Rural Economics and Development

Competitiveness of Cotton in Organic and Conventional Production Systems in Uganda

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Abstract

Organic cotton production in Uganda is rising mainly due to the promotional efforts of private multinational cotton exporting companies. Nonetheless, the sustainability of organic cotton projects and their ultimate impact on poverty reduction will depend on the relative profitability of organic cotton production system. This paper therefore attempts to examine the competitiveness of cotton in conventional and organic production systems in Uganda. A survey of 160 cotton farmers was done in Northern Uganda where organic cotton has been introduced. Using whole farm crop budgets and the linear programming method, it was found that cotton was competitive with other 'cash' crops only under organic production system mainly because of the existence of price premium. Gross returns to organic cotton were approximately 7%. In the absence of price premium, organic cotton was an unattractive enterprise since farmers made losses of over 13%. Policy recommendations were thus forwarded to promote organic cotton production in Uganda.

Key words: *Organic, Conventional, Cotton, Production Systems, Price Premium*
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Introduction

World organic cotton production in 2007/08 reached 145,872 MT representing 0.55% of the total cotton production (Ferrigno and Lizarranga, 2009). Although *de facto* organic cotton production took place for many centuries, it was not until 1989/90 when it was first officially certified by Turkey and then by US in 1990/1991 (ICAC, 2003). Organic cotton production has since spread to over 20 countries around the world in a concentrated pattern; more than 87% of the total organic cotton comes from three major producers: India, Turkey, and Syria (Ferrigno and Lizarranga, 2009). Continent-wise, Africa's contribution to global production is still small (about 4.5%), however, organic cotton projects have been introduced to various countries including: Tanzania, Uganda, Egypt, Zambia, Senegal, Burkina Faso, Mali, and Benin (Ferrigno and Lizarranga, 2009; Ferrigno et al., 2005).

Driven by economic, social, and environmental motives a number of private multinational initiatives have emerged to promote organic cotton production in Sub-Saharan Africa (Ferrigno et al., 2005). However, Ferrigno et al. (2005) argue that the sustained expansion of organic cotton production in this region might depend more on the profitability of organic relative to conventional cotton production systems.

Several studies have attempted to compare yields, production costs, and overall profitability of organic and conventional cotton production systems in various parts of the world (Ghorbani et al., 2008; Eyhorn et al., 2007; Swezey et al., 2007; Ferrigno et al., 2005; ICAC, 2003; Tulip and Ton, 2002; and Ratter, 2002). These studies have shown mixed results, depending on the study area and period, and conversion year of farmer.

Using the U.S. national cotton production data, ICAC (2003) showed that organic cotton yields were higher than conventional cotton yields in the introductory period. In the first six years, from 1990/91 to 1995/1996, organic cotton average yields were 13% higher than the conventional average yield. However, from 1996/97 to 2001/02, there was a 24% reduction in yield under organic conditions compared to conventional production and, the difference between organic cotton and conventional production was widening every other year. For example, from 1999/00 to 2001/02, the average organic cotton yields were 39% lower than the national average yield. In the same time period (1996-2001), a comparative study of cotton farms in California found that yields were 34% lower in organic than conventional cotton and, this partly caused production costs in organic cotton fields to rise by 37% (Swezey et al., 2007). While Swezey *et al.*, (2007) attributed cotton yield disparities to less than optimum weed management in organic fields, ICAC (2003) noted it coincided with the adoption of transgenic cotton, which had a positive effect on yield of conventional cotton. Yield losses in organic cotton fields were also reported in countries where transgenic cotton had not yet been introduced such as Turkey, Iran, Zimbabwe, Benin and Mali. Changing to organic cotton production in Turkey led to an average yield loss of 5.4-7.4% with some varieties posting yield losses as high as 17-22% (ICAC, 2003). Ghorbani *et al.*, (2008) found that cotton yields in Iran dropped by 34% on conversion from conventional to organic production system and that large farms (more than 10 ha) were more affected than small/medium farms. In Zimbabwe and West African countries (Benin and Mali), although not specified organic cotton yields were said to be lower than those of conventional cotton (Ferrigno *et al.*, 2005). This strongly suggests that suboptimal crop management could have been responsible for the reduction in organic cotton yields in these countries.

On the contrary, no yield deviations were experienced by organic cotton farmers in India (Eyhorn et al., 2007), Tanzania (Ratter, 2002), and Uganda (Tulip and Ton, 2002). These findings demonstrate the importance of improved crop and soil management. With organic cotton production costs reduced by 10-20%, Eyhorn *et al.*, (2007) showed that a 20% organic price premium led average gross margins from organic cotton fields to be 30–40% higher than in the conventional system. Moreover, when other non-premium crops in the system were considered, Eyhorn found organic farms achieved 10–20% higher incomes than conventional farms. However, the introduction of transgenic cotton in these countries might tilt the balance between organic and conventional cotton yields. In India, for example, with 80% of the total cotton area under Bt Cotton, average national cotton yields nearly doubled from 302 kg/ha in 2002/03 to 567 kg/ha in 2007/08 (Karihaloo and Kumar, 2009).

In this paper, special focus is on Uganda because present and future organic cotton projects are expected to bring fresh hope to the declining cotton industry and ultimately contribute to rural poverty reduction. Yet, recent press reports indicate that organic cotton yields have reduced due to outbreak of pests (Kasita, 2008a&b). Therefore, this paper attempts to assess the competitiveness of cotton in organic and conventional production systems in Uganda. Findings from this study will be useful to all stakeholders including organic cotton project sponsors (both private companies and donors), cotton farmers, environmentalists, and policy makers.

2. Status of organic cotton production in Uganda

Uganda is the second major producer of organic cotton in Africa following Tanzania. In 2007/08, Uganda contributed to 39% of the total organic cotton production in Africa (Ferrigno and Lizarranga, 2009). Since the introduction of organic cotton in northern Uganda in 1994, there has been a modest increase in its production despite the protracted insecurity situation in the region. By 2007/08, organic cotton contributed to more than 10% of the total cotton production (CDO, 2008).

The first organic cotton project, the Lango Organic Farming Promotion (LOFP), was set up in 1994 by the Lango Co-operative Union (LCU) with assistance from the Swedish International Development Agency (Tulip and Ton, 2002). The LOFP project started with 200 farmers producing organic cotton for Bo Weevil, a dutch private cotton exporting company. In 1996/97 cotton season, Bo Weevil through its subsidiary, Shares (U) Ltd, also started to buy organic simsim and chillies. And, by 2008/09, there were over 30,000 certified farmers drawn from the Lango sub-region producing organic cotton, sesame, and chillies for Bo Weevil/Shares (U) Ltd. The tripartite agreement involving Bo Weevil/Shares, LOFP, and LCU broke up in 2009/10 and Bo Weevil/Shares opted for independent registration of cotton farmers. In the same year, the North Bukedi Cotton Company, operating mainly in eastern Uganda, entered the Lango sub-region and signed a memorandum of understanding for joint certification of farmers with LOFP. It is also thought that organic certification of some slack season crops such as simsim and beans will be done in order to expand the product range available for organic cotton farmers. In 2006/07, another organic cotton project, known as the Northern Uganda Eco-Organic (NUEO) was started in partnership with two private exporters, Dunavant (U) Ltd and Outspan Enterprises Ltd. The NUEO project registered over 15,000 farmers in the Lango sub-region for conversion to produce organic cotton for Dunavant, and organic sesame and chillies for Outspan. However, in 2007, NUEO/Dunavant shifted their operations to Acholi sub-region where over 15,000 farmers were registered to participate in the organic cotton project. Due to the fact that Acholi sub-region was completely ‘virgin’ as a result of about two decades of rebellion and insecurity, cotton farmers there were directly certified as organic without requiring them to undergo any conversion. In 2008/09, organic cotton production started in Acholi sub-region and Dunavant has continued to vigorously promote it through the provision of critical inputs such as seeds, organic pesticides, farm power, and extension.

3. Methodology

3.1. Study area and data

This study was done in two districts in Northern Uganda, namely: Lira and Pader. Two private organic cotton exporting companies, Bo Weevil and Dunavant, were operating in Lira and Pader, respectively. A paired-matched random sampling method was used to select cotton farmers who participated in the study. Since it allows for comparison of organic and conventional cotton farmers on various characteristics, this method controls for some of the extraneous factors that influence their profitability (Wonnacott and Wonnacott, 1990). Forty (40) organic cotton farmers were randomly selected per district making a total of 80 organic cotton farmers. Similarly, 40 conventional cotton farmers were randomly selected from each district to make a total of 80 conventional cotton farmers. Primary data was collected from the selected farmers using the survey method. A standardized questionnaire was used to collect data including farmers' socio-economic characteristics, nature of crop enterprises, variable production and marketing costs, outputs and market prices of cotton and other commodities for the 2008/09 farming year. Data were then analyzed using whole farm crop budgets and linear programming techniques. Statistical Package for Social Scientists (SPSS) and General Algebraic Modeling System (GAMS) softwares were used.

3.2. Analytical method

The linear programming (LP) model was used to determine the optimal crop enterprise combinations under organic and conventional cotton production systems in Uganda. The LP model framework has four fundamental assumptions: proportionality, additivity, divisibility, and nonnegativity (Wu and Coppins, 1981). The LP model best captures an organic or a conventional cotton farmer's resource allocation problem of choosing acreages of crops in the production system that maximize economic profits. The objective function of the LP model gives the total annual gross profits obtained by the farmer from the sale of crops (Equation 1). The LP model has two resource (land and labor) constraints since a cotton farmer cannot use more than the available resources (Equation 2). To ensure that acreages of crops are restricted to values of zero or larger, the nonnegativity constraint is also incorporated in the LP model (Equation 3). The model is thus expressed as:

$$Maximize \quad \sum_j c_j x_j \qquad (1)$$

$$Subject\ \ to \quad \sum_j a_j x_j \le b_k \quad for \ \ k = 1,2 \qquad (2)$$

$$x_j \ge 0 \qquad (3)$$

where C_j is annual gross profits obtained by a farmer from the j^{th} crop enterprise in Ush/acre; x_j is acreage of the j^{th} crop enterprise; a_j is the technical or usage coefficient for the k^{th} resource; and b_k is the total available amount of the k^{th} resource in acres for land and man-days for labor.

4. Results and discussion

4.1. Characteristics of organic and conventional cotton production systems

Generally, organic and conventional cotton farmers were similar in all socio-economic characteristics except age and household size (Table 1). The average age difference between the two groups of farmers suggests that young farmers with smaller families were more involved in organic than conventional cotton production. Under both organic and conventional production systems, the main source of farm labor was family labor that contributed to 49% in organic farms and 53% in conventional farms. The average land size of organic (conventional) farms was 9.7 acres (13 acres), of which about 9.1 acres (9.6 acres) was under production of crops; divided into 4.4 acres (4.1 acres) for cash crops and 4.7 acres (5.5 acres) for food crops. Thus, both organic and conventional cotton farmers in northern

Table 1: Socio-economic characteristics of organic and conventional cotton farmers

Characteristic	Organic	Conventional	Total	Chi-square
Gender				
Male	86.3%	85.0%	85.6%	
Female	13.7%	15.0%	14.4%	0.051
Education				
Never	16.3%	22.5%	19.4%	
Primary	53.8%	57.5%	55.6%	4.533
Secondary	26.3%	13.8%	20.0%	
Tertiary	3.8%	6.3%	5.0%	
Primary occupation				
Farming	98.8%	98.7%	98.7%	
Non farming	1.2%	1.3%	1.3%	0.000
Source of farm labor				
Family	49.4%	53.2%	51.3%	
Hired	10.4%	2.6%	6.5%	3.852
Both	40.2%	44.2%	44.2%	
Age (years)	37	44	40	7.913***
Household size	6	8	7	4.679**
Total land size (acres)	9.7	13.8	11.7	1.112
Land under cash crops	4.4	4.1	4.2	0.170
Land under food crops	4.7	5.5	5.1	0.749
Cotton farming	13	15	14	1.542

Uganda were mostly smallholders involved in semi-subsistence agriculture.

Typical of the farming system in Northern Uganda show that, most of the crops that were grown under both organic and conventional cotton production systems were the same. These crops included: simsim, sunflower, soybeans, groundnuts, sorghum, millet, maize, beans, pigeon peas, cassava, sweet potatoes, rice, cow peas, tobacco, sugar cane, chillies and ginger. Nonetheless, it was hard to distinguish some of these crops into cash or food crops. Cotton used to be the major cash crop in this region but some food crops such as rice, sunflower, soybeans, and simsim have recently gained popularity as 'cash' crops due to increasing market demand in urban areas or as inputs for making value-added products such as edible vegetable oil. For example, Mukwano Industries Limited has been promoting the production of sunflower for industrial use in edible vegetable oil.

Descriptive statistics on acreage, output, price, marketable output, and production costs associated with crops grown under organic and conventional cotton production systems have not been presented in this paper but can be obtained from the authors. However, it should be noted that with the exception of prices, the rest of the data were often estimated since farmers did not keep or remember any production or marketing records, used family labor, and used farm saved seeds. Secondly, some crops were not considered in the study because it was not possible to estimate their production and marketing data (sweet potatoes and cassava) or they were extremely rare crops (for example, cow pea, tobacco, sugar cane, ginger, and chillies).

4.2. Differences in yield, prices and costs of production of organic and conventional crops

Differences existed between yields of crops produced under organic and conventional cotton production systems. While yields of soybeans, pigeon pea, millet, and groundnuts appeared to have increased, those of cotton, simsim, sunflower, beans, sorghum, maize and rice had somehow decreased in organic cotton production system. For example, cotton yields dropped 15% to 466 kg/ha (Figure 1). These findings seem to contradict those from an earlier study where organic and conventional cotton in Uganda were at par at 600 kg/ha (Tulip and Ton, 2002). Similarly, organic cotton farmers have experienced significant yield losses in the U.S. (Swezey et al., 2007; ICAC, 2003), Iran (Ghorbani et al., 2008), Turkey (ICAC, 2003), Zimbabwe and some West African countries (Ferrigno et al., 2005). Yield discrepancies between organic and conventional cotton have been related to the adoption of transgenic cotton (ICAC, 2003) and suboptimal crop management (Swezey *et al.*, 2007), and farmer experience (Ferrigno et al., 2005). In Uganda, poor yields of organic cotton could have been the result of pest invasion as reported in the press (Kasita 2008a&b). Cotton production requires heavy application of chemicals to combat a wide variety of pests and diseases associated with it (Ferrigno *et al.*, 2005). Alternatively, organic cotton farmers in northern Uganda used locally concocted organic pesticides (for example, hot pepper, wood ash, and cow dung) as well as relied on black ants locally known as *Nginingini* as natural predators for cotton pests. These cultural and biological control methods seemed to have been effective in the early period of organic cotton introduction as noted by Tulip and Ton (2002) perhaps because much of the area in northern Uganda had returned into 'virginity' following a protracted local rebellion there. However, with stability and peace returning into the area, there has been continuous production of cotton allowing for the possible build up of pest and disease pathogen populations to economic levels. This might be the case for other rotation crops that are susceptible to pests and diseases such as beans.

Significant differences existed in prices of crops produced by organic and conventional farmers, especially cotton (37%), simsim (27%), and sorghum (33%) as shown in Figure 2. Among the studied crops, cotton and simsim, were the only certified organic crops. Therefore, higher prices fetched by organic cotton and

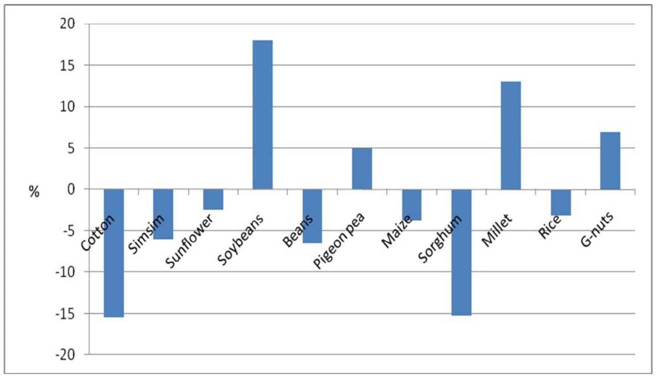

Figure 1: Percent differences in yields of organic and conventional crops

simsim farmers could be mainly explained by the premium prices offered by Bo Weevil/Shares (U) Ltd and Dunavant (U) Ltd. In 2008/09 the unit price of conventional cotton was Ush600/kg (including a government subsidy of Ush150/kg) whereas organic cotton fetched a premium of Ush200/kg or 33%. However, it is quick to note that some cotton farmers, especially in the Lango sub-region, received lower than the above prices. Before the government subsidy intervention some farmers had already sold their cotton at lower prices. The breakup of the tripartite agreement between LOFP, LCU, and Bo Weevil/Shares (U) Ltd late in the season also forced some organic farmers to desperately dispose off their cotton at lower prices prompting another government intervention to buy it. In the same season, unit price for simsim fluctuated from Ush1100 – 1600/kg with organic simsim placed at the upper end of the price spectrum. However, organic simsim prices were equally affected in the Lango sub-region since it was one of the crops produced under contract for Bo Weevil/Shares (U) Ltd. For the other crops that were not certified as 'organic,' the observed price differences between organic and conventional farmers could be related to such factors as: type of crop variety, time of sale, type of market outlet, and marketing arrangement used by farmers. Some food crops such as groundnuts, beans, and rice have premium varieties; Red Beauty, Yellow beans and Super, respectively. Typical of agricultural commodities, selling them immediately after harvest or during periods of glut attracts lower prices and vice-versa. In addition, those farmers who could have sold their produce at farmgate or local markets might have obtained a lower price than those who accessed town markets such as Lira and Gulu. Differences in prices of sunflower and

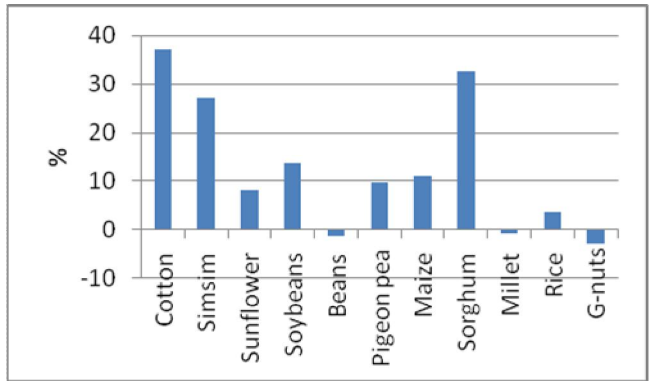

Figure 2: Percent differences in unit prices of organic and conventional crops

sorghum could have also arisen because they were grown under contracts by some farmers in the Lango sub-region for Mukwano Industries (vegetable oil producer) and SABMiller (beer producer), respectively.

Generally, organic cotton farmers were low cost producers compared to conventional cotton farmers. Unit production costs for all crops except maize, pigeon pea, millet, rice, and groundnuts were lower under the organic than conventional production system. By converting to organic production system, farmers in Uganda reduced cotton production costs by about 4% (Figure 3). In India, organic cotton production costs have also been found to have declined by 10-20% (Eyhorn *et al.*, 2007). In contrast, switching to organic cotton production in the U.S. raised costs by 37% (Swezey *et al.*,2007).Non usage of inorganic pesticides in the production of organic cotton could be explaining this cost reduction in Uganda as in India. Organic cotton farmers in Uganda used locally made organic pesticides such as hot pepper, wood ash, and cow dung. However, organic pesticides such as Oxymetrin and Nimbicidine were being introduced and promoted by private companies and that might mean an added cost to organic cotton farmers in the

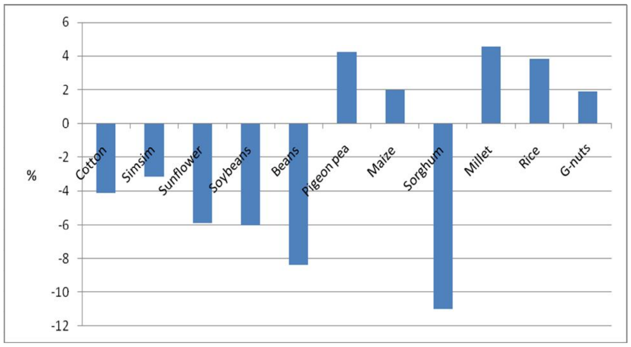

Figure 3: Percent differences in cost of production of organic and conventional crops

future once these pesticides are commercialized. In the U.S., the introduction of high yielding transgenic cotton varieties put organic farmers at a cost disadvantage compared to conventional farmers (ICAC, 2003).

4.3. Profitability of organic and conventional cotton production systems

Crop budgets were used to determine gross margins associated with organic and conventional cotton production systems. Sensitivity analysis was done to determine the impact of increasing either crop yields or prices on gross margins. Rice and sunflower were the only crops that fetched both organic and conventional farmers' positive returns. Gross returns to organic and conventional rice (sunflower) were approximately 6% (10%) and 5% (0.6%). Organic farmers also obtained positive gross returns from cotton which stood at about 7% (Figure 4). In contrast, conventional cotton was not profitable. This is not surprising because previous studies in Uganda have also found conventional cotton to have negative returns (Lunbaek 2002) or the lowest profitability compared to other crops (Baffes 2009, You and Chamberlin 2004). Moreover, the removal of price premium would plunge organic cotton farmers into losses of over 13%. This underscores the importance of price premium in the profitability of organic cotton as found in India (Eyhorn et al., 2007).

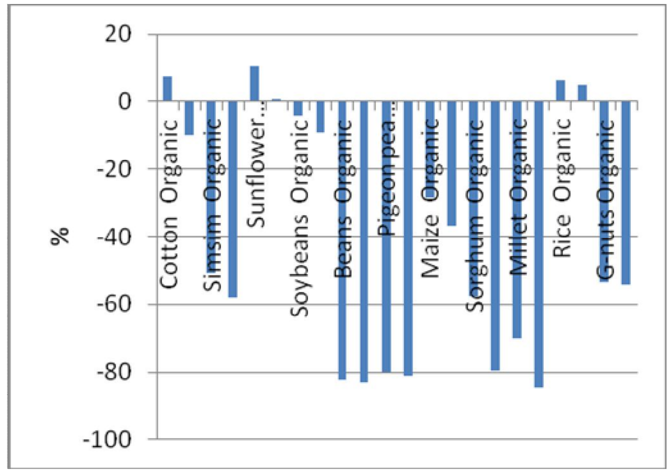

Figure 4: Gross returns to organic and conventional crops

Low yields and price of conventional cotton could have contributed to the observed loss to farmers. However, the price of conventional cotton depends on the world market conditions implying that in order to be profitable, farmers' best strategy is to enhance the productivity of conventional cotton that averaged about 551 kg/ha. This is possible given that potential conventional cotton yields in Uganda can be as high as 2500 kg/ha (USAID, 2002). With the other crops, both organic and conventional farmers made losses mainly because they appeared to be more of food than cash crops and only those farmers with surpluses participated in the market.

Sensitivity analysis showed that soybeans would have been another profitable crop if its price or yield improved. Three optimistic assumptions for price or yield improvement were considered: small (10%), medium (20%), and large (30%). Both 'organic' and 'conventional' soybeans were profitable when either price or yield was increased.

Conventional cotton also became profitable when both medium and large price/yield improvement were assumed (Figure 5). Given that market price premiums for organic products are usually low, sunflower, soybeans, and rice could be good candidates for organic certification. Otherwise, if farmers embarked on yield improvements of these crops while controlling associated production costs, their profitability would tremendously increase.

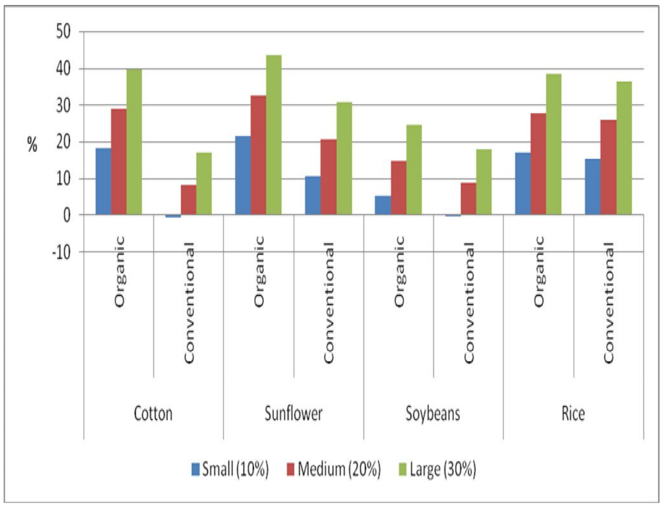

Figure 5: Effect of price/yield changes on crop enterprise profitability

4.4. Optimal crop mix in organic and conventional cotton production systems

The linear programming technique was used to determine optimal crop combinations in organic and conventional cotton production systems. Crops included in the analysis in both situations were cotton, simsim, sunflower, soybeans, groundnuts, sorghum, millet, maize, beans, pigeon peas, and rice. Based on typical farming conditions in the study area it was assumed that one man-day was equivalent to Ush5,000 and thus, the imputed labour cost for each crop was divided by this figure to arrive at man-days. This gave a total available labor of 542 man-days and 548 man-days for an organic and conventional cotton farmer, respectively. Another assumption made was that all the crops were grown as pure stands and in the appropriate season of the year.

For a typical organic cotton farmer with 9.7 acres, it was optimal to grow only cotton and sunflower and the maximum profit obtained was Ush232,848. The shadow prices for land and labor were Ush19,542 and Ush80, respectively. The shadow prices show how much total profits would increase when 1 acre of land or 1 man-day of labor is brought into production. Since the average price of 1 man-day of labor was Ush5,000, then the opportunity cost for labor was very high and hence, it was not economical to add an extra unit of labor to production. However, if 1 acre of land could be hired for less than Ush19,542, then it paid to bring it under production. Reduced costs associated with non optimal crops were also generated and showed how much total profits would decrease if 1 acre of the corresponding crop was forced into production. Apart from rice, all the other non optimal crops had high reduced costs implying that they were less attractive to produce (Table 2). Sensitivity analysis was therefore done to determine optimal farm enterprise combinations under different resource levels. This was done in order to capture the decision making behaviors of farmers in which some land and labor have to be devoted to food security crops. From Table 1, we find, for instance, that organic farmers typically dedicated only 4.4 acres of land to cash crops; although apart from cotton and sunflower it was difficult to ascertain from them which crops constituted pure cash crops. Further, no information was obtained from farmers about how much labor they set aside for food crop production.

Table 2: Optimal crop mix and profit in organic cotton production system

Crop enterprise	Level	Reduced cost
Cotton	5.969	-
Simsim	-	-1.485E+5
Sunflower	3.731	-
Soybean	-	-3.209E+4
Beans	-	-2.181E+5
Pigeon peas	-	-1.924E+5
Maize	-	-8.723E+4
Groundnuts	-	-1.894E+5
Sorghum	-	-1.167E+5
Millet	-	-1.937E+5
Rice	-	-861.431

Therefore, three possible cash crop land allocation levels were considered: 25%, 50%, and 75%. Then, for each level, the proportion of labor used in cash cropping was varied progressively starting from 10% through to 100%. It was generally found that when labor availability was low, it was optimal to grow only sunflower. As more labor became available it was optimal to mix sunflower with cotton. With moderate labor availability, it was optimal to grow only cotton. Beyond this point, it was optimal to mix cotton with rice. And, when labor availability was high, it was optimal to grow only rice. For example, when 50% of land was devoted to cash crops, organic cotton production was possible only if at least 40% of available labor was dedicated to cash crops. With 40% to almost 50% of labor used for cash cropping, an optimal mix of sunflower and cotton was obtained and with about 60% of labor cotton and rice were optimal. Optimal annual profits increased with the proportion of labor available to cash crops until it reached a maximum of about Ush118,000 (Table 3). Doubling the amount of available land for cash cropping doubled the labor requirements, optimal crop acreage, and annual profits and vice-versa.

The forgone results have essentially shown that more labor was required in cash than food crop production and that rice was the most labor-intensive but most profitable crop, followed by cotton, and least by sunflower. Therefore, these findings have important implications for farm management decision making. Organic cotton farmers need to choose their optimal crop mix depending on their degree of commercialization of farm operations. While it is optimal for near subsistence farmers to produce cotton and sunflower, commercially-oriented farmers could focus on cotton and rice for higher profits. However, the acreage allocated to both cash and food crops could be distributed in the first and second seasons of the year depending on labor availability on the farm, type of crop, and agro-climatic conditions.

In the conventional cotton production system, it was optimal to grow only rice as a cash crop because of its higher returns. By considering a typical farmer with 13.8 acres and 548 man-days, only 7.5 acres could be put under rice giving a maximum profit of Ush135,162. The shadow price for labor, which was the only constraint, was Ush247 implying that the opportunity costs for labor were still high given that the average price of 1 man-day of labor was Ush5,000. Reduced costs associated with non optimal crops were high, except for sunflower, reflecting their level of unattractiveness in the conventional

Table 3: **Optimal crop mix and profit in the organic cotton production system under different cash crop intensity levels**

% Labor	Level 1: 25% of Land (2.425 acres)				Level 2: 50% of Land (4.85 acres)				Level 3: 75% of Land (7.275 acres)			
	Sunflower (acres)	Cotton (acres)	Rice (acres)	Profit (Ush)	Sunflower (acres)	Cotton (acres)	Rice (acres)	Profit (Ush)	Sunflower (acres)	Cotton (acres)	Rice (acres)	Profit (Ush)
10	1.305	-	-	28,040	1.305	-	-	28,040	1.305	-	-	28,040
20	2.098	0.327	-	52,985	1.609	-	-	56,080	1.609	-	-	56,080
30	-	1.943	0.482	58,811	3.914	-	-	84,120	3.914	-	-	84,120
40	-	-	2.425	59,946	4.196	0.654	-	105,971	5.218	-	-	112,160
50					1.878	2.972	-	112,096	6.523	-	-	140,200
60						3.887	0.963	117,622	6.293	0.982	-	158,956
70						-	4.85	119,892	3.976	3.299	-	165,081
80									1.658	5.617	-	171,206
90									-	5.83	1.445	176,433
100									-	0.749	6.526	179,401

cotton production system. When sensitivity analysis was done, it was found that under each cash crop intensity level, the optimal rice acreage and profits were attained only when the amount of available labor was adequate for complete utilization of the available land. For example, when 25% of the total available land was dedicated to rice, it required allocating at least 50% of the total available labor to obtain optimal annual profits of about Ush62,000. When the amount of rice acreage was doubled, labor demands and profits also doubled and vice-versa. While it was optimal to grow rice under the conventional system, rice production compromises food security if farmers allocate much land to it as it diverts much of the available labor from food crops. This problem is exacerbated if rice production takes place in one season of the year. Another complication with rice is that not all cotton farmers had access to suitable land for the production of wetland rice that was commonly grown in the area. Even if they were, wide adoption of wetland rice could also lead to wetland degradation in this region. This therefore calls for conventional cotton farmers to commercialize the production of food crops such as simsim and maize as well as improve the productivity of cotton, sunflower and soybeans to become profitable. Otherwise, farmer conversion to organic cotton production could earn them cotton price premiums and above all lead to less environmental degradation.

5. Conclusion

Unlike conventional cotton, organic cotton production in Uganda was profitable mainly due the existence of price premiums. Thus, in the fight against poverty, appropriate policies need to be formulated to promote the production of organic cotton in Uganda. The competitiveness of organic cotton with other 'cash' crops can be enhanced through education of farmers on organic farming principles and practices to improve its productivity. Promote collective marketing of organic cotton through the revival of agricultural co-operatives to lower marketing costs and improve the negotiation power of farmers against agribusinesses. Direct organic certification of farmers should be encouraged to avoid conflict of interest between farmers and promoters of organic farming. Mechanisms to enforce organic cotton production or marketing contracts made between farmers and agribusinesses also need to be established to guard against any opportunistic behavior that might arise.

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