REFEREED ARTICLE

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Food Security: How Rural Ghanaian Households Respond to Food Shortages in Lean Season

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ABSTRACT

A rural household, with little or no formal education and limited opportunities for non-farm income generating activities, will produce rather than purchase staples for household consumption. Many subsistence farmers are net-food buyers, often facing the challenge of ensuring household food security in lean seasons of production when their stock is exhausted (cyclical food insecurity). This paper determined the optimal farm plan, profit levels of crops, and farmer behaviour when given the option to purchase or produce food using a linear programming framework. Findings from the LP model show that capital is the most constraining resource for both male and female farmers. Making an additional capital of US$180 available to female farmers will increase their net income by US$823 but making one additional acre of land available to them will only increase income by US$200. As land reforms take time, addressing their credit needs is an appropriate short-term intervention.

KEYWORDS: Linear Programming; Relative profitability; Ghana; Gender; Purchasing food

1. Introduction

The increased variability in global food prices between 2007 and 2008 and concerns about food security for future generations has created a heightened awareness around the world with renewed commitments by nations to ensure food security. Farmers in Ghana have faced very high prices of inputs since the 1990s as a result of the structural adjustment programme, and are constrained by inadequate productive resources and services. The FAO State of Food and Agriculture report for 2011 noted that women face gender-specific constraints that reduce their productivity and limit their contributions to agricultural production, economic growth and the well-being of their families (FAO, 2011). Their limited access to productive resources is a result of cultural practices in bequeathing land and other properties.

In most developing countries, including Ghana, people eat food grown locally particularly since purchasing power in these countries is generally low. Though tastes are changing towards the consumption of imported food products, food consumption deficits occur in periods of high prices and production deficits. In Ghana, among the rural poor, the ability to produce food in one season does not guarantee availability of food for household members throughout the year. The Africa Human Development Report 2012 noted the challenge smallholder farmers face in selling their crops immediately after harvest, exhaust their food stocks a few months later and begin buying food at higher prices (UNDP, 2012).

IFAD recognizes that in Ghana, as in much of the rest of the world, rural women are making considerable contributions to household food security, either by growing food or by earning income to purchase food (IFAD, 1998). It added that household food insecurity is a seasonal problem in some parts of Ghana, such as the north, occurring every year between February and July.

A recent UN report notes that an effective response to the challenge of ensuring a food secure future for Africa is broad and cannot be narrowed to a single intervention, discipline or institutional mandate. It will take a coordinated response across sectors (UNDP, 2012). Food security is about availability, access, and utilization. Researchers have agreed that food insecurity is primarily a problem of low household incomes and poverty, and not just inadequate food production (Gladwin, et al., 2001; Pinstrup-Anderson, Pandya-Lorch and Rosegrant, 2001; Schuh, 1997). African governments need to reassess the role of agriculture within their national development strategy. According to Oxfam (2006), governments need to tackle the root causes of hunger such as poverty, agricultural mismanagement, unfair trade rules, and the unprecedented problems of climate change. Funk and Brown (2009) however argue that local agricultural production is critical to food security among the rural poor. Hence, if we can establish an understanding of what crops are

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profitable for farmers to concentrate on in alleviating poverty, it will inform policy as well as effective agricultural extension delivery in the fight against food insecurity. Even stronger outcomes will be achieved if research results are effectively communicated to the farming community.

Building a food secure continent requires transformative change that will be most effective if accompanied by a shift of resources, capacities and decisions to smallholder farmers, poor communities and women. New inputs and farming techniques can liberate farmers from cycles of low productivity and poverty (UNDP, 2012). The report however added that technology dispossesses or marginalizes smallholder farmers when misapplied and science that is compartmentalized and conducted far from where its results are used can lead to designs that are poorly suited to smallholder farms.

This paper examines the behaviour of rural households in Ghana when given the option of producing or purchasing food for household consumption in the frame of a linear programming (LP) model. Food security includes the ability to purchase food when it is not produced. A sensitivity analysis was carried out to observe farmers' response under different policy scenarios and the changes in the optimal farm plan. The relative profitability of food crop enterprises was calculated in order to determine the crops that are profitable and could be produced at a marketable surplus, beyond what is needed for the household's consumption. The Central Region of Ghana was used as a case study.

Due to their general risk aversion behaviour, farmers attempt to produce all they need for household consumption, especially when their monetary income levels are low. The role of women in food production continues to increase in the face of rural-urban migration and lack of incentives for agricultural production. Understanding the nature of male and female enterprises can inform policy in designing interventions for the farm level.

2. Food Security at Farm Household Level

Based on food production, availability, purchasing power, and access to common resources, participants in a survey in Bangladesh categorized food insecurity of households into severe or chronic, occasional or transitory, break even or food surplus (Mallick and Rafi 2010). Cyclical or longer term stresses such as seasonal harvesting patterns can result in long 'hungry seasons' between harvests (UNDP, 2012), yet research has not explored the specific mechanisms underlying seasonal effects of food security on rural households (Hillbruner and Egan, 2008). Seasonality affects rural livelihoods and can result in cyclical food insecurity in rural households (UNDP, 2012; Ellis, 2000; Hedzro-Garti, 2010). According to Hillbruner and Egan (2008), the magnitude of stunting and wasting in children fluctuates largely depending on the season. The role of rural areas becomes critical in the fight against seasonal food shortages. Because their production levels are so low, rural households often run out of the same food they produce, thereby facing food insecurity in lean seasons. As net-food buyers, rural households are producers, marketers and consumers of locally produced food. Melgar-Quinonez *et al* (2006) assert that household food expenditure consists of food consumed from own production, purchased, received as a gift or payment. It becomes necessary to analyse the possibility and willingness of rural households to purchase food so as to understand their behavioural patterns for policy formulation and interventions.

Households are plagued with managing a diverse range of challenges year by year. As they produce, they need to ensure sufficient availability of food till the next harvest. They also need seed for the next planting season and some surplus to sell to meet household financial needs. The income from selling the surplus enables them to pay school fees, buy school uniforms for their children, purchase clothing, and to ensure adequate nutrition for the household. Rainfall patterns are particularly important in determining household and national food security in Ghana. For most rural households, agricultural production is the main means of ensuring food availability all year round.

There are two seasons in a year, the major season and the minor season. The major season lasts from March till about July and the minor season begins early September. Minor season crops are harvested around the end of November and this food must last till June the following year. Besides, the minor season has a shorter rainy period and farmers reduce the size of their farms as a good harvest is not always assured, though it has to last for a longer period. This phenomenon results in food shortages during the long dry season till the major season crops are harvested. Farmers use diverse coping strategies including reduction in quantity of food consumed, shift to the consumption of less preferred foods, and purchase of food for household consumption. Maxwell, Caldwell and Langworthy (2008) consider eating less-preferred foods or reducing portion size as modest dietary adjustments and reversible strategies.

Most of Ghana's staple food consumption is met by domestic production and the country is said to be self-sufficient in the production of maize (Armah and Asante, 2006). Ghana's food self-sufficiency ratio is estimated at 100 percent for starchy staples, 30 percent for meat and 60 percent for fish, 80 percent for cereals, except for rice which is 30 percent (Aggrey-Fynn *et al.*, 2002). Though agricultural production is a factor of household food insecurity, it is not the only cause.

The concept of food security encompasses access to and availability of food, the distribution of resources to produce food, and the purchasing power to buy the food where it is not produced at national, local and household levels. Producing a marketable surplus in one season may not mean sufficient food for the rest of the year. That is why certain rural farmers are compelled to purchase the same products they produce during lean seasons. The ability of rural households in sub-Saharan Africa to combine the right crop enterprises is critical for ensuring sustainable livelihoods.

The importance of gender equality in achieving development objectives and the need to close the gender gap in agriculture and other priority areas have featured much in FAO and World Bank publications (Meinzen-Dick, et. al, 2011). Due to the unequal access to resources and productivity-enhancing inputs, women

often have lower yields and lower output, most of which is consumed at the household level.

Empirical evidence suggests that increasing women's control of resources has positive effects on a number of development outcomes of food security, child nutrition and education within the household (Duflo and Udry, 2004, Fafchamps, Kebede, and Quisumbing, 2009, Millennium Challenge Corporation, 2012). Men and women contribute in different ways and use different strategies for ensuring household food security.

A major source of inequality which is too often unrecognized is gender differences in access to resources and markets that result in forgone agricultural output, higher levels of poverty, and food and nutrition insecurity (Byerlee, De Janvry and Sadoulet, 2009). Meeting food needs in the future is increasingly dependent on the capabilities and resources of women. Women play a significant role in agricultural production, producing both food and cash crops in addition to processing, purchasing and preparing food for household consumption (Brown *et al.*, 1995). Africa has about 60 percent of the population living in rural areas and mostly engaged in agriculture (Wiggins, 2009), with women being responsible for about 80 percent of the food production (Kabeer, 1994). Empowering women to play economic, social and even political roles is beneficial to food security and development (Scanlan, 2004). This paper examines both male and female farm enterprises to understand their contributions to household food security.

3. The Data

The Central Region has had a high incidence of poverty in 1998-1999 (Ghana Statistical Service, 2000), but has made great strides in reducing the incidence of poverty, which is prevalent among small-scale food producers (Ghana Statistical Service, 2007). Ensuring food security and continuous and sustained improvements in income levels among small-scale farmers requires the cultivation of crops that bring income at frequent and regular intervals. The production of maize, which is a major staple crop, was used as a basis for farmer selection in addition to gender and farm size. The main maize producing districts in Ghana produce an average of about 10,000 metric tonnes per annum (MOFA, 2000) and the selected districts for the study (Agona, Assin and Mfantsiman) fall within this category. The region has the potential for increasing food production, improving food security and further reducing poverty. There are three main agro-ecological zones: Coastal, Forest and Transition zones with diversity in production systems. Temperatures are high with humidity of 60 percent, and bimodal rainfall patterns, which supports crop production in two seasons of the year.

The data consist of the crop budgets prepared by the Ministry of Food and Agriculture (MOFA) for various crops in the region for the year 2005. This is supplemented by an earlier survey which was conducted to determine farmer characteristics, describe the farming systems, farm size categories, cropping calendars and household labour availability. The crop budgets provide detailed information on various crop enterprises with the cost elements, output and selling prices. The respondent farmers fall within three size categories namely: large, medium and small-scale, and farmers were randomly selected from all categories. Farms that fall within the large scale category consisted of 22 percent of the respondents and these had farms of more than 5 acres (ranging up to 14 acres). The medium scale is between 2.5 to 5 acres, representing 43 percent of the respondents. The small-scale farms ranged from 1 to 2.5 acres.

The information from the cropping calendars was used to determine the labourdays needed for each enterprise and the months in which each activity occurs. The asset base of the farmers was used to determine the cost of tools. Crop enterprise budgets were prepared by gender to estimate the variable costs and profit levels for each enterprise, for a gross margin analysis. The information from the gross margin analysis was used for constructing the linear programming matrices. The LP matrix is for a representative male or female farmer and not for individual farmers. The results of this study provide insights into the characteristics and performance of farm enterprises in Ghana that are useful for policy formulation and development planning and the process of designing food security interventions in an effort to achieve the Millennium Development Goals, especially MDG_1.

Farming Systems, Gender and Food Security

The farming system that characterizes the Central Region of Ghana can be termed as maize-based, with cassava, plantain and cocoyam being important crops. Vegetables such as garden-eggs (or egg plant), tomatoes and pepper are important in certain parts of the Coastal Savannah Zones. Tree crops and perennial crops are also present in certain parts of the Forest Zone.

The most important cereal crop is maize, being the major staple food and traditional crop in the region. Farmers always grow some amount of it in each season, at least for household consumption. The storability of maize is a motivation for its production, giving farmers the opportunity to sell when prices are favourable. Income from maize was said to be quick and regular and to some women, it is termed as *obatanpa* (good mother). However, there is the problem of cyclical shortage of the produce for some farmers. As mentioned earlier, their stock runs out during the lean season. The only option then is to adopt coping strategies of shifting to the consumption of roots and tubers or purchase maize for household consumption. Because many of these farmers derive their livelihoods primarily from agriculture, income from other enterprises may be needed to purchase food when their stock runs out. For small-scale farmers, they will need to have money from other crop enterprises to support such food purchase.

Female respondents from the survey showed a lower resource endowment and lower level of education. Forty-six percent of the women never had any formal education, compared to only 5 percent of the men. Women had smaller land holdings, smaller farm sizes with strong evidence against the hypothesis that there is no association between gender and farm size (with a Pearson Chi-Square value of 9.00, which is significant at 5 percent confidence level). The majority of the female managed farms are less than 2.5 acres in size while male

managed farms are between 2.5 and 5 acres. Forty-three percent of the respondents were within the ages of 41 to 55 years, 11 percent were under 30 years and 28 percent were between 30 and 40 years. A number of youth were found to be active in farming. About 46 percent of the respondents never used fertilizer or have once used it but stopped. Reasons they gave included high and unaffordable prices, lack of interest, beliefs that fertilizer adversely affects taste of farm produce, and lack of knowledge about its use.

4. The Linear Programming Analysis

Linear programming (LP) models predict the effects of possible changes to a system by asking 'what if?' questions (Hildebrand, 2001). The model maximizes total gross margins of the various enterprises engaged in by women and men farmers at their resource endowments. The sum of the gross margins is maximized to assess the income level and optimum farm plan. According to Hazell and Norton (1986), the problem is to find the farm plan, which is defined by a set of activity levels, which has the largest possible gross margin, but does not violate any of the fixed resource constraints. Abdoulaye and Lowenberg-DeBoer (2000) stated that a representative farm linear programming model is used with solutions at various land, labor and capital levels. As such, the model is constructed for a representative farm rather than for individual farms.

According to Tegene *et al.* (1988), the decisions confronting each farmer at a point in time can be represented as a plan for capacity utilization - allocating the available resources among alternative crops. LP models can show why households choose the livelihood strategies that they do, given their resources and constraints. They also predict the effects of different policy situations on farm enterprises by allowing for sensitivity analysis to the model and simulating the complex farming system of smallholder households by including the many different crops, intercrops and other activities (Gladwin *et al*, 2001).

The general specification of the LP's objective function is:

$$Maximize Z = \sum_{j=1}^{m} C_j X_j \qquad \text{(Objective Function)} \quad (1)$$

Subject to the following constraints:

$$\sum_{j=1}^{m} A_{ij} X_{ij} \leq b_j \qquad \text{(Resource constraint)} \quad (2)$$

$$\sum Q_{jk} X_{jk} \geq d_k \qquad \text{(Food consumption constraint)} \quad (3)$$

$$x_j, \geqslant 0 \qquad \text{(Non-negativity constraint)} \quad (4)$$

(i=1, 2, ...m; j=1, 2, ...n), where:

Z is the sum of gross margins of the various activities in the year, C_j is the gross margin per acre of the j^{th} activity in the year, and X_j is the level of the j^{th} activity in the year. A_{ij} is the requirement of the i^{th} resource by an acre of the j^{th} activity in the year. These are the technical coefficients. b_j is the level of the j^{th} resource available for the year. Q_{jk} is the yield per acre of crop k in the j^{th} activity, X_{jk} is the acreage of the activity in which crop k appears in the year, n is the total number of activities in which crop k appears (n=m if all the activities contain crop k), and d_k is the minimum quantity of crop k required by a household for consumption.

The resources constrained are land, labour and capital according to the levels employed by the farmers in order to answer the question 'given their current resource availability, what would they do to maximize returns'? A sensitivity analysis was undertaken to show the effects of making more of these resources available to the farmers. In addition to fourteen cropping activities, the model focused on labour hiring, capital borrowing, purchase of fertilizer, land rental, selling of produce, storage activities, purchasing of output for consumption, and consumption of output. The combination of crop production and other activities is to determine the optimum farm plan which will result in the maximum income level or maximum value of the objective function.

Production activities include the growing of food crops, vegetables, and cowpea. The authors built a one-year model, with two cropping seasons–a major season and a minor season. Unlike Delforce (1994), household consumption is relevant in this model and the household consumption requirements are estimated and used in model construction. Buying and selling prices are differentiated according to the time of the year at which the activity occurs. The price at which the farmer buys the produce and the price at which it is sold if they produced it are not differentiated in the model (Table 1). Because these are small-scale farmers, their subsistence activities are all included as was possible, including how they respond to lean season shortages. Small-scale farmers have little influence on price and can be said to be price takers. They maximize their activities in order to maximize profit.

The objective of the LP analysis is to determine the optimal farm plan in order to understand farmer response to the options for ensuring food security, given the crops that are grown by the farmers. A separate matrix was developed for male and female farmers. The results of the LP analysis present a practical decision-making tool. Maize is presented in three forms in the model: maize that is consumed, that which is sold immediately after harvest, and maize that is stored to sell later or stored for consumption in the lean season. Storage capacity is made available by the farmers constructing some form of crib (local or improved) to store their maize. Cassava, cocoyam and plantain are not usually stored and are therefore consumed or sold immediately after harvest. Vegetables are neither stored nor consumed in large quantities. Their production however can generate revenue to enable the farmer meet other financial needs.

A simulation analysis was conducted to observe the optimal income level, the profit generated by the various crops and whether the farmers will purchase what they consume or take it from own consumption. This includes a unit increase in the amount of land available and an increase in the credit to a level beyond which the objective function value does not increase.

Table 1: Assumptions of the model

Variable	Assumption	Explanation
Prices of produce	Selling price for produce is the same as price at which produce is purchased for consumption.	Price at which produce is sold and the price at which it is purchased for home consumption is not differentiated. Prices are generally higher in lean seasons, but the farmer also benefits from this higher prices if they have produce to sell
Variable costs	Variable costs include seed cost, cost of tools used, fertiliser cost.	
Cost of capital	Cost of capital includes the interest rate, which is included to the level at which capital is used.	An interest rate of 40% was applied to capital. Capital repayment period is one year. Loan to farmers are usually given on short-term basis
Other costs	Other costs include cost of storage	This allows farmers to store their maize to sell at a later date when prices are higher or for consumption in lean season
Land rental	Two additional acres were available to female farmers and 3 to male farmers.	Land rental was at a fee. These quantities were doubled in the simulation analysis.
Profit generated by crop	Profit is revenue minus variable costs, where revenue is the quantity sold multiplied by the price.	At the optimal farm plan, this amount is profit earned by the farmer after all variable costs are deducted and after allowances for what will be stored and consumed are taken from total output.

Table 2: Profit calculation by crop for female and male farmers

Crop	Measurement	Amount Produced			Profit per Crop (US$)		
		Base Level	Increase in Land	Increase in Capital	Base Level	Increase in Land	Increase in Capital
Female Farmers							
Optimal income level (US$)		*1,089.1*	*1,292.3*	*1,911.7*			
Maize - Major	Mini-bags [a]	6	6	26.6			316.5
Maize - Minor	Mini-bags	6.5	6.5	6.5			
Cassava	Mini-bags	10	10	16.1			28.1
Plantain	Bunches	140	140	143.1			4.1
Cocoyam	Mini-bags	9.4	3.3	16.1	51.4	18.1	88.2
Cowpea	Mini-bags	0	0	15.6			383.3
Tomatoes	Mini-bags	89.6	107.6	112	1,177.3	1,413.8	1,472.1
Male Farmers							
Optimal income level (US$)		*2,257.0*	*2,283.6*	*3,361.2*			
Maize - Major	Mini-bags	6	2	27.2			325.5
Maize - Minor	Mini-bags	6.5	6.5	6.5			
Cassava	Mini-bags	10	10	10			
Plantain	Bunches	140	140	438.1			391.8
Cocoyam	Mini-bags	5.4	3.8	7.1	29.4	21.1	38.9
Cowpea	Mini-bags	0	0	15.4			379.3
Garden eggs	Mini-bags	396.4	402.1	480	2,431.7	2,466.3	2,944.1

[a]1 mini-bag of maize is 50kg, and 1 mini-bag of cassava is 45.5 kg.

5. Linear Programming Results and Discussion

The model analyzes the crop enterprises farmers engage in, the amount of labour needed for the various enterprises, level of input use, the output levels of the different crops, the capital availability for the farmer, and the amount borrowed. The model allowed for the consumption of food either from own production or from purchased products to meet the consumption requirements. The optimal income level recorded in the base model was about US$2,257[4] for male farmers and US$1,089 for female farmers (Table 2). Women in the study area face the same labour requirements and input and output prices as their male counterparts, though they are constrained with smaller farm sizes, less credit facilities, and have relatively lower output levels for some crops.

Among the resources, credit was found to be the most limiting factor for both male and female farmers. The capital base of the farmers does not match with increases in prices of inputs and they are unable to benefit significantly from grain price increases due to low levels of production and yields. An improvement in the non-farm economy in rural areas can help overcome the capital constraint to some extent, as well as help reduce poverty. A strong non-farm economy can give them multiple options of getting out of poverty with

[4] In early June 2013, US$1 was approximately equivalent to £0.64 and €0.76 (www.xe.com)

Table 3: Food consumption patterns

Produce	Requirement	Source of Produce		Cost to Farmer for Purchasing (US$)		
		From own Production	Quantity Purchased	Base Model	Increase in Land	Increased Capital
Female Farmers						
Maize: - Major	4 Mini-bags	All	0	-248.5	-248.5	-3.9
- Minor	3.5 Mini-bags	All	0	-269.7	-269.7	-2.8
- Major Stored	2 Mini-bags	All	0	-275.9	-275.9	-5.4
- Minor Stored	3 Mini-bags	All	0	-293.6	-293.6	-4.1
Cassava	10 Mini-bags	All	0	-102.1	-102.1	-1.6
Plantain	140 bunches	All	0	-28.6	-28.6	-0.5
Male Farmers						
Maize - Major	4 Mini-bags	All	0	-255	-255	-9.2
- Minor	3.5 Mini-bags	All	0	-265.8	-265.8	-7.7
- Major Stored	2 Mini-bags	All	0	-285.8	-285.8	-11.1
- Minor Stored	3 Mini-bags	All	0	-292.7	-292.7	-9.3
Cassava	10 Mini-bags	All	0	-125.7	-125.7	-1.5
Plantain	140 bunches	All	0	-33.8	-33.8	-0.9

1 mini-bag of maize is 50kg, and 1 mini-bag of cassava is 45.5 kg.

the ability to earn additional income to invest in the farm enterprise and to purchase food when the need arises.

The female farmers are neither renting any land in the major season nor using up all the land in the minor season. Having an additional acre of land in the major season will increase the net income by US$200 for female farmers. However, making less than US$200 available to them in the form of credit will increase their net income level by US$822. Further, the answer to the question of what is enough capital for these women was explored. These farmers have very little money to invest into their farm enterprises and the only way they can cope with increases in the price of inputs is when they have the opportunity to borrow capital to invest in the farm. Without additional capital, making more land available to them will not be beneficial. Land is useful only in the context of more capital.

Given their current resource endowment, results from the sensitivity analysis show that the optimum level of capital for female farmers in order to almost double their net income is US$180. The objective function changes considerably with increased capital while using the same amount of land. Considering the difficulties women have in accessing land, policy intervention, at least in the short term should be credit availability. A higher level of capital (beyond the optimal level) does not improve the solution at the current resource endowment. For male farmers, the optimum amount of capital is US$380. The objective function value for male farmers only increased by US$26 with a unit increase in land but went up by US$1,078 with the optimum credit level. Increasing credit beyond this level does not make a difference for male farmers either. Again, credit is an important factor for male farmers.

Profit from Various Crops

The profit generated for each crop based on the optimal farm plan was calculated to observe how the crops performed. This was done for the base model and repeated for increased land and capital level and the results shown in Table 2. The highest profit generating crop was garden-eggs for male farmers and tomatoes for female farmers. The level of profit for some of the food crops depends on the enterprises which enter the optimal farm plan. More maize, plantain, and cowpeas were produced and sold with increase in capital (Table 2).

The profit from maize is appreciable considering its importance for both food and cash. Production of maize, cassava and plantain are necessary for household food security. Maize could have been more profitable but much of it is used for household consumption, creating a difference between quantity produced and quantity sold. The maize that was sold by both female and male farmers with increased capital was stored maize, which attracts a higher price, although maize storage comes at some cost. All the staple crops, except cocoyam did not enter the optimal plan beyond what is needed to meet household consumption requirements until capital level changed.

Purchasing Food for Household Consumption

To ensure food security at the household level, a consumption constraint was included in the model. This guarantees sufficient food to meet the food needs of all household members all year round. Average household requirements of maize, cassava, and plantain were used. Since food security includes the ability to purchase food for consumption, food purchasing activities were included whereby farmers have the option of purchasing or producing the staple crops they eat.

The model allows the farmer to choose between producing and purchasing what they consume. When given the option of producing or purchasing food for home consumption, the LP results show that farmers would prefer to produce for their household consumption (Table 3). This portrays a typical characteristic of subsistence farmers, and is consistent with the results from the survey. Both male and female farmers face the same prices for selling and purchasing farm produce. The values in the last column of Table 3 show the amount by which the objective function value or farm income will decrease if a unit of the product is purchased (i.e. the cost for purchasing the different farm products for consumption). The cost of purchasing food was very

high in the base model and with a one unit increase in land. In the base model, purchasing maize costs female farmers between 249 and 294 US dollars per unit, depending on the type of maize and the season in question. This result is not very different for male farmers. The cost of purchasing food however decreased considerably for both male and female farmers when more capital became available. Addressing the credit needs of rural farmers is particularly important for household food security.

6. Conclusion and Recommendations

This paper answers the question whether or not rural households will purchase food when it is not produced. Discussions about food security should focus not only on ability to produce but also on the ability to purchase when it is not produced. When given the option of producing or purchasing food for household consumption, the LP results show that farmers would choose to produce for their household food needs, portraying a characteristic of subsistence farmers.

This result gives an indication of the response pattern of farmers in times of drought and other crises that cause food shortage. Coping strategies such as reducing food portions and shifting to less preferred food are adopted in times of crisis. Policy intervention should focus on credit availability so farmers can produce crops that give them higher revenue, and increase the possibility of purchasing food when it is not produced. Appropriate strategies must be adopted to insulate the poor against food price increases as there is little probability that farmers will purchase food when there are price shocks.

Despite the fact that farmers in the Central Region of Ghana produce a surplus of some farm products for sale in the local market, they always ensure that they have sufficient maize and major staple crops for household consumption. Producing staple food crops assures farmers of food security, and they seem to continue producing these crops even when it is not profitable to do so. Results of a sensitivity analysis in the frame of LP modeling show that both male and female farmers did not buy food for consumption in any of the scenarios. The opportunity cost of purchasing food reduces when capital becomes available. A crop such as maize is not only important for food security but can be produced to generate financial resources for the household. However, credit is critical for increased productivity and the production of a marketable surplus.

The amount of additional capital needed in order to almost double the value of the objective function for female farmers is only US$180 for the year. For male farmers, an amount of US$380 results in an increase in their objective function by US$1,078. Additional capital beyond this level does not improve the objective function. Among the inputs that were constraining, credit is one that requires short-term policy intervention as land reforms take longer periods. Considering the difficulties women have in accessing land, in the short run, credit availability should be the focus of policy intervention. Without additional capital, making more land available to them is not beneficial. Land is useful only in the context of more capital. There is a high risk associated with agricultural production and financial institutions are hesitant extending credit to small farmers. But a policy environment can be created that addresses the credit needs of farmers to ensure increased production and improved incomes.

For yields to increase, farmers also have the responsibility of adopting improved and good agricultural practices, and improved varieties. At the same time, policy makers may need to consider providing specific support systems towards the acquisition of specific inputs and market access.

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