

Assessment of the Constraints in Soybean Production: A Case of Northern Region, Ghana

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In Ghana, soybean production has been promoted by the Ministry of Food and Agriculture to increase cash income and improve the nutritional status of rural households. However, as yet there has been little increase in soybean cultivation. To an even greater extent than with other, already common crops, soybean production depends on a variety of socioeconomic factors, along with technical requirements such as access to improved seed cultivars; adequate land preparation, planting, weeding, and pests and diseases control; and appropriate harvesting, postharvest handling, processing, marketing, and product utilization (MoFA, 2006). My aim was to help support the livelihoods of the Ghanaian people—particularly rural women—by promoting soybean production and consumption and disseminating technological information among agricultural extension staff. To identify the technical and socioeconomic constraints on soybean production, in 2010 I conducted a household survey of 42 randomly selected respondents in 10 communities in the Sawla-Tuna-Kalba district of the northern region of Ghana. The interviews included questions on land tenure and use, input acquisition, agronomic practices, technology adoption, postharvest loss, and processing, marketing, and product use. I also interviewed seven traders and one agro-processing company that dealt with soybean. The results showed that farmers were not obtaining the expected incomes from soybean because the processing and marketing channels were poorly organized; this had led to low prices for the crop. Farmers grew the crop mostly for cash income, but the low prices were negatively affecting production and the farmers were unwilling to increase their production levels. The results also showed that, among farmers, the level of adoption of technology that would improve soybean production was low, resulting in low yields. Pests and diseases were becoming prominent threats to production and could also have been factors in the low yields.

Key words: Assessment, constraints, soybean production

Introduction

Importance of soybean cultivation in Ghana

The agricultural sector is the backbone of Ghana's economy, contributing 51% of the gross domestic product and 54% of the labor force in 2010 (GSS, 2010). Major food crops grown are cereals such as maize, rice, sorghum, and millet, legumes such as soybean, groundnut, and cowpea, and root and tuber crops such as yam, cassava, and cocoyam. The total land area of the country is 23,853,900 ha, with an agricultural land area of 13,628,179 ha (Ministry of Food and Agriculture [MoFA], 2009b). The permanent crop area accounted for only 9.22% of the total land area for agricultural production in 2002 (CIA, 2011) and forest

cover accounted for 20.70% in 2010 (FAO, 2011), with the remaining land includes savannah grass woodland suggesting that the total land area in Ghana has not yet been fully utilized.

Small-scale farming accounts for 80% of the country's domestic production (MoFA, 2009a). About 90 % of farm holdings are less than 2 ha in area, although there are some large farms and plantations, particularly for cocoa, rubber, oil palm, and coconut and to a lesser extent rice, maize, and pineapple. Many small-scale producers still depend on traditional methods of farming with few technological improvements; postharvest losses are as high as about 30% (MoFA, 2009a), and there is a lack of appropriate storage and processing. Together with inappropriate marketing strategies and

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market information and poor soil fertility as a result of improper farming practices (e.g. poor land preparation and management), along with bushfires, these factors have resulted in poor production and productivity, with an actual soybean yield of about 60% of the potential yield (MoFA, 2009b). The farmers rely solely on highly unpredictable and sporadic seasonal rainfall.

From my observation in rural areas, to support their husbands the women contribute economically, for example, by paying school fees and medical bills and feeding the household. To be able to provide this support, the women need to make an income. They therefore cultivate cash crops. Soybean is one of the alternatives to the main cash crop, groundnuts. Apart from using soybean to bring in extra income, the women use soybean to improve the diets of their children. Women play a vital role in crop production in Ghana. Although men dominate in the production of export cash crops such as cocoa, coffee, and cotton, the participation of women in cash crop production is very important. According to MoFA (2008), women constitute 40% of the overall agricultural labor force, and an estimated 30% of cocoa farmers are women, although it is not known whether they are involved as farm owners or as family farmhands (MoFA, 2006). Women formally by tradition were required to contribute labor on their husbands' farms for planting, weeding, and harvesting, however, this trend is changing whereby they can farm on their own aside these roles (Blench, 2005; MoFA, 2006). In the Sawla-Tuna-Kalba district of the northern region of Ghana, women farm either directly on their own or indirectly on their husbands' farms. Those farming directly are usually widowed or divorced, but even those who are supporting their husbands have their own fields, where they cultivate crops of their choice, particularly legumes. In the Ghanaian tradition, women are therefore involved in all farming activities from planting to harvesting, and in the Sawla-Tuna-Kalba district women are at the core of farming and involved equally with men from planting to harvesting. They are also involved in animal rearing and processing of agricultural products at home and marketing of agricultural produce.

Soybean (*Glycine max* L.) is one of the world's most important legume crops (Noureldin and Dadson, 1998). It is used mainly as a food crop, serving as a good source of protein and oil. However, it is often grown as a pasture or forage or fodder crop; it is an

excellent source of feed for livestock and poultry and is also used for industrial purposes (Kochhar, 1981; MoFA, 2006). In Ghana, soybean is commonly cultivated in the northern sector of the country and in the forest-savannah transition zone. Soybean was first introduced into Ghana in 1910 (Plahar, 2006). The crop was cultivated by local farmers in the northern sector at Bimbila, Nakpanduri, Karaga, Tilli, and Bawku and was added to vary their traditional foods (Plahar, 2006). The main problem facing farmers in the mid 20th Century was loss of seed viability in storage. Soybean research performed by the Crop Research Institute (CRI) of the Council for Scientific and Industrial Research and the University of Ghana Agricultural Research Station in the late 1960s and early 1970s was aimed at improving human and animal health by encouraging soybean cultivation. However, attempts to produce a viable soybean industry failed because of poor knowledge of soy utilization in the home, a weak industrial base for soybean processing, a production package that was unattractive to farmers, and lack of a market for the crop (Plahar, 2006). In 1975 and 1977 a major soybean-growing campaign was launched in support of the growing Ghanaian poultry industry (Plahar, 2006). The initial farmer response was high and a considerable increase in production was recorded, but again the utilization base was low and knowledge of processing was inadequate (Plahar, 2006). Effective and substantial efforts to promote soybean production were resumed in the 1990s by the Ministry of Food and Agriculture and non-governmental organizations (NGOs) such as the Adventist Development and Relief Agency; these efforts targeted both small-scale farmers and commercial farming support. According to the CRI (2010), soybean production increased from 1000 to 10,000 t between 1979 and 1992 as a result of farmers' adoption of improved cultivars and production technologies, yet soybean imports continued to increase (198,000 t import, versus 96,050 t production in 2009 (MoFA, 2009b).

Soybean is recognized as the crop with the greatest nutritional value for growing in all suitable regions of Ghana (MoFA, 2006). Its use is recommended by Women in Agricultural Development of the Ministry of Food and Agriculture, Ghana, and by some NGOs through the promotion of various home recipes, particularly in rural areas, aimed at incorporating soybean into the diet and reducing malnutrition among children.

A number of agro-based firms purchase and process soybean crops for value-adding for human and live-stock rations (MoFA, 2009b). However, despite the advantages of soybean, it is not commonly used by these industries as a raw material. Some of the processing firms are not using soybean because of poor domestic production and the high cost of importation (MoFA, 2009b). Many people have continued to search for possible reasons as to why soybean production is low in Ghana (Plahar, 2006), despite the potential of this crop for generating income and improving nutrition, particularly among rural people.

Land-tenure system and management in northern Ghana

Land is the fundamental basis for agriculture. However, its ownership varies across the regions, and patterns of labor or monetary input vary accordingly. To analyze soybean cultivation in Ghana it is first necessary to understand the existing land ownership systems. In the upper east region (Fig. 1), where the land is undulating and rocky, the amount of agricultural land is very limited. Conditions for land acquisition are therefore restricted, and it is difficult for women to acquire land (other than family holdings) for agricultural purposes. However, circumstances differ in other parts of the northern sector of the country, for example, in the Upper West and Northern Regions. Although women here, as in other parts of Ghana, do

not inherit land and are therefore at a disadvantage, there is more land available for agriculture and land acquisition for arable cropping by women is not difficult. Trends are changing in the Upper West and Northern Region, because it is realized that women can contribute greatly to household development. Therefore, in rural areas women are becoming more involved in the farming of arable crops such as maize, groundnut, soybean, cowpea, and bambara nuts on their own as a way of supporting their families.

According to Blench (2005), the land in Ghana was originally held by *tendanas* (priest-kings), who made it available to anyone who needed a piece for various purposes, including agricultural production, especially in the case of settlers in the northern sector of Ghana. In this sector, across which the cultures of the people are similar, there are two types of land ownership: chief land ownership and family land ownership. Generally, the chief is the custodian of the land, and he settles any land-tenure disputes to maintain law and order. Women and settlers can acquire land from the chief or family for various purposes by meeting various formalities and conditions, but the land is not sold, and it can be taken back at any time if the owners are not satisfied that the conditions are being met by the lease basis.

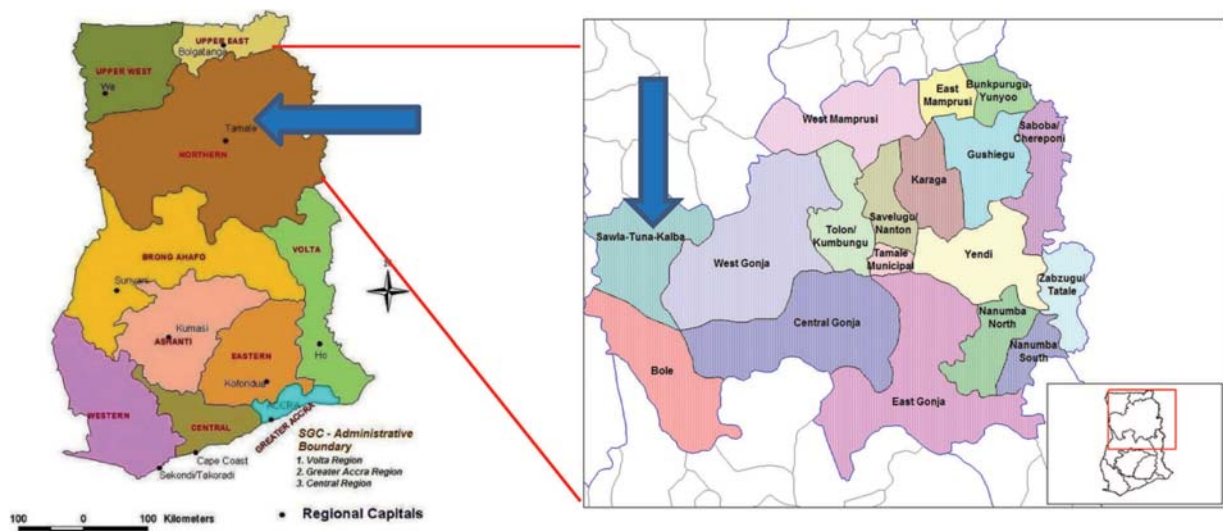


Fig. 1. (a) Map of Ghana, (b) Map of Northern Region, showing the study area. Arrow: region and district of study area. Sources: ADRA Ghana, 2009; Rarelibra, 2006.

Input requirements, production practices, and technology adoption

Many farmers in the Northern Region do not use improved technologies such as row planting or application of nutrients to replenish soil fertility, and sometimes they do not follow routine agronomic practices to ensure optimum yields. Usually, farmers have different sources of seeds for planting of soybean. Farmers use mostly seed from their own stocks and from markets. Some acquire certified planting seed from the District Agricultural Development Units or from designated seed sale outlets (MoFA, 2009b).

According to MoFA (2006) and the Savannah Agricultural Research Institute (SARI, 2006), there is a very large number of recommended soybean cultivars in Ghana with seeding rates of 37.5 kg/ha and yields of 1.8 to 2.5 t/ha. Weed control is essential in soybean production to ensure maximum crop yield (Buhler and Hartzler, 2004). Most farmers do not plant in rows, and in most crops the plant populations are usually low, leaving wide gaps for weed growth and thus giving very low yields at harvest. Berglund and Helms (2003) reported that row spacing is a critical determinant of yield in soybean production, because appropriate spacing can ensure effective weed control. Weeds are a major problem in soybean production; not only does their presence reduce seed yield, but it also increases production costs (Buhler and Hartzler, 2004).

Grau *et al.* (2004) reported that soybean plant health is a critical component of profitable soybean production, and that plant pathogenic fungi are an important group of disease organisms that affect soybean health and will eventually result in poor yield. Tolin and Lacy (2004) reported that viruses occur in soybean worldwide and cause agronomic losses in soybean. The most important insect pests of soybean are classified broadly on the basis of the damage they cause, namely defoliation or feeding on pods; these two groups of insect pests can reduce soybean yield by up to 65% (Heatherly and Elmore, 2004). Fungicide treatment with soybean seed can help control damping-off particularly on most common pathogenic fungal diseases such as *Pythium* spp., *Phytophthora sojae*, *Rhizoctonia* spp., and *Fusarium* spp., which are associated with reduced soybean germination and emergence and subsequent crops failure. Early planting will ensure efficient performance of treated fungicide (Heatherly and Elmore, 2004).

In Ghana, small-scale soybean producers, unlike large-scale commercial producers, depend little on inputs such as fertilizer, herbicides, and pesticides for increasing production. These small-scale producers take advantage of the fact that soybean, being a legume, supports bacteria that supply nitrogen to the soil; moreover, inputs such as pesticides are very expensive. The farmers may therefore wish to avoid using such inputs so as to balance the increased cost of production against the potential increase in income and thus meet production costs and profit margins. However, proper management of inputs can balance costs with increased yield (Heatherly and Elmore, 2004). Legumes have a high phosphorus (P) requirement for growth (Johnson, 1987; Wan Othman *et al.*, 1991) and also for nodulation and nitrogen fixation (Israel, 1987). Low soil P may contribute to the poor survival of some rhizoidal strains (Cassman *et al.*, 1981). Maximum nodulation requires the addition of Phosphorus at 400 to 5000 mg/kg (DeMooy and Pesek, 1966).

Lin *et al.* (1985) reported that low P availability is liable to limit soybean yield on many highly degraded soils in the tropics, even though the external P requirements of soybean are lower than those of some other legumes. Holford (1976) reported that generally the longer the P is in contact with the soil, the greater the fixation that occurs; for annual crops such as soybean, P application 2 weeks after planting was recommended. BEST (2011) recommended the use of a biostimulant in addition to P.

Harvesting, storage, processing, and use of soybean in Ghana

After harvesting their soybeans, farmers generally leave them at the mercy of the weather, instead of storing them in a cool, dry area. According to MoFA (2006), soybean is harvested when 90% of the pods turn yellow or are dry. Delaying harvesting beyond this period leads to shattering of seeds, especially in late-planted soybean, the seeds of which are ready when the weather is completely dry. MoFA (2009b) catalogued a number of agro-firms in Ghana, some of which were considered to be processing vegetable oils, including soybean, but only a few are in fact currently processing soybean and some are now not operating. Soybean is processed for use in a number of recipes and is on the daily menu in many farmers' homes as a way of adding nutritional value.

Marketing of agricultural commodities in Ghana

Farmers' produce is usually sold to traders at the farm gate or at the local markets. These traders are usually the link between producers and consumers, and they usually take advantage of the poor road networks in the rural areas or because the farmers find it difficult to travel to the markets to offer low prices for the agricultural commodities that they purchase from the farmers (Poulton *et al.*, 2006). Food crops are usually marketed immediately after harvest to meet household economic demands; alternatively they may be stored by the farmers to wait for lean seasons in anticipation of price rises because of supply shortages in rural areas.

There is also no formalized system of produce marketing in terms of grading and standardization. For instance, for quantifying grain in the southern sector of Ghana, a tomato tin container called an *olunka* is used as a unit of sale for different crops, but in the northern sector an enamel bowl is used usually of a different size from the *olunka*. Grain is usually graded by sight, and grading is highly subjective; usually grading is tied to only one criterion rather than many (i.e. size, shape, color). Small-scale farmers lack access to price information from local, regional, and national markets; they may also not be able to process complex price-sensitive information when it is available (Coulter and Onumah, 2002). Besley (2010) observed that insurance markets are virtually non-existent in rural areas of Sub-Saharan countries, unlike in Western countries; as a result, small-scale farmers face substantial variations in yield and price. With the exception of major cash crops such as cocoa and coffee, food crops in Ghana do not have guaranteed prices.

My objective was therefore to identify the constraints to soybean production as a potential way of improving the livelihoods of rural Ghanaian people, particularly women farmers. I intended to achieve the following specific objectives: (1) identify the specific socio-cultural, agronomic, storage, processing, marketing, and product utilization challenges faced by soybean farmers; and (2) assess the contribution of soybean to household incomes and nutrition.

Materials and Methods

Study area in Ghana

The Sawla-Tuna-Kalba district is one of the 20 administrative districts in the northern region of Ghana

(Fig. 1). It was established in 2004 and is one of the most deprived districts in the Northern Region. It has a total population of 94,664 (females 51.8%, males 48.2%). The population density is 14 persons/km² (STKDA, 2010). The land is generally undulating, with elevations ranging between 120 and 240 m above sea level (STKDA, 2010). Agriculture in the district is predominantly rain-fed. The district is characterized by unpredictable rainfall (Fig. 2), traditional farming methods where farmers planting patterns are not in rows given low plant population resulting in low yield (Fig. 3a), low soil fertility in most areas, postharvest losses, inappropriate storage and processing methods (Fig. 3b), inappropriate marketing strategies, a high illiteracy rate, a poor road network (Fig. 3c), and poverty.

The district has two main seasons (wet and dry) and receives a unimodal annual average rainfall of 1200 mm, with monthly rainfall ranging between 200 and 300 mm, because of the area's closeness to the transitional zone (STKDA, 2010). Temperatures are usually high, ranging from 28 to 40°C during the day but lower at night. The vegetation is characterized by Guinea savannah woodland, which is suitable for rearing a wide range of animals, such as cattle, sheep, goats, pigs, guinea fowl, and poultry, all of which are raised to complement crop production. The major crops produced in the district are maize, rice, sorghum, millet, yam, cassava, groundnut, cowpea, soybeans, bambara nut, and vegetables (MoFA, 2009b; STKDA, 2010).

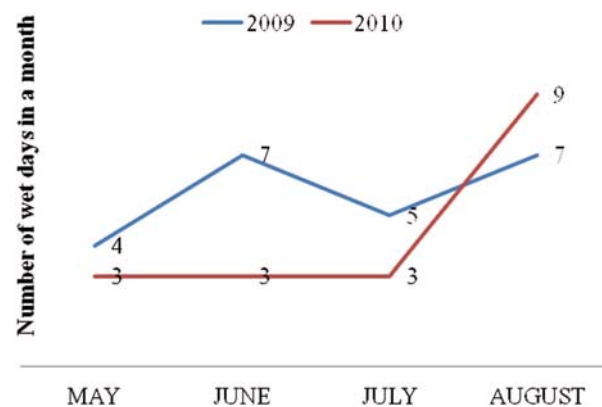


Fig. 2. Erratic rainfall distribution in terms of trend in the study area with numbers on the graph indicating number of days per month.

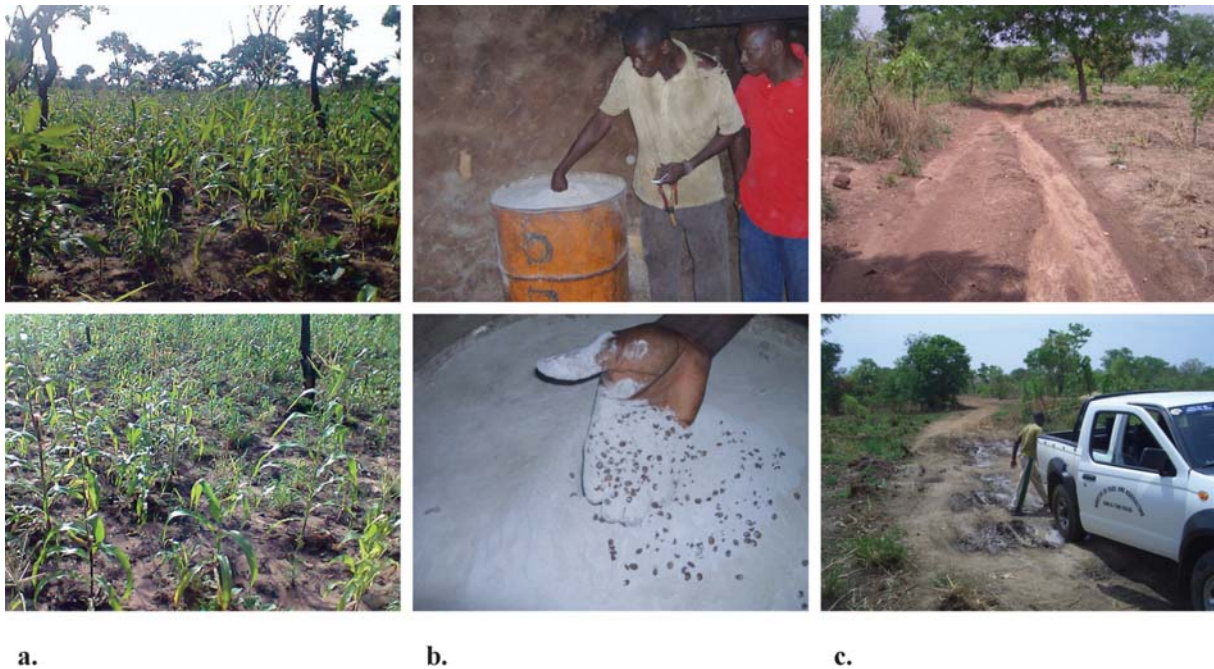


Fig. 3. (a) Crops planted by traditional methods, showing lack of row spacing (b) Traditional method of storage of cowpea using wood ash and photo taken by extension officer (c) Roads linking marketing centers in the study are in poor condition.

Data collection and analysis

A survey was conducted with structured questionnaires delivered by interview in 10 communities (Blema, Doumeh, Jeme, Sansanyiri, Sogoyiri, Jimperiyir, Jochinteng, Kalba, Kong, and Gindabuo) in January 2011 and June 2011 to collect data from individual farmers on land tenure and management, agricultural inputs, farming practices and technology adoption, storage and processing practices, agricultural production output and marketing, product utilization, and farmer perceptions of soybean production in the 2010 cropping season. Because soybean was not commonly cultivated, I could interview a total of only 42 respondents (15 males and 27 females) who actually cultivated soybean in the 2010 cropping season from May to October in the various communities. Farmers were randomly selected adapting “snowball sampling” from three agricultural zones (Sawla, Tuna, and Kalba) to ensure accurate representation of data in the district. Blema, Doumeh, Jeme, Sansanyiri, and Sogoyiri are in the Sawla zone, which is the largest; Jimperiyir, Jochinteng, and Kalba are in the Kalba zone; and Kong and Gindabuo are in the Tuna zone.

Women dominated the survey population because they were more involved in soybean cultivation than

were their male counterparts. In addition, seven traders and one agro-processing firm were interviewed. Reports and statistics were collected from the Ministry of Food and Agriculture and the STKDA (Sawla-Tuna-Kalba District Assembly). The questionnaires were administered by me and Ministry of Food and Agriculture staff to farmers but that of the traders by me. Each interview lasted for 30 to 45 min, depending on the individual farmers’ and traders responses. The processing company production/ feed manager administered the questionnaire by himself in the presence of me to clarify questions to his understanding where there was the need. Data collected covered basic household information, land tenure and management, production practices and technology adoption, input information, output information, market information, storage and processing information, product utilization information, and farmers’ perceptions. Informal interviews were also held with key informants, particularly in regard to land tenure outside the questionnaire interview. Data were processed by using Microsoft Excel and SPSS, <https://www.u.tsukuba.ac.jp/SOFT/SPSS/>. The currency unit was the Ghana cedi (GH¢).

Table 1. General Attributes of Respondents

	Ave.	Min.	Max.	Categorical information
Age	45.0	21	60	—
Sex	—	—	—	Male: 15; Female: 27
Education	—	—	—	Literate: 14%; Illiterate: 86%
Religion	—	—	—	Traditional: (24%); Christian: (48%); Muslim: (28%)
Household size	8.2	4	14	—

Results

Basic information on sample farmers

Of the 42 farmers, males represented 36% and females 64% (Table 1). Thirty-six (86%) of the 42 farmers were illiterate and six (14%) literate. Illiteracy rate was higher among the female respondents (Table 1). These literacy levels influenced the subjects' levels of acceptance and adoption of technology to improve their livelihood. Among the farmers, (females: 11 Christians, 9 Muslims, 7 African traditional; males: 9 Christians, 3 Muslims, 3 African traditional. Christianity was practiced in all of the villages except Jeme and Kong. Islam was practiced in Blema, Jimperiyir, Kalba, Kong, and Gindabuo, whereas African traditional religion was practiced in Doumeh, Jeme, Sansanyiri, and Jimperiyir. Different religions therefore coexisted. Despite this mix of religions, the villagers respected each other's religions and participated in activities together for the development of their communities. The respondents' ages ranged between 21 and 60. The ages were ranked into groups of (20–29, 30–39, 40–49, 50–59 and 60 or more). The cumulative percentage age group rank from 30 to 49 years was 62%; this is the age range of most working farmers in Ghana, meaning that sufficient farmers are always probably available to work on soybean crops without the need to employ the very young or old (Fig. 4).

Land tenure system and management

As already mentioned, there are two types of land ownership: chieftdom and family. The land of 28 (8 male and 20 female) of the 42 farmers had been acquired through chiefs; the land of the remaining 14 (seven male and seven female) was family land (Table 2). Farmers were interviewed about whether the land they occupied was inherited, leased, purchased, or freehold. Twenty-five females and 15 males occupied land that was owned by chiefs or families and was

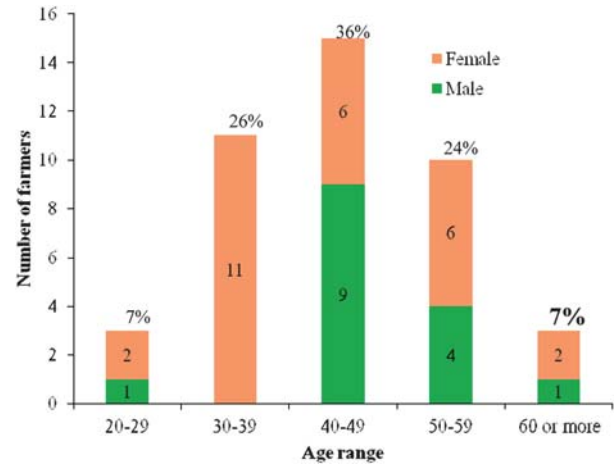


Fig. 4. Frequency histogram showing age distribution of respondents (n=42).

freehold or had been inherited; the remaining two females occupied land that was leased by chiefs. The land was acquired almost free, either from chiefs or family heads. For females, the total area of land occupied was the same as the area cropped, but for males the total land area was greater than the area cropped (Table 3). Females occupied less land than males, but the questionnaires revealed that there was more land available for them if they needed it for soybean cultivation.

Soybean production practices and technology adoption, yield and inputs

Assessment of production revealed that soybean production by women (in kg/ha) was less than groundnut, maize, and sorghum production. Soybean production by men was also lower than the production of all other crops. Therefore, the overall average soybean production was lower than those of the other three crops (Table 4).

Farmers had different areas of land under soybean production. The respondents answered the area rough-

ly in acreages and were converted into hectares. There was no correlation ($r=0.32$) between land cultivated and soybean yield per unit area (Fig. 5). Even the highest productivity (1.36 t/ha) did not reach the 1.8 to 2.5 t/ha references, which were obtained from experimentations of some soybean varieties (MoFA, 2006; SARI, 2006). However, the maximum achievement can be compared favorably with the national average of 1.58 t/ha (2009) in Japan (MAFF, 2011).

Possible constraints of the overall low yield among the respondents were examined from technological and chemical inputs. Though proper cultivation techniques are required, wide range of planting time, from June to August was observed among the respondents (Fig. 6a). I also investigated whether row planting was used to facilitate efficient agronomic practices such as fertilizer application, weeding, and harvesting for optimum yield (Fig. 6b). Soybean seeding rates for the various land areas cultivated were less than recommended, as the recommended rate of 37.5 kg/ha greater than farmers 1 ha (Fig. 6c). Seed for planting was mainly obtained from their own storage, but often improperly

preserved, or from the local market. Thirty-three percent of farmers acquired seed from certified seed outlets, 38% from their own seed stocks, 19% from markets, and 10% from friends (Fig. 6d). All of the respondents applied the first weeding, but those continued the second weeding remained 69.0% (Fig. 6e). The ratio of male who conducted the second weeding (80.0%) was higher than female (63.0%). Sixty-nine percent of farmers did not practice pest and disease control on their farms; More men practiced pests and diseases control than did women (Fig. 6f). Farmers' stored soybean for periods ranging from 1 to 6 months, the most common storage period was 4 months (Fig. 7a). The respondents' farmers used polythene sacks (78.6%), jute sacks (19.0%), or pots 24

Table 2. Farmers' land ownership and land acquisition by sex

	Land tenure (%)		Acquisition (%)	
	Chief	Family	Leased	Freehold
Female	74	26	7	93
Male	53	47	—	100

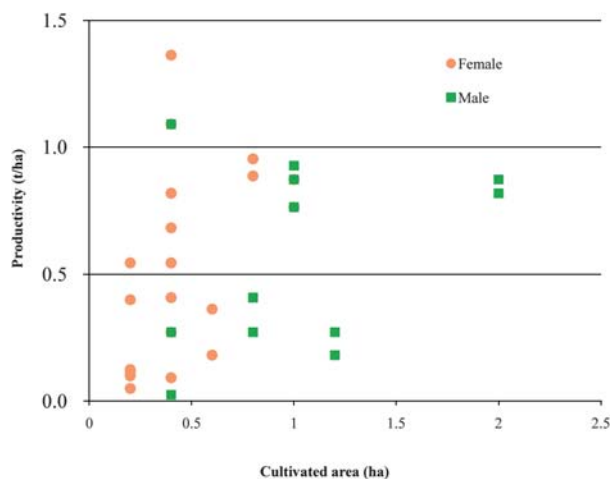


Fig. 5. Yield and cultivated area

Table 3. Average total and cropped land areas by sex

	Total area (ha)	Average area cropped in 2010 (ha)			
		Soybean	Groundnut	Maize	Sorghum
Female	1.5	0.5	0.5	0.2	0.3
Female	13.4	1.1	1.1	1.8	2.5

Table 4. Production of 4 major crops in the 2010 cropping season (Kg/ha)

	Soybeans	Groundnuts	Maize	Sorghum
female	320.2	459.5	871.4	797.6
Male	587.3	646.4	1833.3	2163.5
Mean	453.8	552.9	1352.4	1480.6

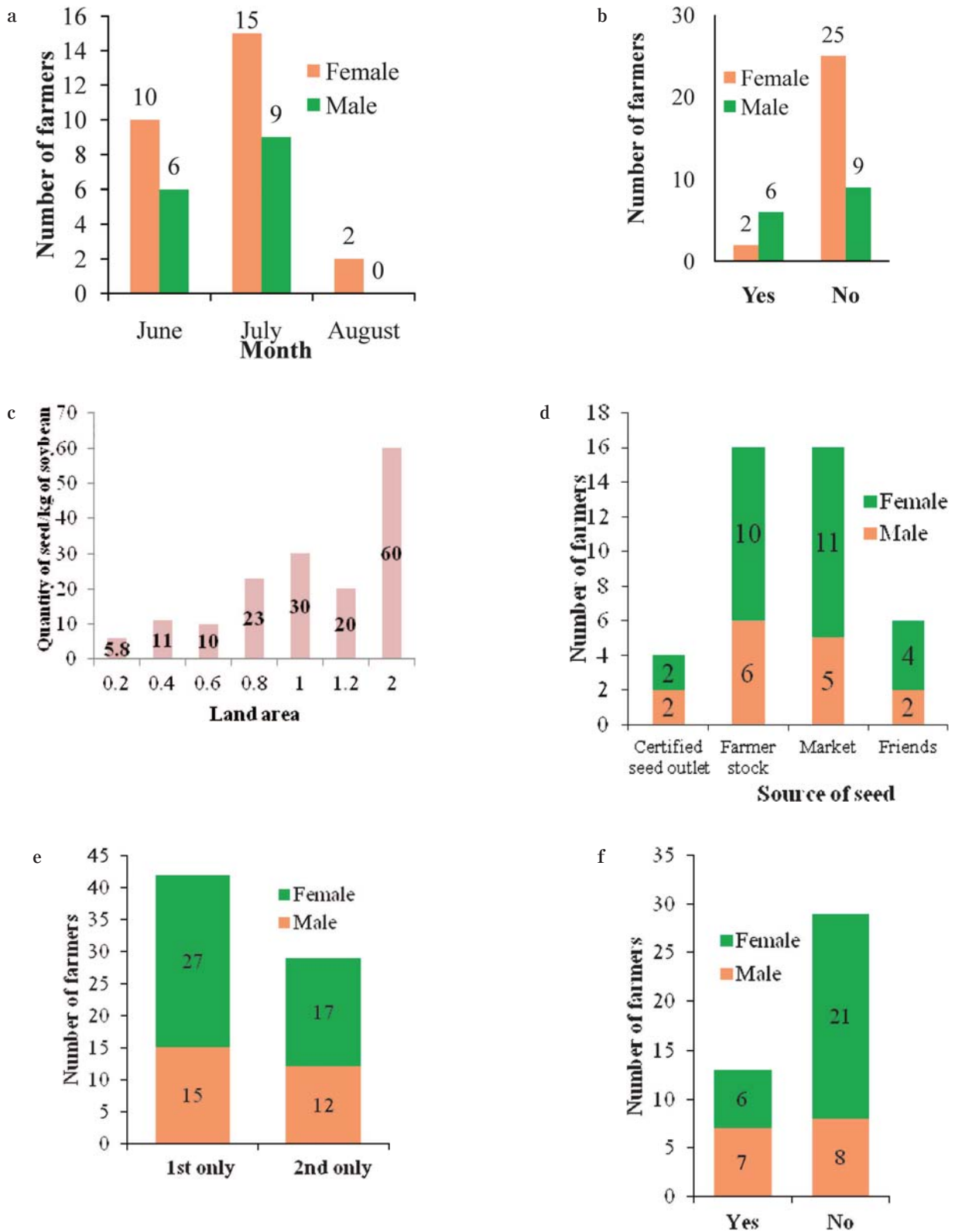


Fig. 6. Use of common farming practices and rates of technology adoption by farmers to increase yields: (a) planting times; (b) use of row planting; (c) seeding rates; (d) source of seed; (e) frequency of weeding; and (f) pests and diseases control.

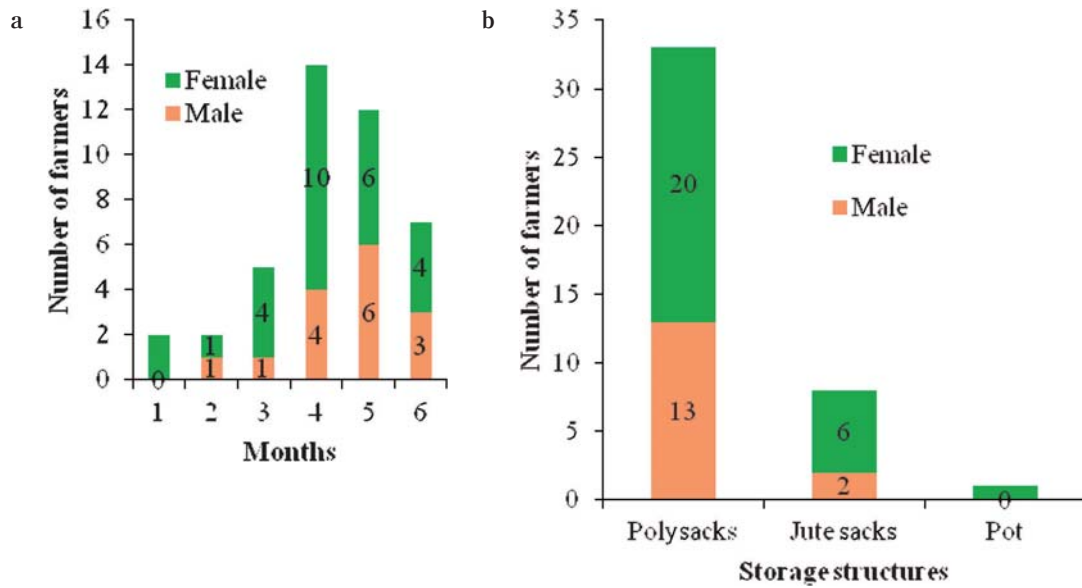


Fig. 7. (a) Periods of storage of soybean by farmers; (b) types of storage used by farmers.

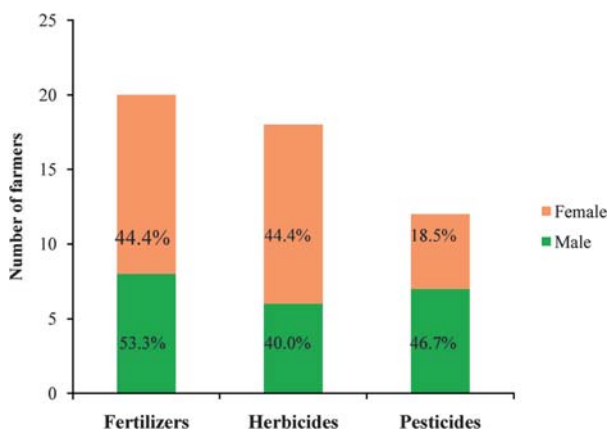


Fig. 8. Number of respondents who applied fertilizers, herbicides, and pesticides with the percentage to the total of each group

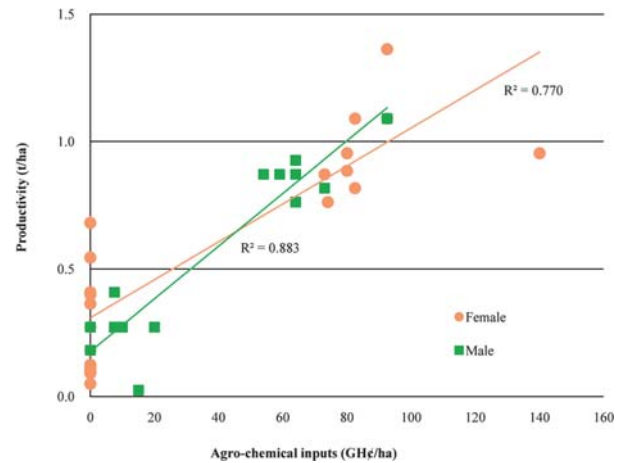


Fig. 9. Correlation between agro-chemical inputs and the yield of soybean

percent (Fig. 7b). Though application of a good combination of fertilizers, herbicides and pesticides are required for an ideal level of yield (ibid.), only 48.9% of farmers applied fertilizers, 42.2% sprayed herbicides, and 32.6% sprayed pesticides. The ratio of those who applied fertilizers and pesticides were higher in the male respondents (Fig. 8). The agro-chemical inputs and productivity showed positive correlation ($R=0.89$), particularly obvious among male respondents (Fig. 9). Including other inputs, namely seeds and sacks, the correlation becomes higher ($R=0.92$). In addition, two different strategies, namely high input-

high output and low input-low output strategies were also observed (Fig. 10). The exchange rate at the time of the survey was GH¢1.49 to US\$1.00.

Though less number of female respondents applied fertilizers and pesticides (Fig. 8), the average expenditure per unit area was almost the same between male and female (Fig. 11). The details were also not much different, where purchase of seeds accounted for almost 50%.

Sale, consumption and perception in soybean production

The average price received by farmers for a maxi bag (109 kg) of soybean was GH¢40.00; for a maxi bag (82 kg) of groundnut GH¢100.00; for a maxi bag (100 kg) of maize GH¢56.00; and for a maxi bag (109 kg) of sorghum GH¢58.00. The price per kg becomes GH¢ 0.37 (soybean), 1.22 (groundnut), 0.46 (maize), and 0.53 (sorghum) (Table 5). Unless achieving higher productivity, soybean cannot be competitive against other major crops in the northern Ghana.

Though the level of cash income derived from the sale of soybean was inadequate to compensate for the

expenditure, most of respondents sold their produce. The amount sold was 22.5% of the total yield of female, and 18.9% of the total yield of male respondents. Contrary to my expectation, female sold soybean more than male. Income calculation was based on the total production knowing the unit price. Overall expenditures by both women and men were higher than incomes; the average expenditure of GH¢189.93 was greater than the average income of GH¢161.61. Women’s expenditures and incomes were lower than those of men (Table 6).

I also examined the use of soybean by respondents in different menu items (Fig. 12), including *dawadawa* (prepared by 86% of farmers), wean mix (40%), *soykhebab* (36%), *apapransa* (36%), soymilk (28%), *koose* (26%), stew (17%), and *tubani* (14%). *Dawadawa* is a condiment; soy khebab, *weanmix*, *apapransa* *koose*, stew and *tubani* are dishes and soymilk is beverage prepared as food at home and for sale to consumers. All 42 farmers said that soybean was nutritious and improved their children’s bodyweights and health. However, the yield exceeded the household consumption, or in other words, domestic demand was not so high. The average household consumption of the respondents was 93.5 kg, which corresponds to the average consumption of two Japanese.

Farmers accessed their markets via traders, who purchased the product at the farm gate or at the local markets; traders then sell to consumers and companies when interviewed. I assessed the farmers’ perceptions of why they were not producing more soybeans. The major reasons given were poor markets, followed by pests and diseases and lack of credit required to expand

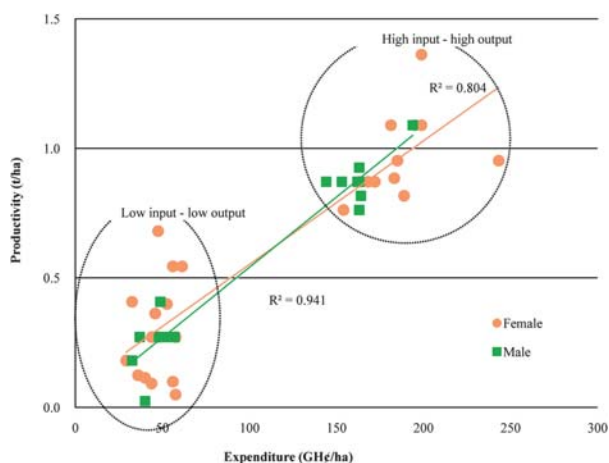


Fig. 10. Correlation between the expenditure and the yield of soybean

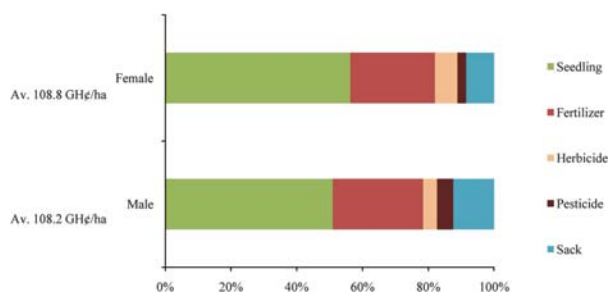


Fig. 11. Comparison of the expenditure between female and male respondents.

Table 6. Overall expenditure and income in the 2010 soybean cropping season

	Expenditure	Income
Female	186.72	161.1
Male	193.14	162.12
Average	189.93	161.61

Table 5. Unit prices of 4 major crops in the 2010 cropping season

Crop	Soybean	Groundnut	Maize	Sorghum
Weight of a bag (kg)	109	82	100	109
Average price (GH¢/kg)	0.37	1.22	0.46	0.53

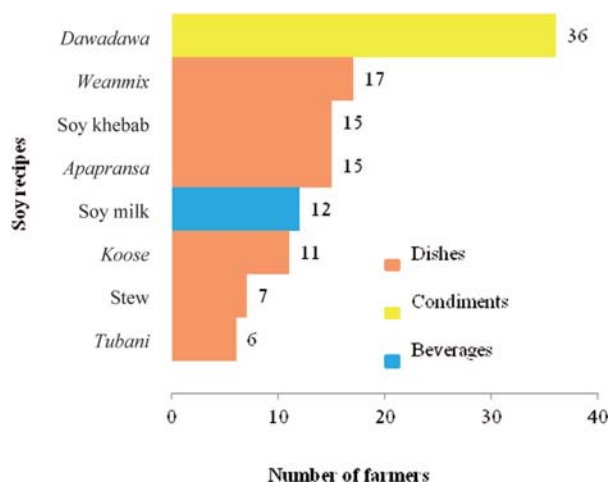


Fig. 12. Number of respondents by soybean receipts

(Fig. 13).

Traders and agro-processing companies

Seven traders were interviewed to gather marketing information. I assessed the traders' views on quantity, quality, and pricing and their perceptions of why soybean production levels were low. One trader said that soybean was available for purchase and 1 said it was sometime available for purchase, whereas 5 traders said it was not available for purchase. All of the traders said that the soybean quality was poor, and all of them said that the soybean price was poor compared with those for other food crops. All traders perceived that soybean production levels were low because of the poor price; 3 also said that farmers had complained to them about cultivation difficulties and pest and disease problems.

Only one agro-processing firm was available for interview; some firms that used to process soybean were no longer operating, and most of those still in operation were not using soybean as a raw material. The production/feed manager of the firm was interviewed. The firm uses both domestic and imported soybean. It does not obtain the required quantity domestically because of low production levels, the seasonal nature of production, and the poor quality of local soybean. Alternatives, such as other oil seeds (sunflower and cotton), were considered to have inferior digestibility and nutrient content compared with those of soybean. The manager said that poor enzymatic activity after roasting during processing resulted in poorer protein and oil quality in domestic soybean than in imported soybean; this difference oc-

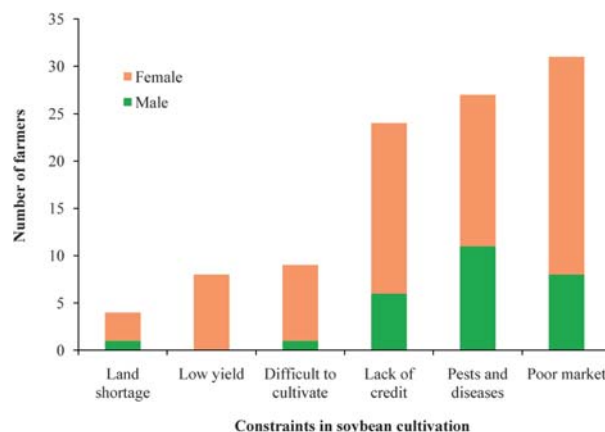


Fig. 13. Perceptions on the constraints in soybean cultivation (multiple answer)

curred because of poor seed quality as a result of poor storage. The processing target for 2010 was 20,000 t, but the firm had been able to obtain only 5000 t. Previous records were unavailable at the time of interview.

Discussion

Technical constraints to soybean production

Land was acquired almost freely either from chiefs or family owned (Table 2). Not all of the available land was cultivated, and there was a room of expanding soybean cultivation (Table 3). Women had less access to land but have access to land for soybean production when needed. Only few farmers agreed they lack access to land during perception assessment.

Good production practices and technology adoption are vital if soybean farmers are to obtain optimum yields. Row planting was not widely practiced by northern region soybean farmers: only 19% of farmers practiced row planting, and within each sex there were significant differences between row planters and non-row planters. ($\alpha=0.05$, $P=0.010$; Fig. 6b). The reluctance to use row planting is likely due to a lack of education about higher yield close spacing gives, together with perception that row planting requires more time. During the interviews, some farmers said that they had no knowledge of row-planting technology and that they considered row-planting to be time-consuming. Row planting determines the plant population per unit area, and if cultivation practices are not optimized then a low population (i.e. wide spacing) can adversely influence the total yield of a given area. However, some of the soybean farmers interviewed

agreed that those who planted in rows usually received higher yields if other cultural practices were performed well. Low yields could discourage potential farmers from cultivating soybean this is supported by their low yield in the results (Table 4) and their perception of low yield (Fig. 13). Berglund and Helms (2003) reported that row spacing is a critical determinant of yield in soybean production, because it ensures effective weed control. MoFA (2006) reported that, for optimum yield, soybean should be planted in rows. Production figures for the 2010 cropping season showed that, among four major crops (maize, sorghum, groundnuts, and soybean), soybean production by both women and men, and overall, was the lowest, but female production of all crops was lower than male production. Analysis of the production figures and yields of soybean in the 2010 cropping season indicated that production was lower than the recommended value of 1.8 to 2.5 t/ha in Ghana (SARI, 2006; MoFA, 2006). This could be attributable to the low level of adoption of technology by farmers. Only 31% of the 42 farmers practiced pest and disease control, but, among these farmers, females predominated (Fig. 6f). However, farmers reported that pests and diseases were causes of low yield in their soybean fields (Fig. 13). Grau *et al.* (2004) reported that plant health is a critical component of profitable soybean production, and that plant pathogenic fungi are an important group of disease organisms affecting soybean health. Tolin and Lacy (2004) reported that viruses occur in soybean worldwide and cause agronomic losses in soybean production. The most important insect pests of soybean are defoliators or pods feeders; these two groups of insect pests can reduce soybean yield by up to 65% (Heatherly and Elmore, 2004). Fungicidal treatment of soybean seed before planting can help to control damping-off; this is particularly true with the treatment of common pathogenic fungi such as *Pythium* spp., *Phytophthora sojae*, *Rhizoctonia* spp., and *Fusarium* spp., which are associated with reduced soybean germination and emergence and subsequent crop failure. Early planting can ensure efficient performance of fungicides (Heatherly and Elmore, 2004).

The price of agricultural commodities determines the revenue that should accrue from sales to traders, which ultimately determines the farmer's income after harvest particularly in cash crop production. Average prices for soybean were lower than those for maize, sorghum, and groundnut (Table 5). The higher maize

price is attributable to the fact that maize is a staple crop and is always in demand unless supply exceeds demand in a particular year and there is lack of market information or farmers are not able to process complex price-sensitive information (Coulter and Onumah, 2002). Sorghum is a staple crop and is used by small-scale industries (e.g. for brewing the local beer called *pito*); it is also used as a raw material by commercial breweries to produce light and dark beers, and non-alcoholic beer. The groundnut price is high because of constant consumer demand for its oil. Soybean, in contrast, is consumed little at the household level; it is required for processing into quality protein foods and oil by processing companies and the demand is highly dependent on the quality of the seed. However, the results of the interviews showed that domestic soybean seeds are considered by processing companies to be of poor quality; this leads to low demand by companies and therefore likely contributes to low prices. Price of soybean was lower than other crops (Table 5); this could be a disincentive for farmers to increase production.

The interview results showed differences between expenditure and income among the various sex groups. Because of the low price of soybean, the overall average expenditure by both sexes was higher than the income received (Table 6). The relatively high expenditure could be attributable to the costs of inputs (Fig. 10 and 11) and the relatively low income was likely a result of the correspondingly low price for soybean (Table 5). Low income and high expenditure affects the profit margin from production which can adversely influence farmers' production decision in soybean production.

Marketing of farm produce by farmers in rural Ghana is determined by traders, who do not have well-defined sources. These traders usually come from the towns to trade agricultural outputs. The interviews revealed that farmers did not have in place other market channels such as marketing or cooperative groups to determine prices or arrange for convenient market with processing companies in order to attract quick and reasonable prices for their produce. The traders took advantage of this and exploited the farmers, offering poor prices so as to make their own profits. These results agree with previous findings that small-scale farmers lack access to price information from local, regional, and national markets and are vulnerable in terms of price and lack of access to

markets (Coulter and Onumah, 2002; Poulton *et al.*, 2006). The farmers perception that the soybean market was poor was significant at ($P=0.05$; Fig. 13) for both females and males, 8 females, 23 males said it was a problem and 4 females, 7 males said is not a problem; moreover, more farmers than not said that lack of credit to expand, along with pest and disease problems, was a reason why soybean production levels were low by the difference between the numbers and the total sampled farmers; though, some farmers mention of lack of access to land they were only 4 out of the total 42 farmers. The farmers defined a “poor market” by low price and lack of direct means of sale of their produce to companies, which they believed could offer them better prices by eliminating the cuts taken by traders when asked for explanation during interview.

My analysis of agro-inputs in soybean production; fertilizer, herbicide and pesticide were seen to have a positive correlation ($R=0.89$; Fig. 9) with productivity (yield). The more inputs farmers applied for soybean production in 2010 the more output they got. Further analysis of all inputs gave more correlation of ($R=0.94$; Fig. 10). This is in complement with (Heatherly and Elmore, 2004; Wan Othman *et al.*, 1991 Israel, 1987; Cassman *et al.*, 1981; Holford, 1976; DeMooy and Pesek, 1966). The positive correlation gave room to further correlation between yield and expenditure (Fig. 10). Therefore, higher input - higher expenditure - higher yield. However, it is better for farmers to treat their soybean seed with fungicide at planting to improve germination percentages (Heatherly and Elmore, 2004); they should also inoculate the seed with *Bradyrhizobium japonicum* if the land has been newly cropped, because soybean is capable of fixing its own nitrogen through the action of this bacterium in the root nodules (Heatherly and Elmore, 2004). Application of low-cost inputs such as biofertilizer to increase yield is therefore recommended (BEST, 2011).

Farmers commonly stored their soybean seed in airtight polythene sacks (Fig. 7b) to prevent moisture absorption and deterioration of the seed in storage. However, seed deterioration could still have been caused by exposure to sunlight, because the farmers often did not have appropriate storage places for their farm produce. The processing firm confirmed that poor enzymatic activity results in poor protein and oil quality after roasting during processing; this is the

result of poor seed quality due to poor storage conditions. The poor quality likely led the firm to offer low prices to compensate for any potential profit losses. Eight different soybean menu items were used by farmers, but the majority did not eat most of these items, the number of farmers who utilized the various dishes, condiments and beverages were less than half of the total number of farmers interviewed except *dawadawa* (Fig. 12). Thus the use of soybean for nutritional improvement in the home was not widespread, and this lack of interest in soybean product utilization could have influenced the farmers’ decisions not to produce the crop.

The traders and the processing company confirmed that the quality of soybean after it had been stored by farmers was poor. The traders confirmed the low prices facing the soybean industry. If the seed were of low quality, then the companies would be likely to offer low prices to the traders who, in order to maintain their profit margins, would in turn offer low prices to the farmers. There is a lack of harmony in marketing in the Ghanaian soybean industry.

Different strategies observed from the results

From the relation between input and output, two different strategies were observed. One is relatively high input and high output strategy, and the other is low input and low output strategy. There was no clear relation between male and female in the selection of the strategy. However, if soybean farmers adopt low input - optimum output strategy by applying sustainable methods of production practices and in addition to adoption of improved technologies they are likely to achieve a higher output of the recommended yield of 1.8 to 2.5 t/ha.

Soybean and women

The results showed that Ghanaian women are as capable of cultivating soybean as their male counterparts. Women tend to hold smaller land blocks than their male counterparts and applied less extensive management. In general, women in rural societies go on working without a break, and may not be able to share as long time as men. Therefore, high input - high output strategy compels women to employ labor force, which may lead to less profitable results. To avoid labor shortage, it seems better to encourage women either to apply low input - low output strategy, or to apply more improved farming systems based on agro-

chemicals. However, another concern on the environmental issues, such as human health damage and biodiversity degradation, may arise from excessive dependency on chemical inputs.

Conclusions

Additional land was available for soybean cultivation by women. Respondents' land acquisition status and perceptions also supported this point. The failure of farmers to adopt technology to ensure optimum yield in soybean production could have resulted in low yields. Low yield reduces total income as against expenditure. Pests and diseases were prominent threats to soybean production and could have been factors in the low yields. Average prices for soybean were lower than those for groundnut, maize, and sorghum, and total expenditure was greater than income. This could influence the farmers' decisions about producing soybean. Poor seed quality has resulted in poor processing of soybean into finished products, as reported by the processing company. Poor seed quality thus likely causes low prices and disincentives to production. I also found low rates of soybean use in the home.

Recommendations

To promote soybean production, the key issues are for farmers (women) to devise marketing strategies and identify efficient marketing outlets by forming marketing/cooperative groups with the support of the Ministry of Food and Agriculture and the Department of Co-operatives. Government marketing policy should include price guarantees for agricultural commodities and buffer stocks for soybean. Government policy on processing should be to revamp soybean-processing firms (e.g. Bosbel oil mill in Tamale) and reinforce support for mills that are already functioning.

The Ministry of Food and Agriculture should step up awareness creation, education, and training of extension staff and farmers (particularly women farmers) in terms of production practices, new technologies, and product use to increase soybean yield per unit area. Special farming packages from the Ministry of Food and Agriculture that are designed to help women farmers in soybean production could be implemented through government food policy strategies. Farmers' (women) should focus on small scale production by adopting low input — optimum output strategy using sustainable methods of production practices and in

addition to adoption of improved technologies in order to improve their livelihood and to avoid environmental issues such as human health damage and biodiversity degradation. Finally, there should be further investigations of the pests and diseases suspected to be associated with soybean fields in Ghana to determine the extent of damage they cause to crop growth and yield.

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