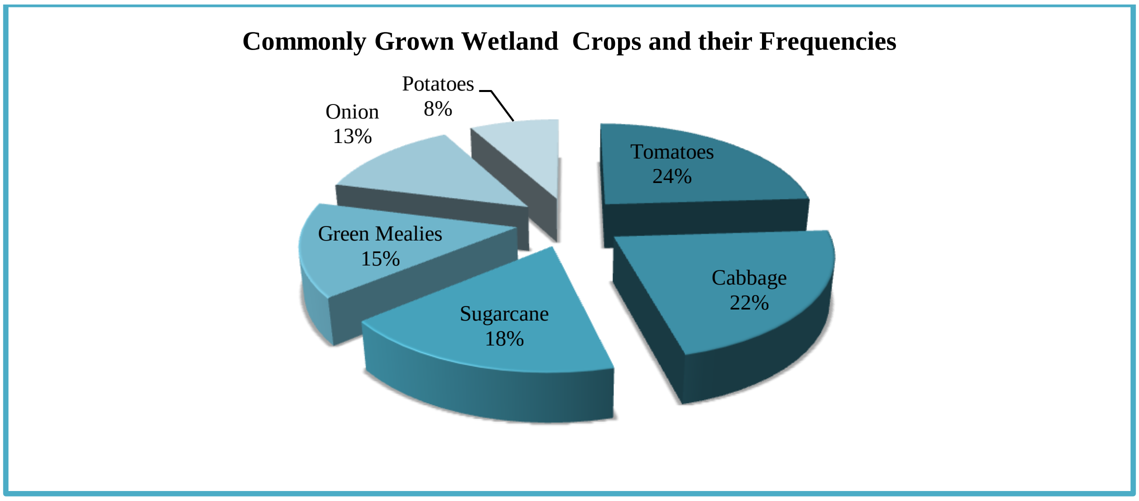


Figure 5.1: Commonly Grown Wetland Crops and their Frequency

Source: Research Data, (2009)

Other horticultural crops were widespread but not dominant implying for purposes of this study the above six mentioned crops were considered as the main wetland horticultural crops from Mashonaland East Province. Detailed crop budgets for the six major wetland horticultural crops from the study area were captured, based on operational costs and yields recorded by the farmers as shown in Tables 5.1 to 5.6.

Table 5.1: Gross margin budget for onion

Area	Requirement per ha	Units	1ha	Total Wetland Size (1ha)
1) Yield levels		kg	15,000 (15t)	
2) Selling price		US$/kg	0.60	
3) Gross Income		US$/ha	9,000.00	**9,000.00**
4) Total Variable Costs		US$/ha	1,785.59	
5) Gross Margin		US$/ha	7,214.41	**7,214.41**
VARIABLE COSTS ITEMS			**US$/ha**	**US$/ha**
Prior to harvesting				
a. Labour,	88,35	ld/ha @$1.5	132.53	
b. Seed,	6	kg/ha @$1	6.00	
c. Land Preparation,	89,29	Lits @$1.5	133.94	
d. ***Fertilizer and lime (ex-factor)***				
1) Ammonium Nitrate,	100	kg/ha @$700/t	70.00	
2) Agric. Lime,	250	kg/ha @$360/t	90.00	
3) Transport to wetland area,	350	0.35 @$20/t for 100km	7.00	
4) Insurance,	3%	of total value of fertilizer	5.61	
e. Pest and disease control				
1) Mancozeb,	1	kg/ha @$8	8.00	
2) Endosulfan 35MO,	3	litres/ha @$10	30.00	
3) Oxidiazon 25% EC,	5	litres/ha @$7.5	37.50	
f. Irrigation,	6000	cubic metres	-	
SUBTOTAL			520.58	
Miscellaneous costs, 2%			10.41	
TVC PRIOR TO HARVESTING			530.99	**530.99**
Harvesting and marketing				
g. Labour,	4	days/ton @$1.5	180.00	
h. Tractor,	1	litre/ton	-	
i. Transport,	50	Km @$20/t	600.00	
j. Packing,	50	@$0.30/t	450.00	
SUBTOTAL			1,230.00	
Miscellaneous, 2%			24.60	
TOTAL HARV. & MARKETING			1,254.60	**1,254.60**
TOTAL VARIABLE COSTS			1,785.59	**1,785.59**

Source: Research Data, (2009)

Farmers from the study area were capable of realising, on average, 15 metric tonnes of onion per hectare which was lower than commercial yields (25-35 tonnes per ha) in Zimbabwe (de Jong *et al.,* 1993). A supportive price of US$0,60 per kilogram was common across all the business centres to which farmers were selling their produce. Farmers were capable of realising at minimum, a gross revenue of US$9 000 per hectare as shown in Table 5.1, from each wetland area that was devoted to onion production.

Operational costs were relatively low compared to other crops, with the bulk of the costs (US$1 254,60) incurred during harvesting and marketing. Major variable costs at this level of production were transport, packaging material and labour as shown in Table 5.1. Prior to harvesting there was not much in terms of operational costs with an average total production cost of US$530 per hectare as shown in Table 5.1. Land preparation was the main expensive operation at this stage of production costing, on average, US$133.94 per hectare. Labour was also significantly high, costing on average US$132,53 per hectare.

Despite the claimed lucrative nutritional status of wetland soils, farmers reported that they used fertilizers especially ammonium nitrate and agricultural lime. Farmers reported a significant response of yields to application of ammonium nitrate as the main reason why they used fertilizers since some acknowledged that without applying fertilizers they were able to reap “good yields”. According to local extension officers from Ministry of Agriculture, agricultural lime was mainly used for correctional purposes to address the acidity nature of some wetland soils.

Pests and diseases were major challenges to wetland cultivators due to the surrounding vegetation harbouring insects in wetlands. Costs in the range of US$75,50 per hectare for chemicals were noted for onion production as shown in Table 5.1. Weed challenges were apparent but farmers used mechanical control measures (manual labour) for chemicals proved to be too expensive. No irrigation costs were also incurred by the farmers due to high water table of wetlands throughout the year.

In summary, to produce one hectare of onion under wetland plots, farmers incurred US$1 785,59 as operational variable costs. Under the same conditions farmers were capable of realising gross revenue of US$9 000 per hectare. This would give a gross margin of US$7 214,41 per hectare as shown in Table 5.1. By rule of thumb a positive and high gross margin is ideal and can be a good indicator of profitability. Based on this limited descriptive analysis, onion production can be considered as a viable enterprise under wetland plots as reported by wetland cultivators from Mashonaland East Province.

Table 5.2: Gross margin budget for potatoes

Area	Requirement per ha	Units	1ha	Total Wetland Area (1ha)
1) Yield levels		kg	15,000 (15t)	
2) Selling price		US$/12.5kg	7.50	
3) Gross Income		US$/ha	9,000.00	**9,000.00**
4) Total Variable Costs		US$/ha	4,975.97	
5) Gross Margin		US$/ha	4,024.03	**4,024.03**
VARIABLE COSTS ITEMS			**US$/ha**	**US$/ha**
Prior to harvesting				
a. Labour,	100	ld/ha @$1.5	150.00	
b. Seed,	1000	kg/ha @$2	2,000.00	
c. Land Preparation,	78	Lits @$1.5	117.00	
d. Fertilizer and lime (ex-factory)				
1) Compound S,	1250	kg/ha @$1160/t	1,450.00	
2) Ammonium nitrate	100	kg/ha @$700/t	70.00	
3) Transport to wetland area,	1350	1.35 @$20/t for 100km	27.00	
4) Insurance	3%	of total value of fertilizer	46.65	
e. Pest and disease control				
1) Mancozeb,	1	kg/ha @$8	8.00	
2) Monochrotophos,	2.8	Lits @$7.5	21.00	
f. Herbicide				
1. Dual 720EC,	2.50	Lits @$10	25.00	
g. Irrigation,	5000	cubic metres	-	
SUBTOTAL			3,914.65	
Miscellaneous costs, 2%			78.29	
TVC PRIOR TO HARVESTING			3,992.94	**3,992.94**
Harvesting and marketing				
h. Labour,	0.7	days/ton @$1.5	26.25	
i. Tractor,	0.28	Litres/t	-	
j. Transport	50 km @$20/t		500.00	
k. Packing	50packs @$0.35/t		437.50	
SUBTOTAL			963.75	
Miscellaneous, 2%			19.28	
TOTAL HARV. & MARKETING			983.03	**983.03**
TOTAL VARIABLE COSTS			4,975.97	**4,975.97**

Source: Research Data, (2009)

On average, yields of 15 metric tonnes per hectare were claimed by farmers. These were lower than commercial yields which range between 25 – 30 tonnes per hectare in Zimbabwe (de Jong *et al.,* 1993). A lucrative price of US$7,50 per 12.5 kilogram was common across all the business centres to which farmers were selling their produce. Farmers were capable of realising a revenue of US$9 000 per hectare as shown in Table 5.2, from each wetland area that was devoted to potato production.

Operational costs were quite high with the bulk of the costs (US$3 992,94) incurred prior to harvesting. Major variable costs at this level of production were fertilizer, seed and labour, as shown in Table 5.2. Harvesting and marketing stages had low operational costs with an average total production cost of US$983,03 per hectare. Transport and packaging were the main variables at this stage of production costing, on average, US$500 and US$437,50 per hectare respectively.

Potatoes are heavy feeders in terms of nutrient requirement from a production point of view (de Jong *et al.*, 1993). Despite the claimed lucrative nutritional status of wetland soils, farmers reported using high rates of fertilizers (1 250kg of compound D and 100kg of ammonium nitrate per hectare) as shown in Table 5.2. Late blight was the major disease threatening potential of potato production. Weed challenges were also critical to the extent that, farmers were using both chemical and mechanical weed control measures. No irrigation costs were incurred by the farmers due to high water table of wetlands throughout the year.

In summary, to produce one hectare of potatoes under wetland plots, farmers incurred US$4 975,97 as operational variable costs. Under the same conditions farmers were capable of realising a gross revenue of US$9 000 per hectare. This would give a gross margin of US$4 024,03 per hectare as shown in Table 5.2. The gross margin for potatoes was positive implying that it was profitable but not as profitable as onion production.

Table 5.3: Gross margin budget for tomatoes

Area	Requirement per ha	Units	1ha	Total Wetland Area (1ha)
1. Yield levels		kg	20,000 (20t)	
2. Selling price		US$/kg	0.80	
3. Gross Income		US$/ha	16,000.00	**16,000.00**
4. Total Variable Costs		US$/ha	6,622.76	
5. Gross Margin		US$/ha	9,377.24	**9,377.24**
VARIABLE COSTS ITEMS			**US$/ha**	**US$/ha**
Prior to harvesting				
a. Labour,	200	ld/ha @1.5	300.00	
b. Seed,	6	kg/ha @10	60.00	
c. Land Preparation,	86	Litres @1.5	129.00	
d. Fertilizer and lime (ex-factory)				
1) Compound S,	1000	kg/ha @$1.16/kg	1,160.00	
2) Manure	25000	kg/ha @$0.04/kg	1,000.00	
3) Ammonium Nitrate,	100	kg/ha @$0.7/kg	70.00	
4) Potassium Sulphate	100	kg/ha @$0.7/kg	70.00	
5) Transport to wetland area	1200	1.2 @$20/t for 100km	24.00	
6) Insurance	3%	of total value of fertilizer	39.00	
e. Pest and disease control				
1) Mancozeb,	1	kg/ha @$8/kg	8.00	
2) Dimethoate 40EC	3	litres/ha @$7.8/l	23.40	
3) Wettable Sulphur,	2	kg/ha @$10/kg	20.00	
4) Hustathion,	2	lits/ha @$6/l	12.00	
f. Irrigation,	6000	cubic metres	-	
g. Trellising wire,	420	kg/ha @$3	1,350.00	
h. String,	21	kg/ha @$2.50	52.50	
SUBTOTAL			4,317.90	
Miscellaneous costs, 2%			86.36	
TVC PRIOR TO HARVESTING			4,404.26	**4,404.26**
Harvesting and marketing				
i. Labour,	4	days/ton @$1.5	300.00	
j. Tractor,	0.25	litres/ton	-	
k. Transport	50	50 km @$20/t	1,000.00	
l. Packing boxes,	50	Packs/t @$0.35	875.00	
SUBTOTAL			2,175.00	
Miscellaneous, 2%			43.50	
TOTAL HARV. & MARKETING			2,218.50	**2,218.50**
TOTAL VARIABLE COSTS			6,622.76	**6,622.76**

Source: Research Data, (2009)

On average, yields of 20 metric tonnes per hectare were claimed by farmers. These were lower than commercial yields which range between 75 – 90 tonnes per hectare in Zimbabwe (de Jong *et al.,* 1993). However, a lucrative price of US$0,80 per kilogram was common across all the business centres to which farmers were selling their produce. Farmers were capable of realising a revenue of US$16 000 per hectare, as shown in Table 5.3, from each wetland area that was devoted to tomato production.

Operational costs were quite high with the bulk of the costs (US$4 404,26) incurred prior to harvesting. Major variable costs at this level of production were fertilizer, manure and labour as shown in Table 5.3. Harvesting and marketing costs were also high with an average total cost of US$2 218,50 per hectare. Transport, trellising, packaging and labour were the main variables at this stage of production costing, on average, US$1 000 US$1 350, US$875 and US$300 per hectare respectively.

Tomatoes are relatively heavy feeders in terms of basal dressing from a production point of view (de Jong *et al.*, 1993). Despite the claimed lucrative nutritional status of wetland soils farmers used high rates of fertilizers (1 000kg of compound S, 25 000kg manure, 100kg potassium sulphate and 100kg of ammonium nitrate) per hectare as shown in Table 5.3. Late blight was the major disease threatening potential of tomato production. No irrigation costs were incurred by the farmers due to the high water table of wetlands throughout the year.

In summary, to produce one hectare of tomatoes under wetland plots, farmers incurred US$6 622,76 as operational variable costs. Under the same conditions farmers were capable of realising a gross revenue of US$16 000 per hectare. This would give a gross margin of US$9,377.24 per hectare as shown in Table 5.3. This gives a significantly high positive gross margin worth to indicate profitability of tomato production under wetland plots.

Table 5.4: Gross margin budget for cabbages

Area	Requirements per ha	Units	1ha	Total Wetland Area (1ha)
1. Yield levels		heads	22200 (20t)	
2. Selling price		US$/head	0.50	
3. Gross Income		US$/ha	11,100.00	**11,100.00**
4. Total Variable Costs		US$/ha	4,144.02	
5. Gross Margin		US$/ha	6,955.98	**6,955.98**
VARIABLE COSTS ITEMS			**US$/ha**	**US$/ha**
Prior to harvesting				
a. Labour,	188.54	ld/ha @$1.5/ld	282.81	
b. Seed,	450	g/ha @$0.5/g	225.00	
c. Land Preparation,	95.43	Lits @$1.5/l	143.15	
d. Fertilizer and lime (ex-factory)				
1. Compound S,	1000	kg/ha @$1.16/kg	1,160.00	
2. Ammonium Nitrate,	100	kg/ha @$0.7/kg	70.00	
3. Manure,	25000	kg/ha @$0.04/kg	1,000.00	
4. Transport to wetland area,	1100	1.1 @$20/t for 100km	22.00	
5. Insurance	3%	of total value of fertilizer	36.90	
e. Pest and disease control				
1. Mancozeb,	1	kg/ha @$8/kg	8.00	
2. Dimethoate 40EC,	3	lits/ha @$7.8/l	23.40	
3. Cypermethrin,	0.1	lits/ha @$15/l	1.50	
4. Endosulfan 50WP,	5	kg/ha @$10/kg	50.00	
f. Irrigation,	6000	cubic metres	-	
SUBTOTAL			3,022.76	
Miscellaneous costs, 2%			60.46	
TVC PRIOR TO HARVESTING			3,083.22	**3,083.22**
Harvesting and marketing				
g. Labour,	4	days/ton @$1.5/ld	240.00	
h. Tractor,	0.60	litres/ton	-	
i. Transport		50 km @$20/t	800.00	
SUBTOTAL			1,040.00	
Miscellaneous, 2%			20.80	
TOTAL HARV. & MARKETING			1,060.80	**1,060.80**
TOTAL VARIABLE COSTS			4,144.02	**4,144.02**

Source: Research Data, (2009)

On average, yields of 22 200 heads (20 tonnes) per hectare were claimed by farmers. These were lower than commercial yields which range between 45 – 60 tonnes per hectare in Zimbabwe (de Jong *et al.*, 1993). A lower price of US$0,50 per head was common across all the business centres to which farmers were selling their produce. Farmers were capable of realising a gross revenue of US$11 100 per hectare as shown in Table 5.3, from each wetland area that was devoted to cabbage production.

Operational costs were high with the bulk of the costs (US$3 083,22) incurred prior to harvesting. Major variable costs at this level of production were fertilizer, manure and labour as shown in Table 5.4. Harvesting and marketing costs were also high with an average total cost of US$1 060,80 per hectare. Transport and labour were the main variables at this stage of production costing, on average, US$800 and US$240 per hectare respectively.

Cabbages are heavy feeders in terms of basal dressing from a production point of view (de Jong *et al.*, 1993). Despite the claimed lucrative nutritional status of wetland soils farmers used high rates of fertilizers (1 000kg of compound S, 25 000kg manure and 100kg of ammonium nitrate) per hectare as shown in Table 5.4. A fair share of disease challenges was pronounced costing farmers some considerable amounts towards sprays. No irrigation costs were incurred by the farmers due to high water table of wetlands throughout the year.

In summary, to produce one hectare of cabbages under wetland plots, farmers incurred US$4 144,02 as operational variable costs. Under the same conditions farmers were capable of realising a gross revenue of US$11 100 per hectare. This would give a gross margin of US$6 955,98 per hectare as shown in Table 5.4. This gives a positive gross margin worth to indicate potential profitability of cabbage production under wetland plots. High operational costs under cabbage production possess a great threat to potential profitability of this enterprise amid lower selling prices.

Table 5.5: Gross margin budget for green mealies

Area	Requirement per ha	Units	1ha	Total Wetland Area (1ha)
1. Yield levels		cobs	32,000 (5t/ha)	
2. Selling price		US$/cob	0.50	
3. Gross Income		US$/ha	16,000.00	**16,000.00**
4. Total Variable Costs		US$/ha	1,079.26	
5. Gross Margin		US$/ha	**14,920.74**	**14,920.74**
VARIABLE COSTS ITEMS			**US$/ha**	**US$/ha**
Prior to harvesting				
a. Labour,	29.48	ld/ha @$1.5	44.22	
b. Seed,	25	kg/ha @$2.5/kg	62.5	
c. Land Preparation,	41.46	Lits @$1.5	62.19	
d. Fertilizer and lime (ex-factory)				
1. Compound D,	300	kg/ha @$1.16/kg	348.00	
2. Ammonium nitrate	150	kg/ha @$0.7kg	105.00	
3. Transport to wetland area,	450	0.45 @$20/t for 100km	9.00	
4. Insurance	3%	of total value of fertilizer	13.59	
e. Pest and disease control				
1) Carbofuran,	3	kg/ha @$8	24.00	
2) Monochrotophos,	2.8	Lits @$7.5	21.00	
f. Herbicide				
i. Atrazine,	2.50	Lits @$15	37.50	
g. Irrigation,	5000	cubic metres	-	
SUBTOTAL			727.00	
Miscellaneous costs, 2%			14.54	
TVC PRIOR TO HARVESTING			**741.54**	**741.54**
Harvesting and marketing				
h. Labour,	8.74	days/ton @$1.5	131.10	
i. Tractor,	3.51	Litres/t	-	
j. Transport		50 km @$20/t	200.00	
k. Packing			-	
SUBTOTAL			331.10	
Miscellaneous, 2%			6.62	
TOTAL HARV. & MARKETING			**337.72**	**337.72**
TOTAL VARIABLE COSTS			**1,079.26**	**1,079.26**

Source: Research Data, (2009)

On average, yields of 32 000 cobs (5 tonnes) per hectare were claimed by farmers. These were in line with yields for medium to short seasoned varieties in Zimbabwe (de Jong *et al.*, 1993). A lower price of US$0,50 per cob was common across all the business centres to which farmers were selling their produce. Farmers were capable of realising a gross revenue of US$16 000 per hectare as shown in Table 5.5, from each wetland area that was devoted to green mealies production.

Operational costs were low with the bulk of these costs (US$741,54) incurred prior to harvesting. Major variable costs at this level were fertilizers and land preparation as shown in Table 5.5. Harvesting and marketing costs were much lower with an average total cost of US$337,72 per hectare as shown in Table 5.5. Transport and labour were the main variables at this stage of production costing, on average, US$200 and US$131,10 per hectare respectively.

Green mealies are light feeders in terms of basal dressing from a production point of view (de Jong *et al.*, 1993). Farmers used low rates of fertilizers (300kg of compound D and 150kg of ammonium nitrate) per hectare as shown in Table 5.5. Not much of diseases were pronounced in terms of diseases and pests with the exception of maize streak virus that was perpetuated by the green nature of maize during peak winter when the rest of the vegetation was dormant. No irrigation costs were incurred by the farmers due to high water table of wetlands throughout the year a factor that was critical to the growth of maize.

In summary, to produce one hectare of green mealies under wetland plots, farmers incurred US$1 079,26 as operational variable costs. Under the same conditions farmers were capable of realising a gross revenue of US$16 000 per hectare. This would give a gross margin of US$14 920,74 per hectare as shown in Table 5.5. This gives a significantly high positive gross margin worth to indicate potential profitability of green mealies production under wetland plots. Low operational costs under green mealies production were very lucrative for farmers.

Table 5.6: Gross margin budget for sugarcane

Area	Requirement per ha	Units	1ha	Total Wetland Area (1ha)
1) Yield levels		canes	40,000 (35t/ha)	
2) Selling price		US$/cane	0.20	
3) Gross Income		US$/ha	8,000.00	**8,000.00**
4) Total Variable Costs		US$/ha	2,622.62	
5) Gross Margin		US$/ha	**5,377.38**	**5,377.38**
VARIABLE COSTS ITEMS			**US$/ha**	**US$/ha**
Prior to harvesting				
a. Labour,	101.59	ld/ha @$1.5	44.22	
b. Seed,	8000	kg/ha @$2.5/kg	62.50	
c. Land Preparation,	44.92	Lits @$1.5	62.19	
d. Fertilizer and lime (ex-factory)				
1) Compound D,	300	kg/ha @$1.16/kg	348.00	
2) Ammonium nitrate	150	kg/ha @$0.7kg	105.00	
3) Transport to wetland area,	450	0.45 @$20/t for 100km	9.00	
4) Insurance	3%	of total value of fertilizer	13.59	
e. Pest and disease control				
1. Dieldrin,	2.25	kg/ha @$10	24.00	
2. Carbaryl,	2.8	Lits @$7.5	21.00	
f. Herbicide				
a) Dual,	2.50	Lits @$10	25.00	
g. Irrigation,	5000	cubic metres	-	
SUBTOTAL			714.50	
Miscellaneous costs, 2%			14.29	
TVC PRIOR TO HARVESTING			**728.79**	**728.79**
Harvesting and marketing				
h. Labour,	0.42	days/ton @$1.5	56.70	
i. Tractor,	0.57	Litres/t	-	
j. Transport	50 km @$20/t		1,800.00	
k. Packing			-	
SUBTOTAL			1,856.70	
Miscellaneous, 2%			37.13	
TOTAL HARV. & MARKETING			**1,893.83**	**1,893.83**
TOTAL VARIABLE COSTS			**2,622.62**	**2,622.62**

Source: Research Data, (2009)

On average, yields of 40 000 canes (35 tonnes) per hectare were claimed by farmers. These were much lower compared to commercial yields which range from 50 – 60 tonnes in Zimbabwe (de Jong *et al.*, 1993). Prices of US$0,20 per cane were common across all the business centres to which farmers were selling their produce. Farmers were capable of realising a gross revenue of US$8 000 per hectare, as shown in Table 5.6, from each wetland area that was devoted to sugar cane production.

Operational costs were low with the bulk of these costs (US$1 893,83) incurred post harvesting and marketing. Major variable costs at this level were transport and labour as shown in Table 5.6. Prior to harvesting costs were much lower with an average total cost of US$728,79 per hectare. Fertilizer, seed and land preparation were the main variables at this stage of production costing, on average, US$453, US$62.50 and US$62.19 per hectare respectively.

Sugarcane is a light feeder in terms of basal dressing from a production point of view. Farmers used low rates of fertilizers (300kg of compound D and 150kg of ammonium nitrate) per hectare as shown in Table 5.6. Not much was pronounced in terms of diseases and pests. No irrigation costs were incurred by the farmers due to high water table of wetlands throughout the year.

In summary, to produce one hectare of sugar cane under wetland plots, farmers incurred US$2 622,62 as operational variable costs. Under the same conditions farmers were capable of realising a gross revenue of US$8 000 per hectare. This would give a gross margin of US$5 377,38 per hectare as shown in Table 5.6. This gives a positive gross margin worth to indicate potential profitability of sugar cane production under wetland plots. Low operational costs under sugar cane production were very lucrative for farmers. However, low yields and selling prices were critical factors capable of affecting the potential of sugar cane production under wetland plots in rural areas of Zimbabwe.

5.2 Potential of Wetland Cultivation to Address Household Food Security

This section presents empirical findings on the distribution of food security status of respondents with respect to their wetland cultivation status. The implied objective was to establish the potential of wetland cultivation to address household food security. Although partial inference could be made at this level they are only limited to descriptive statistics. Table 5.7 gives a cross tabulation summary of food security with respect to wetland cultivation at gross food security level.

Table 5.7: Wetland cultivation status with respect to gross food security index

Household Characteristic	**Gross Food Security Index**				**Total**	
	Secure		Insecure			
	Number	% of Total	Number	% of Total	Number	% of Total
Cultivator	121	41.9%	24	8.3%	145	50.2%
Non Cultivator	105	36.3%	39	13.5%	144	49.8%
Total	**226**	**78.2%**	**63**	**21.8%**	**289**	**100%**

	Value	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.701	.030*
N of Valid Cases	289	

*. Significant at 99%

Source: Research Data, (2009)

Seventy eight percent (226 households) of all the respondents were food secure at gross level while 21,8% (63 households) were food insecure. Out of the 78,2% secure respondents 36,3% (105 households) were non cultivators while 41,9% (121 households) were cultivators. Of the 21,8% insecure respondents, 13,5% (39 households) were non cultivators while 8,3% (24 households) were cultivators as shown in Table 5.7. A significant relationship (*p-value:* 0.030) was confirmed between food security of households at gross food security level and wetland cultivation according to the *Pearson Chi-Square* test, although at this level results could not ascertain the strength and direction of the association.

Table 5.8 presents a cross tabulation summary of association between wetland cultivation and food security at net food security level. 37% (107 households) of all the respondents interviewed were food secure at net level while 63% (183 households) were insecure. Of the 37% secure respondents, 0,7% (2 households) were non cultivators while 36,3% (105 households) were cultivators. On the other hand, of the 63% insecure respondents 49,1% (142 households) were from the non cultivator category while 13,8% (40 households) were from the cultivator category as shown in Table 5.8.

Table 5.8: Wetland cultivation status with respect to net food security index

Household Characteristic	**Net Food Security Index**				**Total**	
	Secure		Insecure			
	Number	% of Total	Number	% of Total	Number	% of Total
Cultivator	105	36.3%	40	13.8%	145	50.2%
Non Cultivator	2	0.7%	142	49.1%	144	49.8%
Total	**107**	**37.0%**	**182**	**63.0%**	**289**	**100%**

	Value	Asymp. Sig. (2-sided)
Pearson Chi-Square	156.313	.000*
N of Valid Cases	289	

*. Significant at 99%

Source: Research Data, (2009)

A significant relationship (*p-value*: 0.000) was confirmed between food security and wetland cultivation according to the *Pearson Chi-Square* test, whose direction and strength could not be ascertained at this level of analysis.

Empirical findings show that at gross food security level, a relatively higher proportion (78,2%) of all the respondents regardless of their wetland cultivation status was food secure than at net food security level, (37%) as shown in Figure 5.2. Just a few respondents were food insecure (21,8%) at gross food security level in comparison to 63% of respondents that were food insecure at net food security level.

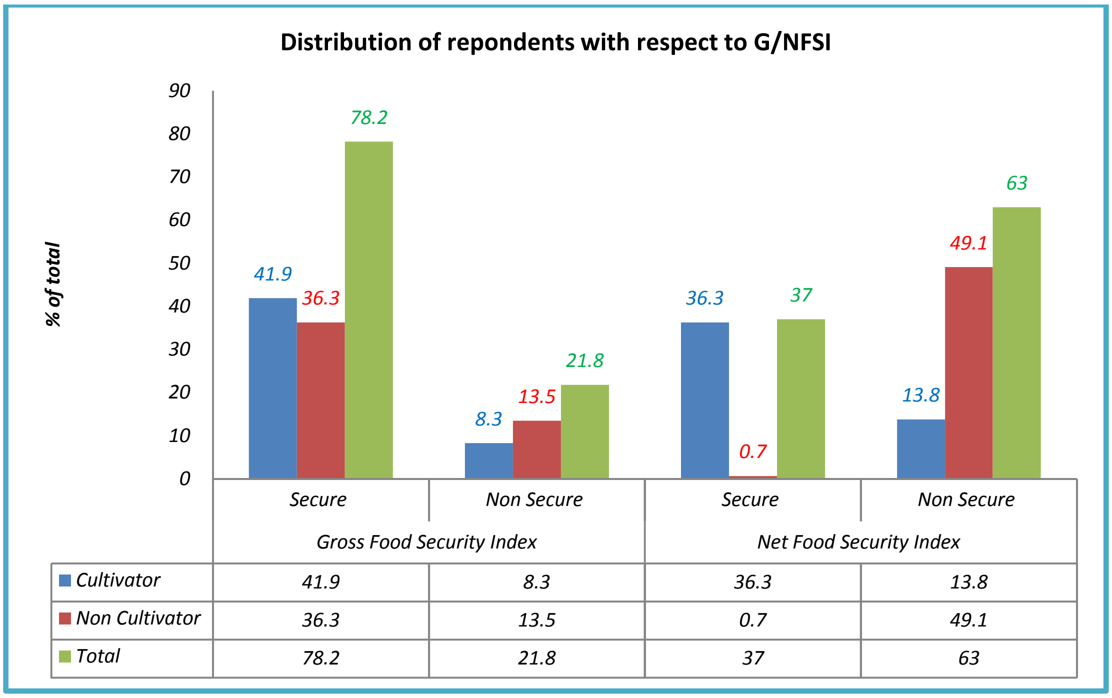
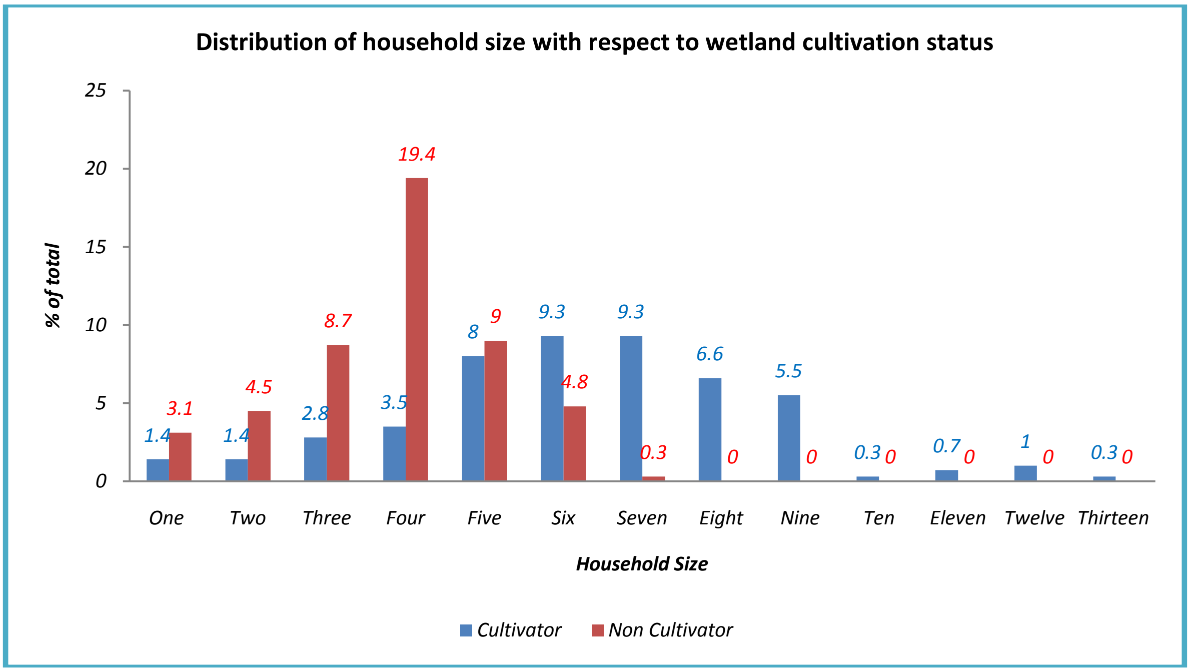


Figure 5.2: Distribution of Respondents with Respect to G/NFSI

A slight difference could be noted between cultivators and non cultivators with respect to food insecurity. To that end, assessing contribution of wetland cultivation to household food security based on gross food security index may portray an insignificant association leading to wrong conclusions. Using the net food security index approach clearly shows the association that may exist between wetland cultivation and household food security as noted by a marked variation between cultivators and non cultivators in Figure 5.2. Based on this limited descriptive analysis a clear association between wetland cultivation and household food security at net food security level was confirmed. However at gross food security level a slight variation in terms of food insecurity between wetland cultivators and non wetland cultivators was confirmed.

5.3 Factors that Influence Households` Participation in Wetland Cultivation

This section presents research findings based on descriptive statistics in as far as factors that influence farmer wetland use choice are concerned. Household size as measured by number of family members within a household was one of the factors expected to be critical towards influencing farmer wetland use choice as explained in Chapter 4. Figure 5.3 presents a cross tabulation graphical summary of household size with respect to wetland cultivation status of households from the sample.



	Value	Asymp. Sig. (2-sided)
Pearson Chi-Square	117.952	.000*
N of Valid Cases	289	

*. Significant at 99%

Figure 5.3: Household Size with Respect to Wetland Cultivation Status

Source: Research Data, (2009)

On average for cultivators, a household size ranging from 4 to 9 family members was common. For non cultivators, a household size ranging from 2 to 6 was common. Non cultivators dominated up to 5 family members while cultivators dominated above 5 family members, implying that the bigger the household size the more that household would want to participate in wetland cultivation.

Household head gender was also investigated its association to participation in wetland cultivation by households as shown in Table 5.9. Of the 298 respondents from the study area 51,9% (150 households) were males while 48,1% (139 households) were females. Table 5.9 gives a summary of household head sex with respect to wetland cultivation status of the respondents.

Table 5.9: Household head sex with respect to wetland cultivation status

Household Gender	Wetland Cultivation Status				Total	
	Cultivator		Non Cultivator			
	Number	% of Total	Number	% of Total	Number	% of Total
Female	41	14.2%	98	33.9%	139	48.1%
Male	104	36.0%	46	15.9%	150	51.9%
Total	**145**	**50.2%**	**144**	**49.8%**	**289**	**100%**

	Value	Asymp. Sig. (2-sided)
Pearson Chi-Square	45.798	.000*
N of Valid Cases	289	

*. Significant at 99%

Source: Research Data, (2009)

From the cultivator category, 41 households (14,2%) were headed by females while 104 households (36%) were headed by males. From the non cultivator category 98 households (33,9%) were headed by females against 46 households (15,9%) headed by males.

Education status of respondents as defined by maximum level of education attendance by respondents (household heads) as explained in Chapter 4 was distributed as shown in Table 5.10. Cultivators were more highly educated than non cultivators in contradiction to findings by Zidana *et al.* (2007).

Table 5.10: Household head education with respect to wetland cultivation status

Household Head Education	Wetland Cultivation Status				Total	
	Cultivator		Non Cultivator			
	Number	% of Total	Number	% of Total	Number	% of Total
Uneducated	11	3.8%	72	24.9%	83	28.7%
Primary level	15	5.2%	29	10.0%	44	15.2%
Secondary level	49	17.0%	33	11.4%	82	28.4%
Tertiary level	70	24.2%	10	3.5%	80	27.7%
Total	**145**	**50.2%**	**144**	**49.8%**	**289**	**100%**

	Value	Asymp. Sig. (2-sided)
Pearson Chi-Square	97.406	.000*
N of Valid Cases	289	

*. Significant at 99%

Source: Research Data, (2009)

Availability and enforcement of wetland cultivation restrictive measures through national laws and local restrictive measures was also considered as a factor that could influence participation of households in wetland cultivation as explained in Chapter 4. Table 5.11 summaries the general distribution of restrictive measures from various areas to which respondents were drawn.

A general decline in number of participants in wetland cultivation was portrayed from low enforcement areas (83 households) to high enforcement areas (2 households) under the cultivator category. A different picture was portrayed under the non cultivator category where more non participants were from areas with medium enforcement (62 households) followed by high enforcement areas (59 households) and lastly low enforcement areas (23 households).

Table 5.11: Restrictive measure with respect to wetland cultivation status

Restrictive Measures	**Wetland Cultivation Status**				**Total**	
	Cultivator		Non Cultivator			
	Number	% of Total	Number	% of Total	Number	% of Total
Low	83	28.7%	23	8.0%	106	36.7%
Medium	60	20.8%	62	21.5%	122	42.2%
High	2	0.7%	59	20.4%	61	21.1%
Total	**145**	**50.2%**	**144**	**49.8%**	**289**	**100%**

	Value	Asymp. Sig. (2-sided)
Pearson Chi-Square	87.255	.000*
N of Valid Cases	289	

*. Significant at 99%

Source: Research Data, (2009)

Table 5.12 summaries the general sample characteristics in terms of measure of central tendency, measure of dispersion and measure of distribution for various household characteristics. The mean and the median did not vary greatly implying that there were no any outstanding outliers for each household characteristic considered in the study. The asymmetry of distribution of household characteristics was both negatively and positively skewed. The following household characteristics were positively skewed;

1) household size,
2) household head age,
3) availability and enforcement of restrictive measures,
4) livestock units and
5) wetland cultivation status.

Household head sex, household head education and distance to wetland area were negatively skewed. Skewness and kurtosis values for all the household characteristics were below 1, indicating that the distribution did not differ significantly from a normal symmetric distribution as shown in Table 5.12.

Table 5.12: Basic sample characteristics

	Mean	Median	Std. Dev	Skewness	Kurtosis
N	289	289	289	289	289
1) Household Size	5.10	5.00	2.24	0.57	0.51
2) Household Head Sex (F=0: M=1)*[1]	0.52	1.00	0.50	-0.08	-2.01
3) Household Head Age	53.71	55.00	20.73	0.52	-1.04
4) Household Head Education (U=0: P=1: S=2: T=3)*[2]	1.55	2.00	1.17	-0.14	-1.47
5) Restrictive Measures (L=1: M=2: H=3)*[3]	1.84	2.00	0.75	0.26	-1.16
6) Distance to Wetland Area (<1km=1: 1-3km=2: >3km=3)	2.15	2.00	0.85	-0.29	-1.56
7) Amount of Livestock	3.52	2.00	2.70	0.76	-0.78
8) Wetland Cultivation Status (Cult=1: Non Cult=2)*[4]	1.50	1.00	0.50	0.01	-2.01

Notes:

*[1]. (2) F=Female; M=Male:

*[2]. (4) U=Uneducated; P=Educated to Primary level; S=Educated to Secondary level; T=Educated to Tertiary level:

*[3]. (5) L= Low; M=Medium; H=High:

*[4]. (8) Cult=Cultivator; Non Cultivator

Source: Research Data, (2009)

5.4 Chapter Summary

Based on descriptive statistics viability of wetland cultivation using gross margins of common wetland cultivated crops from the study area indicated positive gross margins which could be partially associated to viability of wetland cultivation. Some elements of association between wetland cultivation and food security were confirmed. Their direction and strength could not be established using descriptive statistics. Several household socio-economic factors showed some elements of association to wetland cultivation capable of influencing wetland cultivation by households, although the magnitude and direction of the association could not be established at descriptive statistics level. Chapter six presents estimates of the missing strength and direction of association based on analytical models used to analyse the data.

Chapter 6 (Six):

Results and Discussion: Inferred Findings

6.0 Introduction:

This chapter presents research findings, analysis and sub-conclusions for each hypothesis in an effort to address set objectives and operational research questions of the study. In broad terms, the chapter gives an analysis of the economics of wetland cultivation. Results discussed are based on analytical methods and their conformity to the tested hypotheses. An exploration was made on whether the results indicates a significant viability of wetland cultivation to warrant conversion of wetlands into crop lands as a possible land use option applicable to communal areas. The possible connection between wetland cultivation and food security was also investigated using several tests of association and risk estimate ratios. For purposes of policy guidance in the event of devolution of wetland cultivation user rights to communities, the study further explored determinants of wetland cultivation with the embedded goal of gaining a broader knowledge on socio-economic factors that influence participation of households in wetland cultivation.

6.1 Viability of Wetland Cultivation

Viability of wetland cultivation was investigated against a null hypothesis that wetland cultivation was not viable to warrant conversion of wetland area to cropland. Major wetland crops from the study area were assessed and their production costs captured in a Gross Margin format as shown in Table 6.1. Green mealies had the highest gross margin of US$ 14 920,74 per hectare followed by tomatoes with US$ 9 377,24 per hectare. Relatively lower production costs (US$ 1 079,26/ha) for green mealies contributed to the much higher gross margin recorded by these wetland cultivators.

Of interest was the total production cost for tomatoes (US$6 622,76/ha) which was the highest. High gross income for tomatoes was capable of absorbing these production costs still making tomatoes the second largest gross income earner for the farmers. Selling price (US$0,80/kg) and higher yields (20 000kg/ha) were some of the factors contributing to the viability of tomatoes under wetland cultivation. Table 6.1 presents a summary of operational costs, recorded yields, and earned gross margins from the six horticultural crops considered in this study.

Table 6.1: Whole gross margin analysis for crops under wetland cultivation

2009 Production Season	Cabbage (Head/ha)	Tomatoes (kg/ha)	Onion (kg/ha)	G/mealies (cobs/ha)	Potatoes (kg/ha)	Sugarcane Canes/ha)
Area (ha)	1ha	1ha	1ha	1ha	1ha	1ha
Yield (kg/ha)	22 200	20 000	15 000	32 000	15 000	40 000
Price (US$/kg)	0,50	0,80	0,60	0,50	7,50*	0,20
Gross Income (US$)	11 100	16 000	9 000	16 000	9 000	8 000
TVC	4 144,02	6 622,76	1 785,59	1 079,26	4 975,97	2 622,62
Gross Margin	6 955,98	9 377,24	7 214,41	14 920,74	4 024,03	5 377,38

*. Price of potatoes: US$7.5/12,5kg

Source: Research Data, (2009)

Positive gross margins were realised in all the crops grown as shown in Table 6.1 implying their viability. Relating these gross margins to operational costs may be a better indicator of viability of individual enterprises, as suggested by Johnson (1992). The following sections further assess the claimed viability using the multiplier coefficient approach as explained in Chapter 4.

6.1.1 Enterprise Viability based on Return per Dollar Variable Cost Invested

Table 6.2 summarizes a comparative analysis of expansion factors of wetland cultivated crops as weighed against the commercial threshold (MC = 2.5) as explained in Chapter 4. At gross income level cabbage production was viable with a multiplier coefficient (MC) of 2.7. At gross margin level cabbage production was not viable with a multiple coefficient of 1.7. This was mainly attributed to high production costs in the range of US$ 4 144,02 per ha. As for tomatoes at both levels (gross income and gross margin) it was not viable, with the following multiplier coefficients respectively, 2.42 and 1.42.

Onion production was viable at both gross income and gross margin level with the following multiplier coefficients respectively, (5.04 and 4.04). Green mealies production was viable with a multiplier coefficient of (14.82) at gross income level and (13.82) at gross margin level. Contrary at both levels (gross income and gross margin) potato production was not viable, with the following multiplier coefficients respectively, (1.81 and 0.81). Lastly, sugar cane production was viable at gross income level and not viable at gross margin level with the following multiplier coefficients respectively (3.05 and 2.05).

Table 6.2: Return/$VC invested in wetland crops

2009 Production Season	Cabbage	Tomatoes	Onion	G/mealies	Potatoes	Sugarcane
GI/$VC	2.68**	2.42	5.04**	14.82**	1.81	3.05**
GM/$VC	1.68	1.42	4.04*	13.82*	0.81	2.05

**. Significant at gross income level: * significant at gross margin level: Threshold level MC = 2.5

Source: Research data, (2009)

Results reveal a mixed conclusion in as far as viability of the above named wetland cultivated crops is concerned. Figure 6.1 summaries the relative viability of the above named wetland cultivated crops using a radar presentation.

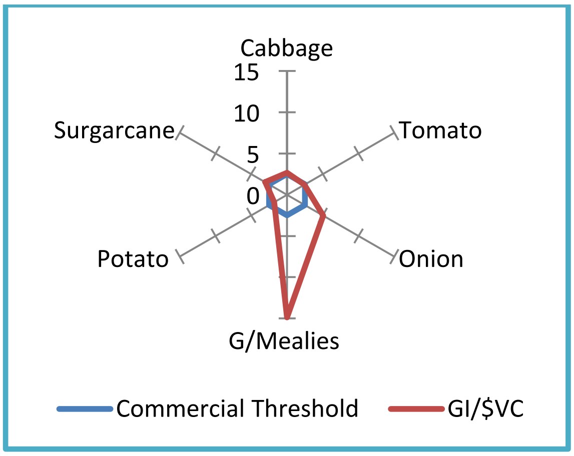


Figure 6.1(a): Relative Viability at GI level

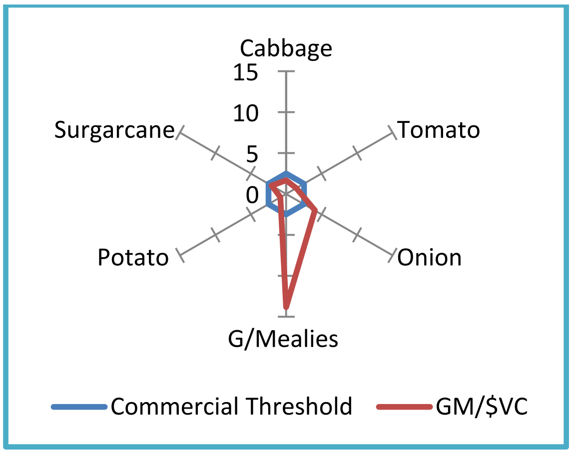


Figure 6.1(b): Relative Viability at GM level

Source: Research data, (2009)

Two crops were entirely viable (onion and green mealies), while on the other hand four crops were purely not viable (tomatoes cabbage, sugar cane and potatoes) based on multiplier coefficients as interpreted at gross margin level of analysis as shown in Figure 6.1(b). Contrary four crops (green mealies, onion, sugar cane and cabbage) were purely viable and only two crops (potatoes and tomatoes) were non viable at gross income level of analysis as shown in Figure 6.1(a). Based on this partial descriptive analysis it was difficult to conclude whether wetland cultivation was viable or not based on a commercial threshold bench mark as suggested by Johnson (1992).

To that end a further analysis was conducted using the *Wilcoxon Signed Ranks* Test to verify the significance of the variation between obtained multiplier coefficients and the commercial threshold coefficient. The objective was to investigate whether the variation between obtained multiplier coefficients and viability threshold coefficient was attributed to chance or non viability of wetland cultivated crops, implying whether the difference was significant or not. Table 6.3 summarizes the test statistics of the *Wilcoxon Signed Ranks* Test conducted.

Table 6.3: Test statistics: *Wilcoxon Signed Ranks* Test

	MC at Gross Income Value – Threshold Value	MC at Gross Margin Value – Threshold Value
Z	-1.153(a)	-.105(a)
Asymp. Sig. (2-tailed)	.249**	.917*

(a). Based on negative ranks

**. Significant at Gross Income level: *. Significant at Gross Margin level

Results reveal that at gross income level the multiplier coefficients of wetland cultivated crops did not differ significantly (*p-value* 0.249) from the commercial threshold multiplier coefficient, implying that there was no significant difference between obtained multiplier coefficients and the commercial threshold coefficient. The same conclusion was true and much stronger at gross margin level as indicated by a *p-value* of 0.917. Although two and four crops did indicate that they were not viable at gross income and gross margin level of analysis respectively, this variation was too weak most probably due to chance according to the *Wilcoxon Signed Ranks* Test to offset the overall viability of the rest of the crops.

In summary, wetland cultivation based on the above named wetland cultivated crops was viable under wetland plots of Mashonaland East Province. Similar results were obtained by

Seyam *et al.* (2001) who noted a significant contribution of wetland cultivation to the GDP of Zambia. Interestingly, the radar presentation explicitly showed that the relative viability of crops differs under wetland cultivation worth noting for recommendations to farmers. Similar conclusions were inferred by Ralph *et al.* (1998) who noted that the economic effect of wetland conversion on the farm sector depended on how much area was converted, types of crops planted and the price offered to farmers from the product market. The gross margin model also clearly indicated the relative importance of operational costs, prices and yields to the general viability of enterprises. Baltezore *et al.* (1989) also noted the same effects, concluding that factors that affect drainage returns were drainage costs, expected production expenses, yields and prices, which were different for each wetland.

6.1.2 Enterprise Viability based on Net Present Value

In an effort to ascertain the overall value of wetland cultivation to society the net present value approach was used as a proxy measure to quantify the overall contribution of wetland cultivation to society an approach also used by Barbier *et al.* (1993) and Maclean *et al.* (2003a). This was possible by aggregating individual wetland plots into a single unit thereby combining operational costs and obtained revenue into a whole farm model for analysis. Expected yearly incremental benefits from the created hypothetical model were projected for a period of ten (10) years.

Using a variable discount factor approach (18% to 24%), yearly incremental benefits were discounted to present values and summed to give an estimate of the net present value of wetland cultivation. Table 6.4 summaries the projected yearly incremental benefits discounted to present values and summed to give an estimate net present value of wetland cultivation to society in the event that government chooses to consider wetland cultivation as an option under rural communities.

Incremental Benefits: (10^{th} year) = "Wetland Cultivation Incomes" projected for 10 years

Discounting factor (n^{th} year) = $1 / (i + r)^{n}$

Discounting factor (5^{th} year) = $1 / (1 + 0{,}22)^{5}$ = 0,36999925

Table 6.4: Net Present Value of wetland cultivation

	Incremental Benefits* (US$)	Variable Discount Factor**		Present Value (US$)
Year 1	8,442.76	18%	0.84745763	7,154.88
Year 2	8,611.35	20%	0.69444444	5,980.10
Year 3	8,869.41	21%	0.56447393	5,006.55
Year 4	9,224.18	22%	0.45139909	4,163.79
Year 5	9,593.15	22%	0.36999925	3,549.46
Year 6	9,976.87	22%	0.30327808	3,025.77
Year 7	10,475.72	23%	0.23478169	2,459.51
Year 8	10,999.50	23%	0.19087942	2,099.58
Year 9	11,659.47	24%	0.14427957	1,682.22
Year 10	12,359.04	24%	0.11635449	1,438.03
NPV/6ha				**36,559.89**
NPV/ha				**6,093.31**

Source: Research Data, (2009) All figures in US$

Key: * **Incremental Benefits**: These are projected incremental wetland cultivation benefits calculated as follows;

1) **Step 1**, Combine individual enterprise wetland crop budgets into a whole farm budget.
2) **Step 2**, Factor in fixed costs in the range of 30% of total production costs
3) **Step 3**, Using a variable inflation factor project expected costs and revenue streams for the next 10 years (2 – 6 % inflation was used in this study)
4) **Step 4**, Subtract corresponding projected wetland cultivation costs from projected wetland cultivation revenue: Since partial valuation approach was considered in this study based on the assumption that partial wetland cultivation was compatible with wetland bio-diversity; no pure wetland conservation incomes were considered.

*[1]**Variable Discount Factor**: The bank interest rate of borrowed capital was used as the discount factor taking into account the following risk and inflation factors;

- The annual discount factor used was a summation of the following factors as suggested by Baker (2000)

1) Annual Interest Rate (10% , November 2009 bank rate)
2) Annual Risk of Loss (6%, November 2009 bank rate)
3) Annual Inflation (2%, November 2009 bank rate)

- During the first 5 years the discount factor was therefore projected to range from 18% - 22%. From year 5 to year 10 the discount factor was projected to range from 22% to 24%.

Results reveal a positive Net Present Value of US$ 6 093,31/ha. It therefore follows that wetland cultivation may be a profitable land use option of economic significance to rural communities. Similar conclusions were inferred by Seyam *et al.* (2001) based on an evaluation study of the Zambezi wetlands in southern Africa, who noted a significant contribution of wetland cultivation (4,7%) to the gross domestic product of Zambia.

Based on current productions from Mashonaland East Province, wetland cultivation has a significant economic premise. Yields were significantly high against low production costs for most crops, especially perennials that exhibit elements of ratooning[35] like sugarcane. This observation was also noted by Rukuni *et al.* (2006) who reported that researchers studying *dambos* in Zimbabwe found that yield per unit of land and water were approximately twice as high as in formal irrigation systems. Small horticultural crops like potatoes and tomatoes were also profitable but with high production costs mainly from fertilizers and chemicals.

The nutrient status of wetland soils was reported to be relatively stable by respondents, who claim to reap significantly high yields year by year without meaningful replacement. Water availability was the major determinant factor behind the success story of wetland cultivation. During late winter and early summers when temperatures are so high wetlands will be having adequate moisture for plant growth. Respondents have cited this combination as the major determinant success factor in wetland cultivation where high heat units are supported by high moisture content, the same success factor in irrigation agriculture. Makombe *et al*. (2001) also noted the same findings concluding that dry-land cultivation was the main alternative production system of communal smallholders, but was only a tenth as productive as the *dambos*. Equally critical in terms of the success story of wetland cultivation is ready market for all products during off peak production by many farmers where prices would be more than twice as under normal production season.

6.2 Potential of Wetland Cultivation to Address Household Food Security

Using non parametric correlation models the magnitude of association between food security (estimated through gross and net food security index of households) and wetland cultivation was investigated. Rigorous statistical attempts were made to ascertain the strength and direction of the association between the two variables. Table 6.5 summaries the *Kendall`s tau_b* and *Spearman`s rho* correlation matrix between wetland cultivation and food security.

Correlation was used initially to give a possible clue on the relationship, with full understanding that correlation does not necessarily imply causation, but rather indicates a

[35] Re-growth after decapitation

systematic relationship which could also imply causation when supported with logical inference. A weak positive correlation was confirmed between wetland cultivation and food security status of households at gross food security level as shown in Table 6.5. Although wetland cultivation and food security status of households indicated a significant positive linear relationship as supported by *Kendall`s tau_b p-value* of (0.030) and *Spearman`s rho p-value* of (0.030), in Table 6.5, the coefficient in both models were (0.128), whose absolute value was not large enough to give a convincing clue of the association. This was also noted by significance of the *p-values* at 95% instead of 99% as shown in Table 6.5.

At net food security level of households a strong positive linear correlation between wetland cultivation and food security was confirmed as shown in Table 6.5. At 99%, both *Kendall`s tau_b p-value* of (0.000) and *Spearman`s rho p-value* of (0.000) were obtained indicating a strong linear correlation between the two variables. A much higher absolute value of the coefficient (0.735) was obtained indicating the strength of the association between wetland cultivation and food security at net food security level. A convincing clue was therefore conferred indicating a systematic relationship between wetland cultivation and household food security. Similar findings were inferred by Seyam *et al.* (2001) who noted a significant contribution of wetland cultivation to the Gross Domestic Product of Zambia`s economy.

Table 6.5: *Kendall`s tau_b* and Spearman`*s rho* correlation matrix between wetland cultivation and food security

			Wetland Cultivation	Gross Food Security	Net Food Security
Kendall`s tau_b:	Wetland Cultivation:	Correlation Coefficient:	1.000	.128*	.735**
		Sig. (2-tailed)	-	.030	.000
		N	289	298	289
	Gross Food Security:	Correlation Coefficient:	.128*	1.000	.231**
		Sig. (2-tailed)	.030	-	.000
		N	289	289	289
	Net Food Security:	Correlation Coefficient:	.735**	.231**	1.000
		Sig. (2-tailed)	.000	.000	-
		N	289	289	289
Spearman`s rho:	Wetland Cultivation:	Correlation Coefficient:	1.000	.128*	.735**
		Sig. (2-tailed)	-	.030	.000
		N	289	298	289
	Gross Food Security:	Correlation Coefficient:	.128*	1.000	.231**
		Sig. (2-tailed)	.030	-	.000
		N	289	289	289
	Net Food Security:	Correlation Coefficient:	.735**	.231**	1.000
		Sig. (2-tailed)	.000	.000	-
		N	289	289	289

*. Correlation is significant at the 0.05level (2-tailed)

**. Correlation is significant at the 0.01 level (2-tailed)

The variation in significance of association at net and gross food security level of households may indicate the weakness in using the gross food security index to distinguish food security status of households. Ideally, no significant association was noted between wetland cultivation and household food security at gross food security level of analysis, while a significant association was conferred at net level of analysis. Probable explanation to this may be based on definitions of gross and net food security index. According to Guveya (2000), a household is food secure at gross food security level when it has enough food (grain) to last until the next harvest season if the household had not sold any of its grain. In practice, all households strive towards having enough food to carry them to the next harvest regardless of their wetland cultivation status. Trying to assess association of wetland cultivation and food security using the gross measure as a unit of analysis may fail to pick up the association for all households to some extent.

The confirmed systematic association between wetland cultivation and food security was further investigated to ascertain the established relationship for further quantification of the strength and direction of the association. This was possible through several tests of association and directional measures as summarised in Table 6.6. Using *Pearson Chi-Square* of association the relationship between wetland cultivation and food security was investigated. A *p-value* of 0.030 was obtained as shown in Table 6.6, inferring a significant association between wetland cultivation and household food security as measured by the gross food security index of households. A much stronger significant association was confirmed at net level of household food security analysis with a *p-value* of 0.000 as shown in Table 6.6.

Using *Goodman & Kruskal tau* and *Cramer`s V* tests the strength of the significance was investigated. At gross food security level of households, low values of the test statistic (*Goodman & Kruskal tau;* 0.016: 0.030 and *Cramer`s;* 0.128: 0.030) were obtained as shown in Table 6.6, indicating a fairly weak association between wetland cultivation and food security. However, at net food security level of households, high values of the test statistic were obtained (*Goodman & Kruskal tau;* 0.541: 0.000 and *Cramer`s V;* 0.735: 0.000) as shown in Table 6.6, implying a strong significant association between wetland cultivation and household food security.

Direction of association was estimated using *Somer`s d* test. At gross food security level a significant positive weak association was confirmed with a *p-value* of 0.029 supported by a weak test statistic value of 0.015 as shown in Table 6.6. It therefore implied that per every increase in participation in wetland cultivation by households a fairly weak increase in household food security at gross level was possible. This was in agreement with earlier tests of strength which indicated a fairly weak association between household food security at gross level and wetland cultivation, with strong association noted at net level.

A strong association was confirmed between wetland cultivation and household food security at net level. High values of the test statistic (*Somer`s d;* 0.735: 0.000) as shown in Table 6.6, were obtained implying that per every increase in participation in wetland cultivation by households a strong increase in household food security at net level was likely. To that end earlier on confirmed linear positive correlation between wetland cultivation and household food security was supported implying that the conferred systematic relationship may mean a worth noting observation that could explain some linkages between the two variables.

Table 6.6: Association and directional measures between food security and wetland cultivation

Food Security Status vs Wetland Cultivation Status	Test of Association (*Pearson Chi-Square*)		Directional and Strength Measures (*Goodman & Kruskal tau*)		(*Somer`s d*)		(*Cramer`s V*)	
	Value	Sig	Value	Sig	Value	Sig	Value	Sig
Gross Food Security Level								
Food Security Status Gross Food Security Index	4.701	0.030*	0.016**	0.030	0.105*[1]	0.029	0.128**	0.030
Net Food Security Level								
Food Security Status Net Food Security Index	156.313	0.000*	0.541**[2]	0.000	0.735*[2]	0.000	0.735**[2]	0.000

*. Significant relationship

*[1]. Significant positive weak relationship

*[2]. Significant positive strong relationship

**. Significant weak relationship

**[2]. Significant strong relationship

In an effort to quantify the meaning of the systematic relationship between wetland cultivation and household food security inferred above, the relative food insecurity risk estimate of wetland cultivators and non wetland cultivators was explored using the odds ratio approach as summarised in Table 6.7 to infer the potential of wetland cultivation to address household food security.

An initial exploration was aimed at investigating the relative food insecurity risky between wetland cultivators and non wetland cultivators. After conferring this relationship the paper went on to probe the significance of the variation between the two groups with the implicit goal of establishing whether non wetland cultivators were more at risk of being food insecure than wetland cultivators, thereby quantifying the inferred systematic correlation between household food security and wetland cultivation.

Results reveal that at gross food security level non wetland cultivators were more at risk of being food insecure but not more than twice (0.751 and 1.405) as shown in Table 6.7, than wetland cultivators. Similar findings which were much stronger were confirmed at net food security level of households, where risk of food insecurity was more than double (0.024 and 4.465) to non cultivators as shown in Table 6.7, than their counterparts (wetland cultivators).

At gross food security level the noted variation on the risk of being food insecure between the two groups was found to be significant (1.057 – 3.317) at 95% confidence interval as shown in Table 6.7. A much stronger significance was conferred at net food security level of households with test statistic values of 44.053 – 788.491 at 95% confidence interval. Based on previous arguments results reveal a significant positive association between wetland cultivation and household food security. Per every increase in participation in wetland cultivation by households a strong increase in food security of households was confirmed, resulting in wetland cultivators being more than twice as food-secure as non wetland cultivators at net food security level. Kambewa (2005) noted similar observations in Malawi, where the author acknowledges that people with access to wetland gardens had an advantage in terms of food availability than non cultivators.

Table 6.7: Relative food insecurity risk estimate between wetland cultivators and non cultivators

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for Gross Food Security Index (Secure / Insecure)	1.873	1.057***	3.317
For Cohort: Wetland Cultivation Status; = Cultivator	1.405	1.003	1.969
For Cohort: Wetland Cultivation Status; = Non Cultivator	.751*	.591	.953
N	289		
Odds Ratio for Net Food Security Index (Secure / Insecure)	186.375	44.053***	788.491
For Cohort: Wetland Cultivation Status; = Cultivator	4.465	3.392	5.878
For Cohort: Wetland Cultivation Status; = Non Cultivator	.024**	.006	.095
N	289		

* .Risk but not more than twice

**. More than twice as risk

***. Indicates significant difference at 95% confidence interval

The major task of the study was to explore possible contributors to the association between wetland cultivation and household food security using logical inference. Two major contributors to the association were noted as possible explanations behind the correlation. In this study food security was defined and estimated by gross and net food security index of households as measured by total quantities of grain (maize and sorghum) available to households. In essence, any technology, system or intervention (wetland cultivation) that addresses availability of grain at household level was noted to be a critical factor in explaining the inferred association.

Umoh (2008), shares the same conclusion based on a study of evaluating contribution of wetland farming to household food security in Nigeria. The author noted that farmers cultivate wetlands to satisfy household food need and to sell produce to supplement their incomes. Umoh, (2008) established that wetland farming contributed more than 56% of total food supply to the household compared to 33% from uplands implying that wetland cultivation was very important for achieving household and indeed national food security of Nigeria.

It therefore follows that wetland cultivators are more capable of attaining higher grain quantities than dry-land non wetland cultivators in rural areas. In essence wetland crops which are purely horticultural are sold or traded in exchange for grain. This improves income levels as noted by Umoh (2008) and earlier on by Kambewa (2005) and grain reserves of wetland cultivators who also have equal plots upland like non cultivators. Non wetland cultivators mainly rely on grain from uplands which may not be enough to cater for households needs throughout the year, hence their relative food insecurity status as compared to wetland cultivators who can supplement grain from uplands with grain bought in using cash incomes from sale of wetland products.

The observed correlation between wetland cultivation and household food security is therefore logical from a rural setting worth pursing to the benefit of society. To that end wetland cultivation can be viewed as a strategic land use option in rural areas that can address household food security from a broader welfare economic point of view. Similar conclusions were also inferred by Thiessen (1975) who noted that there was a positive relationship between the area of *dambo* cultivation by individual families and their socio-economic well-being.

From a policy perspective, Makombe *et al*. (2001) noted that southern African policy makers were rethinking the potential for "wise use" of *dambos* in response to evidence of the economic contributions and benign environmental effects of *dambos*. However the excludability and rivalry nature of wetlands typical of all common pool goods and services makes this dream a mammoth task to accomplish. Instead of using the "invisible hand" to accomplish this dream, a much more complex collective action is required in the name of policy intervention to assist the free forces of demand and supply in efficiently distributing scarce wetlands to the unlimited society's wants.

Critical to the success of transfer of wetland cultivation user rights to society is to first understand socio-economic factors that influence households` participation in wetland cultivation. This would give policy makers an eye opener on the significant socio-economic factors that currently influence households` participation in wetland cultivation and their relative influence. Basing on these factors policy makers would be better informed on how the society is likely to react and adopt such a policy. This also further creates an opportunity for policy makers to target educational campaigns to different groups within the society to increase awareness. The following section estimates socio-economic factors affecting households` participation in wetland cultivation using a logistic binary regression model.

6.3 Factors that Influence Households` Participation in Wetland Cultivation

With regards to model fit, the Lemeshow Goodness-of-Fit test statistic was 1.000, implying that the model`s estimates fit the data at an acceptable level. Since R^2 cannot be exactly computed for Logistic Regression (Norusis, 2004), a pseudo R^2 was therefore computed. *Nagelkerke* R^2 was computed in this study as a proxy estimate to R^2 in OLS regression which according to Norusis (2004), measures proportion of the variation in the response that is explained by the model. In this study, *Nagelkerke* R^2 of 0.98 was obtained indicating that more of the variation was explained by the model with an overall prediction percentage of 98.3 as shown in Table 6.8.

From the seven predictor variables fitted in the logistic regression model, six variables had a significant (household head age, household head education, distance to wetland area, amount of livestock units, household size and availability and enforcement of wetland cultivation restrictive measures) impact on influencing households' participation in wetland cultivation, while one variable (household head sex) was not significant, implying that gender had no impact on influencing household`s participation in wetland cultivation as earlier on noted by Zidana *et al.* (2007) although not supported by Kapanda *et al.* (2005) who confirmed a significant influence by gender.

Of the six significant predictor variables three had positive signs (household head age, distance to wetland area and availability and enforcement of wetland cultivation restrictive measures) implying an increase in either of these variables would be associated with an increase in households` participation level in wetland cultivation and the other three (household head education, amount of livestock units and household size) had negative signs meaning an increase in either of these variables would be associated with a decrease in participation level as shown in Table 6.8.

The positive significant coefficient of household head age indicates its positive influence on participation in wetland cultivation which was as expected. Per every unit increase in household head age, a 0.211 increase in the log odds of participation in wetland cultivation by households holding all other independent variables constant was confirmed as shown in Table 6.8. Similar findings were obtained by Kapanda *et al.* (2005) who noted a significant positive relationship between age of household and the probability of adoption of fish farming in wetlands. Wetlands are state-lands in Zimbabwe, their legal ownership remains with Rural District Councils on which such pieces of land are geographically defined. To that end rural communities enjoy statutory rights to use wetlands as part of a local authority to which collectively they use them as a public good. Those with fields stretching into wetlands have managed to claim "temporal ownership" of wetlands in proximity to their fields although not legally binding. Such "temporal ownership" has grown to levels where at local level communities have agreed to allocate wetlands in relation to household field positions.

In rural areas, older household heads are expected to have better access to land/wetland than younger household heads because younger men either have to wait for a land distribution or have to share land with their families. A significant *p-value* (0.010) in the model confirms this relationship. On most occasions younger households were either reported to have moved to urban areas in search for work given that they comprised the economically active age group, or had migrated to resettlement areas in response to the Land Reform Program since 1980.

The coefficient of household head education was significant but negatively related implying that the more educated the household head would be, the less likely that household would participate in wetland cultivation. Per every unit increase in household head`s education, a 3.556 decrease in the log odds of participation in wetland cultivation by households holding all other independent variables constant was confirmed as shown in Table 6.8. Zidana *et al.* (2007) noted a similar negative relationship between river bank cultivation and education level of households as mainly attributed by the fact that less educated households had less access to non farming incomes hence resorted to river bank cultivation. Educated households enjoy multiple better options to trade their labour as compared to their uneducated counterparts. In essence it would be logical to find uneducated household heads engaging in wetland cultivation for they are limited in terms of their labour trade options. Educated households were on most occasions reported to be working in urban areas.

Table 6.8: Estimated parameters of factors that influence households` participation in wetland cultivation

Predictor Variables:		β:	S.E:	Wald Statistics:	Significance:
Constant	β_0	-16.361	7.558	4.685	.030
a) Household Head Age	β_1	.211	.082	6.556	.010*
b) Household Head Education	β_2	-3.556	1.701	4.369	.037*
c) Distance to Wetland Area	β_3	7.940	3.144	6.377	.012*
d) Amount of Livestock Units	β_4	-1.084	.415	6.832	.009**
e) Household Size	β_5	-1.617	.681	5.634	.018*
f) Household Head Sex	β_6	-4.378	2.356	3.453	0.63
g) Availability & Enforcement of Restrictive Measures	β_7	4.577	2.178	4.416	.036*

1) Chi-Square (df = 7) = 382.371
2) (- 2) Log Likelihood = 18.264
3) Accuracy of prediction; Overall (%) = 98.3
4) Nagelkerke R^2 = 0.98

Note: ** and * indicate significance at 0.01 and 0.05 probability level respectively

On another dimension wetland cultivation is an illegal operation according to the Zimbabwean Environmental Management Act of 2002; elements of risk aversion could also explain a *p-value* of (0.037) with a negative coefficient. Educated households logically would be expected to be more risk averse and sceptical to engage in illegal activities compared to uneducated households. Muchapondwa (2003) observed a similar behaviour as manifested by educated household heads on conservation of wildlife at local level attributing such behaviour to access of information and ability of educated households to comprehend more seriously negative and positive externalities associated with such schemes.

The more distant wetlands are located in respect to fields of households, the more households would want to participate in wetland cultivation because the probability of getting a meaningful yield from uplands decreases with distance from wetlands, *ceteris paribus*. Results therefore indicate that per every unit increase in distance of wetland area from the fields, a 7.940 increase in the log odds of participation in wetland cultivation by households was expected holding all other independent variables constant. The observed positive effect of distance to wetland area on the probability that a household would view wetland cultivation as vital and essential is therefore reasonable. Households with fields near wetlands enjoy spill-over moisture (Peters, 2004) and nutrient effects of wetlands making them realise at least a harvest even under drought conditions. Wetland cultivation to such a category of households would be a secondary issue especially given the illegality associated with wetland cultivation. On the contrary, their distance counterparts face sandy soils and dry conditions in their fields making it difficult for them to realise meaningful yields to support their families. Coping strategies (wetland cultivation) associated with risk taking (illegal wetland cultivation) characterise this group; hence a significant *p-value* of (0.012) with a positive coefficient was obtained as shown in Table 6.8.

Households with higher numbers of livestock units would be expected to be sceptical of wetland cultivation for they weigh grazing benefits to their livestock versus benefits they might get from illegal wetland cultivation. In this study, a negative effect of the number of livestock units in relation to wetland cultivation was realised where per every unit increase in livestock units, a 1.804 decrease in the log odds of participation in wetland cultivation by households, holding all other independent variables constant was confirmed as shown in Table 6.8. Wetland remains the only all year round green areas crucial for livestock survival in communal areas. With persistent droughts ravaging southern Africa dry-land crop production in semi arid areas has been substituted by cattle ranching given that farmers can get milk, meat and cash out of livestock sales. Comparing livestock production and crop production, more effort, risk and inputs are associated with crop production especially under communal setting in arid areas than livestock production. With that background it would therefore be logical to expect households with higher livestock units to distance themselves from wetland cultivation as confirmed by a significant *p-value* of (0.009) with a negative coefficient. Contrary to this conclusion, Kapanda *et al.* (2005) noted a positive relationship between number of livestock and adoption of fish farming in wetlands as explained by synergies that exist between the two variables (use of livestock manure in crops, vegetable gardens and fish ponds).

Household size was significant but negatively related to participation in wetland cultivation. Per every unit increase in household size, a 1.167 decrease in the log odds of participation in wetland cultivation by households, holding all other independent variables constant, was confirmed as shown in Table 6.8. Ideally, scarcity of wetlands and their tricky ownership entails "one household - one piece of wetland area", principle making it difficult to take advantage of the normally expected multiple ownership generic to public goods by large household sizes. Pressure on outputs from wetlands by higher household sized families may far outweigh the labour benefits of large family members making smaller household sized families comparatively better and more willing to participate in wetland cultivation. It would be logical therefore to expect larger household sizes to trade their labour elsewhere, for much of the required labour under wetland cultivation is normally during establishment of the area and once established labour will only be required for watering. Conflicting conclusions were inferred by Zidana *et al.* (2007) who noted a positive relationship implicating this to lack of access to land by large households as a possible reason for the positive correlation. Large families would therefore be expected to invade wetlands in search of land for cultivation.

A significant and positive effect of availability and enforcement of wetland cultivation restrictive measures signals a communication message from society to policy makers. Mutambikwa *et al.* (2000) confirms this relationship where they report a wide invasion of wetlands amid restrictive policies. Per every unit increase in availability and enforcement of restrictive measures a 4.577 increase in the log odds of participation in wetland cultivation by households, holding all other independent variables constant, was confirmed. The message from society points to errors of commission and omission that could have dominated crafting of available restrictive policies. In other words, society is pointing a finger at the potential of wetlands to address their immediate needs hoping to get an accommodative response from policy makers. It would be shocking to note such a sinister observation where a country introduces a new environmental policy and establishes an agency to enforce statutes to restrict wetland cultivation then in practice wetland cultivation increases, as confirmed by Bullock, (1995), Ellis-Jones and Mudhara (1995), Mutambikwa *et al.* (2000) and Muzenda (2001) who acknowledge that contrary to policy objectives rural communities have been cultivating wetlands to an increasing degree. A significant *p-value* of (0.036) with a positive coefficient confirms this relationship implying the strength and direction of the signal of the message from society.

Messages from results presented in this section are four pronged: Firstly, there is a strong signal from society to reconsider the way in which wetland cultivation is treated in Zimbabwe. Current status quo characterised by rampant invasion of wetlands have serious environmental implications in future. No meaningful adherence is given to limits in as far as wetland cultivation with respect to wetland ecology is concerned. Worse still, appropriate wetland cultivation methods are rarely practiced for they are either missing from a research perspective or they are not user friendly from a farmer`s point of view.

Secondly, where devolution of wetland cultivation user rights is to be considered as a possible option, targeting of specific groups within a society will not be an easy task because mixed perceptions dominate the current society making it difficult to rely on specific community groups that would rally behind such a policy. This would have been created by a cocktail of policies that have been introduced, repealed and amended from time to time. Putting such a policy on a referendum where the vote of the majority rules, may risk its rejection since the dominant age groups within societies enjoy secondary[36] benefits of wetland cultivation.

Thirdly, characteristics of households with negative attitude towards wetland cultivation such as the young and highly educated cast a bleak future for wetland cultivation as a possible land

[36] Due to scarcity of wetlands not all rural communities have direct access to their cultivation. Those with direct access to their use are just the minority uneducated older age group. In the wake of introduction of a policy that would regularise their cultivation, the majority, young, educated who does not have direct access may use their voting power to prevent ratification of such a policy.

use option. Ideally, this group is expected to take over current wetland cultivation initiatives in the future. Entrusting this group before eliminating the current perception they hold would compromise the potential of the policy. Targeting this group with informational campaigns remains the only pathway to address the current perception enshrined in the youth and highly educated household heads, because it is easy to convince educated people of the potential benefits attached to wetland cultivation.

Fourthly, scarcity of wetlands in relation to available and yet to be available demand from societies as population increases further warrants careful articulation of practical people driven devolution of user rights to society. Conflict and scramble for wetlands is likely to characterise the whole process. Grouping societies into community wetland cultivation groups pursuing schemes may be the panacea rather than individual ownership of wetland plots as is the current position in rural areas. This approach unites societies and makes it easy for extension service facilities. Conferring user rights under this set up is also easy and manageable. From a credit facility point of view, groups are easy to deal with and track for loan repayment.

Conflict of grazing and wetland cultivation as manifested by a negatively significant relationship between amount of livestock units and participation in wetland cultivation emanates from rapid conversion of forests into crop land. Also increasing population and failure to maintain specific livestock numbers accommodated within the carrying capacities of specific communities may be a contributing factor. Mountains and forests have been converted into crop lands which used to be the traditional grazing areas. No meaningful yields are realized from such land classes depriving livestock their sources of grazing. To counter that, wetlands have been targeted as main grazing areas competing with wetland cultivation. Reserving mountains, forests and river banks for livestock may be a sustainable pathway towards unlocking the created competition of land use in wetlands.

6.4 Chapter Summary

Profitability of wetland cultivation as a possible land use option for wetlands in rural areas of Mashonaland East Province in Zimbabwe was confirmed indicating a significant value attached to wetland cultivation. The confirmed value was also found to be significant and capable of addressing household food security of rural communities. However, the established mixed perceptions regarding wetland cultivation by respondents was conjectured to pose a potential challenge towards regularising wetland cultivation given the negative attitude towards wetland cultivation by the young and educated households who are expected to be the future custodians of wetlands.

Chapter Seven (7)

Research Summary, Conclusions and Policy Recommendations

7.0 Introduction

This chapter summarizes and concludes this study. The chapter is organized in such a way that it first presents a one-on-one mapping of the major objectives that were outlined in the first chapter to the major findings inferred from the analytical chapters. This will lead to the general conclusion of the study and highlights policy recommendations. Lastly, the chapter will expose areas of further study towards closing the gap that currently exist in literature, and explore new areas in the field of environmental economics with the sole objective of unlocking the hidden harvest in natural resources to the benefit of society.

7.1 Research Summary

This section summarizes the major findings from the analytical chapter in order to infer on the major hypotheses and thesis of the study. The broad objective of the study was to investigate the economics of wetland cultivation. In pursuit of this objective, the study focused on the following specific objectives;

The first specific objective was to investigate the viability of wetland cultivation. The fundamental hypothesis to this objective was that wetland cultivation was a viable venture. Major findings drawn from the analytical chapters were that wetland cultivation was viable. Therefore the major conclusion inferred was that wetland cultivation has a significant economic value.

Secondly, the study focused on the potential of wetland cultivation to address smallholder household food security. The principle hypothesis to this objective was that wetland cultivation has a significant potential to address smallholder household food security. The study supported by the analysis conducted discovered that wetland cultivation enjoyed a strong positive linear correlation with food security, where non wetland cultivators were found to be more than double at risk of being food insecure than wetland cultivators at net food security index. The chief conclusion therefore was that wetland cultivation has a significant potential to address household food security.

Thirdly, the study focused on investigating factors capable of influencing households' decision to participate in wetland cultivation. Socio-economic household characteristics including household size, household head age, amount of livestock units and household education were expected to influence households` decisions to participate in wetland cultivation as the main hypothesis. Major findings inferred indicated that household size, amount of livestock units and household head education were significant factors capable of negatively influencing participation of households in wetland cultivation. Household age, distance to wetland area and availability and enforcement of wetland cultivation restrictive measures were also significant factors capable of positively influencing participation of households in wetland cultivation. Household head gender was found to be insignificant in as far as its influence on wetland cultivation participation by households was concerned.

7.2 Conclusions

The study concludes that wetland cultivation under rural setting was viable, with a significant positive linear correlation to household food security to such an extent that wetland cultivators were more than twice as food secure as non cultivators at net food security level of households. Household head age, distance to wetland area and availability of wetland restrictive measures were chief factors capable of positively influencing participation of households in wetland cultivation. Household head education, amount of livestock units and household size were negatively related to participation.

The study therefore calls for promotion of partial wetland cultivation from a rural setting through lifting of the technical ban in wetland cultivation as currently contained in the environmental legal framework of Zimbabwe. Caution however should be taken in crafting transfer user rights amid mixed perceptions from society and general scarcity of wetlands in relation to potential demand from society. The negative relationship between participation and household head education as well as the young households further casts a bleak future for wetland cultivation as a possible land use option in Zimbabwe. The study recommends targeted awareness campaigns to correct current mixed perceptions in societies regarding wetland cultivation and grouping of communities in wetland cultivation schemes to accommodate the potential shortage that can cause scramble and conflict as explained in section 7.3 to follow.

7.3 Policy Recommendations

In this section, current policies shall be reviewed in light of research findings with the sole objective of improving the involvement of scientific research in policy formulation. In theory, scientific findings should be the basis for policy drafts, but in practice and as a general norm especially in African Governments, influence of scientific findings has been so minimal (Campbell and Luckert, 2002).

The Zimbabwean Environmental Management Act as read with Statutory Instrument Number 7 of 2007 provides the legal basis for wetland utilization in Zimbabwe, the former as the main Act and the latter setting standards, *modus of operandi* and level of fines. The Zimbabwean Environmental Management Act repealed the Natural Resources Act and the Public Streams Regulation that maintained a ban on wetland cultivation based on the conventional belief that wetland cultivation would lead to its degradation, using the safe minimum standards (SMS) approach. The Environmental Management Act still technically maintains the ban, for set standards and the *modus of operandi* in as far as wetland cultivation is concerned, as contained in Statutory Instrument Number 7 of 2007 are far beyond the reach of rural communities implying a technical ban has been maintained.

In 1995, ecologists provided an ecological premise in wetland cultivation disputing the general belief that wetland cultivation and wetland ecology were not compatible. A safe threshold was set at 10% of the wetland catchment area, or 30% of the wetland area as practically compatible for wetland cultivation. In this study an economic premise was confirmed and a strong potential of wetland cultivation to address smallholder household food security was also supported. From a sustainable development concept, resource utilization should satisfy an ecological premise supported by an economic basis as well as social equity, to which current research seems to have provided for the benefit of wetland policy crafting.

Under normal circumstances wetland policy formulation should be based on three pillars of sustainable development, so that societies benefit from policies rather than becoming victims of policies. With that background, the following policy recommendations are forwarded to shape current wetland policy towards improving welfare economics of current generation without compromising the ability of future generations to meet their own needs from current wetlands.

- The three pillars of sustainable development, (economic, ecological and social equity) positively support partial wetland cultivation, to which policy formulation should be based, if current generations are to sustainably manage wetlands with an intergenerational equity mind for the future generations.

- Policy conflicts with society imply an element of imposition, where autocracy would have dominated in policy formulation. The main danger lies in errors of commission and omission where in most cases such policies will fail to address the intended problem. Current conflicts in wetland cultivation between society and policy signal errors of commission and omission in the draft of existing environmental statutes.

- Widespread invasion of wetlands also signals lack of policy enforcement at both national and local level. This was mainly witnessed through wetland cultivation by policy makers and enforcers (chiefs) at local level.

- The value attached to wetlands by users of wetlands indicates a true value of wetlands and society`s willingness and ability to protect them. To that end, a people centred approach becomes the only pathway towards formulating wetland policies if ever errors of commission and omissions are to be avoided.

Current environmental policies are skewed towards conservation at the expense of utilization[37]. No utilization incentive is guaranteed to society amidst a wide expectation of a conservational stance, by the same society. Striking a balance between the two (conservation and utilization), provides an income source to wetland users, capable of stimulating users to guard and use wetlands in a sustainable way, since in the user`s eyes, wetlands would mean a

[37] Utilization in this context shall be limited to mean cultivation

source of income and survival. The safe minimum standard approach entails a pure conservation stance where only ecological benefits of wetlands are expected to benefit society culminating into shaping society`s behaviour in terms of wetlands conservation. This approach would work in the developed world, where societies attach more value to leisure associated with undisturbed wetlands than cultivation as noted by Hanley and Craig (1991) based on a study conducted in Scotland (Chapter 2 section 2.5.1). On the contrary African societies attach more value to wetland cultivation than leisure values attached to undisturbed wetlands.

To that end, environmental policies that depend on the safe minimum standard approach as adopted from the developed world, normally miss the gist of the problem leading to policy conflict with stakeholders, who are purely Africans expecting policies to address African needs in the African context, not blue prints from the developed world. An ecological and economic premise confirmed in wetland cultivation by research provides a technical basis for a paradigm shift from policies that are skewed towards pure conservation to policies that balance conservation and utilization so as to create incentives in society to own wetland as valuable resources that warrant conservation, through generating incomes to improve their welfare.

Scarcity of wetland in relation to potential demand from societies warrants careful articulation of devolution of wetland cultivation user rights to societies. Schemes that accommodate more people instead of individual ownership are recommended to instil group ownership hence involving the masses of rural people as partners, to marry conservation with development as well as employing positive rewards in place of bureaucratic regulations as the main instrument of wetland conservation. Targeted educational campaigns are very crucial especially to the young and educated age groups who seem to have a negative attitude towards wetland cultivation. As future custodian owners of tomorrow's natural resources a massive educational campaign to this group is critical to eliminate the current attitude if ever future sustainability of wetland cultivation is to be achieved.

7.4 Areas of Further Study

This section presents gaps in wetland cultivation economics exposing areas of further research with the implicit goal of closing current gaps in literature, towards proving the necessary economic evidence in sustainable wetland economics. Property rights of wetlands as a natural resource in Zimbabwe and most African countries are not that properly defined capable of presenting an occupational issue that may cause serious problems when it comes to ownership cum utilization. To that end economics of wetland cultivation need to be assessed across various property rights regimes, to investigate the most efficient regime implying a regime that gives the best economic premise.

The implicit value attached to pure wetland cultivation by rural society remains unclear. This warrants further investigation into the true value of pure wetland conservation as a possible competing land use option with wetland cultivation, if ever the true picture behind wetland cultivation economics is to be revealed. This approach would imply consideration of pure wetland conservation values at a larger scale to avoid systematic bias from wetland users using a contingency valuation approach as a proxy measure of pure wetland conservation value. Wetlands are also not homogenous; implying that a wider coverage to include several other provinces across the country would be required to confirm viability of wetland cultivation under different wetland eco-systems.

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Annexure 1

University of Fort Hare
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RESEARCH TITLE:

Economics of Wetland Cultivation in Zimbabwe

Case Study of Mash East Province

UFH

KEY INFORMANT QUESTIONNAIRE:

Background Information:

Amon Taruvinga is a postgraduate student from University Fort Hare currently conducting research on "Economics of Wetland Cultivation in Zimbabwe". Your responses shall be treated as confidential information and within the ethics of research for purposes of research and only for research.

Expectations of the Researcher:

Any form of bias, will affect and negate the core objective of this study leading to wrong conclusions; hence you are expected to give correct information.

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Section A

General Information

✓ *Please Tick the Appropriate* √

Name of Enumerator: .... Mr / Mrs / Miss / Dr

Name of Respondent: .... Mr / Mrs / Miss / Dr

Name of Institution: .... Gvt / Para / NGO / RDC

Position: ....

Number of years in service: ≤ 2 years / ≤ 5 years / ≤ 10 years / ≥ 10 years

Section Summary Matrix: (*For Official Use*)

Systematic error check — Recovered / Spoiled

Validity Check — (+ve) / (-ve)

Section B

Crop Production History

(Yes) (No)

1. Do farmers in your district cultivate wetlands

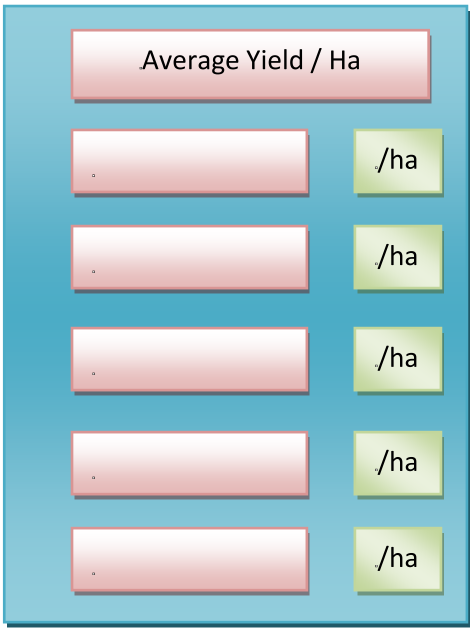
If yes go to question 2, if no go to question 3

2. Which are the main horticultural crops grown in wetlands and their average yields:

Crop	**Average Yield (t/ha)**
(2003 production season)	Average Yield / Ha
1.………………………………………………	/ha
2.………………………………………………	/ha
3.………………………………………………	/ha
4.………………………………………………	/ha
5.………………………………………………	/ha

Crop **Average Yield (t/ha)**

(2004 production season)



1……………………………………………………

2……………………………………………………

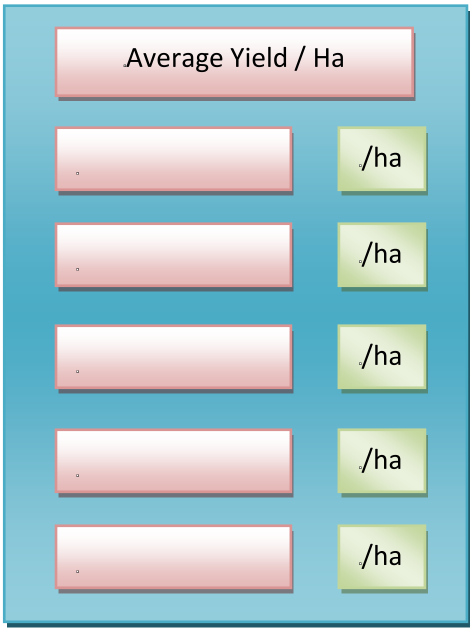
3……………………………………………………

4……………………………………………………

5……………………………………………………

Crop **Average Yield (t/ha)**

(2005 production season)



1……………………………………………………

2……………………………………………………

3……………………………………………………

4……………………………………………………

5……………………………………………………

Crop **Average Yield (t/ha)**

(2006 production season)

Average Yield / Ha

1……………………………………………………… /ha

2……………………………………………………… /ha

3……………………………………………………… /ha

4……………………………………………………… /ha

5……………………………………………………… /ha

Crop **Average Yield (t/ha)**

(2007 production season)

Average Yield / Ha

1……………………………………………………… /ha

2……………………………………………………… /ha

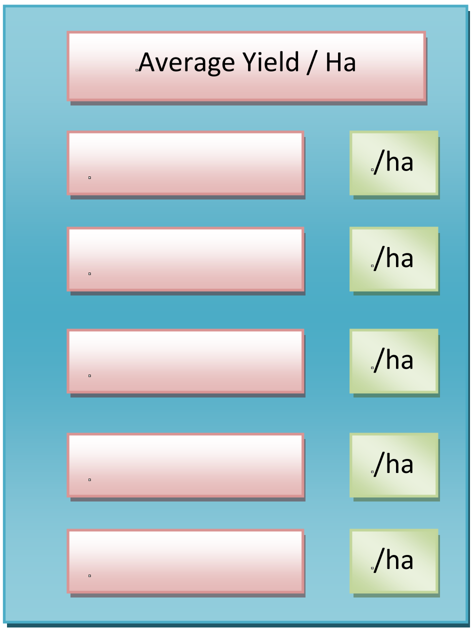
3……………………………………………………… /ha

4……………………………………………………… /ha

5……………………………………………………… /ha

Crop **Average Yield (t/ha)**

(2008 production season)



1……………………………………………………

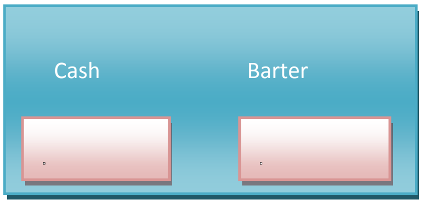
2……………………………………………………

3……………………………………………………

4……………………………………………………

5……………………………………………………

3. What is the most used payment vehicle in your district



(If cash go to Section C; if barter trade go to question 4 and then Section C)

4. List the common goods / services used as barter trade in your district

…………………………………………………………………………………………..

…………………………………………………………………………………………

…………………………………………………………………………………………

Cross the appropriate ◯ χ

Section C

Food Security Crops

1. Indicate the commonly used crops for food security:

	Low	Medium	High
1. Maize ………………….	◯	◯	◯
2. Sorghum………………	◯	◯	◯
3. Finger Millet…………..	◯	◯	◯
4. Rapoko…………………	◯	◯	◯
5. Rice……………………..	◯	◯	◯
6. Cassava…………………	◯	◯	◯
7. Potatoes……………………	◯	◯	◯
8. Pearl Millet………………	◯	◯	◯

2. Rank the most common crops in order of merit

1. ……………………………………………………………………………

2. ……………………………………………………………………………

Proceed to Section D and Finish

Tick the appropriate √

Section D

Factors influencing participation in wetland cultivation

	Low	Medium	High
1. Household size...			
2. Household head sex.................................			
3. Household head education........................			
4. Number of livestock units..........................			
5. Distance to wetland area...........................			
6. Restrictive measures.................................			
7. Plot size..			
8. Awareness campaigns..............................			
9. Rainfall reliability....................................			
10. Upland soil fertility..................................			
11. Wetland size..			
12. Availability of alternative grazing area......			

Thank You for Your Cooperation

Annexure 2: Household Questionnaire

A Identification

Province	District	Ward	IDCODE	
			(1) C	(2) NC

Location of Respondent: A B C

If **IDCODE** is **"(1) C"** proceed to D after C then finish with E; If **IDCODE** is **"(2) NC"** after C skip D and proceed straight to E

B Household Characteristics / C Food Security Index

	Household Size	Household Head Age	Household Head Sex	Household Head Education	Livestock Units	Distance to wetland Area	Availability of Restrictive Measures		Gross Food Security Index	Sales	Net Food Security Index
	1	2	3	4	5	6	7	8	9	10	11
Household Characteristics	Indicate household size	Indicate age of household head	Is household head male or female? 0: Female 1: Male	Indicate level of education of the household head 0: Uneducated 1: Primary level 2: Secondary level 3: Tertiary level	Indicate total number of livestock units *Note*: 1LU = 500kg live mass	How far are households` fields to the nearest wetland area? 1: < 1km 2: 1 – 3km 3: > 3km	How effective are wetland cultivation restrictive measures 1: Low 2: Medium 3: High	Indicate total production (Maize and Sorghum) in kg	Divide total production by requirement to give gross food security status 1: Secure 2: Insecure	Less sales to give surplus (kg)	Divide surplus by requirement to give net food security status 1: Secure 2: Insecure
	A	B	C	D	E	F	G	H	I	J	K
	---------	--------- Years	0 1	0 1 2 3	--------- LUs	1 2 3	1 2 3	-------- kg	1 2	---- kg	1 2

Use D* to solicit for more production information

D Production Summary (wetland crops)

	12	13	14	15
	Indicate crops cultivated in wetlands	Indicate production costs incurred during production per ha (us$)	Indicate market price obtained (us$)	Indicate yield recorded (kg/ha)
	L	M	N	O
1	Tomatoes	US$:......................................	US$:..................	Kg/ha
2	Onion	US$:......................................	US$:..................	Kg/ha
3	Green mealies	US$:......................................	US$:..................	Kg/ha
4	Sugar Cane	US$:......................................	US$:..................	Kg/ha
5	Potatoes	US$:......................................	US$:..................	Kg/ha
6	Cabbage	US$:......................................	US$:..................	Kg/ha

E Numerator

Name	Signature	Date
--------------------------	------------------------- ---------------------	-------/--------/----09---

Economics of Wetland Cultivation: July 2009

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Questionnaire

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Annexure 2: Household Questionnaire

D*

Area	Requirement per ha	Units	1ha	Total Wetland Size (1ha)
6) Yield levels		kg	....	
7) Selling price		US$/kg	....	
8) Gross Income		US$/ha	....	
9) Total Variable Costs		US$/ha	....	
10) Gross Margin		US$/ha	....	
VARIABLE COSTS ITEMS			**US$/ha**	**US$/ha**
Prior to harvesting				
a. Labour,	....	ld/ha @	....	
b. Seed,	....	kg/ha @	....	
c. Land Preparation,	....	Lits @	....	
Sub Total				....
d. Fertilizer and lime (ex-factor)				
5) Ammonium Nitrate,	....	kg/ha @	....	
6) Agric. Lime,	....	kg/ha @	....	
7) Compound D	....	kg/ha @	....	
8) Compound S	....	kg/ha @	....	
9) Transport to wetland area,	....	.... @......../t for.......km	....	
10) Insurance,	3%	Total value of fertilizer	....	
Sub Total				....
e. Pest and disease control				
4) Mancozeb,	....	kg @	....	
5) Endosulfan 35MO,	....	l @	....	
6) Endosulfan 50WP	....	kg @	....	
7) Oxidiazon 25% EC,	....	l @	....	
8) Dimethoate 40 EC	....	l @	....	
9) Monochrotophos	....	l @	....	
10) Cypermethrin	....	l @	....	
11) Carbofuran	....	kg @	....	
12) Dieldrin	....	kg @	....	
13) Carbaryl	....	l @	....	
14) Hustathion	....	l @	....	
15) Wettable Sulphur	....	kg @	....	
f. Irrigation,				
Herbicides				
1. Dual 720EC	....	l @	....	
2. Atrazine	....	l @	....	
SUBTOTAL			....	
Miscellaneous costs, 2%			....	
TVC PRIOR TO HARVESTING				....
Harvesting and marketing				
g. Labour,	....	days/t @	....	
h. Tractor,	....	l/t @	....	
i. Transport,	....	km @ ..../t	....	
j. Packing,	....		....	
SUBTOTAL			....	
Miscellaneous, 2%			....	
TOTAL HARV. & MARKETING			....	....
TOTAL VARIABLE COSTS				....