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Agricultural Productivity Constraints In Uganda: Implications For Investment

Rosetti Nabbumba and Godfrey Bahiigwa

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Acronyms

EPRC	Economic Policy Research Center
GOU	Government of Uganda
IFPRI	International Food Policy Research Institute
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MFPED	Ministry of Finance, Planning and Economic Development
MOPS	Ministry of Public Service
MTEF	Medium Term Expenditure Framework
NAADS	National Agricultural Advisory Services
NARO	National Agricultural Research Organization
PEAP	Poverty Eradication Action Plan
PMA	Plan for Modernization of Agriculture
UPPAP	Uganda Participatory Poverty Assessment Project

Abstract

Uganda has put emphasis on the agricultural sector as a strategy for raising rural incomes and reducing rural poverty. The Plan for Modernization of Agriculture (PMA) was designed in 2000 for this purpose. However, available secondary data show that crop yields are low despite the availability of productivity-enhancing technologies on the market. This study uses household data from four rural districts selected from two agro-ecological zones to explore profitability and productivity of two technologies: improved maize varieties and improved cattle breeds. The research findings indicate that growing improved maize is more profitable than local maize across all farm sizes. Similarly, improved cattle breeds (exotic and cross-breeds) are more profitable and more productive than indigenous cattle. The findings suggest the need to strengthen the PMA interventions, especially under the National Agricultural Advisory Services (NAADS) in order to promote the adoption of improved technologies. The results further reveal that the farming system in northern Uganda is as productive as the coffee-banana farming system. Therefore, the poverty situation in northern Uganda is not due to low productivity or profitability of agriculture, but perhaps due to exogenous factors such as the war that has afflicted the area since the late 1980s.

I. Introduction

Poverty reduction is at the top of the agenda of policy makers in Uganda. The Government of Uganda (GOU) has a comprehensive development strategy – the Poverty Eradication Action Plan (PEAP)/Poverty Reduction Strategy Paper (PRSP) – that aims to shift substantial budgetary resources towards poverty sensitive areas while remaining within the overall resource envelope and macroeconomic targets set in the medium term expenditure framework (MTEF). The PEAP has four pillars: sustainable economic growth and structural transformation; ensuring good governance and security; increasing the ability of the poor to raise their incomes; and, improving the quality of life of the poor.

In order to operationalise one of pillars of the PEAP - increasing the ability of the poor to raise their incomes - the government designed the Plan for Modernization of Agriculture (PMA) (MFPED and MAAIF, 2000). The PMA is a strategic and operational framework for poverty eradication that focuses on the agricultural sector. The drive is to transform agriculture from being largely subsistence farming to a more commercially oriented sector. The policy objectives of the PMA are to: increase incomes and improve the quality of life of poor subsistence farmers, improve household food security, provide gainful employment, and promote sustainable use and management of natural resources.

It is widely believed that successful implementation of the PMA will most certainly come from technological progress through the introduction of new technologies that will increase factor productivity and profitability. Uganda, like many other developing countries in sub-Saharan Africa, is continuing to record very low levels of farm productivity. Available evidence indicates that farm level yields are several times lower than at agricultural research stations for similar crops. Farmers achieve between 13 and 33 percent of yields attainable at research stations (MAAIF, 1996). This study finds similar results, with crop yields in the range of 13-49 percent of the yields at research stations. The NARO results were recorded in 1993. This study demonstrates that there have not been significant changes in crop yields in almost a decade as table 1 shows.

Table 1: Yields of selected crops in Uganda, 1993 and 2001

	Farm level (FL1)[1]	Farm level (FL2)[2]	Research	FL1 as a	FL2 as a
Crop	**1993**	**2001**	**Station (RS)**	**% of RS**	**% of RS**
Beans	1.0	0.66	3	33	22
Maize	1.8	1.23	8	23	15
Finger millet	1.6	0.67	5	32	13
Cassava	9.0	10.98	50	18	22
Sweet potatoes	4.0	8.47	30	13	28
Irish potatoes	7.0	10.56	35	20	30
Bananas	5.9	17.26	35	17	49

Source: Kawanda Agricultural Research Institute (KARI), 1993 and Survey 2001

Such a state of agricultural sector performance raises serious policy questions that have implications for focusing on the agricultural sector as the avenue for raising rural incomes and reducing poverty. What constrains farmers from achieving higher levels of productivity? Could there be specific farm level factors that hinder technology adoption? Do the constraints vary across districts and agro-ecological zones? One of the implicit assumptions that the PMA makes is that if technologies are developed and disseminated, farmers will adopt them

[1] Based on farm survey by KARI of NARO in 1993
[2] Based on farm survey for this study in 2001

and increase farm productivity. It is assumed that at current prices, the technologies that are available are profitable. In fact, there are several improved technologies on the market, and yet the adoption rate by farmers is very low. It has not been clearly established whether the low adoption rate is due to poor technology dissemination or low product prices that make it unprofitable for farmers to adopt the technologies.

This report presents findings of a research effort that was intended to offer some answers to questions raised above. It examines the profitability and productivity of two available technologies – improved maize seed, and improved cattle breed - in four districts in Uganda. The profitability of these improved technologies is compared to those of unimproved maize and indigenous cattle, in that order. A similar comparison is made for the measures of productivity - maize yield and milk yield.

The PMA correctly recognizes the location specific nature of poverty and the constraints to agricultural production and productivity. Decentralization is central to the country's chosen mode of governance with responsibility for service delivery devolved to the local governments (districts and sub-counties). However, there is little or no district or sub-county specific empirical research available to these local governments that articulates productivity constraints. For example, maize is grown throughout the country, but the constraints to increased maize productivity may vary from one district to another and therefore policy responses and investment decisions will vary accordingly.

Study objectives

On the basis of the foregoing discussion, this study set out to assess district differences in agricultural productivity and profitability and analyze constraints to increased productivity in agriculture with the ultimate aim of proposing policy strategies for appropriate investment in the sector in Uganda. The research process was guided by three key objectives:

1. Determining agricultural productivity levels and constraints for several districts, focusing on maize and cattle.
2. Assessing profitability of two available technologies (improved maize, and improved cattle breed).
3. Suggesting policy strategies to improve agricultural productivity.

The following four hypotheses were tested:

- Growing improved maize seed is not profitable to farmers at current market prices.
- Rearing improved cattle is not profitable at current market prices.
- Agricultural productivity levels in Uganda vary across districts due to technological differences
- Factors constraining agricultural productivity are location-specific.

II. Measuring Productivity and Profitability

Raising agricultural productivity has long been on Uganda's development agenda, although progress has been slow. The modest increases in agricultural production during the 1990s have largely come from expansion in cultivated land rather than improvements in unit area productivity (World Bank, 2001). We can draw on a range of schools of thought on how best to increase agricultural productivity especially in a developing country. Thirwall (1983) observes that the quickest and cheapest way to raise productivity will depend on the reasons for low productivity and constraints to agricultural growth. These vary from country to country and from region to region. He notes that in some cases, it is an inappropriate labor to land ratio combined with a lack of appropriate and complementary inputs; in other cases, it is the structure and organization of agriculture and in many cases it is a combination of both coupled with unfavorable natural factors. He concludes by laying emphasis on policies to raise the level of farm productivity as the most urgent development priority.

Kalirajan et al (1996) complement this line of argument by pointing out that as long as farmers are not operating on their frontiers due to various non-price and organizational factors, which is very likely in the case of Uganda, technical progress cannot be the only source of total factor productivity growth. A substantial increase in productivity under these circumstances can still be realized by improving the method of application of the given technology. It is important to know whether technological progress is stagnant overtime and whether the given technology has been used in such a way as to realize its potential fully. Certainly, the yield results in table 1 show that Uganda farmers are operating below their frontiers and therefore available technologies are not being used to their full potential.

The approaches to productivity measurement in literature range from the Cobb-Douglas functions, linear programming, indexes based on the Translog Transformation Function, the Divisia index, Laspeyres quantity index and many other econometric transformations based on modern production theory. The choice of method to use has generally depended on the nature of problem being addressed and the available database. Most of the productivity measurements have concentrated on macro-level analysis, as most data is available in the aggregated form. Savadogo *et al* (1994) argue that such aggregate studies are limited to only a few composite product categories because of lack of more detailed data on labor, land and capital allocations over crops. Comparatively, microanalysis tends to track smaller samples over shorter periods but digs below the aggregate surface to discern and explain productivity differences over crops, zones and farmer groups. Due to data constraints, here productivity is simply taken as the yield of maize (metric tons per hectare) and milk (liters per lactating animal).

While Africa is the only developing region where crop output and yield growth is lagging seriously behind population growth, there is very scanty literature on measurement of productivity in this region essentially due to lack of reliable data. Savadogo et al (1994) show that, since the spate of African farm management studies in the 1960s and 1970s, soils have rapidly degraded, access to land has become increasingly constrained, and factor and credit markets have changed structurally. These changes should affect productivity across farm types, suggesting the need to revive attention to farm level analysis. Such analyses are important for Uganda; given the emphasis the country is putting on agriculture, not only for improving rural livelihoods, but also for general economic growth and poverty reduction.

III. Data Collection

A cross-sectional, stratified sampling design was used in this study. Four sample districts, Iganga, Hoima, Lira and Apac, were purposively selected to broadly represent two different regions and two agro-ecological zones within the country. The choice of districts was based on three criteria: agro-ecological zoning, geographical location and population density as a crude indicator of land productivity[3]. Two major farming systems were investigated in this study: the Banana/Coffee Farming System and the Northern Farming System. For comparison purposes, it was found necessary to select at least 2 districts from the same agro-ecological zone.

Iganga district, located in the eastern region, falls within the Banana/Coffee Farming System while Hoima also in the same farming system is in the western region. Both Lira and Apac are in the northern region and fall within the Northern Farming System. Two districts were purposively selected from Northern Uganda because it is the largest region in the country covering 35% of the total land surface. Since the PMA has been conceived as one of the major interventions for reducing poverty, we thought that it was important to focus on districts in a region that has experienced increasing poverty at a time when livelihoods were improving in other regions of the country[4].

Because of the differences in soil types and rainfall patterns, there are major variations in the cropping characteristics within the two farming systems. Farmers in the Banana/Coffee System which is characterized by fertile soils and more reliable rainfall of over 1000mm on average are able to grow a variety of crops including robusta coffee, banana, maize, root crops and horticultural crops. Livestock production also plays an important role in farmers' livelihoods. Those in the Northern System are faced with low rainfall ranging between 500mm-1000mm on average – and hence farmers tend to grow drought resistant crops like simsim, finger millet, sorghum and sunflower. Cotton and tobacco also do well in the region, and livestock is important as well.

Forty households were interviewed in each of the two sub-counties that were selected from each district, making up a total of 320 respondents for the study. Respondents were purposively selected across scale (small and medium), but randomly within scale. Identification of farmers' lists from which we sampled was facilitated by local agricultural extension workers and local council officials. In order to get a quick understanding of the farming systems, participatory rural appraisal (PRA) techniques such as focus group discussions and key informant discussions were held with extension workers at sub-county and district level, input suppliers and produce buyers.

In the assessment of productivity and productivity levels and constraints, maize and cattle were the enterprises selected. Maize was chosen because it is grown in almost all districts of Uganda and also because of its importance in terms of food security and as a growing source of foreign exchange through exports. Cattle are also found in all districts, though with varying scales and degree of importance. Cattle are a store of wealth or savings, a source of household income and an important contributor to household nutrition, especially milk and

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[3] In Uganda, farming populations tend to inhabit first, those areas with very fertile land and as population grows, they migrate to areas that are less fertile. High population density is associated with high land productivity at the time of settlement.

[4] The 1999/2000 National Household Survey revealed that between 1997 and 2000, poverty in Northern Uganda increased from 60% to 65% (Appleton, 2001).

butter. They are also an important source of manure that rejuvenates soil productivity, especially when integrated with crop production.

While it would have been more informative to collect data for two cropping seasons representing a calendar year, this was not done for one major reason. Experience shows that farmers have a short recall period beyond which answers given are more hypothetical rather than real. This study, therefore, limited itself to the most recent complete cropping season (August 2000 to January 2001) to avoid this shortcoming. The household surveys were conducted between May and September 2001.

Data Analysis

A combination of analytical tools was used including descriptive statistics, measures of profitability and productivity, and simple regressions. The study set out to assess the profitability of improved technologies (maize and cattle) and establish levels of agricultural productivity for both maize and cattle. In order to assess profitability, data were collected on quantity and prices of output, variable inputs and fixed inputs for maize and cattle. Profit is computed as total revenue less total costs (variable costs plus fixed costs). Computing fixed costs for farms with multiple enterprises presents a problem of apportioning fixed costs to individual enterprises. In this study, total fixed costs for crops were computed and divided by the number of the major crops grown by the household. This approach has the underlying assumption that fixed inputs are used uniformly across the different crops, and therefore there is a potential of under- or over-estimation of fixed cost for an individual crop. A similar approach was used to compute fixed costs associated with cattle.

Maize profits Π_{mz} are given by

$$\prod_{mz} = P_{mz}Q_{mz} - \sum_{i=1}^{n} P_{xi}X_i - FC_{mz}$$

where P_{mz} is the output price of maize, Q_{mz} is the quantity of maize produced, P_{xi} is the price of the i^{th} variable input, X_i is the quantity of variable input i used in the production of maize, and FC_{mz} is the fixed cost incurred in maize production.

Cattle profits Π_{ct} are given by

$$\prod_{ct} = (P_{ct}Q_{ct} + P_{mk}Q_{mk}) - \sum_{j=1}^{m} P_{xj}X_j - FC_{ct}$$

where P_{ct} is the price of cattle, Q_{ct} is the number of cattle in herd, P_{mk} is the price of milk, Q_{mk} is the quantity of milk produced, P_{xj} is the price of the j^{th} variable input, X_j is the quantity of variable input j used in cattle rearing, and FC_{ct} is the fixed cost incurred in cattle rearing.

Maize profitability was compared in two main ways. First by controlling for technology (local versus improved maize), and second, by controlling for scale (land allocated to maize). For cattle, profitability was compared by controlling only for technology (type of cattle breed). Regression analysis was used to identify determinants of both maize and cattle profitability. Theoretically, the profit function is a function of output and input prices, and should be non-decreasing in output prices and non-increasing in input prices (Varian, 1992).

Maize productivity is simply measured as quantity produced per unit of land (tons per hectare), to be differentiated by improved and local maize varieties. Cattle productivity is similarly measured as milk produced per lactating animal (liters by animal), differentiated by improved and indigenous cattle breeds.

IV. Research Findings

To put the discussion into context, we begin with a brief description of the key characteristics of the sample. This is then followed by a more in-depth analysis of profitability, productivity and the key constraints faced in farming.

Sample Characteristics

The sample had 318 households, 95% male headed and only 5% female headed. Close to half the household heads (48%) had primary education, 25% secondary, 14% tertiary, 5% vocational and 8% did not attend school at all. The average farm size for the lowest 25% was 1.56ha, while the highest 25% had an average farm size of 27ha. Most of the land is used for crop farming (55%), livestock (20%), while unutilized (idle) land accounted for 25% of total farm size. Within the sample, 61% of the households planted improved maize seed, compared to 39% that planted local seed during the cropping season of study. Unlike the case of maize, 90% of households reared indigenous cattle; 3% cross-breed and 7% exotic (pure breed).

Land Utilization

The average farm size was 10ha ranging between 11.9ha in Apac and 2.7ha in Iganga (Table 2). On average, 4ha (40% of total land) were dedicated to livestock production as compared to 2.6ha (26%) to crop farming. Hoima district had the largest proportion of land allocated to livestock production (3.6ha) and Iganga the least (0.4ha). There was not much variation among districts with regard to the average land allocated to crop farming.

Table 2: Land use (ha) characteristics by district

District	Farm size (Ha)	Land for livestock (Ha)	Land for crops (Ha)	Unused land (Ha)	Average area for maize (Ha)
Apac	11.9	2.5	3.3	6.1	1.05
Hoima	11.6	3.6	2.5	5.5	0.59
Iganga	2.7	0.4	2.0	0.2	0.68
Lira	5.6	1.3	2.7	1.6	2.14
Sample Average	**10.0**	**4.0**	**2.6**	**3.3**	**1.18**

Source: Survey 2001

Apac and Hoima districts had substantial tracts of idle land. Leaving land under fallow and keeping it as a form of long-term investment were the two main reasons given for having unused land. It was only in a few cases (about 10%) where conflict over ownership arose as another reason for leaving land idle particularly in Apac district. Regarding land ownership, 88 percent of the sampled households indicated that land was owned by men (either household heads or male relatives), about 7 percent was co-ownership between husband and wife while the remaining 5 percent was land either owned by a woman (particularly female household heads), the clan or church. Hoima district had the smallest average area for maize production (0.59ha) while Lira had the largest average area for maize (2.14ha), almost four times that of Hoima district.

Land allocation and yields of 12 crops by district are presented in table 2. The table serves to illustrate the importance of maize all four districts. Cropland allocation to maize was highest in two districts (Hoima and Iganga) and second highest in the other two districts: Apac (maize was second to cotton) and Lira (maize was second to sunflower).

Table 2: Land allocation and yield by crop

	District							
	Area allocated (ha)				Yield (mt/ha)			
Crop	Apac	Hoima	Iganga	Lira	Apac	Hoima	Iganga	Lira
Maize	1.03	0.66	0.69	1.92	1.50	1.50	1.45	0.59
Beans	0.81	0.35	0.21	1.50	0.64	0.60	0.98	0.34
Cassava	0.82	0.45	0.49	0.87	7.49	5.81	4.36	4.90
Coffee	-	0.44	0.58	-	-	1.06	1.29	-
Millet	0.57	0.37	0.17	1.06	0.53	2.53	1.03	0.43
Cotton	1.44	-	0.34	1.37	0.65	-	1.16	0.12
Bananas	-	0.46	0.31	-	-	13.3	2.24	-
Groundnuts	0.69	0.39	0.22	0.71	2.67	1.80	0.32	0.32
Simsim	0.89	-	-	1.05	0.50	-	-	0.27
Sunflower	0.76	-	-	1.93	2.37	-	-	0.74
Sweetpotatoes	-	0.46	0.32	-	-	4.09	8.92	3.90
Sorghum	-	-	-	1.28	-	-	-	0.37

Source: Survey 2001

Maize profitability and productivity

Marketing and farm incomes

More than half of maize produced on farm is marketed, with the share of marketed output ranging from 59 percent in Iganga located in Eastern Uganda to 63 percent in Lira found in northern Uganda. These results are consistent with those found in the National Service Delivery Survey (MOPS, 2001) which found that most farmers in Uganda sell less than 50 percent of their produce and this is done mainly at the farm gate. There is hardly any difference in the share of maize that is marketed by households in all four districts (Table 4). Yields are similar in all districts, except in Lira where maize yield is significantly lower than in the other three districts. As a result, the returns per hectare are lowest in Lira, despite having the highest maize price per metric ton.

Table 4: Maize characteristics

District	Share of marketed production (%)	Price (Sh/Mt)	Returns per ha (Sh/Ha)	Yield (Mt/Ha)
Apac	61	148,910	250,508	1.50
Hoima	59	177,459	284,332	1.50
Iganga	59	165,066	241,469	1.45
Lira	63	206,890	124,052	0.59

Source: Survey 2001

There was no statistically significant difference in the average price and yield of maize in Hoima and Iganga, both districts in the same agro-ecological zone, and as a result, the returns per hectare were also not significantly different. Apac and Lira have significant differences in both the price and yield, and as a result the returns per hectare are different and lowest in Lira. Maize yield was lowest in Lira mainly due, perhaps, to pests and diseases that were reported in the previous season and during the past years (refer to Tables 12 and 13).

Certainly, the differences were not due to maize technology because 77% and 79% of farmers planted improved maize in Apac and Lira, respectively.

Profitability of Maize

Maize profit was computed by subtracting total maize production costs from maize revenue. Total costs include variable costs (labor, seed, herbicides and fertilizers) and fixed costs (mainly farm implements such as hoes, ox-ploughs, axes, etc). Maize revenue is the product of the quantity of maize produced and the price. The difficulty faced in computing maize profits was apportioning fixed costs. For example most households grow a multiple of crops using the same farm implements. It is difficult to share out the fixed costs across various crops. In this study, the fixed costs associated with crop production were simply divided by the number of major crops grown. This has the possibility of under- or over-estimating fixed costs for a particular crop, thereby over-or under-stating its profitability.

Table 5 presents overall maize profits per hectare by district, without differentiating between the types of maize planted. The results show great variability in maize profitability, with Lira district having the lowest level of profitability, while Hoima district has the highest. Even within the same agro-ecological zone, there are wide variations. Apac and Lira districts are in the same agro-ecological zone, however, it is about 50% more profitable to grow maize in Apac than in Lira district. Hoima and Iganga are also in the same agro-ecological zone, but maize profitability in the former district is about one and a half times more than in the latter district. However, the differences in maize profitability per hectare (without differentiation by maize variety) are not statistically significant, except between Lira and Hoima.

Table 5: Maize profits per hectare

Farming System	District	Sh/Ha
Northern	Apac	173,563
	Lira	108,336
Coffee Banana	Iganga	162,766
	Hoima	216,715

Source: Survey 2001

The key objective in assessing maize profitability was to determine whether or not it was profitable to grow improved maize seed compared to local or indigenous maize seed. Table 6 presents a comparison of maize profit per hectare, maize price, and maize yield for the entire sample, controlling for the type of maize seed planted. A test of the difference in means shows that farmers who planted improved maize had an average profit that was statistically significantly higher than the average profit for farmers who planted the local maize variety.

Two more variables are compared: price of maize and yield. Results show that the difference in price between local and improved maize was not significant. Maize yield was significantly higher for improved maize than for local maize. These results clearly indicate that differences in maize profitability are due to the type of maize seed grown. Growing improved maize seed is more profitable than growing local maize. Table 6 also presents the three variables (profit, price and yield) compared by farming system for the entire sample. Except for yield, the results clearly indicate that maize profitability is not determined by where it is grown, and that there are no significant differences in the price received by farmers in the two farming systems (northern and coffee-banana).

Table 6: Key economic variables for maize by variety and agro-ecological zone

	Improved Maize (n=179)	Local Maize (n=109)	T-test[5] (mean difference) P-value
Maize Profit (Sh/Ha)	190,531	111,872	0.0555
Price (Sh/Mt)	176,139	173,009	0.5663
Yield (Mt/Ha)	1.37	1.00	0.0414
	Coffee-banana system (n=130)	Northern system (n=160)	
Maize Profit (Sh/Ha)	186,005	140,135	0.2499
Price (Sh/Mt)	170,625	178,625	0.1278
Yield (Mt/Ha)	1.47	1.04	0.0165

Maize profitability of local and improved varieties was also compared across the four districts. Improved maize was more profitable than local maize in all four districts in absolute terms, but statistically significant (5% level of significance) in only 2 two districts (Hoima and Lira) as shown in table 7.

Table 7: Maize profit per hectare by variety and district

District	Improved maize	Local Maize	T-test (mean difference) P-value
Apac	201,083 (60)	81,829 (18)	0.383
Hoima	378,427 (22)	108,927 (33)	0.020
Iganga	184,427 (32)	147,703 (41)	0.395
Lira	120,200 (65)	62,980 (17)	0.024

Source: Survey 2001. Numbers in parentheses are the number of observations

Maize profitability of local and improved varieties was also compared, controlling for farm size. Again improved maize was more profitable in absolute terms across the four farm size quartiles, and differences in means were statistically significant in the first, third and fourth quartiles (Table 8). These findings show planting improved maize is profitable for all farm sizes, implying that scale may not be important in explaining profitability of maize.

Table 8: Maize profit per hectare, by farm size

Quartile	Improved maize	Local Maize	T-test (mean difference) P-value
1	347,051 (46)	153,845 (62)	0.053
2	186,749 (42)	153,254 (24)	0.436
3	182,347 (43)	60,030 (9)	0.056
4	126,049 (48)	61,136 (14)	0.052

Source: Survey 2001. Numbers in parentheses are the number of observations

Regression results

Table 9 presents the results of regression analysis for maize profit as the dependent variable. All variables are in logarithms except number of extension visits and the dummy for type of maize seed planted. The results indicate that there are five main determinants of maize profitability. First, the amount of land allocated by a household to maize production is important, implying that access to land by a household is important. Second, extension advise

[5] This it a student t-test for the difference in means of improved maize seed and local maize seed that were grown by the household, but here only the p-values are presented.

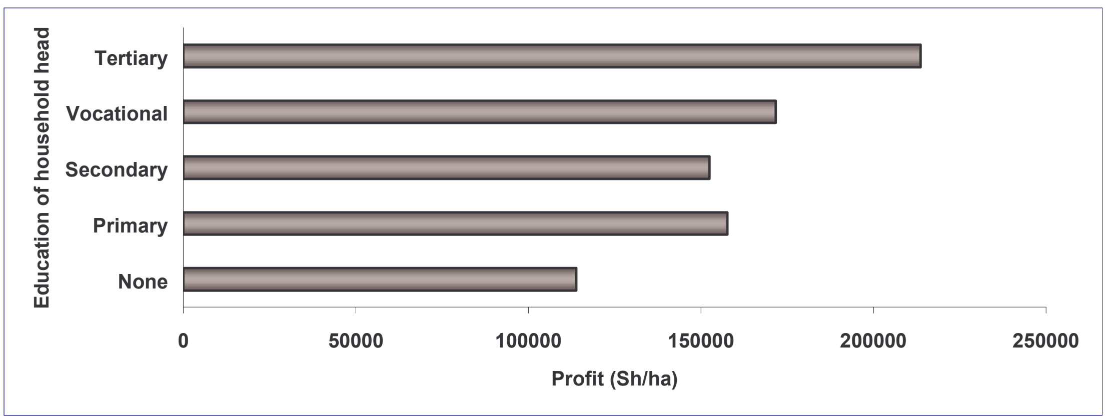
(proxied by number of extension visits) also contributes to increased profitability, perhaps either through advice on what maize variety to plant, when to plant or other agronomic information such as spacing that is important to realizing higher yields. Third, the price of maize is very important, the higher it is, the higher will be the profits. Whereas this is obvious and conforms to theory, it points to the importance of markets and market information. Farmers can only derive full benefits of investing in improved technology if the prices are high enough to warrant the investment.

Fourth, the type of maize seed is important. Planting improved maize seed increases profitability. Indeed this is consistent with results presented in Tables 6, 7 and 8, that improved maize is more profitable than local maize. Fifth, education of the household head is important. The higher the number of years spent at school, the higher the level of profits realized from growing maize. This is perhaps related to the ability to appreciate and uptake improved technology. As figure 1 shows, farmers with no education had the lowest level of profits per ha, and those with tertiary education had the highest level of profits per hectare.

Table 9: Determinants of maize profitability (dependent variable: maize profits)

Variable	Coefficient	T-statistic	P-value
Maize area	0.71	8.42	0.000
Number of extension visits	0.14	2.84	0.005
Price of maize	1.15	4.05	0.000
Maize variety dummy (1=improved, else 0)	0.35	2.10	0.036
Years of schooling of household head	0.53	2.11	0.036
Intercept	-3.96	-1.44	0.256
$R^{-2} = 0.374$			
N = 230			

Figure 1: Maize profitability and education of household head



Maize productivity

Maize productivity is simply measured as output per unit of land. Across all four districts, improved maize had a higher level of productivity (measured as metric tons per hectare) than local seed in absolute terms and the differences were statistically significant for two districts (Hoima and Lira) (Table 10). This implies that farmers that have not adopted planting improved maize seed are doing so for reasons other than non-profitability of improved maize varieties.

These findings from the statistical and regression analyses are significant in several ways. First, growing improved maize is more profitable than growing local maize seed. Even though there is no significant difference in the output price for both varieties, the higher productivity (yield) of improved maize seed ensures higher returns for farmers growing improved seed. These findings give impetus to the need to promote productivity enhancing technologies through the National Agricultural Advisory Services (NAADS) that is responsible for dissemination of agricultural technologies to farmers. At the same time, the results also render support to research efforts, especially by NARO in developing high yielding maize varieties.

Table 10: Maize yield by district and type of maize seed planted

District	Improved maize	Local Maize	T-test (mean difference) P-value
Apac	1.67 (60)	0.95 (18)	0.242
Hoima	2.34 (22)	0.93 (33)	0.000
Iganga	1.61 (32)	1.43 (41)	0.268
Lira	0.66 (65)	0.36 (17)	0.024

Source: Survey 2001. Numbers in parentheses are the number of observations

Second, the results indicate the potential for the Plan for Modernization of Agriculture (PMA) to make a difference in Northern Uganda, especially in rural areas where poverty rose between 1997 and 2000 from 62 to 67 percent (Appleton, 2001). The fact that poverty fell in the rest of the country among producers of food crops implies that promoting food crop production, especially maize in northern Uganda has the potential to reduce poverty in that region.

Third, the results dispel the widely held view that the northern farming system is less productive than the banana-coffee system because of less rainfall in the former region and having one main planting season. Therefore, promoting improved maize production in the northern region is one way of reducing rural poverty. In fact the survey results indicate that 78% of sampled farmers in the northern farming system planted improved maize seed, compared to 41% in the coffee-banana system. This improved technology that has high returns should be promoted in all districts of northern Uganda in the fight against poverty. The persistence of poverty in the north is not due to non-productivity of the region, but perhaps due to the war that has affected that areas since the late 1980s.

Fourth, extension is important in promoting productivity and profitability, and therefore NAADS has to ensure that it reaches farmers with the right information to enable them to improve their farming. NAADS is mandated to provide market information to farmers, something important as it determines profitability and influence resource allocation by households.

Fifth, farmer education is important, and therefore the agricultural education intervention in the PMA should be fully operationalized. Of particular importance is the adult education component to benefit farmers with no level of education, and whose profitability is lowest. The introduction of agriculture as a subject in all schools should contribute to increased productivity in the long-term.

And sixth, the results show that the more land dedicated to maize production, the higher the profits. This follows the national trend in crop production that increase in production and profit has mainly been through expansion of land than improved productivity of land. Given the increasing scarcity of land in Uganda, particularly among the poor[6], future increases and productivity are unlikely to come from expansion in crop acreage or pastureland, but rather from increases in land and pasture productivity through adoption on improved technologies.

Maize productivity constraints

Since most of the government programs are now implemented in a decentralized framework, whereby local governments have autonomy over their budgets, it is imperative that districts are aware of the major constraints to farming so as to provide for them in their planning and budgeting processes. In addition to measuring profitability and productivity, this study analyzed factors, from the farmers' perspective, that constrain agricultural production. The hypothesis behind the analysis was that agricultural productivity constraints are location specific hence requiring location-tailored interventions.

In order to get a deeper understanding of the major factors constraining crop production, the study analyzed the priority constraints at two levels: constraints to maize production generally over the years and then focusing on the priority problems experienced during the previous season. While some constraints appear to be season specific, on the whole, the problems that are faced by farmers are consistently similar across the years. However, there are variations in the constraints faced by farmers in the specific districts as discussed further in the proceeding sections.

Crosscutting constraints

The main constraints to increased maize production across the four districts during the season under study (Aug 2000-Jan 2001) were pests and diseases followed by inadequate capital to invest in production, and low and fluctuating prices. When asked to rank the priority constraints to maize production generally over the years, farmers still brought up these constraints, although in a slightly different order. Pests and diseases still ranked as the number one problem, closely followed by low and fluctuating prices and inadequate capital (Table 11), in that order.

Table 11: Crosscutting priority constraints to maize production

Constraint	**Percentage response (%)**	
	Previous season	**Generally over years**
Bad roads	0.39	0.94
Drought	7.16	5.80
Expensive labor	0.87	0.00
High input costs	2.90	3.37
Inadequate capital	9.57[2]	10.48[3]
Inadequate labor	6.77	3.84
Inadequate land holding	0.77	2.25
Inadequate market	6.67	8.33
Lack of inputs	4.35	4.77
Lack of extension services	0.48	0.94
Lack of good means of transport	2.13	4.30

[6] MFPED/UPPAP, 2003. The 2nd Participatory Poverty Assessment Report. Depeening the Understanding of Poverty, Kampala.

Low price and price fluctuation	8.22[3]	13.19[2]
Low soil fertility	0.97	2.15
Low yields	1.64	1.50
Pests and diseases	23.02[1]	15.25[1]
Poor storage	6.87	5.43
Theft	1.06	3.09
Unpredictable weather	2.80	3.09
Weeds	3.97	2.15
Wild animals/birds	7.25	4.96
Other constraints	2.13	4.21
Total	100.00	100.00

Source: Survey 2001.

District specific constraints

While pests and diseases still stood out as the most pressing problem for Apac, Iganga and Lira districts in the previous season, for Hoima district the most constraining factor to maize production was that of wild animals and birds (Table 12). This is probably explained by the large unexploited forests in parts of Hoima that harbor wild animals and birds that damage crops in the field.

Table 12: Priority constraints to maize production for the previous season by district

Constraint	**Percentage response (%)**			
	Apac	**Hoima**	**Iganga**	**Lira**
Bad roads	1.13	0.00	0.00	0.00
Drought	6.50	0.45	**15.24**[2]	7.23
Expensive labor	1.13	2.26	0.00	0.00
High input costs	6.50	0.45	1.90	0.80
Inadequate capital	3.11	**14.93**[2]	**10.48**[3]	**13.25**[2]
Inadequate labor	6.50	**8.60**[4]	3.33	**8.43**[4]
Inadequate land holding	0.28	1.36	1.90	0.00
Inadequate market	**8.47**[4]	7.24	3.33	6.43
Lack of inputs	5.93	3.17	1.90	5.22
Lack of extension services	0.85	0.90	0.00	0.00
Lack of good means of transport	3.11	1.36	1.43	2.01
Low price and price fluctuation	**12.43**[2]	6.33	**10.00**[4]	2.41
Low soil fertility	0.28	1.36	2.86	0.00
Low yields	2.82	0.90	2.38	0.00
Pests and diseases	**19.21**[1]	**12.22**[3]	**29.52**[1]	**32.53**[1]
Poor storage	**10.17**[3]	3.62	1.90	**9.24**[3]
Theft	0.28	1.81	0.48	2.01
Unpredictable weather	1.69	2.26	3.33	4.42
Weeds	8.19	1.36	3.81	0.40
Wild animals/birds	0.85	**27.60**[1]	1.90	2.81
Other constraints	0.56	1.81	4.29	2.81
Total	100.00	100.00	100.00	100.00

Source: Survey 2001. Note: The four priority constraints in each district are highlighted in bold and ranked, 1 as the most constraining factor

In Northern Uganda, low and fluctuating prices was the second most pressing constraint in Apac while it seemed not to be an issue in neighboring Lira district. This has already been confirmed by the relatively higher prices received by farmers in Lira district as compared to Apac district (Table 4). Instead, inadequate capital was the second most important constraint in Lira district. Poor storage conditions, unique to these two districts was ranked as the third priority constraint; inadequate market for farm produce was a priority constraint in Apac but not Lira where the fourth most pressing problem was inadequate labor. This finding may partially explain why the share of marketed output was slightly higher for Lira compared to Apac district (Table 4).

Regarding the two districts in the coffee-banana system – Iganga and Hoima – there were some shared priority constraints and major differences, indicating the specificity of the problems to location. For Hoima, following the problem of wild animals and birds, inadequate capital was the second priority problem, pests and diseases as the third constraint and lastly inadequate labor. Comparatively, in Iganga, pests and diseases was the most significant constraint, followed by drought, inadequate capital and low and fluctuating prices. In Table 13, an attempt is made to analyze constraints to maize farming over the years to see whether they are the same with those experienced during previous season.

Table 13: General constraints to maize production by district

Constraint	**Percentage response (%)**			
	Apac	**Hoima**	**Iganga**	**Lira**
Bad roads	3.04	0.00	0.00	0.00
Drought	2.13	4.81	5.20	**10.89**[3]
Expensive labor	0.00	0.00	0.00	0.00
High input costs	7.90	1.60	2.40	0.33
Inadequate capital	6.69	**17.65**[2]	**10.40**[3]	**10.23**[4]
Inadequate labor	1.82	4.81	2.40	6.60
Inadequate land holding	0.30	1.07	**8.40**[4]	0.00
Inadequate market	**15.81**[2]	**7.49**[3]	3.20	4.95
Lack of inputs	6.99	3.21	3.60	4.29
Lack of extension services	1.22	1.60	1.20	0.00
Lack of good means of transport	**8.81**[4]	2.14	3.20	1.65
Low price and price fluctuation	**19.15**[1]	**5.88**[4]	**11.60**[2]	**12.54**[2]
Low soil fertility	0.30	3.74	6.00	0.00
Low yields	0.91	1.07	2.40	1.65
Pests and diseases	**10.33**[3]	5.35	**20.40**[1]	**22.44**[1]
Poor storage	4.86	4.81	4.00	7.59
Theft	0.91	4.28	2.40	5.28
Unpredictable weather	2.13	2.67	2.40	4.95
Weeds	2.74	5.35	1.60	0.00
Wild animals/birds	0.91	**18.72**[1]	3.60	1.98
Other constraints	3.04	3.74	5.60	4.62
Total	100.00	100.00	100.00	100.00

Source: Survey 2001. Note: The four priority constraints in each district are highlighted in bold and ranked, beginning with 1 as the most constraining factor.

Looking at a longer time horizon beyond the previous season, it is evident that there are interesting issues that emerge. Some general constraints seem to be major challenges to farmers but were not given as key constraints in the previous season. On the other hand, there are constraints that seem to have emerged specifically during the previous season but were not important problems over the years. The differences in rankings between Tables 11 and 12 bring out this point.

While pests and diseases stood out as the number one priority problem in 3 out of 4 districts during the previous season, they did not emerge as the main constraint when farmers were asked to give the constraints that they generally face in maize production over the years. While pests and diseases have continued to be the most limiting in Iganga and Lira, low and fluctuating commodity prices and inadequate markets stand out as main constraints for Apac and Hoima districts generally over the years. It is possible that farmers feel that there is nothing that they can do to change marketing conditions and that might explain why they indicated pests and diseases as the priority problem during the previous season. Again, low commodity prices was ranked second in Iganga and Lira, yet it was not an issue in Lira during the previous season.

Interestingly, while inadequate land holding was not reflected as a priority problem in any of the districts during the previous season, it was a major constraint to farming in Iganga when farmers were asked to indicate the problems that they face generally in maize production. This fact is confirmed by earlier findings that show that farmers in Iganga have small farm holdings averaging 2.7ha as compared to other districts like Apac with an average of 11.9ha (Table 2).

Cattle Profitability and Productivity

Profitability of Cattle

Computation of cattle profits was slightly different from that of maize, an annual crop. Cattle are reared for several reasons, the primary objective being a store of value or savings. Contribution to household cash flow is a secondary objective. Therefore, computing pure economic profits may be incorrect. In this study, revenue is taken to be the value of the stock of cattle (not just the value of cattle sold) plus the value of cattle products sold. By the nature of cattle rearing in Uganda and lack of farm level record keeping, it would be extremely difficult to compute cattle profits based on number of cattle sold. Cattle may be reared for several years before selling and realizing cash income from them. However, costs are incurred constantly to keep them alive. Economic profits are realized over the long-term. In the short-run, the value of existing stock can be used as revenue. Table 14 presents cattle profit per animal for the four districts, without differentiating among the types of cattle breeds reared. While there is variation in average profits per animal among districts, the difference is only statistically significant between Iganga and Hoima districts (p-value=0.008).

Table 14: Cattle profit per animal by district

Farming System	**District**	**Profit (Sh)**
Northern System	Apac	200,333
	Lira	226,478
Coffee-Banana System	Iganga	302,785
	Hoima	158,118

Source: Survey 2001

District level comparison of cattle profits by breed was not possible because exotic and crossbreed cattle were not captured in the sample across the four districts. Only the indigenous cattle are reared in all four districts. Therefore, comparisons are made for profitability by breed without differentiating among districts. The differences in average profits are statistically tested (Table 15). There were three cattle breeds in the sample: exotic, crossbreed and indigenous. The comparisons indicate that there was no significant difference in profit per animal between exotic and crossbreed cattle, but a very significant difference existed in profits between exotic and indigenous cattle. Also, the difference in profits was very significant between crossbreed and indigenous cattle.

Table 15: Cattle profits (Sh) per animal by breed

Exotic	Crossbreed	T-test (mean difference) P-value
1,185,668	1,417,062	0.7052
Exotic	Indigenous	
1,185,668	691,066	0.0031
Crossbreed	Indigenous	
1,417,062	691,066	0.0051

Source: Survey 2001

These results clearly demonstrate that rearing improved cattle brings more returns to farmers than rearing indigenous cattle. Yet, the adoption of improved cattle breeds by farmers remains very low (3% adopted crossbreeds; 7% exotic breeds) compared to the level of adoption by maize farmers (61%). The policy challenge, therefore, is to promote adoption of improved cattle breeds, and the improvement can be gradual from indigenous to crossbreed. Such an approach to upgrading is likely to be cheaper and more appealing to cattle keepers.

Regression Results

Table 16 presents the results of regression analysis for cattle profit as the dependent variable. All variables are in logarithms. The results indicate that there are three main determinants of cattle profitability. First, the sell price of cattle is important, the higher it is, the more profits. Profits are positively related to output price, hence the importance of ensuring that efficient markets exist. Second, the amount of land under pasture is a very important factor in determining cattle profitability. The more land under pasture, the higher the profits. Indeed, inadequate pasture was mentioned as a major constraint to livestock production (Table 18), implying that having pasture is important for livestock production. Third, the distance to an all-weather road is important. Living further away from a good road reduces cattle profitability, especially for milk which is a perishable commodity. Farmers far from reliable road may get lower prices for their products compared to those close to good roads.

Table 16: Determinants of cattle profitability (dependent variable: cattle profits)

Variable	Coefficient	T-statistic	P-value
Cattle price	0.78	3.71	0.000
Land under pasture	0.46	9.24	0.000
Distance to an all weather road	-0.07	-1.62	0.109
Intercept	4.52	1.78	0.078
R^{-2} = 0.459			
N = 122			

To enhance farm level profits from cattle rearing, it is absolutely critical that farmers are in easy reach of basic infrastructure, particularly markets and roads. The challenge is to ensure that the Marketing and Agro-processing Strategy (MAPS) that has been developed under the PMA to address marketing problems at farm level is operationalized to ensure increased access to output and input markets, market information and better prices. While access to pastureland is important in explaining cattle profitability, the future lies in focusing on pasture productivity because land is becoming a limiting factor. This is in view of earlier findings of the relatively smaller farm size in Lira (5.6 Ha) and Iganga (2.7) and consequently the proportion of land allocated to livestock in these two districts being small as well (refer to table 2).

Cattle productivity

Cattle productivity is simply measured by the amount of milk produced by lactating animals over the previous season. Another simple measure would have been live or carcass weight, but data on these measures were not collected. A comparison of milk yield reveals that there is no statistical difference between milk yield of exotic and crossbreed cattle, yet the differences are significant for exotic and indigenous, and crossbreed and indigenous as shown in table 17.

Table 17: Milk yield (liters) per season by breed

Exotic	Crossbreed	T-test (mean difference) P-value
1736	823	0.1296
Exotic	Indigenous	
1736	465	0.0000
Crossbreed	Indigenous	
823	465	0.0051

Source: Survey 2001

Milk prices are similar regardless of the type of cattle breed reared and therefore profit differences are due to higher milk production by the improved cattle breeds as well as the higher prices for the live animals. Milk yield per exotic cattle is more than twice that of crossbreed cattle and about four times that of indigenous cattle. The average price for live exotic cattle is more than twice that of indigenous cattle and about one and a half times that of crossbreed cattle. These findings underscore the importance of promoting adoption of improved cattle breeds.

Constraints to livestock production

Like in the case of maize production, in addition to cattle profitability and productivity, we analyzed farmer responses regarding what they considered to be constraints to cattle production. The responses were sought for constraints faced during the past few years as well as during the previous season. These were grouped into two categories: those that were crosscutting or common to all districts and those that were district specific.

Crosscutting constraints

Without controlling for location, for both the previous season and in general over the years, pests and diseases remained the main constraint to livestock production (Table 18). The second major constraint across both time horizons was inadequate pasture, followed by high cost of inputs and lack of capital, in that order. The ordering of constraints was consistent for the entire sample. Present but less prominent across the districts, was the constraint of inadequate water for livestock production.

Table 18: Crosscutting constraints to livestock production

	Percentage Response	
Constraint	Previous Season	**Generally over years**
Lack of Capital	**5.80**[4]	**9.04**[4]
Conflicts	0.00	1.53
Diseases/Pests	**30.93**[1]	**22.80**[1]
Drought	1.42	2.93
High Input Costs	**10.57**[3]	**10.96**[3]
Inadequate Pasture	**19.97**[2]	**16.31**[2]
Inadequate Water	4.12	2.04
Lack of Farm Inputs	3.61	3.82
Lack of Clean Water	5.28	4.08
Lack of Extension Services	2.71	3.06
Lack of Good Means of Transport	0.64	0.51
Lack of Market	2.71	3.31
Low Price and Price Fluctuation	1.93	4.46
Low Yields	2.45	2.17
Poor Breeds	1.42	2.17
Theft	1.55	4.71
Other Constraints	4.90	6.11
Total	100	100

Source: Survey 2001

District specific constraints

The major limitations to livestock production by district for the previous season as well as for the past few years are summarized in Tables 19 and 20, respectively. During the previous season, pests and diseases were the main constraint in all four districts, still followed by inadequate pasture except in Hoima where high input costs featured as the second major constraint (Table 19). Pasture inadequacy was more severe in Iganga as well as Lira. This is probably explained by the much smaller farm sizes and hence a small proportion of land allocated to livestock production in these districts as compared to Hoima and Apac (Table 1). High cost of inputs was the third most constraining factor in Apac and Lira, while in Hoima and Iganga the third main constraint was lack of capital. Interestingly, the lack of clean water for livestock production was important only in Apac during the previous season but was very insignificant in neighboring Lira district indicating the location specificity of this particular constraint, hence requiring targeted intervention.

In general, over the years, there are more variations in the constraining factors among districts when a longer time horizon is considered. High input costs were the main constraint in Apac and Hoima, while pests and diseases were the main constraint in Lira and Iganga (Table 20). Lack of capital was second in Hoima and Iganga, while pests and diseases and inadequate pasture were the second most constraining factor in Apac and Lira, respectively. There was no commonality among districts with regards to the third and fourth most constraining factors to livestock production, again reflecting the fact that some constraints are district specific. For instance, theft of livestock was among the top four only in Hoima district. The other factors in the top four but are district specific include lack of extension services (Apac), lack of market (Iganga), conflicts (Iganga), and low prices and price fluctuation (Lira).

Table 19: Constraints to livestock production for the previous season by district

	Percentage Response			
Constraint	**Apac**	**Hoima**	**Iganga**	**Lira**
Lack of Capital	1.16	**11.66**[3]	**9.29**[3]	**4.67**[4]
Conflicts	0.00	0.00	0.00	0.00
Diseases/Pests	**18.92**[1]	**23.31**[1]	**32.86**[1]	**50.00**[1]
Drought	2.70	1.23	0.71	0.47
High Input Costs	**14.67**[3]	**14.72**[2]	4.29	**6.54**[3]
Inadequate Pasture	**17.37**[2]	**11.04**[4]	**27.86**[2]	**24.77**[2]
Inadequate Water	1.93	4.91	**6.43**[4]	**4.67**[4]
Lack of Farm Inputs	5.02	4.29	1.43	2.80
Lack of Clean Water	**10.81**[4]	5.52	0.71	1.40
Lack of Extension Services	7.34	1.23	0.00	0.00
Lack of Good Means of Transport	1.93	0.00	0.00	0.00
Lack of Market	3.74	1.84	6.43	0.00
Low Price and Price Fluctuation	2.70	4.91	0.00	0.00
Low Yields	3.86	1.23	2.14	1.87
Poor Breeds	2.32	3.07	0.00	0.00
Theft	0.00	1.84	3.57	1.87
Other Constraints	5.79	9.20	4.29	0.93
Total	100	100	100	100

Source: Survey 2001

Table 20: General constraints to livestock production by district

	Percentage Response			
Constraint	**Apac**	**Hoima**	**Iganga**	**Lira**
Lack of Capital	**8.33**[4]	**12.71**[2]	**17.53**[2]	3.30
Conflicts	0.00	1.69	**6.49**[3]	0.00
Diseases/Pests	**14.17**[2]	**11.86**[3]	**21.43**[1]	**35.90**[1]
Drought	1.25	3.39	1.30	5.13
High Input Costs	**14.58**[1]	**19.49**[1]	4.55	**7.69**[3]
Inadequate Pasture	**11.25**[3]	5.08	**21.43**[1]	**22.71**[2]
Inadequate Water	0.83	4.24	2.60	1.83
Lack of Farm Inputs	4.58	5.08	1.30	4.03
Lack of Clean Water	**8.33**[4]	3.39	1.30	2.20
Lack of Extension Services	**8.33**[4]	3.39	0.00	0.00
Lack of Good Means of Transport	1.25	0.85	0.00	0.00
Lack of Market	4.17	4.24	**6.49**[3]	0.37
Low Price and Price Fluctuation	4.17	4.24	1.95	**6.23**[4]
Low Yields	1.25	1.69	2.60	1.47
Poor Breeds	4.17	3.39	0.65	0.73
Theft	0.83	**9.32**[4]	5.84	5.49
Other Constraints	12.50	5.93	4.55	1.74
Total	100	100	100	100

Source: Survey 2001

V. Policy Implications

The findings of this study demonstrate that the differences in profitability and productivity are due to the type of technology used by farmers. Those that planted improved maize had higher returns per hectare than those that planted local (unimproved) maize. Similarly, farmers that reared improved cattle breeds realized higher profits and productivity per animal than those that reared indigenous breeds. The results of this study have several policy implications for PMA implementation.

First, it is important to promote growing of improved maize varieties because they are more profitable than indigenous maize varieties across all farm size farms. A study by NIDA (2001) on assessing the socio-economic benefits of SASAKAWA Global 2000 interventions in Uganda also showed positive marginal returns to investment in improved maize varieties over the local varieties. Farmer sensitization and education, through the National Agricultural Advisory Services (NAADS) should play a significant role in this regard. Along with these, it will be important to support the evolution of stockists so that farmers can get the seeds at nearer places. As illustrated by this study, contact between farmers and extension agents plays an important role in profitability. The farmers' groups being formed under NAADS should provide opportunities for maximizing the benefits of extension. PMA interventions must be sensitive to the location specific nature of farmer constraints. If the interventions are implemented broadly, their impact is likely to be less effective.

Second, cattle farmers should be encouraged to raise improved cattle breeds because they are more profitable than indigenous cattle. They yield more milk and the price for live animals is also higher. For example milk yield per exotic cattle is more than twice that of the crossbreeds and about four times that of indigenous breeds. However, the predominance of indigenous cattle in all districts means that a lot of effort by NAADS will be necessary to bring about transformation among cattle farmers rearing indigenous cattle. There is no significant difference between exotic and cross-breeds in milk yield and profitability, yet the transition from indigenous to exotic can be costly especially for poor farmers. Therefore, the policy challenge is to promote gradual upgrading from indigenous to cross-breeds perhaps through artificial insemination or promoting bull exchanges among farmers. Pests and diseases are serious constraints to cattle rearing because they have two main effects – reducing the productivity of the infested animal and increasing the production cost to the farmer. The high prevalence of pests and diseases emerges as the most critical problem facing maize production as well

Third, farmers in Northern Uganda should be encouraged and facilitated to grow improved maize and rear improved cattle breeds which are as productive and profitable in this region as in the coffee banana region despite the seemingly unfavourable climatic conditions. This could be one way of increasing household incomes and therefore reduce poverty in the North were poverty trends have been on the increase. The fact that 78 percent of sampled farmers in Northern Uganda had planted improved maize seed gives positive indications of quicker uptake of improved technology when introduced and promoted, an opportunity that should be fully exploited.

Fourth, although expansion of land for maize production and pasture is an important determinant of profitability, this may be so in the short-run as land availability becomes a constraint, as the case was in Iganga district. Improved maize production and profitability should come from adoption of improved seeds. Similarly, increased livestock production must come from adoption of improved breeds and improved pasture

Fifth, we have also examined the findings of this study against the government's PMA interventions. While the qualitative assessment of the constraints to production study reveals that pests and diseases, both for crops and livestock, are major constraints to productivity, government interventions in the PMA are not aggressively tackling this problem. In the PMA, the government commits to handle pests and diseases that are of epidemic proportion, and argues that farmers ought to be responsible for purchase of chemical to fight any other pests or diseases. It seems the problem needs a more integrated approach. In the short-run, farmers complain about the high cost of inputs, among them pesticides, yet government is limited in its ability to subsidize inputs. Additionally, even if farmers were willing to borrow and purchase the necessary inputs, rural micro-finance is not readily available. One of the PMA interventions is rural finance, but this is yet to be operationalised. In the long-run, research has got to focus on developing pest and disease resistant maize varieties and cattle breeds. The research agenda needs to be informed by the constraints facing farmers

Finally, the study did not establish why livestock farmers are not adopting improved cattle breeds. But what is clear is that non-adoption is not due to technology being unprofitable. Findings suggest to some extent that maybe low adoption could be linked to the limited access to sizeable pieces of land, low literacy levels since close to half of the farmers had only attained primary education, which could have resulted in limited appreciation of improved technologies. This is an area that warrants further investigation. The gender aspects of technology adoption also need to be explored further as this was not possible in this study where the majority of respondents were male.

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