RESPONSES OF RURAL AGRICULTURAL HOUSEHOLDS TO AGRICULTURAL POLICIES IN SOUTH AFRICA

BY

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I certify that the work reported in this thesis
is my own original and unaided work
except where specific acknowledgement is made.

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CHAPTER 1

INTRODUCTION

Poverty is the greatest challenge to humankind, it affects millions of people, most of whom are in developing countries where the majority are found in rural areas engaged in agriculture. It is estimated that by 1985 there were at least 17 million people in South Africa surviving below the Minimum Living Level (M.L.L) i.e. the theoretical minimum amount of income to ensure minimum subsistence of a human body. Out of these, 11 millions were living in rural areas and were dependent on agriculture in one way or another (Wilson and Ramphele, 1989).

The Government of National Unity is committed to alleviating poverty, indeed it is the central aim of the Reconstruction and Development Programme (RDP) to set South Africa firmly on the road to recovery. Alleviating poverty in the South African context will require an increase in output of the rural sector and in particular the subsistence sector through rural development schemes.

South Africa is characterised by two dissimilar systems within the agricultural sector:

(a) Modern large scale commercial farming and
(b) Small scale farming.

Table 1.1 shows that output per worker in the modern agricultural sector is about twenty fold compared to that in the small scale sector, and productivity per hectare is over three times more than in the small scale sector. The performance of the small scale sector over the years has been lagging far behind that of modern commercial farming, and the trend is not likely to have changed in the 80's and 90's. The poor performance in terms of output per worker

and output per hectare of the rural subsistence sector results in low agricultural income and contributes to widespread poverty in rural areas. This serves as one of the explanations for the rampant poverty in the rural areas of South Africa.

Table 1.1 A comparison of South Africa's modern large and small scale agricultural sectors

Description	Agricultural Sector	
	Modern large scale	small scale
1. Total land area ('000's hectares)	87 795	15 076
2. Percentage cultivated	14%	14%
3. Employment ('000's) 1970	1 126	1 103
4. Output per worker	R1 298	R65
6. Output per hectare cultivated	R119	R34

Source: Nattrass (1990)

Within the former homelands where the bulk of the rural poor live, the relative importance of small scale over commercial farming is seen in table 1.2 where on average the subsistence sector contributes 7.6% of GDP as

compared to the 3.1% of the commercial sector.

The subsistence sector is dominant in all the former homelands. This is an indication that this sector is of vital importance and that the battle to eliminate poverty in South Africa will either be won or lost depending on whether the right agricultural policies are pursued with respect to the upliftment of rural subsistence agriculture.

A comparison of total agricultural earnings from both subsistence and commercial farming with migrant/commuter earnings (table 1.3), reveals that to a certain extent rural agriculture has collapsed and households in these former homelands depend mostly on migrant and commuter earnings (income from those that migrate and those that commute on a daily/weekly basis to work outside the homelands). Causes of the collapse of rural agriculture are numerous and the consequence of this is the wide spread poverty found in these rural areas, especially among the elderly, women and the youth, whose chances of securing jobs as migrant/commuter workers are limited by the nature of the migrant/commuter system which favours young adult males.

Over the years, a large number of varied opinions have been advanced to explain the failure of small scale agriculture to expand its output. These include:

(a) placing the full responsibility of failure on the limiting nature of tribal system and communal land tenure (Hobart 1964),

(b) the central government policy of not supporting the subsistence agricultural sector by providing credit, extension services etc. (Bundy 1972),

(c) the apartheid system that was intended to create a pool of cheap supply of black labour (Legassick 1974).

TABLE 1.2 Contribution of small scale and commercial agricultural production in the former homelands

Homeland	Commercial farming (R'000's)	GDP. (%)	Small-scale farming (R'000's).	GDP (%)
Ciskei	2964	0.7	16600	3.9
Transkei	26700	2.0	137000	10.1
KwaZulu	75000	7.1	133000	12.5
Venda	9141	4.6	17100	8.7
Lebowa	12000	2.2	33000	6.1
Gazankulu	3540	1.5	20310	8.8
Bophuthat-swana	22400	1.9	30000	2.6
Kangwane	8500	7.9	9100	8.5
KwaNdebele	800	1.5	1500	2.9
QwaQwa	2000	1.8	1990	1.8
Total	163045	3.1	399600	7.6

Source: Cobbett (1987)

Although there is no doubt that all aspects of the above mentioned factors do exert limiting effects on economic development of the rural areas, it should not be seen that eliminating these factors only, will increase the productivity of the rural small scale agricultural sector. In order to increase the performance of the subsistence agricultural sector, we need to look beyond the above mentioned causes of low productivity potential, i.e lack of development assistance, the limiting nature of tribal systems and apartheid policies. A new and better way of viewing farm household decision-making can contribute to our understanding of the nature of the socio-economic

constraints to increase production of the small scale agricultural sector.

TABLE 1.3 A comparison of agricultural earnings with migrant and commuter earnings in the former homelands (1985)

Homeland	Total migrant & commuter earnings (R'000's)	Total agriculture earnings (R'000's)	Agriculture earnings as a % of Household earnings
Ciskei	449625	19564	6.6
Transkei	1588423	163700	31.2
KwaZulu	3028582	208000	8.7
Venda	205790	26241	22.8
Lebowa	1121126	45000	7.3
Gazankulu	307168	23850	15.7
Bophuthatswana	1671247	52400	5.4
Kangwane	382180	17600	6.9
KwaNdebele	361651	2300	1.3
QwaQwa	258093	3990	4.2
Total	9373886	562645	10.1

Source: Cobbett (1987)

Realising the need to redress the imbalance, rural development projects are initiated in order to alleviate poverty by increasing production in the small scale agricultural sector, while at the same time recognising the

importance of, improved nutritional levels, basic services like water, health, education, etc. in the rural areas. This conception of rural development led countries like Zambia which relied heavily on mining before attaining its independence, to pursue agricultural policies whose objectives among others, were: (Mudenda, 1989)

(a) the expansion of agricultural production to achieve self-sufficiency in staple foods and provide raw materials for the development of agro-industries,

(b) the creation of employment and income opportunities in the rural sector in order to counter rural-urban migration,

(c) the rapid integration of smallholder farmers into the market economy,

(d) provision of adequate and nutritional food at reasonable low prices and,

(e) the diversification of exports through the expansion of agricultural products in order to broaden the sources of foreign exchange earnings which are dependent on mineral exports.

After pursuing the stated objectives above for two decades, Zambia's agricultural policy results were far from satisfactory. Agricultural exports remained stagnant, agricultural imports, mainly foodstuffs increased and the overall quality of life especially for the rural sector remained below what should be considered the minimum basic needs (Mudenda, 1989). The basic problem was that of not knowing how the pursued policies would affect rural households or how rural households would respond to such external factors. This was coupled with the fact that production and consumption policies were designed and implemented separately.

It can be argued that the agricultural policies within the Reconstruction and Development Programme of the African National Congress (ANC) as outlined in the agricultural policy document, have more or less the same policy objectives as those of Zambia stated above. Hence the manner in which agricultural households will respond to government intervention (in the form of agricultural policies) is a critical factor in determining the relative merit or success of these policies. If the stated objectives above are implemented outside the household economics (i.e ignoring the response of agricultural households to the agricultural policies) the result may not be different from that of Zambia.

Statement of the problem

Alleviating poverty in the rural sector of South Africa will require rural strategies to increase output. If rural development policies are pursued with a view to compensating for sector imbalances between the two agricultural sectors, ignoring rural household economics, the results may not be all that desirable given the experience of Zambia even if the agro-climatic conditions are favourable. The issue is not that these rural development strategies are not necessary, but rather that they are not sufficient. The success of any rural agricultural development policy pursued will depend on its incorporation of the socio-economic constraints. Policy makers intervene in the agricultural sector through, for example, pricing policies, investment projects, rural infrastructure, credit availability, land reforms etc. These policies are designed to generate revenue and improve rural income as well as self-sufficiency in food, by influencing production and consumption decisions. The manner in which agricultural households respond to such intervention is an important factor in determining the success of these policies.

It is therefore essential to know what factors

determine the level of production and demand for farm input, what factors govern consumption and supply of labour and how the behaviour of the household as a producer affects its behaviour as a consumer and supplier of labour and *vice versa*. This requires the incorporation of production and consumption in the analysis of responses of agricultural households to external factors (agricultural policies).

In a study on agricultural household modelling in a multicrop environment in Nigeria, It was found that the price elasticity of own consumption of millet and sorghum was negative when production and consumption are separated and positive when integrated (Singh and Subramanian 1986). In the same way the price elasticity of rice with respect to own consumption produced similar results in a study on Korean households. In a separate study, Barnum and Squire (1979) found the same results with respect to Malaysian farm households.

There is therefore ground to argue that a study that integrates production and consumption, and captures the various complexities of the rural agricultural households is required in order to understand how South Africa's rural agricultural households are likely to respond to various rural development policies. This may lead to proper policies being implemented that will uplift the standard of living of the rural household and alleviate poverty in the rural areas.

Objectives of the study

The objectives of the study are :

(a) to analyze the impact of changes in output prices on the supply and demand for household labour, and retained output,

(b) to analyze the effect of changes of the wage rate on the demand and supply of labour,

(c) to analyze how agricultural household

characteristics affect demand/supply of labour.

The remainder of the study is organized as follows: chapter two will analyse the sample data, chapter three will review the theoretical models of farm households, chapter four will discuss the results of the study and finally the conclusions and policy implications are drawn in chapter five.

CHAPTER 2

RESOURCES OF RURAL AGRICULTURAL HOUSEHOLDS

"Analysis of the social, cultural and economic environment of a community is an essential prerequisite in developing strategies for successful agriculture and community development. Often insufficient understanding of needs and aspirations of particular farming societies are cited as the major reasons for the failure of many agricultural development programmes and projects in less developed societies" (Brembridge 1986). Conventionally farm management studies have commonly sought to explain variations in output in terms of such factors as farm size, labour and capital inputs. These factors however exclude the human element which is a key factor in agricultural development. Land, capital inputs and technology are also important but, to be developed, organised and fully utilised, rational decision making is required which also depends on the characteristics, resource availability (utilisation) and decision making of the farming households that are discussed in this chapter.

Background information

The agrarian economy of South Africa in the mid 19th century comprised of large scale white farmers and small scale black farmers. Land was plentiful, the technology used was simple and labour was the most critical factor in the success of farming. Despite their small scale operations the black farmers were able to compete effectively against the larger scale white farmers. The relative inefficiency of large white farmers implied low profitability and resulted in difficulty of offering wages

sufficient to attract black labour away from their own small farms. This led to labour shortages for large scale white farmers.

The labour shortage kept African small scale farmers competing effectively leading the larger scale white farmers to persuade the government of the day to intervene on their behalf. The government responded by:

(a) setting up small overpopulated black homelands (reserves) to create artificial shortages of land for black farmers forcing them to seek work not only on white owned farms but also in the mines,

(b) limiting competition between African small scale and large scale white farmers in the market place by not allowing the former to join state sponsored co-operatives or farmer's unions, and without such membership it became increasingly difficult to secure credit, market output, or obtain extension services.

A combination of the above factors began to erode the development of small scale African farmers and gradually they declined to their present state.

The present agrarian structure of the former homelands is inflexible, with households falling into four basic categories in terms of resource access and commercial orientation (Nicholson and Brembridge, 1991). These are:

(a) Resource-poor households with no arable land or grazing rights comprising about 31% of the total households,

(b) Small holders, who operate at below subsistence levels and who usually do not sell produce (56%),

(c) Small scale farmers, who sell produce and/or livestock some of the time (13%),

(d) Market orientated commercial farmers, who make a living from farming (0.2%).

Given the legacy of the past racially based policies, the former homelands today are overcrowded, poverty stricken and lack infrastructure compared to the former

white republic of South Africa. Resource endowment of the former homelands is recognised to be poor by design, for example, total arable land available per capita ranges from 0.08 hectares in Qwaqwa to 0.27 hectares in Bophuthatswana (World Bank Report, 1994). Although some of the former homelands generally receive abundant rainfall, steep terrain, lack of resources and technical knowhow of soil conservation reduces the amount of arable land. In some cases areas of land allocated for cropping purposes are in fact not arable or are of low quality. Transkei (one of the former homelands) which was previously thought to contain a significant share of arable land, is now believed to have only 50% of its land arable, the balance being marginal with high erosion propensity (van Rooyen *et al* 1990). Although, it is argued that a large proportion of the former homeland's arable land is left uncultivated every year, it has been noted that such areas are heavily stocked with livestock thus making it difficult for farming. It is obvious that the comparatively low productivity of small scale rural agricultural households is a result of decades of oppressive apartheid policies which artificially boosted the viability of larger scale white farming.

Characteristics of the sample population

The data used for this analysis are from the living standard and development survey (LSDS) conducted by the Southern African Labour Development Research Unit, University of Capetown (UCT) in 1993/4. The South African household survey is a large and complex multilevel data set. It is very comprehensive, it covers both rural and urban households. The data collected by systematic stratified sampling covers a wide range of issues and it includes: household demographic characteristics, crop and animal production, household labour force, income by source as well as it's distribution, expenditure by category,

availability of clean water, sanitary conditions and educational levels of members of households.

In preparing the data for this analysis, focus was on black rural households that engage in agriculture on a small scale. The data set for this study represent the rural small scale agricultural households that do sell some of their produce. These households were extracted from the original LSDS data set according to the size of land available to the household. Caution was taken not to include households that were cultivating more than five hectares. It was felt that such households were far beyond a typical rural small scale agricultural household. To avoid problems of diversity in crop pattern, households that are situated in more or less the same agro-ecological areas were chosen. The result is the 166 households covered in this study and are from some of the former homelands namely; Ciskei, Transkei, Kwazulu and Kangwane.

The basic unit of observation as per this study is the rural household and it is defined to include all the people who occupy the same homestead and pool their resources together but may not necessarily have any kin relationship. It excludes members of the household that have settled elsewhere and are no longer financially linked to the other members left behind. It does however include those who migrate or commute for work and return home occasionally and do remit money back to their households. The household in question forms one work team under the guidance and the direction of one leader namely the head of the household.

South Africa's agricultural population at present may be divided into two groups in terms of commercialisation in agricultural production. At one extreme are the white commercial farms that are heavily capitalised, use modern technology and have strong market orientation coupled with large farm size. At the other extreme are the black rural households operating small farm units, with weak market links, and with an average size of one hectare, are much smaller than the average commercial farm. The farm

populations covered in this study are small scale farmers, whose production and consumption choices are expected to be strongly interdependent.

Household demographics

Rural areas in particular those of the former homelands are over-populated and overcrowded. Transkei the oldest homeland, by 1985 had 92.5% of it's population in the rural areas and only 7.5% was urbanised. It had an overall average household size of 5.2 persons and for the rural areas the figure ranged from 4.6 to 8.2, more than half of the population (55.8%) were outside the labour force (Kayemba 1992).

The average household size for the sample was found to be almost eight persons per household. Table 1 (Appendix II) shows that 45% of the households had more than the average household size of 8. This is an indication that rural households are more than just nuclear family households and are closer to the extended family unit. This is consistent with the normal rural agricultural household setup in South Africa and elsewhere.

Table 2 (Appendix II) shows that the number of dependants (defined as any member of a household below the age of 15 years) on average was 3.4 and the average number of workers in table 3 (adults above the age of fifteen) was 4.6 for the sample. However caution should be taken with regards to the average size of workers for a household, as the number given above includes even those who are above the age of 15 but are not yet participating in the labour force either being in educational institutions or otherwise, as well as those above the age of 64 who are already retired. These average figures of 3.4 and 4.6 illustrate the high dependency burden that faces the agricultural rural household (i.e. ratio of those below 15 and those above 15) and for the sample 43% are below the age of 15 years old. This is consistent with the findings

of Muller and Tapscott (1985) in their study of rural Transkei where 48.9% of the rural population was found to be below 14 years of age.

Characteristics of rural small scale farmers

Rural small scale farmers in South Africa are quite distinctive from commercial large scale farmers. Small scale farmers are mostly women and part-time farmers who derive only a portion of their gross income from farming. This portion ranges from 5 to 30% at most (Coetzee 1991). Brembridge (1986) found that out of his sample of 538 households, 60% were headed by women, and 45% of household heads were over 50 years of age. Some of his findings are indicated in table 2.1 where it is shown that sex, knowledge, level of education of the head of the household and the size of land are all significantly correlated to the crop yield.

TABLE 2.1 Correlation of household characteristics with crop yield

Factors	Total crop yield
Age of farmer	0.06*
Female farmer	0.12**
Farmer's education	0.13**
Knowledge of crops	0.31**
size of arable land	0.18**
Crop sales	0.20**
Outside employment	0.08*

* Significant α = 10%

** Significant α = 5%

Source: Brembridge (1986)

Most if not all rural small scale farmers do not have title deeds to the land they work on. This means that

their borrowing potential for long term credit is limited by lack of collateral assets. Contrary to the traditional settlement pattern found elsewhere, where small and intensive farmers are near urban centres and large extensive farmers lie in outlying and remote areas, in South Africa the majority of small farmers are situated on the geographical and economic periphery (former homelands) where most of the necessary support services are lacking. Large extensive farmers are near urban areas where the necessary infrastructure is readily available.

Survey information on small scale farmers indicates that the average level of formal education is low ranging between standard one and standard three. They mostly produce for home consumption and few have surplus for the market (Brembridge 1986).

Land availability and productivity

An assessment of the prevailing situation in South Africa's two agricultural sectors highlights the different environment or milieu in which they operate. The commercialised farming sector generally operates under firm business principles and encourages commercial production while comprehensively supported by:

(a) specialised institutions and organisations such as the Land Bank, agricultural marketing boards and co-operative movements,

(b) subsidized access to water resources and a range of other direct and indirect subsidies, tax concessions and massive financial assistance and in general benefits from a highly developed infrastructure.

For example according to Lipton (1977), from the government expenditure budget of two billion rand, 1.7 billion rand was allocated to white large scale farming and the remaining 0.3 billion was allocated to black small scale farming. Out of the total transfer payment in the

budget, 96.7% went to white farmers. Moreover, the rural small scale agricultural sector operates largely outside the comprehensive institutional support structure, has restricted access to available credit facilities, land and extension services.

Land availability in rural areas of South Africa especially the former homelands poses a serious problem for most of the households in these rural areas. This is a result of past land policies that discriminated against the Black rural agricultural households. A comparison of white large scale commercial agriculture and rural small scale black agriculture reveals that the commercial sector covers about six times the land area covered by the subsistence sector (Cobbett 1987). This land shortage was brought about as a result of government policies that introduced the migrant labour system which allows migrants from overcrowded rural areas of the former homelands to retain land for cultivation that is insufficient to allow any farming for cash purposes. However, it was assumed that the land was sufficient for the subsistence needs of the households.

Land in the rural homelands is organised under the following land tenure systems:

(a) communal tenure,
(b) quitrent tenure and
(c) trust tenure.

In all the tenure systems, an adult married male is in principle entitled to a residential site, arable land and grazing land that is shared by the community but in practice, is only awarded such land if it is available. People have no title deeds for the land they occupy and selling, renting or leasing is strictly prohibited except under quitrent where selling may only be possible if the buyer has no allotted piece of land. Such a purchase has to be sanctioned by the magistrate on behalf of the minister concerned. The most common method of passing on land is through inheritance from father to son, usually the

eldest one. This excludes females from inheriting land. Such types of land tenure systems give people rights of occupation rather than those of ownership.

The rapid growth of the rural population over the years has forced further fragmentation of the existing land into even smaller plots that are not economically viable for agriculture. Unlike the rural black agricultural sector, the private land tenure system or what is commonly known as freehold tenure exists only in the white commercial agricultural sector. Under this system an individual who owns land has a title deed, is entitled to sell if he/she wishes and thus provides the owner with a considerable degree of security of tenure. The average acreage for a rural household in the former homelands is one hectare or less as compared to the rest of South Africa where the average is over 20 hectares per household (Fenyes, van Zyl and Vink, 1988).

Table 4 in Appendix II illustrates that for the sample of 166 households in this study, the average size of land for each household is 1.16 hectares and 64.8% cultivate less than 1 hectare whereas only 3.4% households have access to more than 3 hectares.

In table 2.1 it is indicated that the size of arable land is positively correlated with the total crop yield therefore the shortage of land in rural areas severely constrains output. One indicator of the severity of the land shortage in the former homelands is the ratio of arable land to rural population, only in the case of two former homelands Kangwane (0.25) and Bophuthatswana (0.27) does the ratio exceed 0.2 hectares per resident. The rest of the former homelands registered 0.10 arable hectares per resident or less. By way of contrast the ratio in the white areas ranges from 1.37 hectares/resident in Natal to 2.87 in the Cape (World Bank 1994). Such extreme densities in the former homelands severely constrain agricultural development potential and accentuates their role as labour reserves.

Inspite of substantial increases in production levels mainly through project investment in rural agriculture, indications are still that the productivity gap between rural small scale agriculture and commercial large scale farming has been widening (Christodoulous and Vink 1990). Table 7 in Appendix II shows that the average output per hectare for the sample is almost 372 Kg per hectare, although more than 50% produce less than 300 Kg per hectare. The productivity gap between rural small scale and commercial large scale agriculture is not surprising given the prevailing conditions in both sectors.

Aside from poor access to credit, transport, extension services and land, the household characteristics in Table 5 in Appendix II show that almost 60% of the household heads are above the age of 50 years old and in table 8 (Appendix II) almost 70% of the household heads have formal education ranging from 0 to 4 years. Tauer (1995) indicates that productivity, of an individual, generally increases by about 5% to 10% every 10 years up to the maximum at the age of between 35 - 44 years and then decreases at the same rate thereafter. In another separate study in Transkei, Brembridge (1986) concluded that progressive small scale farmers tend to be in the younger age groups, have a relatively high level of education, readily adopt modern technology and have a higher level of managerial skills. He also found out that rural small scale agricultural households headed by men on average tend to produce higher output than those headed by women.

It should therefore not be surprising that the productivity of rural agricultural households is low and should not be viewed as inefficient vis a vis the commercial farming sector. The picture presented by agriculture in South Africa is diverse in nature with commercial farming dominating the scene. The question is whether restructuring the agricultural sector in South Africa will be able to reverse this observed phenomenon. This question can be tackled if one is in position to

access the response of the rural agricultural households to the inevitable changes in agricultural policies.

CHAPTER 3

LITERATURE REVIEW OF FARM HOUSEHOLD MODELS

Microeconomics traditionally separates the economy into firms and households. The firm is designated as the unit where production takes place and the household as a unit where consumption takes place. Consequently two separate theories were developed:

(a) the theory of consumption and,

(b) the theory of the firm.

The theory of the firm is used to analyze production decisions and the theory of consumption to analyze household consumption decisions. Such dichotomy however, may only be meaningful where the production and consumption units are functionally separate. This may not always be the case, particularly among agricultural households where production and consumption decisions are integrated. In such a context the incorporation of production-consumption linkages may be fundamentally important to the overall understanding of farm-household economic behaviour.

The modern theory of household economics as it stands today originated from the work of Becker (1965), Lancaster (1966) and Muth (1966). Their approach represented a fundamental reformulation of the theory of consumer choice. The essence of their reformulation is that consumers do not directly maximise their utility by consuming the best combination of goods, but that a two stage process is involved. In the first stage the household uses goods as inputs in a production function to generate more basic commodities. In the second stage consumers choose the best combination of these basic commodities in the conventional way of maximising utility functions.

In the years that followed there was a renewed interest in economics over and above early attempts to develop a theory of firm and household economic behaviour that would recognise the interactional aspect of production and consumption decisions. One of the earliest attempts at modelling farm household economic behaviour that recognised the functional relationship between production and consumption is that of Chayanov (1966). Through his concept of the labour consumer balance, he argued that the peasant family farm, using subjective equilibria seeks equilibrium between production and consumption. This type of model is applicable to households which do not employ hired labour nor sell surplus output. Therefore its behavioral motivation and subjective equilibrium is bound to be different from that of any other type of farm household that hires/sells labour and/or sells surplus output.

Nakajima (1969) presented a mathematical model of Chayanov's work, in which he classified the farm household on the basis of the degree of subsistence production and the proportion of family labour input on the farm. He classified household on the basis of family labour and hired labour input into:

(a) farm household (family farm) and,
(b) firm farm (farm firm).

And on the basis of output consumed at home and output sold into:

(a) subsistence production firm and,
(b) commercial firm.

Using the characteristics of agriculture as an industry namely:

(a) the technical characteristics of agricultural production,
(b) the characteristics of the farm household as an economic unit,
(c) the characteristics of agricultural products as goods.

These in conjunction with the concepts of, "labourer's household" (a household which aims to maximise its utility by performing only wage income generating activities at a given wage rate), the "consumers household" (a household which holds a certain amount of money income already acquired by some means and which engages only in consumption activities to maximise utility). He defined the farm household as an economic unit which is a complex of the farm firm, labourer's household and consumer's household, and whose behavioral principle is utility maximisation.

From his classification he formulated the following models:

(a) a purely commercial family farm without a labour market,

(b) a purely commercial family farm with a competitive labour market,

(c) a semi-commercial family farm, family labour and a single product and

(d) a semi- commercial family farm with family labour and two products.

The complexity of rural households and the difficulty in applying the above models have resulted in combining some of these models, producing synthetic models which take into account the difference in labour, off-farm employment, production and consumption patterns that prevail in different parts of the rural agricultural sector. The wide application of the synthetic models as used by Singh *et al* (1986) can be attributed to the fact that much of the work that has been carried out to date relates to the rural sectors where agriculture is predominantly of a small scale by nature. Recent applications of the household models have generally been built around the synthetic basic model that takes into consideration only one agricultural output, market purchased goods and leisure (home time). Such models were used in early empirical endeavours to investigate and

understand the agricultural household.

The basic model

A household is assumed to maximise a utility function

$$U = U(X_a, X_m, X_l) \quad \ldots\ldots (1)$$

Where:

X_a = agricultural staple
X_m = market purchased goods
X_l = leisure (home time)

The utility function is maximised subject to:

(a) a cash income constraint

$$p_m X_m = p_a(Q - X_a) - w(L - F) \quad \ldots\ldots (2)$$

Where:

p_m = price of market purchased goods
p_a = price of agricultural staples
Q = household's production of the staple
F = family labour input
w = wage rate
L = total labour input

(b) a time constraint

$$X_l + F = T \quad \ldots\ldots (3)$$

Where:

T = total stock of household time

(c) the production constraint or production technology that depicts the relationship between inputs and outputs

Where:

$Q=Q(L,A)$ ..... (4)

A = households fixed quantity of land

By substitution and re-arranging of terms it can be shown that the following relationships hold (Singh *et al* 1986).

$$F = (T - X_1) \quad \text{.....(5)}$$

$$p_m X_m = p_a [Q(L, A) - X_a] - w[L - (T - X_1)] \quad \text{.....(6)}$$

$$p_m X_m = P_a Q (L, A) - p_a X_a - wL + wT - wX_1 \quad \text{.....(7)}$$

$$p_m X_m + p_a X_a + w X_1 = p_a Q (L,A) - wL + wT \quad \text{.....(8)}$$

$$p_m X_m + p_a X_a + w X_1 = w T + \pi \quad \text{.....(9)}$$

Where:

$$\pi = p_a Q (L, A) - w L \quad \text{.....(10)}$$

and is a measure of household farm profit.

The left hand side of equation (9) measures the total household expenditure on the three items X_a, X_m, and X_1. And the right hand side is Becker's concept of full income, which is equal to wT (the value of the household stock of time) and the profit level of the farm household. The household decides the level of labour input into agricultural production and this determines the profit level. The profit level in return determines the level of consumption of the three commodities: leisure, agricultural staple and purchased goods. The household equates the

marginal revenue product of labour to the wage rate, i.e $P_a.MP_l=w$ (the price of the agricultural staple times the marginal product of labour will be equated to the wage rate).

Subsequent household models are extensions of the basic model built to account for different structural specifications that are characteristics of the rural agricultural sector in developing countries. Singh and Subramanian (1986) extended the basic model to account for the variety of crops that are produced to meet family consumption needs and markets in Korea and Nigeria respectively. Korea uses irrigation in a multicrop environment whereas in Nigeria (Kaduna), the environment is semi-arid and lacks irrigation facilities which creates a problem of uncertainty of output. To hedge against the uncertainty, farmers plant a variety of crops. In both models like in the basic model a household is assumed to maximise utility.

$$Max.U=U_{(x)}=(X_a,X_m,X_l).....(11)$$

Where:

X = a vector of items consumed (composed of a vector of agricultural staple X_a, a vector of market purchased goods X_m, and leisure X_l).

Subject to:

$$[I]A_i \leq R_i \qquad i=1....k \qquad .....(12)$$

Where:

[I] = is an (1 x n) unit vector

A_i = is an (n x 1) vector of land use by crop and technology on the i'th type of land and A is

(m x 1) vector of A_i

R_i = is the maximum available quantity of the i'th type of land

$$PX = \pi A + Z + E \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

Where:

P = is a (1 x h) vector of prices of consumed goods including leisure

π = is a (1 x m) vector of net returns to fixed factor (after labour costs have been excluded), by crop, technology and land type

Z = full income (Beckers concept) and equals the market value of total time available to the household plus any net non-labour income

E = is any non-farm non-labour (exogenous) income

Although both studies were carried out in different environments both show that results from integrated models (those that treat production and consumption of a household together) produce results different from those that treat production and consumption of a household separately.

Table 3.1 Selected elasticities to test the significance of the integrated household models: Korea (1970)

	Elasticity of					
	Own consumption of the crop		Non-food purchases		Labour supply	
With respect to	i	ii	i	ii	i	ii
Price of rice	-0.18	0.01	-0.19	0.81	0.03	-.13
Price of barley	0.00	0.06	-0.02	0.30	0.00	-.05
Price other crops	0.00	0.12	0.00	0.57	0.00	-.09
Wage rate	0.16	0.01	0.77	0.05	0.00	0.11

KEY: i = elasticities computed when production and consumption are separate

ii = elasticity computed when production and consumption are integrated

Source: Singh & Subramanian (1986)

The results in tables 3.1 and 3.2 show that the elasticities of own consumption of rice (Korea) and sorghum (Nigeria) when profit is constant, are consistent with the traditional demand theory which treats the household as a

consumer only, hence the signs are negative -0.18 and -0.05 respectively. Integrating both the production and consumption side of the household changes the elasticities to positive 0.01 for rice and 0.19 for sorghum. The implication is that increasing/decreasing the price of a staple will increase/decrease own consumption of the staple.

Table 3.2 Selected elasticities to test the significance of the integrated household models: Nigeria (1976/77)

	Own consumption of millet		Own consumption of sorghum		Non-food purchase		Labor supply	
With respect to	i	ii	i	ii	i	ii	i	ii
Price of millet	-.08	.07	-.5	.08	-.15	.23	.08	-.02
Price of sorghum	-.09	.19	-.05	.19	-.14	.57	.03	-.06
wage rate	.03	.01	.06	.06	.04	.01	.01	.10

KEY: i = elasticities computed when production and consumption are separate
ii = elasticity computed when production and consumption are integrated

Source: Singh & Subramanian (1986)

The model also highlights the elasticity of the supply of family labour. The traditional demand theory suggests that an increase in wage rate would result in a negative or zero response of family labour supply as it increases the income of the household. The integrated model shows that an increase in wage rate results in a positive or more elastic response with respect to labour supply (0.11 and 0.1 for Korea and Nigeria respectively), as it increases cost on the production side and reduces farm profit. Such changes in signs and magnitude of elasticities have policy implications e.g traditional economic theory predicts that an increase in the price of a home produced and consumed agricultural staple reduces own consumption and increases the surplus for the market, hence increasing the household's income for other non-agricultural essential commodities. Any policy pursued based on such a theory is likely not to succeed as it ignores the response of the household.

Strauss (1984) used the integrated model to explore the effect of prices and income on household nutrient availability of different income groups in Sierra Leone. The model provided the responses of food consumption to prices and income needed to derive the nutritional effect of government policies. The study focused on calorie availability to the household and its responsiveness to changes in income and food prices. The results are summarised in table 3.3

Table 3.3 Elasticities of calorie availability with respect to prices in Sierra Leone (1984)

With respect to price of	Expenditure group	Profit constant	Profit variable
Rice	low	-0.58	0.19
	middle	-0.38	-0.24
	high	-0.28	-0.20
	mean	-0.38	-0.26
Root crops and other cereals	low	-0.03	0.43
	middle	-0.04	0.13
	high	-0.06	0.11
	mean	-0.05	0.15
Non food	low	0.008	0.12
	middle	-0.02	0.03
	high	-0.02	0.01
	mean	-0.02	0.04
Labour	low	1.2	0.59
	middle	0.57	0.40
	high	0.45	0.33
	mean	0.56	0.41

Source: Strauss (1984)

In the table the results show that there is a marked difference in using the integrated model when determining calorie availability. When profits are held constant,

increasing the commodity price results in decreased caloric availability, except with respect to non-food prices for the low expenditure group. When profit is varied an increase in price will increase the caloric availability for non foodstuffs and root crops of all expenditure groups. For rice an increase in price will only increase caloric availability for the low expenditure group. The policy implication is that an increase in the price of root crops, other cereals and non-foods will increase the caloric availability for all expenditure groups whereas an increase in the price of rice (a staple food) will result in an increase in caloric availability for the low income groups only. The major effect of a price increase (rice) being a decrease in levels of malnutrition among the poor.

The integrated farm household model was used to determine the demand and supply of funds among agricultural households in India (Iqbal 1986). The same model was also used to examine the impact of agricultural pricing policy on income in Senegal (Braveman and Hammer 1986). Barnum and Squire (1979) extended the basic model by incorporating household characteristics using linear expenditure system to examine the effect of increase in prices, on output, marketed surplus, and income distribution. All of which have got welfare effects on households. The linear expenditure model has its shortcomings among which are the following:

(a) the model assumes linear Angel functions, a specification that is not readily supported by evidence except only over a short range of variation of expenditure,

(b) the model assumes perfect substitutability between hired and family labour and between home produced and market purchased goods. Such stringent conditions may not approximate the reality in rural areas, except where both goods and labour markets function properly,

(c) the model assumes that decisions are made sequentially, production decisions first and later

consumption decisions and also that there are no risks and uncertainty.

Never the less the model does incorporate household characteristics in determining household response elasticities, a factor that makes it more appealing especially in rural areas where these characteristics do influence to a large extent production and consumptions patterns.

While household economic theory has been applied to a certain extent in other parts of the world, it has not yet been applied widely in Southern Africa, whereas its potential for the analysis of household activities is likely to be beneficial to policy implementation. In his development paper, Low (1982) formulated a household model to determine the impact of changes in technology on increasing farm output in Swaziland.

The major difference in Low's adapted model and the conventional household model is that in his model a household produces to satisfy some of its subsistence requirements and purchases the balance, unlike in the conventional household model were the household produces for the market and retains some for consumption at home. His approach to household economics is based on the Z_i goods approach which assumes that a household combines time and marketed goods in the production of the basic goods, Z_i which are not marketable and enter directly into their utility functions. This implies that a household will behave as a cost minimising firm in the production of subsistence household goods and as such a household member with the lowest earning potential will be the one in charge of Z_i production. This justifies why agriculture in the rural areas is left to the elderly, less educated and the younger people whose earning potential is lower than that of the others.

Low rejected the household models of Nakajima, Barnum, Squire and others on the grounds that:

(a) they are applicable to farm households that

produce for sale and retain some of their output for own consumption, whereas the prevailing situation in Swaziland is such that each household produces to satisfy some of its requirements and purchases the balance,

(b) the calculation of farm profit using a single household wage rate to cost family labour employed on the farm,

(i) represented a gross simplification of reality in the rural Swaziland household. According to Low, "In 1979 mine employment, open to younger adult males, paid E125 per month; the average unskilled wage in Swaziland was E80 per month and domestic servants (women's work) received E50-60 per month. Children from 10-16 years, who provided significant labour inputs on the farm, are unlikely to obtain any wage employment other than seasonal work such as cotton picking" (Low 1982).

(ii) is at variance with Swaziland's rural household which is subsistence in nature and uses its own labour according to its internal equilibrium not determined on profit maximising principles but on equating marginal family demand with marginal drudgery involved in meeting the family demand.

In a different study on agricultural marketing, Lyster (1990) used discriminant analysis to determine factors that influence the sale of surplus production in KwaZulu. His conclusions were that:

A rural household will engage in surplus sales where:

(a) the land area tends to be bigger than that of households which do not engage in surplus sale,

(b) it receives agricultural information from extension officers,

(c) the household head is not engaged in full time wage employment and
(d) the distance travelled to purchase fertilizers is not too far.

With the conclusion of Lyster's study it is recognised and generally accepted that rural households in South Africa engage in surplus sale. Therefore using Low's formulated household model would not be appropriate in this instance for the following reasons:

(a) Low's assumption that a household produces agricultural products solely for subsistence to augment the market purchased foods is not correct given Lyster's conclusions,
(b) the application of the Z_i good theory in the South African context is not appropriate as the theory assumes that the Z_i good is not marketable,
(c) given the high unemployment level in the rural areas and the low chances or probability of getting a job in the formal sector, one would be tempted to use the same wage for all the sectors i.e. the agricultural, manufacturing and service sector.

CHAPTER 4

PRODUCTION AND CONSUMPTION RESULTS

In this chapter the production and consumption functions of a semi-subsistence rural household are estimated. The production function is estimated in order to derive a profit function (Appendix I) which is incorporated in the estimated consumption function to determine the demand functions of, own consumption of maize (c), market purchased goods (m) and the labour supply (s) functions. Linking the production and consumption functions along the lines as shown in Appendix I will enable the determination of response elasticities of the rural households.

The production function

The production side of the rural farm household model is estimated using a specified Cobb-Douglas production function of the form:

$$F=\alpha_0 A^{\alpha_1} D^{\alpha_2} V^{\alpha_3} K^{\alpha_4} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.1)$$

Which is estimated in the form of

$$\text{Ln } F = \ln \alpha_0 + \alpha_1 \ln A + \alpha_2 \ln D + \alpha_3 \ln V + \alpha_4 \ln K$$

Where:

A = area of land in hectares used in F production
D = total labour input
V = variable input (fertilizers)

K = flow of capital services

F = output of maize

The results of the estimated function are indicated in the table 4.1 below.

TABLE 4.1 Estimated parameters of the production function for a rural household in South Africa.

coefficient	estimates	T-ratio*
α_0	15.14	8.3
α_1	0.53	7.1
α_2	0.21	8.6
α_3	0.16	4.7
α_4	0.06	3.7

* all parameters significant at 10%

Source: model results

The estimated production function is:

$$F=15.14A^{0.53}D^{0.21}V^{0.16}K^{0.06}.....(4.2)$$

R^2 =68.46 F =35.04

The production function in equation 4.2 indicates that rural households are subjected to a constant return to scale, and this may be a result of various factors among which are:

(a) steep terrain which has reduced the arable land available for farming forcing the expanding population to occupy the marginal land that is poor with high soil erosion propensity,

(b) poor knowledge of farming practice combined with limited access to land, agricultural extension

services as well as lack of proper tools.

The results of table 4.1 also indicate that among the factor inputs, output is more elastic with respect to land (α_1=0.53) and least with capital (α_4=0.06). Altering the size of land will affect output of maize more than altering labour, fertilizers and capital emphasizing the shortage of land for the rural agricultural household as shown in chapter 2.

Land distribution in South Africa is skewed in favour of large scale commercial farmers (chapter 2) and the limited land available to the rural household farmers forces them to maximise output (profit) with respect to labour, fertilizers and capital. With land fixed, the profit function can be written in terms of prices of labour, capital and fertilizers as outlined in Appendix I, resulting in a profit function of the form:

$$\Pi = 0.53 p \alpha_0^{1/\alpha_1} \left(\frac{4}{\prod_{j=2}} \alpha_j^{\alpha_j} \right)^{1/\alpha_1} . A . \left(\frac{p}{w} \right)^{\alpha_2/\alpha_1} . \left(\frac{p}{w_v} \right)^{\alpha_3/\alpha_1} . \left(\frac{p}{w_k} \right)^{\alpha_4/\alpha_1} \ldots (4.3)$$

Where:

p = price of maize
w = wage rate
w_v = price of fertilizers
w_k = price of capital

Which can be written after substituting the results of table 4.1, and simplifying into the form :

$$\pi = 39.1 A \left(\frac{p}{w} \right)^{0.4} . \left(\frac{p}{w_v} \right)^{0.3} . \left(\frac{p}{w_k} \right)^{0.11} \ldots\ldots\ldots\ldots\ldots (4.4)$$

The profit function in equation (4.4) is a component of

household income and influences consumption and labour supply decisions.

The consumption function

Estimating the consumption function determines which household characteristics influence the demand functions of own consumption of maize, market purchased goods and supply of labour. The results of the estimated consumption function are combined with the profit function obtained from estimating the production function to determine response elasticities. In this analysis the structure of the consumption side of the model is specified using the linear expenditure system (LES)(see Appendix I). Estimation of LES is done by first estimating single equations for each category i.e. labour supply, retained output (maize) and market purchased goods to determine the initial value for the iteration procedure. The derivation of the estimating equations is presented in Appendix I.

The estimating equations can be represented in a matrix notation as:

$$\begin{bmatrix} -ws \\ pc \\ qm \end{bmatrix} = \begin{bmatrix} b & 0 & 0 \\ 0 & b & 0 \\ 0 & 0 & b \end{bmatrix} \cdot \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \end{bmatrix} + \begin{bmatrix} w'(\beta_1 - 1/k) & -p\beta_1 & -q\beta_1 \\ w'\beta_2 & p(1-\beta_2) & -q\beta_2 \\ w'\beta_3 & -p\beta_3 & q(1-\beta_3) \end{bmatrix} \cdot \begin{bmatrix} \gamma_s \\ \gamma_2 \\ \gamma_3 \end{bmatrix}$$

where:

w = wage rate

s = labour supply per family worker

p = price of maize
c = per capita own consumption of maize
q = price of market purchased goods
m = per capita market purchased goods
γ_i = vector of household characteristics (i = s, 2, 3)
β_i = marginal budget share of commodity i (i = s, c, m)

Where:

$$\begin{bmatrix}\gamma_s\\ \gamma_2\\ \gamma_3\end{bmatrix} = \begin{bmatrix}\delta_{10} & \delta_{11} & \delta_{12} & \delta_{13} & \delta_{14}\\ \delta_{20} & \delta_{21} & \delta_{22} & \delta_{23} & \delta_{24}\\ \delta_{30} & \delta_{31} & \delta_{32} & \delta_{33} & \delta_{34}\end{bmatrix} \cdot \begin{bmatrix}1\\ n_1\\ n_2\\ e\\ a\end{bmatrix}$$

and

n_1 = number of working family members
n_2 = number of dependants
a = age of household head
e = number of years of education received by the household head

The imposed restriction that the marginal budget share be equal to one implies that only two equations need to be estimated. With the preliminary results obtained all coefficients that were not significant were dropped and the system was re-estimated using Shazam that has the Newton-Algorithm used to estimate a system of equations iteratively. The final results obtained are reported in table 4.2.

The result of table 4.2 indicates that the age of the household head (a) does not influence the household's demand for market purchased goods (qm), own consumption of maize (pc) and supply of labour (ws) (i.e δ_{14}, δ_{24}, δ_{34} were found not to be significant at 90% confidence level).

Also δ_{21} and δ_{31} were not significant at the same level indicating that the number of working family members does not affect γ_2 and γ_3. The results of table 4.2 also indicate that dependants (n_2) do influence the labour supply, retained maize and market purchased goods ($\delta_{12}, \delta_{22}, \delta_{32}$ are all significant at 90%). The biggest percentage of the marginal budget share goes to market purchased goods (β_3=0.72) as opposed to retained maize (β_2=0.1) and labour supply (β_1=0.303).

TABLE 4.2 Estimated parameters of the linear expenditure system for a rural agricultural household in South Africa

COEFFICIENT	estimates	T-ratio
β^a_1	0.303	-
β_2	0.1	13.2*
β_3	0.72	10.59*
δ_{10}	31.2	8.58*
δ_{20}	28.9	1.84**
δ_{30}	106	2.68*
δ_{11}	10.5	4.57*
δ_{12}	-4.62	-4.2*
δ_{13}	1.4	3.29*
δ_{22}	20.1	1.85**
δ_{23}	3.5	3.39*
δ_{32}	-35.7	-2.79*
δ_{33}	4.7	1.8**

[a] Derived from the restriction that $k\beta_1+\beta_2+\beta_3 = 1$. In calculating β_1, k was set at its mean value of 0.575.

* Significant at α = 5%

** Significant at α = 10%

Source: Model results

Since estimation was carried out using per capita terms, the household's demand functions for the retained output (maize) and market purchased goods, as well as the supply function for labour were derived from the estimated equation by multiplying the supply function by the number of working family members ($-n_1$) to make the household labour supply positive and the demand equations by the family size (n), the system resulted in the following equations:

$$wS=-0.18(\pi+R)+1091.88+126.1n_1-255.85n_2+51.66e \quad ...(4.5)$$

$$pC=.1(\pi+R)+131.97+15.44n_1+258n_2+9.45e \quad .....(4.6)$$

$$qM=.72(\pi+R)+1222.79+110.76n_1-263n_2+42.19e \quad .....(4.7)$$

Where:

R = non-wage, non-crop net other income

The results in equations (4.5), (4.6) and (4.7) indicate the effects of household characteristics namely: adult working family members (n_1), dependants as those below the age of 15 years old (n_2) and the level of education of the household head (e) on the supply of labour, own consumption of maize and market purchased goods. Household characteristics affect demand and supply equations in two ways. Firstly, they affect the commodity composition of demand as well as the supply of labour given the full income. Secondly, they change the level of full income, since adults can work or take leisure (home time). Dependants are assumed not to work, they do not affect full income, however they do change the commodity composition of goods demanded.

Equation (4.5) indicates that the supply of labour is positively related to the number of adults and the level of education but negatively related to the number of dependants. An additional adult on average contributes to

the supply of labour by about R126.10 whereas a dependant reduces the supply of labour of the household by about R255.85. An increase in the level of education by one year increases the supply of labour of the household by about R51.66. Such results are expected given the prevailing conditions in the rural areas of South Africa where disguised unemployment is common and as such adults spend some of their time in the form of home time (the time that is not spent in directly productive and labour market activities). This involves activities such as family maintenance (like cooking, fetching water and wood, as well as tending house), socialisation (relationship with the family and with neighbours, and the community, festivals, religious practices) and leisure (relaxation, pleasure and sleep). This may account for the low contribution of the adults to the supply of labour. On the other hand dependants reduce the household supply of labour greatly as expected since it is assumed that dependants consume all their available time in the form of home time. The low response of education levels to the household supply of labour can partly be explained by the low average level of education that was found to be 3 years (chapter 2) and in such a case the level of education is expected to contribute less to the household supply of labour since the propensity to get a job in urban areas is low for those with low education levels.

On the basis of the sample data used, equation (4.6) indicates that adult working family members (n_1), dependants (n_2) and the level of education (e) all affect positively the retained output (maize). However a dependant increases retained maize by more than twenty times that of an adult working family member. This is likely to be explained by the fact that the majority of adult working family members are either migrant workers or commuters who are away from home most of the time and are not likely to increase retained output significantly, unlike dependants who stay at home throughout the year and are assumed to consume the

same amount as an adult.

The level of education and the adult working members of the family (n_1) are positively related to the market purchased goods, whereas dependants (n_2) show a negative effect in equation (4.7). The reason for this probably lies in the fact that most rural households in South Africa especially in the former homelands are poor. These poor households tend to reduce their market purchased goods whenever they gain an additional dependant given that there are no savings. The opposite occurs with the "haves" who are likely to increase their market purchased goods by reducing their savings when they gain an additional dependant.

Following Appendix I and incorporating the profit level (Π)(equation 4.4) from production of an agricultural good (maize) in the consumption function shows that the profit level is inversely related to the household supply of labour (equation 4.5) and positively related to the retained output (maize) (equation 4.6) as well as the market purchased goods (equation 4.7) as is expected from traditional economic theory.

The integrated production and consumption model for the rural household in South Africa.

The importance of the integrated production and consumption model to simulate rural household behaviour need not be emphasised again as it was discussed in chapter three. Needless to say, it was shown that because of the interaction between production and consumption decisions, the household responds to changes in exogenous variables by restructuring both production and consumption patterns. The separability of the model emphasises the fact that production decisions are made independently and in turn the production decisions affect the consumption decisions by affecting the level of profit. The one way relationship from production to consumption is transmitted through the

profit derived from the production side and forms part of the overall income that influences the consumption behaviour of the household. The qualitative and quantitative significance of integrating the consumption and production decisions is considered by simulating a rural farm household's responses to exogenous variables through the household's response elasticities.

The profit function is derived from equation (4.1) following the procedure presented in Appendix I. The demand function for retained maize and market purchased goods as well as the supply function for labour are derived from the estimated equations (Appendix I equation 38). Totally differentiating the full system allows determination of response elasticities. Following Barnum and Squire (1979) the total response elasticities can be expressed in terms of their partial elasticities, for example the total response elasticity of an endogenous variable Y with respect to an exogenous variable X can be represented as:

$$\eta_{YX}(\pi\text{-Variable})=\eta_{YX}(\pi\text{-constant})+\eta_{YE}\cdot\eta_{E\pi}\cdot\eta_{EX} \quad \ldots\ldots\ldots\ldots (4.8)$$

Where:

$$\eta_{YX}=\frac{\delta Y}{\delta X}\cdot\frac{X}{Y} \quad \ldots\ldots\ldots\ldots (4.9)$$

$$\eta_{YE}=\frac{\delta Y}{\delta E}\cdot\frac{E}{Y} \quad \ldots\ldots\ldots\ldots (4.10)$$

$$\eta_{E\pi}=\frac{\delta E}{\delta \pi}\cdot\frac{\pi}{E} \quad \ldots\ldots\ldots\ldots (4.11)$$

$$\eta_{\pi X}=\frac{\delta \pi}{\delta X}\cdot\frac{X}{\pi} \quad \ldots\ldots\ldots\ldots (4.12)$$

The importance of integrating production and consumption decisions can be seen by comparing the elasticities when profits are held constant (exogenous) as in the traditional economic theory and when profits are variable (endogenous).

The significance of integrating production and consumption decisions for a rural household in South Africa can be seen by comparing tables 4.3 and 4.4 which show the elasticities obtained if farm profits are exogenous and endogenous respectively. Elasticities of exogenous variables, price (p) and the wage rate (w) are determined using the averages for own consumption of maize (C), market purchased goods (M) and household labour supply (S). The qualitative significance of the household model is shown by comparing signs of the elasticities, for example the elasticities of own consumption of maize (C) and market purchased goods (M) with respect to price is negative and for (S) is positive (see table 4.3).

TABLE 4.3 Household response elasticities with farm profit constant (exogenous): South Africa (1994)

Exogenous variables	endogenous variables		
	own consumption of maize (C)	consumption of market purchased goods (M)	labour supply (S).
price of maize (p)	-0.006	-0.023	0.032
wage rate (w)	0.003	0.011	-0.005

Source: Model results

On the other hand the elasticities for own consumption of maize (c), market purchased goods (m) with respect to wage rate (w) are positive except for the labour supply (s) which is negative. This is consistent with the traditional economic theory that ignores the profit effect.

TABLE 4.4 Household response elasticities with farm profit endogenous: South Africa (1994)

exogenous variables	endogenous variable		
	own consumption of maize (C)	consumption of non farm goods (M)	labour supply (S)
price of maize (P)	0.03	0.86	-0.13
wage rate (w)	-0.02	-0.04	0.015

Source: Model results

Table 4.4 shows that the elasticities change sign when profit is endogenous. This indicates that if the profit effect is taken into account, an increase/decrease in the price of maize will increase/decrease own consumption of maize, consumption of marketed goods and decrease/increase labour supply of the household contrary to the prediction of the traditional economic theory. The quantitative importance of the model is shown by observing the absolute values of the elasticities for example if profit is exogenous a 10% increase in the price of maize would result in a decrease of own consumption of maize of .06% on the other hand if profits are endogenous a 10% increase in the

price will increase own consumption by .3%.

The figures in table 4.5 suggest that in general a rural small scale agricultural household in South Africa is positively responsive to changes in the price of maize with respect to own consumption of maize (a staple food), but compared to figures for rice (Malaysia) and sorghum (Nigeria), it is seen that a South African rural household is less responsive to changes in the price of the staple. An increase in the price of the staple of 10% will induce an increase of own consumption of the staple of 1.9% (Nigeria), 3.8% (Malaysia) and only 0.3% (South Africa).

Table 4.5 Comparison of household response elasticities from different countries

	own consumption of the staple		non-food purchase		labour supply	
Korea (1970)	i	ii	i	ii	i	ii
price of rice	-.18	.01	-.19	.81	.03	-.13
wage rate	.16	.01	.77	.05	.00	.11
Nigeria(1977)						
price of sorghum	-.05	.19	-.14	.57	.03	-.06
wage rate	.06	.02	.04	.01	.01	.10
Malaysia (1979)						
price of rice	-.04	.38	-.27	1.97	.08	-.58
wage rate	.06	-.08	.29	-.35	-.07	.1
South Africa (1994)						
price of maize	-.006	.03	-.023	.86	.02	-.13
wage rate	.003	-.02	.011	-.04	-.005	.015

Key

i = Elasticities when profit are held constant

ii = Elasticities when production and consumption are integrated

Source: For Korea: Singh and Subramanian (1986)
For Nigeria: Singh and Subramanian (1986)
For Malaysia: Barnum and Squire (1979)
For South Africa: Model results

CHAPTER 5

SUMMARY AND CONCLUSIONS

This study has attempted to demonstrate the applicability of household modelling in studying and evaluating decision making practices in production and consumption in rural South Africa. The analysis was restricted to rural semi-subsistence farm households that have access to small acreage of land and were drawn from some of the former homelands.

The study adopted a method of integrating the production and consumption aspects used in analysing decision behaviour of rural household units. The frame-work recognises that a household undertakes decisions in production and the results of these decisions in turn influence consumption decisions and is therefore taken as a unit where both production and consumption decisions take place.

Chapter two sheds light on resource availability in the rural areas of South Africa and the level of their utilisation. The sample data used were collected by the South African Labour and Development Research Unit of the University of Cape Town. These data suggest that a rural household on average:

(a) cultivates 1.2 hectares of land,
(b) has a family size of 7.9 of whom only 4.6 contribute to the labour force,
(c) produces 475 kg of maize,
(d) has a household head of 55 years of age and a formal education of 3 years.

In chapter four the results of the integrated production consumption model are presented. Own consumption of maize and market purchased goods are shown

to be positively responsive to changes in the price of maize whereas labour supply responds negatively. The responsiveness of own consumption of maize (a staple food) to changes in its price in rural South African households is less elastic as compared to households in Korea, Nigeria and Malaysia with respect to their staple foods.

Policy implications

The present South African government recognises the suffering of the rural households in the form of poverty and malnutrition that were inflicted on them by apartheid policies. In addition large scale and capital intensive white commercial farms were created at the expense of the small scale rural black households. It is with this background that the government is committed to redress the existing imbalance by assisting the small scale rural agricultural farmers.

Pricing policies with respect to agricultural commodities are one of the major instruments that governments can use to influence agricultural output and rural development. In the South African case food and agricultural policy has historically been based primarily on obtaining national self sufficiency through high price incentives and input subsidies to large scale white farmers to counteract sanctions. Rural households were neglected, left hungry and malnourished despite national self sufficiency (surplus for export) in the main staple maize. The government's hope to solve the problem by encouraging rural small scale agricultural production through improving the rights to land, access to credit and other resources are likely to be complicated by the way in which these rural agricultural households respond to these policies.

In order to stimulate the rural economy there is a need to improve production of small scale farmers. If the government hopes to achieve this by increasing producer

prices, the way in which small scale farmers are likely to respond to producer price increases is of vital importance. The result from the integrated model suggests that increasing the price of maize increases own consumption of maize (elasticity 0.03). Although output response of small scale farmers to increases in the producer price of maize is likely to be high, the increase in household consumption of maize due to increase in its prices dampens the output response resulting in less output (surplus) available for sale. The implication is that increasing the income of a rural agricultural household (from sale of surplus) by a small percentage requires a significantly larger percentage increase in the price of maize to stimulate a larger increase in output. This is because part of the output consumed at home reduces the surplus for sale and also that households' responses to producer price are rigid(less elastic) as compared to results from other countries(*see table 4.5*). Therefore, increasing producer price of maize as a policy alone may not be the best option if the target is to increase the income of the rural agricultural households. Increase in producer price will require to combine it with another policy(ies) to boost further the output in order to counteract the increase in retained output and rigidity in household responses.

Another area of interest is the impact of price incentives to rural small scale producers on their nutritional status. If these rural households are given access to sufficient land and are provided with the necessary price incentives, there is likely to be an improvement in their nutritional status since increase in maize producer price to increase production for the rural small-scale household will increase their own consumption of maize which is the staple food and hence will lessen malnutrition for these households.

Production incentives in the form of increased producer prices is likely to have positive effects on the other sectors of the economy. Aside from the forward and

backward linkages associated with improvement in the agricultural sector, an increase in the price of maize will have the positive effect of increasing the consumption of market purchased goods.

Landless households are also likely to benefit from increased employment opportunities related to increased price of output (maize). Landed households are likely to reduce their labour supply and this will result in increased demand for labour as long as the increase in the demand for labour does not increase the wage rate. If the wage rate increases this will result in households increasing their labour supply since labour is viewed as a cost from the production side.

Any analysis of what land reform and/or pricing policies are likely to achieve must take into account responses of small scale producers to changes in prices of maize, for it is the responses of these producers that determine the extent to which pursued policies are likely to be successful in fetching forth the desired marketed surplus, especially in situations where producers themselves are consumers as is the case of rural small-scale agricultural households. Restructuring the agricultural sector from its existing state to the desired one will require land reform. The danger is that not all the increase in output brought about by land reform will be available for the market, since part of the output will be consumed at home. Maize production has been dominated by large scale producers whose production and policy responses are:

(a) governed by the traditional economic theory

(b) market oriented.

They are therefore able to reap large scale economies as compared to rural small scale producers whose production and policy response are:

(a) not market oriented,

(b) are in line with the modern household economics.

The small scale farmers will not be in position to reap the

economies of large scale extensive production due to limited land.

The study shows that if pricing policies are to be implemented to boost small-scale maize production, response elasticities should be taken into consideration for South Africa to remain not only self sufficient in maize production but also a net exporter of maize.

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APPENDIX I

THE RURAL HOUSEHOLD MODEL

The model presented below follows that of Barnum and Squire (1979) and describes a rural semi-subsistence family farm that is located between a wholly commercial farm employing only hired labour and marketing all output and, a pure subsistence farm using only family labour and producing no marketed surplus. The individual household is assumed to participate in both the product and resource markets. All the prices are exogenously given to the household and cannot be changed by any action of the household.

For simplicity it will be assumed that the household consumes three commodities: leisure (L), purchased goods (C) and a farm produced good maize (M), part of which is sold on the market.

Suppose that a household utility function exists and is well behaved that is: it is quasi-concave with positive partial derivatives. The household utility function can be represented as

$$U = U(L,C,M,a_i) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$U_L \ , \ U_C \ , \ U_M > 0$$

where:

L = Leisure (home time)
C = Market purchased goods
M = Retained maize output for consumption
a_i = Household characteristics
U_L = Marginal Utility of Leisure
U_C = Marginal utility of a market purchased good
U_M = Marginal utility of retained maize

It is assumed that the goal of the household is to maximise utility from the consumption of three commodities. The household maximises its utility bounded by its limited resources, and faces three resource constraints in attempting to maximise its utility function.

(a) Time constraint

The household can allocate its time to leisure, farm employment or off-farm employment. The household is allowed to have off-farm labour and it is assumed that family labour and hired labour are perfect substitutes. The time constraint can be represented as:

$$T = H + L + D \quad \text{.....(2)}$$

where:

T = Total household available time

H = Net quantity of labour time sold if H>0 and net quantity of labour time purchased if H<0

D = Total labour input (both family and hired) used in the production of maize

(b) The level of technology constraint

The level of technology used by the household in the production of maize imposes a constraint in terms of what and how much to produce. The production constraint can be stated as:

$$F = F(D,A,d,K) \quad \text{.....(3)}$$

where:

D = Total labour input in the production of maize

A = Area of land used in the production of maize

d = Amount of fertilizers used in production of maize

K = The flow of capital services

The availability allocation of land in rural agricultural areas in South Africa necessitate treating land as fixed. Therefore households will maximize profit

with respect to labour, capital and fertilizers.

(c) The income constraint

The household is faced with an income constraint which can be stated as

$$qM+pC = wH + R + pF - w_K K - w_d d \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where:

q = Price of M

p = Price of C

w = Wage rate

R = Non-wage, non-crop net other income

w_K = Price of capital

w_d = Price of fertilizer

The planning horizon is assumed to be one agricultural cycle. Long term decisions and risks are omitted from the analysis since it is assumed that the household has already made its long term decisions and is at least to some extent committed to a fairly well defined course of action for the duration of the agricultural cycle.

Maximizing equation 1 subject to equation 2, 3, 4 and eliminating the Lagrangian multipliers, results in the following:

From equation 2

$$H = T - L - D \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

substituting equation 5 into equation 4 results in:

$$qM + pC = w(T-L-D)+R+pF(D,A,d,K)-w_K.K-w_d d \quad \ldots\ldots\ldots\ldots\ldots (6)$$

The Langrange equation is:

$$Z=U(L,C,M,a_i)+\lambda[wT-wL-wD+R+pF(D,A,d,K)-w_K K-w_d d-qM-pC] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$Z_L = U_L - \lambda w = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

$$Z_C = U_C - \lambda p = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

$$Z_M = U_M - \lambda q = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

$$Z_D = -\lambda w + \lambda p F_D = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

$$Z_K = -\lambda w_K + \lambda p F_K = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

$$Z_d = -\lambda w_d + \lambda p F_d = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

where:

U_L, U_C, U_M are as defined earlier and

F_D = Marginal product of labour

F_K = Marginal product of capital

F_d = Marginal product of fertilizers

Eliminating the Lagrangian multipliers from equations (8) and (10) and rearranging them results in equation (14)

$$\frac{U_l}{U_m} = \frac{w}{q} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (14)$$

$$PF_D = w \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (15)$$

$$PF_K = w_K \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (16)$$

$$PF_d = w_d \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (17)$$

And

$$qM + pC + wL = \pi + R + wT \quad \ldots\ldots\ldots\ldots\ldots (18)$$

where:

$$\pi = pF(D) - wD - w_K.K - w_d.d \quad \ldots\ldots\ldots\ldots (19)$$

Equations (14) express the traditional first order condition of welfare economics; that the marginal rate of

substitution in consumption must be equal to the marginal rate of transformation in production. Equation (15), (16), (17) are the profit maximizing condition for the allocation of labour, capital and fertilizers.

Equation (18) is a combination of the income, time and the technological constraint. The left hand side of equation (18) includes the expenditure on leisure (wL), the own consumption of maize (pC) and the market purchased good (qM). The right hand side is the full income which includes profit from the household's production of maize, the value of the total household's available time (wT) and R which is non-wage, non-crop net other income. Equation (19) shows that production decisions are made independently to determine the profit level and in turn the profit level influences the consumption decisions through equation (18).

The model is implemented econometrically by specifying the form of the production function and the consumption expenditure system. The production function is specified in a Cobb-Douglas form as:

$$F=\alpha_0 A^{\alpha 1} D^{\alpha 2} V^{\alpha 3} K^{\alpha 4} \ldots\ldots\ldots\ldots\ldots (20)$$

where:

A = Area of land in the production of maize
D = Total labour input
V = Amount of fertilizers
K = Flow of capital services
F = Amount of maize produced.

If land is treated as a fixed factor, demand functions can be derived for the rest of the inputs from equation (20) and the profit maximising conditions equations (15), (16) and (17). For example the total demand for labour can be derived from equations (15) and (20). From equation (15)

$$F_D = (w/p) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (21)$$

where:

F_D = Marginal product of labour

w = Wage rate

p = Price of maize

and from equation (20)

$$F_D = \frac{\delta F}{\delta D} = \alpha_2 \alpha_0 A^{\alpha_1} D^{\alpha_2 - 1} V^{\alpha_3} K^{\alpha_4} \quad \ldots\ldots\ldots\ldots\ldots\ldots (22)$$

$$= (\alpha_2/D).F \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (23)$$

Equating equations (15) and (22)

$$w/p = (\alpha_2/D)F$$

$$D = \alpha_2(p/w)F \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (24)$$

Substituting the demand functions in equation 19 and re-arranging yields an expression for the level of restricted farm profits (π) at different levels of output.

$$\pi = \alpha_1 pF \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (25)$$

Substituting the demand function for the other inputs in equation (20) the production function can be rewritten in terms of a fixed factor land and the relative prices of labour (D), fertilizers (V) and capital (K) as

$$F = \alpha_0^{\frac{1}{\alpha_1}} \left[\prod_{j=2}^{4} \alpha_j^{\alpha_j} \right]^{\frac{1}{\alpha_1}} . A . \left(\frac{p}{w}\right)^{\frac{\alpha_2}{\alpha_1}} . \left(\frac{p}{w_v}\right)^{\frac{\alpha_3}{\alpha_1}} . \left(\frac{p}{w_k}\right)^{\frac{\alpha 4}{\alpha_1}} \ldots . (26)$$

Substituting equation (26) into equation (25) gives and expression for profit as a function of factor prices, which can be incorporated in the household model as a component

of the income side of the total expenditure.

The consumption side of the model

The consumption side of the household model is specified econometrically using the linear expenditure system and the system is developed in per capita terms.

For an individual member of the family the utility function is written as:

$$U_j = \sum \beta_i \ln(x_i - \gamma_i) \quad \ldots\ldots\ldots\ldots\ldots\ldots (27)$$

$$j = 1, \ldots . n$$

where:

X_i = per capita consumption of the i^{th} commodity

γ_i = are functions of the variety of household characteristics.

Dependants are assumed to consume all their available time in the form of leisure and to consume the same quantities of other goods as do working family members. It is also assumed that the household utility function is identical for each member and additive across individuals so that summing over the n_1 working family members and the n_2 dependants and substituting $t-s = L/n_1$, for leisure consumption per working family member.

The household maximizes

$$\sum U=n_1\beta_1\ln(t-s-\gamma_1)+n_2\beta_1\ln(t-\gamma_1)+n\beta_2\ln(c-\gamma_2)+n\beta_3\ln(m-\gamma_3).(28)$$

Subject to

$$wL+pC+qM=E.....(29)$$

where:

$\Sigma\beta_i = 1$ and $0<\beta_i<1$

β_i is the marginal budget share of commodity i

Dividing through by n in equations (28) and (29), the utility maximization equations may be written as

$$\max U=k\beta_1\ln(t-s-\gamma_1)+(1-k)\beta_1\ln(t-\gamma_1)+\beta_2\ln(c-\gamma_2)+\beta_3(m-\gamma_3).(30)$$

subject to

$$kw(t-s)+pc+qm=\frac{E}{n}.....(31)$$

where:

$k = n_i/n$

If we let

$\beta'_i=k\beta_i$

$w'=kw$

Then the standard linear expenditure equations can be written as

$$w(t-s)=\gamma_1 w+\beta_1(\frac{E}{n}-w'\gamma_1-p\gamma_2-q\gamma_3).....(32)$$

$$pc=\gamma_2 p+\beta_2\left(\frac{E}{n}-w'\gamma_1-p\gamma_2-q\gamma_3\right)\ldots\ldots\ldots\ldots\ldots\ldots(33)$$

$$qm=\gamma_3 q+\beta_3\left(\frac{E}{n}-w'\gamma_1-p\gamma_2-q\gamma_3\right)\ldots\ldots\ldots\ldots\ldots\ldots(34)$$

The system can be altered to avoid data specification error which could arise through the computation of leisure as the residual after time allocated to work activities (s) is subtracted from total discretionary available time (t). The system can be altered by substituting $(t-\gamma_s)$ for γ_1 in equations (32), (33) and (34). This yields the following equations

$$wt-ws=\gamma_1 w+\beta_1\left[\frac{1}{n}(wL+pC+qM)-w'\gamma_1-p\gamma_2-q\gamma_3\right]$$

$$=\gamma_1 w+\beta_1\left[w'\left(\frac{L}{n_1}\right)+pc+qm-w'\gamma_1-p\gamma_2-q\gamma_3\right]$$

substituting $1/n=t-s$ and $\gamma_1=t-\gamma_s$

$$-ws=-\gamma_s w+\beta_1(b+w'\gamma_s-p\gamma_2-q\gamma_3)\ldots\ldots\ldots\ldots\ldots\ldots(35)$$

Where

$$b = -w_s+pc+qm$$

Similarly equations (33) and (34) can be transformed into equations (36) and (37) as

$$pc=\gamma_2 p+\beta_2(b+w'\gamma_s-p\gamma_2-q\gamma_3).....(36)$$

$$qm=\gamma_3 q+\beta_3(b+w'\gamma_s-p\gamma_2-q\gamma_3).....(37)$$

Equations (35), (36) and (37) can be written in a matrix form representing all system of equations to be estimated as

$$\begin{bmatrix}-ws\\ pc\\ qm\end{bmatrix}=\begin{bmatrix}b & 0 & 0\\ 0 & b & 0\\ 0 & 0 & b\end{bmatrix}\cdot\begin{bmatrix}\beta_1\\ \beta_2\\ \beta_3\end{bmatrix}+\begin{bmatrix}w'(\beta_1-1/k) & -p\beta_1 & -q\beta_1\\ w'\beta_2 & p(1-\beta_2) & -q\beta_2\\ w'\beta_3 & -p\beta_3 & q(1-\beta_3)\end{bmatrix}\cdot\begin{bmatrix}\gamma_s\\ \gamma_2\\ \gamma_3\end{bmatrix}.....(38)$$

or

$$\mathbf{Y = \beta B+P\gamma}$$

Household characteristics are introduced by making the vectors of γ's a linear function of a vectors of household characteristics G

$$\begin{bmatrix}\gamma_s\\ \gamma_2\\ \gamma_3\end{bmatrix}=\begin{bmatrix}\delta_{10} & \delta_{11} & \delta_{12} & \delta_{13} & \delta_{14}\\ \delta_{20} & \delta_{21} & \delta_{22} & \delta_{23} & \delta_{24}\\ \delta_{30} & \delta_{31} & \delta_{32} & \delta_{33} & \delta_{34}\end{bmatrix}\cdot\begin{bmatrix}1\\ n_1\\ n_2\\ e\\ a\end{bmatrix}.....(39)$$

Thus the final system of equations to be estimated can be written as

$$Y = \beta B + P\delta G \quad \ldots\ldots\ldots\ldots\ldots\ldots (40)$$

The non-linearity of the structural parameters in equation (40) and the fact that the model is over-identified as a result of the budget restriction that the sum of expenditures for commodities equals total expenditure. It is clear therefore that only two equations need to be estimated without the danger of losing any information.

INTERACTION OF PRODUCTION AND CONSUMPTION DECISIONS

The interaction between production and consumption is assumed to be unidirectional. The decisions taken in production affect consumption, the mechanism through which changes in production are transmitted to the consumption side is through the full income equation which is written as

$$E=Y=qM+pC+wL=\Pi+R+wT \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (41)$$

The production decisions of the household affect the profit (π) and in turn the profit affects the consumption decisions of the household. Totally differentiating the full system of household equations allows derivation of the set of total response elasticities which give the proportional change in any endogenous variable in response to a proportional change in any exogenous variable. The total response elasticities can be broken down into component partial elasticities which can be written in the form

$$\frac{Y}{X}\cdot\frac{X}{Y}(\Pi variable)=\frac{\delta Y}{\delta X}\cdot\frac{X}{Y}(\Pi constant)+\left(\frac{\delta Y}{\delta E}\frac{E}{Y}\right)\left(\frac{\delta E}{\delta \Pi}\frac{\Pi}{E}\right)\left(\frac{\delta \Pi}{\delta X}\frac{X}{\Pi}\right).$$

or using a more concise notation

$$\eta_{YX}=\eta^{*}_{YX}+\eta_{YE}\cdot\eta_{E\Pi}\cdot\eta_{\Pi X}\cdots\cdots\cdots\cdots\cdots(43)$$

where

η_{YX} = elasticity if farm profit is allowed to vary

η^{*}_{YX} = elasticity if farm profit is held constant.

And η^{*}_{YX} is the standard result of the consumer demand theory for a normal good which is negative. (η_{YE}, $\eta_{E\pi}$, $\eta_{\pi X}$) captures the profit effect, for example a change in the price of an agricultural commodity (maize) increases the farm profit and hence the full income. It is this positive effect of an increase in profit, an effect that is ignored in the traditional model of demand that will dampen and may outweigh the negative effect of the consumer demand theory to make η_{YX} positive.

APPENDIX II
SUMMARY TABLES

TABLE 1 Distribution of household size

Household size	Number of household	Percentage	cumulative percentage
<5	18	10.84	10.84
5-7	69	41.57	52.41
8-10	54	32.5	84.91
>10	25	15.06	100
TOTAL	166	100	

Average household size = 7.9

TABLE 2 Distribution of dependants by household

Number of dependants	Number of household	Percentage	cumulative percentage
0	10	6.02	6.02
1	16	9.6	15.62
2	31	18.7	34.32
3	40	24.1	58.42
4	33	19.9	78.32
5	15	9.04	87.36
6	10	6.02	93.38
7+	11	6.6	100
TOTAL	166	100	

Average number of dependants = 3.4

TABLE 3 Distribution of adults by household

Number of adults	Number of households	percentage	cumulative percentage
1	3	1.8	1.8
2	25	15.06	16.86
3	32	19.3	36.16
4	33	19.9	55.46
5	22	13.3	68.76
6	20	12.1	80.86
7	10	6.02	86.88
8	8	4.8	91.68
>9	13	7.8	100
TOTAL	166	100	

Average number of adults per household =4.6

TABLE 4 Distribution of land by household

Size of Land per Household (Ha)	Frequency	Percentage	Cumulative Figure
0 - 1	104	62.7	62.7
1 - 2	42	25.3	88
2 - 3	14	8.4	96.4
3+	6	3.6	100
TOTAL	166	100	

Average size = 1.158 Ha

TABLE 5 Distribution of the age of household head

Age of Household Head	Frequency	%	Cumulative figure
Below 30	2	1.1	1.1
31 - 40	18	10.2	11.3
41 - 50	53	30.1	41.4
51 - 64	63	35.8	77.2
65+	40	22.7	100
TOTAL	176	100	

Average Age = 54.7 Years

TABLE 6 Distribution of output by household

Output per Household Kg	Frequency	Percentage	Cumulative Figure
Below 100	27	16.3	16.3
100 - 200	47	28.3	44.6
201 - 300	34	20.5	65.1
301 - 400	13	7.8	72.9
401 - 500	15	9.04	81.94
500+	30	18.1	100.0
TOTAL	166	100	

Average Output = 474.7 Kg

TABLE 7 Distribution of output per hectare

Output in Kgs Per Hectare	Frequency	Percentage	Cumulative Figure
Below 150	10	6.02	6.02
151 - 200	28	16.9	23.1
201 - 250	30	18.1	41.2
251 - 300	23	13.9	55.1
301 - 350	23	13.9	69
351 - 400	15	9.04	78.04
401 - 500	19	11.5	89.54
500+	18	10.8	100.0
TOTAL	166	100	

Average Output per Ha = 371.8 Kg

TABLE 8 Distribution of years of formal education of household heads

Years of education of household head	Number of household	Percentage	cumulative percentage
0	65	39.2	39.2
1-2	27	16.3	55.5
3-4	22	13.3	68.8
5-6	27	16.3	85.1
7+	25	15.1	100
TOTAL	166	100	