Understanding the smallholder farmers' crop production choices in the forest-savanna transition zone of Ghana

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ABSTRACT

Crop production choices made by smallholder farmers in Sub-Saharan Africa may enhance food security in the face of biophysical and socio-economic constraints. The forest savanna transition zone of Ghana is traditionally characterized by a multiplicity of uncertainties, to which farmers respond by cultivating a diversity of crops including cereals, root crops, tuber crops and leguminous crops. There is, however, little understanding of the driving forces that underpin individual farmers' choices of the type of crops they cultivate. Using the environs of the Kogyae Strict Nature Reserve as a case study, this paper investigates the array of crops available to the farmer, and what guides the farmer household in the choice of crops to cultivate. The study employed field-based techniques, namely focus group discussions and administration of questionnaires, for the data collection. The findings reveal that a combination of factors including knowledge of local conditions, length of the rainy period, market forces, dietary habits and crop maturity time dictate the choice of crops. The findings further indicate that local adaptation to climate variability has resulted in a shift of the farming calendar in the area from March/April to May/June since 2008; and in the intensification of the production of some lesser-known crops such as cowpeas and rice. Another important observation is that beyond what pertains at the community level, individual choices are based on relative risks posed and opportunities offered by each of the constraining elements. The study concludes that to a large extent, smallholder farmers, regardless of their experience, have to operate within constraints imposed by the biophysical environment and market forces, which potentially render crop production vulnerable to unexpected risks. Crop production choices are therefore an effective risk spreading strategy as a response to environmental vagaries and socio-economic uncertainties.

Keywords: Smallholder farmer, Forest-savanna, Crop production choices, Kogyae Strict Nature Reserve

Introduction

Farming decisions made by smallholder farmers concerning crop production are often influenced by both production and consumption factors (Timmer *et al.,* 1983). On production, the factors relate to biophysical conditions such as soil quality, moisture availability, pests and diseases, climatic factors, yield and constraints posed by institutional arrangements. The factors regarding consumption relate to traditional dietary values, taste and market forces, though the factors may differ across cultures. Most of these factors constitute uncertainties that may be beyond the farmer's control, yet smallholder farmers had demonstrated their ability to adapt to these inherent challenges through time-tested traditional knowledge to sustainably manage their production systems (Gyasi *et al.,* 2004). Farmers' responses, as a form of adaptation, are dynamic and in accordance with changing biophysical conditions. These may involve engagement in diverse management techniques such as moisture conservation, erosion control, pest control and soil nutrient enhancement strategies (Altieri and

Koohafkan, 2008). One important adaptation strategy that most researchers have overlooked in the past is crop production choices that farmers make in an attempt to maximize their livelihood benefits and to minimize the risk of crop failure. The sequential cultivation of a diversity of crops such as cereals, root crops, tubers and legumes on the same farm field and the relevance of such choices in the era of climate change deserve due attention. Unfortunately, there is paucity of information on, and little understanding of what informs individual farmer's choices of the type of crops they cultivate, as these may differ from one community to the other.

About 68% of Ghana's land area is arable, yet only about half of it is under cultivation (World DataBank, 2013). Smallholder rain-fed agriculture using simple tools, notably the cutlass and hoe, dominates the agricultural sector in the country, and accounts for about 80% of total agricultural production (MOFA, 2011). The rudimentary technologies associated with smallholder agriculture imply that any fluctuations in natural conditions, notably climate variability, would invariably have negative impacts on national food production targets. Understanding crop production choices made by the smallholder farmer therefore becomes relevant in explaining how the smallholder system keeps pace with growing national food demands. Using the environs of the Kogyae Strict Nature Reserve as a case study, this study investigated the array of crops available to the farmer, and what guides the farmer household in the choice of crops. The study also investigated gender roles in farm-household crop production choices and farmers' perspective of crops most suitable for food and income security against climate change.

Available literature on factors determining smallholder farmers' choice of crops shows that such choices may not be easily predictable. There is a large body of literature on general patterns of crop production based on agro-ecological zoning and soil suitability traits (Asiamah, 1995; Williams, Hook, & Hamblin, 2002; Agyei-Gyapong and Asiamah, 2002; Quddus, 2009). Such ecological areas have certain types of crops that they are best suited for, which are therefore recommended for cultivation (Asiamah, 1995). In a similar manner, in cases where communal farms are operated such as in Vietnam, collective agricultural decisions are made within a given environmental constraint (Timmer *et al.,* 1983). However, with regard to smallholder farmers, decision making is done on individual initiative, and the incentives that induce them to work in a timely and careful fashion strongly influence the quality and quantity of output (Timmer *et al.,* 1983). In view of this, there is hardly any clear pattern of crop production choices when it comes to smallholder agriculture. According to Mubanga (2015), although climatic factors influence crop yield and may seem to dictate crop production choices, this may not always be the case because such factors vary across local, regional and national boundaries. According to this author, although certain soil and climatic characteristics may be suitable for a particular crop and are more likely to produce higher yields as compared to randomly chosen crops, this in itself is not a sufficient reason for farming households to plant the most suitable crop. A study by Omamo (1998) in Siaya District of Kenya, for instance, revealed that smallholders could raise farm profits by at least one-third by growing more cotton and less maize and sorghum. Yet they regularly devoted larger shares of land and other resources to relatively low yielding maize and sorghum than to cotton which had higher market returns, for the reason that cotton production was more capital intensive and beyond the reach of the poor. Therefore, for the poor smallholder farmers who lacked access to production credit, the preferred choice would be the production of food crops to enhance their nutritional needs.

Another study by Asrat *et al.* (2010) indicated that in the selection of crops among a certain group of farmers in Ethiopia, the highest premium was placed on environmental adaptability, followed by the yield stability of the particular crop. Fafchamps (1992) observed that in third world countries, large-scale farmers devote a larger share of their land to cash crops than do small farmers due to better access to credit, a greater ability to sustain risk and the lower share that staple foods represent in their total consumption expenditure. Earlier, Timmer *et al.* (1983) pointed out that agriculture is site

specific and that what works in one location may not apply in another because farm households face different constraints on their decision making. Keleman *et al.* (2009) explored potential links between crop diversity and improved livelihoods and indicated that such links may be achieved when the sale of diverse crop varieties directly contributes to farmers' incomes, or when the crops themselves improve household nutrition.

Several other researchers have attributed famers' crop production choices to a variety of factors. These include the availability of land, labor, and capital (Collins, 1984; Coomes *et al.,* 2000), the cultural context in which household land use decisions are made (Alcorn, 1984b; Geertz, 1984), the desire by farming households to secure consumption from own production, market failures, and the roles of state and non-state actors (Umar, 2011). Shiferaw and Bantilan (2004) referred to global or national level policies that may be transmitted to the local level through policy reforms, institutional changes and infrastructural investments. Such broad level policies in turn determine relative input–output prices and access to new technologies and markets at the local level (Shiferaw and Bantilan, 2004). Other studies suggest that collective action by the community may enhance and supplement individual production and investment possibilities (Sreedevi *et al.,* 2006; Wani *et al.*, 2006).

Materials and Methods

Geographical Setting

The forest-savannah transition zone of Ghana lies between the semi-deciduous forest zone at the southern fringes and the Guinea Savannah belt to the north. The zone runs across the country from east to west. It covers about 28% of the country's land area and occurs mostly in parts of the Ashanti, Brong-Ahafo and Northern regions of Ghana. The annual average temperature of the zone is about 28°C (Dickson & Benneh, 1995). It experiences annual average rainfall of between 1200mm and 1500mm, with a bimodal pattern which peaks in June–July and again in September–October, with a dry season in December–March. However, in the northern parts of the zone, the rainfall is uni-modal, with a peak in September (SRID, 2014; Tom-Dery *et al.*, 2013; Isaac *et al.,* 2014). Recent studies have shown that the average annual rainfall figures for some parts of the zone are decreasing, possibly as a result of climate change. Owusu and Waylen (2012), for instance, analyzed rainfall figures obtained from an agro-meteorological station in Ejura in the extreme northwestern part of the study area, and noted that from 1950 to 2000, rainfall averages had reduced from 1800mm to 1600mm. Some residents of the area also shared similar views based on their knowledge of the local rainfall regime (Ofori *et al.*, 2015; Ayivor *et al.*, 2015).

The vegetation is dominated by relics of forest patches and savannah woodland with tall trees and occasional riparian woodland along water courses. Soil types vary from Savannah Ochrosols within the wooded savannah areas to Forest Ochrosols along the forest margins (Dickson & Benneh, 1995). A common feature of the zone is its continuous southward expansion, resulting from anthropogenic drivers and climate change (Hagan, 1998).

The zone is a major destination for migrants from northern Ghana, who see internal migration as a livelihood strategy (Anarfi *et al.*, 2003; van der Geest *et al.,* 2010). Thus, decades of extensive agricultural practices in the zone by both the indigenes and a large migrant population have depleted most soils of their vital nutrients and affected crop productivity. Other environmental challenges of the zone include evidence of changing climate conditions (Klutse *et al.*, 2013, Codjoe and Owusu, 2011), annual bush fires, tree felling for both timber and charcoal production and extensive grazing. Visible signs of degradation have been observed and widely documented (e.g. Attua and Pabi, 2013).

The environs of the Kogyae Strict Nature Reserve, located in the heart of the forest-savannah transition zone in the Ashanti Region of Ghana (Fig. 1), was chosen for this study. The choice of this area was because it has numerous environmental challenges such as climate change and annual bush fires. The establishment of the Strict Nature Reserve has reportedly also reduced arable lands in the

area, thus putting a lot of pressure on the available land (Ayivor and Ntiamoa-Baidu, 2015).

The relief of the study area is generally low-lying and undulating with average heights of about 120 m above mean sea level. There are few areas of higher elevation, attaining heights of between 215 m and 230 m. Two major streams, namely the Afram and Sene, and their network of tributaries drain the area. The Sene River drains the northern part of the area while the Afram River and its tributaries drain the southern parts into Lake Volta, located to the east. Most of the drainage channels have adjoining low lying areas that get flooded seasonally, thus creating agroecological niches which are used by farmers for rice cultivation (Hagan, 1998; Ofori *et al.,* 2014; Ayivor *et al.,* 2015).

The population of the area has increased very significantly over the past five decades through both natural means and the high rate of in-migration of farmer families (Ayivor *et al.,* 2015). The main livelihood activity of the area is agriculture. This involves crop farming, livestock raising, lumbering, hunting and fishing (Oduro-Ofori, *et al.*, 2015).

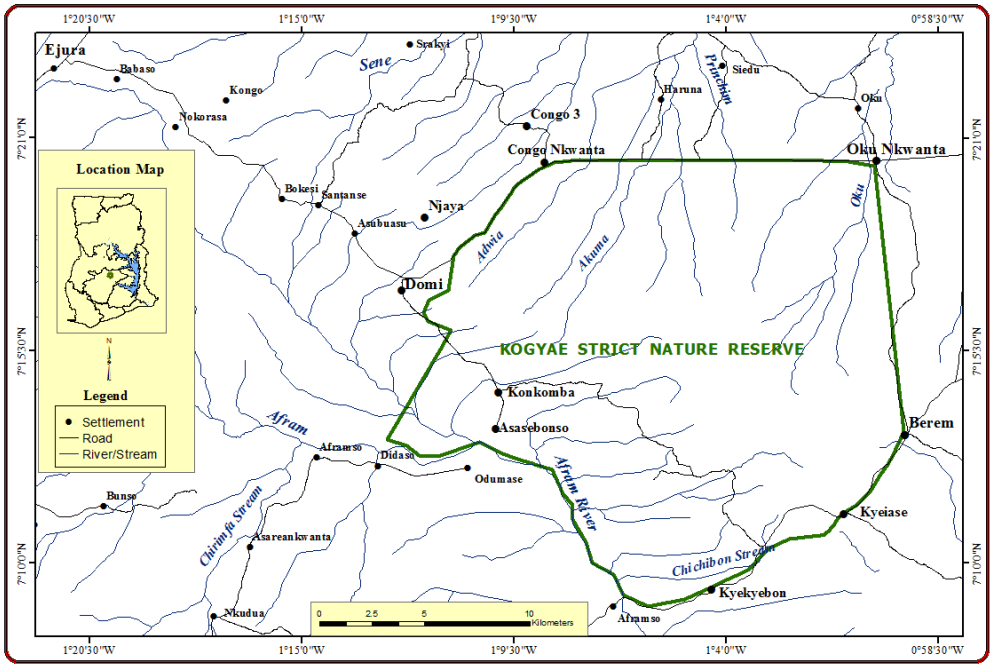

Fig. 1: The Environs of the Kogyae Strict Nature Reserve in the Forest-Savannah Transition Zone

Methods

The study employed field-based techniques in collecting data, namely focus group discussions and administration of questionnaires. A total of 27 communities (Fig. 1) were visited during the preliminary visit, which was also used to hold informal discussions with key community leaders on farming practices. Based on the preliminary observations, purposive sampling was designed for nine (9) communities for in-depth studies. The nine communities were Domi, Njaya, Congo Nkwanta, Oku Junction, Berem, Kyease, Kyekyebon, Aframso and Asasebonso. They were selected on the basis of their accessibility to road transport, relative size and number of households. This was to ensure that a good number of adult respondents were available for the questionnaire administration. A set of 11 questionnaires (more or less) were administered in each of the nine communities

based on random sampling of households within each community. A total of 100 questionnaires were administered.

In addition to questionnaires, one focus group discussion (FGD) was conducted in each of the nine selected communities. Members of the groups were selected with the assistance of the local Assembly members and agents of the community leadership. Each group was made up of nine (9) to 15 adult participants between the ages of 18 and 72. In total, 102 farmers made up of 52% males and 48% females participated in the focus group discussions. The discussions were guided by a check list with a set of questions on general farming practices, types of crops cultivated, reasons for the choice of crops cultivated and adaptive practices that were introduced as coping strategies against changing environmental conditions.

The mode of questioning was similar to the "choice experiment" approach which Asrat *et al.* (2010) used to evaluate farmers' preferences for the various attributes of crop varieties. Based on this approach, the research team inquired about the types of crops cultivated by each farmer and the crop variety attributes that informed the choices. The attributes used in the choice experiment included food security, income security, market forces, environmental conditions, climate change, migrants' experience and the influence of friends and neighbours. The responses were later tallied and ranked by relative frequency for discussion.

The study also made use of secondary data culled from published and unpublished sources including books, peer reviewed journals, technical reports and national and other relevant state documents.

Analysis of the data from the focus group discussions was done qualitatively using a thematic technique through a three-step approach of identification of themes, descriptive accounts and interpretative analysis. Responses received by means of questionnaires were analyzed using non-probability/non-parametric descriptive techniques such as the use of relative frequencies and bar charts.

Results

Background of Respondents

The majority of the respondents, comprising about 76% of the sampled population, were within the age range of 26 to 50, with as many as 45% between the ages of 31 and 40, implying that most of the farming population was youthful. Eighteen percent (18%) of the sampled population was 51 years and above, whereas only 6% were 25 years and below.

Several ethnic groups were identified in the study area. Apart from the indigenous Asante who constituted less than 40% of the sampled population, most of the residents were migrants of diverse ethnicity such as Kokomba, Dagomba, Dargati, Moshie, Sissala, Gruma, Gonja and Frafra from northern Ghana. Due to the migrant status of most of the residents, the length of stay of respondents in the communities varied from person to person as indicated in Table 1. It is remarkable to note from the table that as much as 51% of the respondents had lived in the area for not more than 20 years, underscoring the high rate of in-migration in the area in recent years. Though the length of stay alone may not be sufficient proof of one's migrant status, the fact that about 60% of the population were migrants may seem to validate the use of length of stay to confirm residents' migration status.

Table 1: Length of Stay in Community

No. of years	Percentage (%)
Less than 5 years	3
5-10	17
11-15	17
16-20	14
21-25	9
26-30	11
31-35	10
36-40	5
Over 40	15

The high migrant population in the area was enhanced by a very attractive land tenure system that easily met famers' needs. The findings revealed that about 74% of the farmers engaged in share cropping or other forms of leasehold agreements on favourable terms. For instance, at Njaya, the residents claimed that they paid virtually nothing for farmland; rather, they made annual contributions voluntarily to the landlord, Kwamanhene (the paramount chief of Kwaman), towards the celebration of his annual traditional festival.

The findings further revealed that all respondents in the study area undertook farming either as the first or second major economic activity. About 3% of the population, however, practiced farming only as a second occupation and were engaged in the local artisanal industry such as carpentry, or petty trading. The results also revealed that about 13% of the respondents, mostly women and the aged, engaged in food crop production for subsistence, whilst the rest of the population engaged in both food crop and cash crop farming. It was further noted that about 95% of the respondents were able to produce enough to take care of their basic food needs, whilst 5% were not and had to depend on their families and/or external relations to make up for the deficit. A few food-insecure farmers engaged in waged labour to purchase food from the community markets.

The use of agro-chemicals to enhance farm productivity and to clear weeds and pests was very common in the study area. The results indicated that as many as 64% of the respondents applied chemicals on their farms. The cycle of chemical application by farmers started with the use of weedicides to clear the land (mostly degraded farmlands) for new planting. The non-selective herbicides, Glyphosate 480g/l and Gramokal super, which the farmers nicknamed "condemn", were used at this stage. This was followed by planting, then application of fertilizers (mostly NPK and Sulphate of Ammonia) and the use of Herbextra, a selective herbicide used mostly to clear weeds in rice and maize farms. Finally, pesticides were applied on vegetable farms a few weeks before harvest or on other crops earlier in the cycle, depending on the prevailing circumstance. About 34% of the farmers who did not apply agro-chemicals on their farms practiced rotational fallow. However, with the rapid rate of population increase over the past decades and the shortening of fallow period, lower yields were being recorded by this category of farmers.

About 2% of the farmers used exclusively organic manure or adopted other soil fertility enhancement methods. These were mostly crop farmers who, as part of their management strategy, planted on raised-mounds or ridges to enhance the water infiltration capacity of the soil. They also used organic material for mulching to preserve moisture and as a way of adding organic residue to the soil.

Household Decision Making on Crop Production Choices

According to the findings, farmer decision on what to produce is largely the preserve of the head of family, mostly men. Based on the percentage frequency of responses in male-headed households in relation to who the decision maker was, it was noted that 87% of the decisions were made by husbands whilst 13% were jointly made by husbands and their wives. There was no instance where a decision was made by a woman in a male-headed household. This explains male dominance in these farming communities, which is a major feature in most agrarian communities in Ghana. Instances where women made decisions on the choice of crop included:

- cases of female-headed households;
- cases where husband and wife operated separate farms;
- cases where a wife identified a niche within a joint family farm to cultivate specialized crops such as vegetables;
- occasions when married women established additional farms separate from joint family farms; and
- situations where a husband (head of household) was absent for one reason or the other, and the wife had to mobilize the children to carry out farming operations.

The farmers had a wide range of crops from which they made their choices. The most common staples included maize, yam, beans, groundnuts, cowpeas, rice, cassava, cocoyam and plantain. In general, farm-household choice of crops on an annual basis depended on a combination of factors including sequence of crop in the season, knowledge of local conditions, length of the rainy period, market forces, dietary habits and crop maturity time.

Crop rotation

It was noted during fieldwork that the period between March and May was devoted to the production of fast yielding drought resistant crops, notably cowpeas. This adaptation strategy emerged from several outreach programmes that the Crop Research Institute of the Centre for Scientific and Industrial Research (Ejura) had extended to farmers through the Agricultural Extension Agents and the World Vision International. Through the programme, farmers had adopted the 42-day strain of cowpeas which they harvest before the commencement of the main planting season.

Fig. 2 shows the normal cropping sequence on annual basis as reported by the farmers. The figure depicts several cropping patterns, which the farmers had adopted based on the length of the rainy season and the maturity period of the crop. It shows also that cowpea and maize feature the most in the cropping sequence. The respondents explained that cowpea can withstand the drought spell of about one and half months that follows the first rains in March. Thus, climate variability over the past decade influenced farmers' decisions to start the annual cropping sequence with cowpeas, a practice which had been introduced less than a decade ago. The dual advantage of cowpea was its early maturation period and its ability to fix atmospheric nitrogen in the soil, thus enhancing soil fertility for the maize crop which followed in the sequence. An additional advantage of this innovation, as reported by the farmers, is that the produce from cowpea cultivation was sold for re-investment during the main cropping season. Leafy vegetables and okra, both of which mature quickly, may also be cultivated alongside cowpea for home consumption and for income.

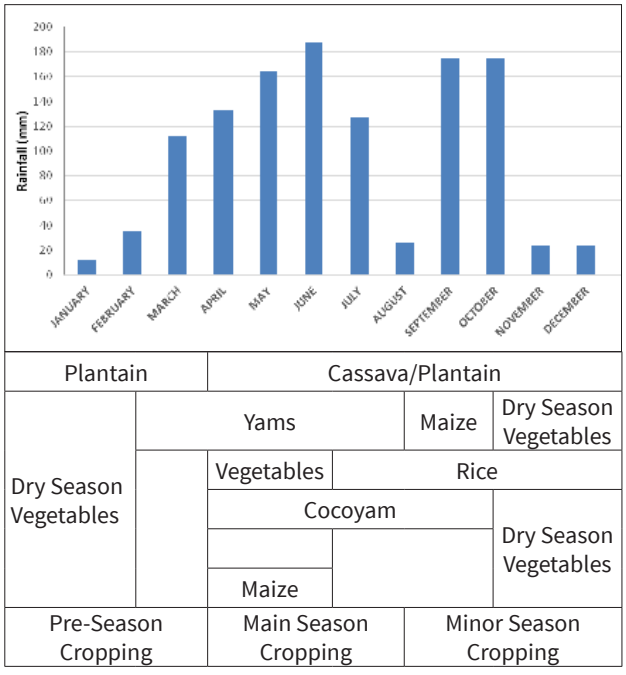

Fig. 2: Annual Sequence of Cropping in the Study Area

A variety of crops was cultivated during the main cropping season based on local knowledge. This knowledge gave farmers enough assurance of the availability of adequate moisture to ensure the growth of the various crops. The crops, which were cultivated mostly either as mixed crops or in combination with other crops, included maize, yam, groundnuts, cassava and vegetables.

The third cropping period in the annual sequence starts in July/August and ends normally in November/December. The crops cultivated during this period included maize, rice and to a lesser extent, cowpeas. According to the findings, this period coincided with the peak rainy season characterized by abundant moisture to support crop growth. Rice was cultivated extensively in swampy areas not suitable for maize production. According to respondents who were practicing rice

farming, the activity gained momentum about a decade ago in response to market forces. Though most farmers considered maize as the most important crop to meet their food security needs, cropped area for rice had increased by 95% from 2005 to 2014 whereas maize had increased by only 30% and yam 17% (Ayivor *et al.*, 2015).

The last period in the sequence of cropping commenced in November and ended around March of the following year. This involved mostly dry season vegetable farming practiced by a handful of farmers encountered at Chichibon. The study also revealed that paramount to the crop production choices was the fact that farmers had a good understanding of the vulnerability to weather extremes of each of the crops they cultivated and were therefore guided accordingly.

With regard to vulnerability to drought, the responses from farmers showed that maize and rice were most vulnerable, followed by cowpeas, yam and groundnuts (Fig. 3). Therefore, during dry spells most farmers preferred to cultivate cowpeas, which are more tolerant of drought, rather than maize and rice. On vulnerability to excessive rainfall, the percentage responses for cowpea ranked the highest, followed by maize, rice, yam and groundnuts.

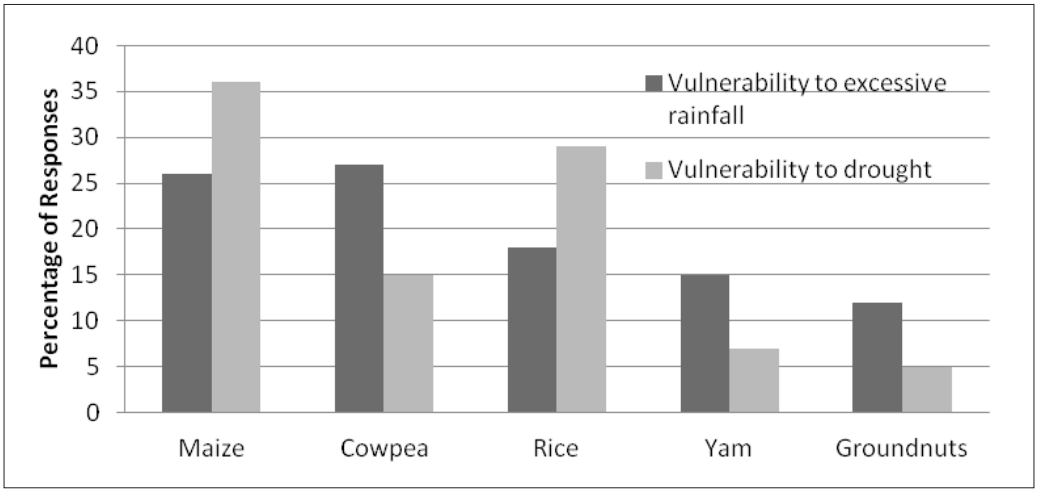

Fig. 3: Vulnerability of Crops to Excessive Rainfall and Drought

Maize and rice appeared to be most vulnerable to both drought and excessive rainfall, yet these two crops were the most cited by farmers for meeting food and income security needs (Fig. 4). Thus, despite the vulnerabilities of these crops to extreme weather conditions, their cultivation was very important in meeting the farmer's food and income needs.

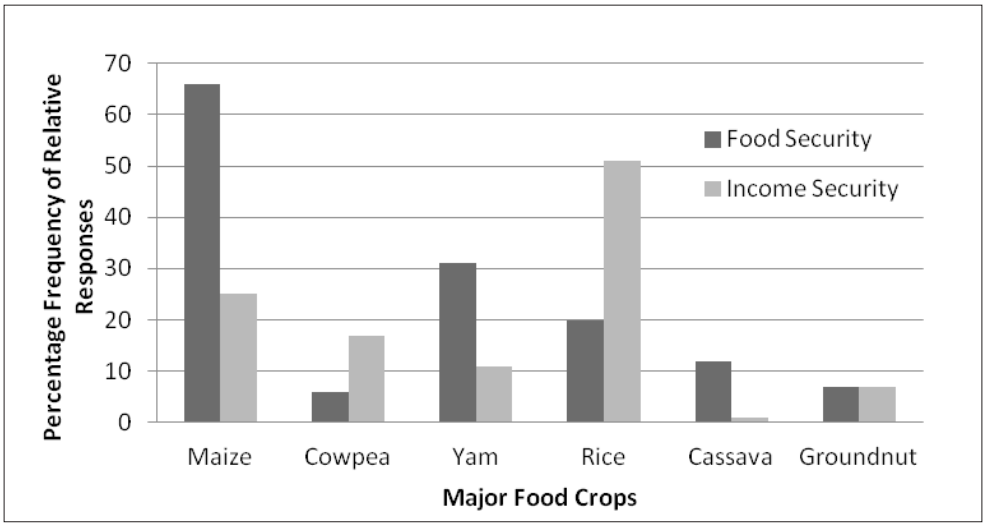

Fig. 4: Crops Meeting Food and Income Security Needs

On the whole, about 96% of the respondents were able to produce enough to meet their food security needs. It was noted further that majority of the remaining 4% who could not produce adequate crops to meet their food security needs, were between the ages of 65 and 70. About 20% of this category of respondents depended on their relations to make up for the food deficit.

Production Capital, Traditional Values and Market Trends

According to the respondents, though rice cultivation guaranteed their income security, its cost of production was higher than that of maize. The cost included the preparation of land and nurseries, transplanting, cost of different agrochemicals needed at various stages of the production process, cost of scaring away grain-eating birds during the fruiting stage and cost of harvesting. The process was therefore capital intensive and in the absence of production credit, most farmers had to rely on middle persons who pre-financed the production process and were paid back in kind soon after harvest. Unfortunately, such arrangements often left such farmers at a disadvantage, as unit prices to the middle persons were pegged lower than the prevailing market price at any point in time. Additionally, such arrangements did not allow farmers to store the produce for a longer period to attract higher market prices. This tends to erode farmer revenue, with most of them only able to break even.

Socio-cultural factors that drove crop production choices by farmers were mainly traditional dietary values, ethnicity and migration. It was observed that certain crops such as yam, plantain and cocoyam which were vulnerable to the current environmental conditions were still being cultivated. The respondents explained that such crops featured prominently in the preparation of their traditional dishes, which explains why they could not stop producing them. For example, plantain and cassava are combined in the preparation of the traditional dish *fufu* which is very popular among the Asante. However, in the past few years, even though erratic weather conditions, especially windstorms, negatively affected the productivity of plantain, most farmers continued to cultivate the crop in every available niche including back yard gardens. In a similar manner, though the yield from yam cultivation had not been impressive over the past years due to soil exhaustion, migrant farmers, mostly from northern Ghana, continued to cultivate the crop because it is an integral part of their diet. Most farmers no longer produced these crops in commercial quantities but just for home consumption.

A cocoyam farmer in Oku Junction in the northern part of the study area claimed that he introduced cocoyam to the area as a result of his cocoyam production experience in the forest zone of Ghana where he migrated from. According to the farmer, his net income from the sale of cocoyam on the local market far outweighed what he got from the maize crop. A few other farmers had adopted cocoyam farming in the area. It is worthwhile to note that the weather condition in the Oku area was mostly the tropical savannah type and offered little opportunity for the cultivation of broad-leafed crops. Motivated by taste and market forces, the farmer in question defied the crop production pattern based on broad agroecological zone and practiced 'niche farming', much to his advantage.

Opinion Ranking on Crop Production Choices

After evaluation of the factors that influenced crop production choices, the study attempted to rank the most preferred production choices based on farmer-responses. The analyses revealed that for the majority of farmers, the main driving force for the choice of crops they cultivated was income and food security. Farmer-responses, as shown in Table 2, indicate that 42% of the respondents were driven by income considerations whilst 27% were influenced by food security needs. 4% of the respondents stated market forces, which also relates to income, as the main driving force in their crop choices. This implies that about 46% of respondents were driven by a combined income and market factor. Field investigations revealed that despite the bad nature of the roads, truck-loads of assorted food items destined for urban markets such as Kumasi, the regional capital and Ejura, the district capital, were a common site, particularly on market days. Other factors of importance that dictated farmer-choices included environmental conditions, migrants' experience and influence by neighbours and friends (Table 2). Eighteen percent (18%) of farmers were influenced by environmental conditions including climate variability.

Table 2: Driving forces for crop production choices

Item of motivation	Percentage responses
Income security	42
Food security	27
Environmental conditions including climate variability	18
Influence of neighbours and friends	6
Market	4
Migrants' experience	3

A further probe into farmers' knowledge of climatic trends and crop adaptability revealed that cowpea recorded the highest number of percentage responses as the most robust crop regarding climate variability in the area (Fig. 5). The crop with second highest percentage of responses was maize. According to the farmers, though maize cultivation was highly vulnerable to climatic uncertainties, the Crop Research Institute of the Centre for Scientific and Industrial Research had developed an early-maturing variety that could also withstand drought. Thus, the earlier variety, *obatampa*, which has a maturation period of 120 days, was being replaced by *omankwa* which takes only 90 days to mature. Therefore, the farmers believed that the production of the new variety of maize could be a good coping strategy against climate variability. The farmers were also of the view that since rainfall peaks around the time rice is cultivated in the area, proper timing of the crop would enhance its ability to cope with climatic uncertainties.

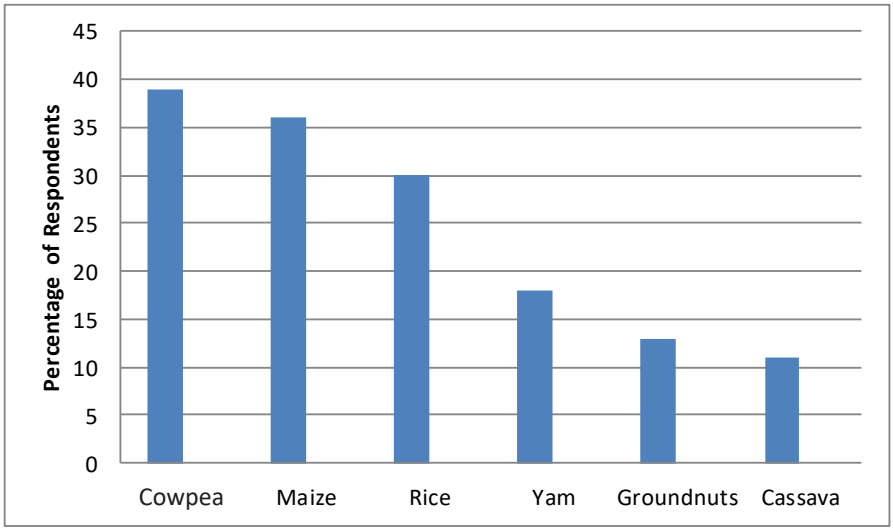

Fig. 5: Crops Suitable for Food Security against Climate Change

Discussions

According to Timmer *et al.* (1983), growing food is a decision-intensive undertaking. Most farmers are occupied routinely with decisions on what crops to plant; what inputs to use; when to plow, seed, cultivate, irrigate, and harvest; how much to keep for home consumption, sell or store for later sale. With regard to the choice of crop to be produced by the smallholder farmer as revealed by the current study, the decision is often subjective and based on the farmers' preferences such as taste and the traditional value placed on the crop. It was however very clear that income and food security needs were the main driving forces.

The sequence of crops in the season and the crop combination grown by the farmers were also very important in the crop production choices. According to Timmer *et al.* (1983), cropping patterns vary among smallholder farms because of differences in soils, irrigation, prices and proximity to markets. In addition to the cropping pattern, the farmers' knowledge of the local environment, particularly the changing climatic conditions and the subsequent change in the planting season since 2008, also played a major role in their crop production choices. For instance, Ayivor *et al.* (2015) reported that there has been a one- to two-month shift in the farming calendar in the area over the past decades. According to Ayivor *et al.* (2015) before the 1980s, there were early rains in mid-March, which used to usher in the planting season, but this is no longer the case. Our findings underscore this observation and confirm the shift in the farming calendar from March/April to May/June since 2008 due to delays in the onset of the rainy season. As an adaptation measure, farmers had adopted the 42-day strain of cowpeas which they harvested before the commencement of the main planting season. This observation suggests that the choice of cowpea at this stage was influenced principally by rainfall availability. Since the farmers practiced rainfed agriculture, rainfall amounts and seasonality were crucial in farming decisions.

Rice cultivation saw a tremendous boom in the area over the last decade. The findings showed that most farmers considered maize as the most important crop to meet their food security needs, but cropped area for rice increased by as much as 95% from 2005 to 2014 whereas maize increased only by 30% and yam 17% (Ayivor *et al.*, 2015). This may be the result of what Ofori *et al.* (2015) described as the use of agro-ecological niches to expand the cultivation of rice as an adaptation to climate change.

It may also be in response to a general trend in West Africa where rice is becoming a staple crop as a result of urbanization. Elbehri *et al.* (2013) estimated that in West Africa, urban markets represent a growing marketing outlet for local staple food, with rice constituting about 60% of local staples consumed. Indeed, most of the rice produced in the study area finds its way to Kumasi, the regional capital.

The high percentage of responses for cowpea followed by maize, rice, yam and groundnuts as most vulnerable to excessive rainfall implies that in the cultivation of maize and cowpeas, for instance, farmers who have alternative sites will look for well drained areas to avoid losses. This partly explains why leasehold and share cropping arrangements were so rampant in the area. Similarly, farmers would ensure that the timing of maize and rice cultivation coincided with periods of adequate rainfall to avoid losses.

Thus, despite the vulnerabilities of these crops to extreme weather conditions, their cultivation was very important in meeting food and income needs. This implies that though farmers might have been mindful of the level of vulnerability of crops they cultivated to environmental stressors, this alone did not influence their crop production choices. Other factors such as production capital, personal taste and preferences, market value of the crop and cultural underpinnings guiding the cultivation of certain crops played a significant role in farmers' decisions (Timmer *et al.*, 1983; Fafchamps, 1992; Keleman *et al.,* 2009). The farmer therefore had to weigh the options to determine which crops were best suitable for certain adaptation measures such as a shift in the sequencing of the crop in the season and the adoption of early maturing varieties.

As Omamo (1998) argued, when the production of a crop from which farmers could raise more income is capital intensive, poor peasant farmers who lack access to production credit would prefer crops that are cheaper to produce and which would enhance their consumption needs.

From the foregoing, it is obvious that most of the crop production choices smallholder farmers made were based on 'crop suitability evaluation' through time-tested indigenous traditional knowledge borne out of the ingenuity of the local farmer. According to Gyasi *et al.,* (2004) such knowledge of local conditions can offer a realistic basis for developing a more locally adaptive resource management model in line with the grassroots bottom-up paradigm. However, beyond the suitability evaluation is a combination of factors such as production capital and markets which may compel the farmer to make alternative choices as a trade-off.

Conclusion

Crop production choices constitute one of several important decisions that smallholder farmers with limited resources make as a strategy against biophysical and socio economic constraints. In the forest-savannah transition zone of Ghana, often referred to as 'the bread basket' of the country, tonnes of foodstuffs including cereals, tubers, roots, fruits and pulses are produced for the urban market. Given the fact that most smallholder farmers engage in the cultivation of a wide range of crops in order to spread risks, a good understanding of all the variables that affect the productivity of each crop is vital. The case study of the environs of the Kogyae Strict Nature Reserve, which offers a classical example of conditions in the forest-savannah transition zone of Ghana, revealed that a combination of factors including knowledge of local environmental conditions, length of the rainy period, market forces, dietary habits and crop maturity time dictate crop production choices made by farmers. Farmers, therefore, need a good understanding of the interplay of these factors to guarantee their food and income security needs.

An important revelation was that between food security and income security, the majority of farmers regarded income security as most critical for their crop production choices. They believed that though food security is important, it is not enough to protect them against the vicious cycle of poverty that farmers find themselves in the contemporary exchange economy. Therefore, farmers

adopted new crops that guaranteed their income security in accordance with changing environmental conditions.

One major conclusion, therefore, is that smallholder agriculture has shifted from mere subsistence to a market oriented activity, with most farms operated as small business estates aimed at meeting demands of the exchange economy in which we are. Thus, for most farmers crop production choice is influenced primarily by income security needs. The good thing about this is that as farmers strive to achieve income security through food production, national food security needs are also being addressed.

The study concludes also that, to a large extent, smallholder farmers, regardless of their knowledge and experience, have to operate within constraints imposed by the biophysical environment, income demands and taste, which potentially render crop production vulnerable to unexpected risks. Crop production choices are therefore an effective risk spreading strategy in response to environmental vagaries and socio-economic demands.

The study recommends effective diffusion of innovations introduced by the Crop Research Institute to help farmers overcome productivity constraints. One such innovation is the production of yam along evenly-spaced constructed ridges with planting done one meter apart, instead of the current technique whereby relatively wider-spaced yam mounds are used for planting the crop. Research has shown that this new technique, if adopted, could raise output by 100% at no extra cost (Ayivor *et al*., 2015). Agricultural Extension Agents should be well-resourced to spearhead the adoption of this innovation.

It is recommended also that the cultivation, marketing and consumption of cowpeas be enhanced and promoted by the Ministry of Food and Agriculture, through identifiable farmer-groups in all areas of similar changing climate conditions in the country. The ability of the crop to fix atmospheric nitrogen and its potential to generate income needed by the farmer for reinvestment in the major farming season makes it one of the most appropriate crops for the future in the face of climate change.

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