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Economics of Improved Crop Production Technologies under the Crop Small Ruminant Project in Ghana

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Abstract: The poor performance of the agricultural sector in Ghana is attributed to the low adoption of improved technologies. As a result, the Crop Small Ruminant project was aimed at making crop production technologies available to farmers for increased productivity and income. To facilitate the process, an on-farm seed treatment demonstrational trial for maize production was conducted in the Atebubu Amantin district of Ghana. Gross Margins (GMs) and Net Returns (NRs) showed farmers would be economically better off using these improved technologies at both lean and peak periods. Returns were enhanced at peak periods when prices were much higher. The farmer made a loss of GHC- 283.72/ha at lean price of GHC 0.58/kg in terms of Gross Margin (GM) when using random planting and local variety compared to a GM of GHC 1 429.02/ha when an improved variety was planted in rows. This further increased to GHC 4 276.02/ha at a peak price of GHC 1.08/kg showing the role of price in enhancing economic returns. Adopting the use of improved varieties with other practices such as row planting, fertilizer application, recommended spacing and seed treatment enhanced economic returns. Governments of developing countries must therefore support farmers to acquire improved technologies as a package for maximum economic returns. Improving storage systems will also further enhance economic returns of the farmer through enhanced prices at peak periods.

Key words: Gross Margin · Total Revenue · Benefit Cost/Ratio · Cost · Market price

INTRODUCTION

Agriculture is the largest employer of labour in Africa and has enormous role to play in the development of the continent [1]. This is not different from Ghana where agriculture employs majority of the people. The sector's importance is what led to the development of the Medium Term Agricultural Sector Investment Plan (METASIP) with a target of 6% growth rate [2]. This is in consonance with the target set by the Comprehensive African Agriculture Development Programme (CAADP) of 6% annual growth rate for agriculture. Despite the importance of agriculture, Ghana's agriculture is dominated by subsistence small holder production units with weak linkages to industry and the services sector [3]. The sector is characterized by low productivity, low income and un-competitiveness in production, processing and distribution. Given its central role in generating income and providing subsistence for majority of the people as well as its potential to lead the transformation of the economy, agriculture is expected to drive the new development agenda under the Ghana Shared Growth and Development Agenda (GSGDA). This agenda is however challenged since the contribution of the sector to Gross Domestic Product (GDP) has in recent times been on the decline. From 29.1% in 2007 it reduced to 22.0% in 2013 [4]. Not only has agricultural contribution to GDP decline, its growth rate has also been challenged. Agriculture's lowest growth rate was in 2010 when it recorded 0.8%. The situation however is improving gradually with growth rates moving from 2.3% in 2012 to 5.2% in 2013.

The poor performance of the sector is attributed to the low adoption of improved technologies. Catherine *et al.* [5] stated only half of the farmers interviewed use fertilizer. They emphased intensity was low since farmers did use only 47 kg/ha of nitrogen on the average compared to the recommended 90kg/ha. They further stated the rate of row planting was 53% which was the same as reported by Morris *et al.,* [6] in 1997. Out of the 63% of farmers using improved maize varieties, only 15% used certified seeds. This was the state of technology adoption in the country affecting productivity and food security.

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In response to this challenge, the Sustainable Intensification of Integrated Crop-Small Ruminant Systems (SIIC-SR) project in West Africa was initiated by Austrian AID (AusAID) now Austrian Department of Foreign Affairs and Trade (DFAT) aimed at increasing agricultural productivity and income for poor rural households to enhanced food security and livelihoods. The project was based on the principles of Integrated Agricultural Research for Development (IAR4D) using the Innovation Systems (IS) approach. As a result, the Innovation Platform (IP) methodology was adopted which brought together actors of the crop small ruminant value chain onto a common platform. The global entry point was the introduction of dual purpose legumes into the system to produce both grain and fodder.

Methodology: This paper used data from a field demonstration trial in Atebubu -Amantin district by highlighting the economic importance of using improved technologies such as row planting, seed treatment and fertilizer application for maize production. The Atebubu-Amantin District is located in the Forest Savannah Transition Agroecological zone in Ghana. The zone is characterized by a bi-modal rainfall pattern with the major season beginning from April and ending in July and the minor season beginning in September and ending in October. Annual rainfall ranges between 1300mm and 2200mm with temperatures relatively low throughout most of the year with the highest of 28 ºC in March and April [7].

The objective of the demonstration was to illustrate the productivity increase and superior economic returns from seed treatment with recommended practice such as row planting, fertilizer application and use of improved seed. Six (6) farmers with each as a replicate were selected in the Atebubu-Amantin district for the study. Five treatments arranged in RCBD were used; (i) farmer variety without recommended practices (no fertilizer + randomly planted), (ii) farmer variety + row planting + fertilizer, (iii) farmer variety + row planting + fertilizer + seed treatment, (iv) improved variety + fertilizer (v) improved variety+ fertilizer + seed treatment. The two varieties used were Aburohoma (farmers variety) and Obatanpa (improved). The spacing for the row planting was at 80cm between rows and 40cm within row resulting in 62500 plants per hectare with 2 plants per hill . The treatments with fertilizer were applied at 90-38-38 kg/ha of N-P_2O_5-K_2O one week after planting and 250 kg/ha of Sulphate of Ammonia 4-6 weeks after planting as recommended by CSIR - CRI [8]. Farmer's variety planted without fertilizer randomly was used as the control.

To estimate profitability, economic analysis was conducted through the estimation of Gross Margins (GM), Net Returns (NR), Returns to Investment (RI) and Benefit Cost Ratio (BCR). NR was estimated to verify if the technologies could still be profitable accounting for fixed cost. The estimation of RI provided information for investment decision. That is if the farmer was to borrow and invest in the technology, could he/she pay back in the short run. BCR gave a long term idea of profitability when fixed cost is taken into account. The used of different profitability methods was therefore to provide the potential adopter all the necessary information needed in taken a decision to adopt or not to adopt. Parameters were thus estimated as adapted from [9] such that;

- GM= TR-TVC

Where GM is gross margin in GHC/ha
TR= Total revenue in GHC/ha
TVC= Total Variable Cost in GHC/ha

- NR= GM-TFC

Where NR= Net Return in GHC/ha
TFC= Total Fixed Cost in GHC/ha

- RI= GM/Total Fixed Cost

Where RI= Returns to investment

- TCP=TVC +TFC

Where TCP= Total Cost of production

- BCR=NR/TCP

Where BCR=Benefit Cost Ratio

RESULTS AND DISCUSSIONS

According to [6], 54%, 53% and 21% of farmers sampled in evaluating the adoption and impact of the GGDP project planted modern (improved) varieties, planted at least part of their maize crop in rows and applied fertilizer respectively. However, from the project baseline report, 77.48% (SIIC-SR, 2012) of farmers in the Atebubu Amantin district still planted their crops randomly. Only 22.55 % of them did plant in rows. This results was what necessitated the seed treatment demonstration with recommended agronomic practices (row planting, fertilizer application, seed treatment, use of improved seed) to demonstrate to farmers the agronomic and economic benefits of these recommended practices.

Farmers in developing countries have several reasons for not adopting improved technologies They normally adopt broadcasting to row planting since it offers the advantage of being up to four times faster than conventional ploughing and drilling. The use of fertilizer is also low and most maize in developing countries is produced under low N conditions because of low N status of tropical soils, low N use efficiency in drought-prone environments, high price ratios between fertilizer and grain, limited availability of fertilizer and low purchasing power of farmers. In the past, long fallow periods of 5–10 years allowed natural restoration of soil fertility. Fallow periods have decreased in length or is almost non-existent in many farming communities because of pressure on land to increase food production and other socioeconomic activities [10].

The rate of germination and achievable yields depends on the quality and type of seed planted. Seed treatment before planting is therefore a recommended practice to prevent it from rodent attack. The rate of seed treatment before planting is however low in developing countries. What makes this situation serious is the high use of local seeds rather than improved seeds. These were the productivity challenges in the Atebubu Amantin district that emanated the trial to demonstrate the technical and economic viability of seed treatment and other improved production practices.

From the trial, the farmer variety planted randomly without fertilizer (control) gave a yield of 1.6t/ha. Planting the farmer variety in rows with fertilizer at the recommended rate gave a yield of 3.99t/ha (Table 1). That is a yield difference of 149% (Table 1).The yield difference increased to 187.5% (4.6t/ha) when the seed of the farmer was treated before planting and planted in rows with fertilizer at the recommended rate. Using improved variety planted in rows with fertilizer without seed treatment gave a yield of 5.3t/ha which is 231.25% higher than the farmers practice. Adding seed treatment to the improved variety planted in rows with fertilizer gave the highest yield of 5.6t/ha representing 250% yield difference over the farmer variety (control). This shows how the farmer is worse off by not adopting improved practices. It can be established from this analysis that the farmer is better off in terms of yield increase as he/she adopts improved production practices and technologies. The highest yield advantage was realised when the technology was adopted as a package. However the adoption of just a single technology still made a difference. It is therefore important to encourage farmers to adopt some aspects of the technology package gradually if they cannot afford the whole package at ago due to some constraints. The gradual adoption of aspects of the technology package will create some benefits leading to adoption of the entire package.

In terms of cost, farmers variety planted in rows with fertilizer and seed treatment had the highest cost of GHC 2 756 of which GHC 2 591 was Total Variable Cost (TVC) and GHC165 as Total Fixed Cost (TFC). Among the treatments, farmer treated seed planted in rows with fertilizer had the highest TVC compared with treated improved variety planted in rows with fertilizer (GHC 1 873). Two major reasons explains this difference in TVC. That is narrow spacing with farmer practice which means more plants per stand. The implication of this is the high cost of labour and seed incurred by not following recommended spacing to achieve the required plant per stand. Farmers can make some saving in terms of labour and seed cost using the recommended spacing. The use of recommended spacing will give the right plant per stand and reduce the required quantity of seed needed for planting leading to cost saving.

The farmer was worse off in terms of Gross Margin(GM) using his/her own variety. Producing at a Total Variable Cost (TVC) of GHC 1,221/ha and selling at the lean market price of GHC 0.58/kg, the farmer made a negative Gross Margin (GM) of GHC -283.72/ha using farmer variety without row planting and fertilizer application. Losses did reduced to GHC -202.96/ha (28.46%) at the same price when the farmer applied fertilizer and planted in rows. Treating the farmer variety and planting in rows with fertilizer improved yield leading to a positive GM of GHC 49/ha. The GM for using improved variety planted in rows with fertilizer was GH 1 285/ha due to the high yield of that treatment. The highest GM (GHC1 429/ha) was improved variety treated and planted in rows with fertilizer. It was evident from this study that as the farmer adopts improved practices, GM improves which will eventually affect farmer income. Farmers should therefore be encourage to adopt improved practices for income enhancement. The use of higher test of profitability like Net Returns (NR), Returns to Investment (RI) and Benefit Cost Ratio (BCR) indicated the farmer was still better off in adopting improved technologies (Table 1).

Table 1: Economics of maize seed treatment trial with recommended agronomic practices

	Farmer variety without recommended practices		Farmer variety+Row planting + Fertilizer		Farmer variety+Row planting + Fertilizer + seed treatment		Improved variety+Row Planting + Fertilizer		Improved variety+Row planting + Fertilizer + Seed treatment	
Variable	Market price	Peak price	Market price	Peak price	Market price	Peak price	Market price	Peak price	Market price	Peak price
Yield(kg)	1616.00	1616.00	3988.00	3988.00	4553.00	4553.00	5318.00	5318.00	5694.00	5694.00
Price/Kg	0.58	1.08	0.58	1.08	0.58	1.08	0.58	1.08	0.58	1.08
Revenue	937.28	1745.28	2313.04	4307.04	2640.74	4917.24	3084.44	5743.44	3302.52	6149.52
Total Variable Cost (TVC)	1221.00	1221.00	2516.00	2516.00	2591.00	2591.00	1798.50	1798.50	1873.50	1873.50
Total Fixed Cost (TFC)	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00
Total Cost of Production (TCP)	1386.00	1386.00	2681.00	2681.00	2756.00	2756.00	1963.50	1963.50	2038.50	2038.50
Gross Margin (GM)	-283.72	524.28	-202.96	1791.04	49.74	2326.24	1285.94	3944.94	1429.02	4276.02
Net Returns	-448.72	359.28	-367.96	1626.04	-115.26	2161.24	1120.94	3779.94	1264.02	4111.02
Returns to investment	-1.72	3.18	-1.23	10.85	0.30	14.10	7.79	23.91	8.66	25.92
BCR	-0.32	0.26	-0.14	0.61	-0.04	0.78	0.57	1.93	0.62	2.02

Source: Field Trial, 2013

Table 2: Marginal Analysis of the Treatments

Treatment	TVC	MC	NR	MRR
T1	1221		359.28	
T2	2516	1295	1626.04	97.82
T3	2591	1370	2161.24	131.53
T4	1798	577	3779.94	592.84
T5	1873	652	4111.02	575.42

Source: Field Trials, 2013

T1= Farmer Variety without recommended practice (control)

T2= Farmer Variety + Row planting +Fertilizer

T3= Farmer Variety + Row planting +Fertilizer + Seed Treatment

T4= Improved Variety + Row planting +Fertilizer

T5= Improved Variety + Row planting +Fertilizer + Seed Treatment

Table 3: Marginal effects above the Minimuim Acceptable Rate of Return

Variable (Improved practice)	% change in MRR Above 100% minimum acceptable rate
Row Planting + Fertilizer	-2.18
Seed treatment	31.53
Improved variety	492.84
Improved variety+ Seed Treatment	475.42

Source: Field Trails, 2013

The effect of price variation was also manifested in determining economic viability and profitability of treatments. Selling at a lean price of GHC 0.58kg, the farmer made a gross margin of GHC -283.72/ha compared to a GM of GHC 524.28/ha at peak price (GHC 1.08/kg) planting farmer variety without any improved practices. This was the trend for all the other treatments such that improved variety treated and planted in rows with fertilizer selling at the peak price gave a GM of GH 4 276.02/ha. This means profitability would be enhanced if farmers are able to negotiate for a good price or store to sell at lean seasons when prices are high. Provision of store structures for farmers is therefore very imperative if returns on technologies are to be enhanced.

Farmer as rational economic beings are willing to adopt a new technology if the additional returns of the new technology exceeds that of the existing technology. To achieve this, the Marginal Rate of Return (MRR) for treatments were compared with the Minimum Acceptable Rate of Return (MARR-100%) through Marginal Analysis (MA). MRR is simply Marginal Returns divided by Marginal Cost in percentage terms. Using the peak prices, Table 2 shows that T2 (Farmer Variety + Row planting +Fertilizer) had the lowest MRR of 97.82% below the minimum acceptable rate of return (100%) meaning farmers are worse off adopting that treatment. The highest MRR (592.84%) was at T4 (Improved Variety + Row planting +Fertilizer) with an NR of GH 3 779.94/ha. Though T4 had the highest MRR, T5 (improved variety + row planting +fertilizer +seed treatment) was the best treatment since the farmer still had the opportunity to increase NR to GH 4 111.02. The implication of this analysis is that, it is not just enough for the farmer to adopt row planting and fertilizer but use of seed treatment and improved variety increases marginal returns and makes the farmer better off. Seed treatment and improved variety increased marginal returns by 31.53% and 492.84% respectively (Table 3). The joint effect however was 475.42% (Table 3).

CONCLUSION

From the analysis, farmers will be economically empowered adopting improved crop production technologies. Just by adopting a single practice within a technology package increased the yield per unit area. Promoting the use of improved technologies can therefore be approached gradually in getting farmers to adopt at least improved varieties if they cannot even afford fertilizer. Treating their seed before planting is very essential to prevent insect and rodent attack in the soil. The role of price in enhancing income levels has been established. Lack of storage facilities cause excess supply during harvesting and demand deficit during planting time. Providing farmers with storage facilities will enable them store and sell at peak price which will further enhance their economic returns. Increased economic returns of the farmer have long term impact on improving household food security and livelihoods.

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