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Agroecological Niches as Ecosystem-Based Adaptive Option to Environmental Change in the Forest-Savanna Transition Zone of Ghana

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Abstract

Generally, local farmers are able to adapt to environmental change (and developments in socio-economic conditions) by engaging in a range of creative practices of on-farm management, use of improved crop varieties and adoption of new technologies. However in the past few decades, there has been growing interest in other adaptive options with the potential of addressing household food security and the multiple dimensions of sustainable agriculture. This study therefore examined the use of niche environments in the agricultural landscape as ecosystem-based adaptive strategy to environmental change among 102 farmers of 9 fringe communities of the Kogyae Strict Nature Reserve of the forest-savanna transition zone in Ghana. The study noted the increasing shift from maize cultivation to rice production using marshy areas and low-lying parts of farm fields and farms. The farmers mentioned climatic, ecological and other socio-economic reasons for this trend. They cited growing insecurity associated with maize production due to changing rainfall pattern and reduction in rainfall amounts, and changes in land cover and soil conditions. Additionally, they emphasized the relative ease with which they are able to store rice and the willingness of padi buyers to visit the villages in spite of the poor nature of the roads. The study advocated for greater institutional support to boost local rice production in order to reduce the country's heavy dependence on imports.

Keywords: agroecology, ecosystem-based, environment, climate change, ecological niche, socio ecological

1. Introduction

Changing environmental conditions (including climate change) and operation of the dynamic socio-economic systems present a lot of uncertainties to local farmers which have far reaching implications for food availability and household food security. However, many scholars and development practitioners appreciate that local farmers are able to adapt to environmental change (Benhin, 2006; Osman-Elasha, et al, 2006) and developments in socio-economic conditions (Ojiem, de Ridder, Vanlauwe & Giller, 2006). Farmers' adaptive strategies to environmental change do evolve from their intimate engagement with the biophysical environment which makes it possible for them to exploit a wide range of ecosystems and ecological niches to produce food in ways that reduce risks and maintain the local environment (Richards, 1985; Wilken, 1987). In the agricultural landscape, the prevailing biophysical factors (including micro-climatic conditions, soil fertility, soil moisture, topography etc.) and socio-economic variables in operation (such as production objectives, market prices, dietary habits, taste and preferences) do influence farmers' adaptive capacities (Ojiem, et al, 2006). They offer opportunities for and, at the same time, set limits to farmers' adaptation strategies.

Generally, agricultural systems have evolved to suit different ecological zones at the larger scale. Hence, the concepts of agroecological region and agroecological zone, which describe an area with similar climatic, soil and terrain conditions that determine crop production potential and carrying capacity under certain level of inputs and management conditions (Fischer, van Velthuizen, Shah & Nachtergaele, 2002; Williams, Hook, & Hamblin, 2002; IIASA/FAO, 2012). However within the broad agroecological region are unique landscapes with certain biophysical conditions at the micro level which affect the welfare of plant (and animal) species (Ojiem, et al, 2006). Such niche environments or ecological niches are suitable for different agricultural practices in terms of crops grown, management systems and sustainability, hence the concepts of agroecological niche and micro-agroecol ogical niche (Pauw, 2003; Gauchan et al, 2005). Gauchan et al (2005) referred to micro-agroecological niches as "land types" on the farm. They are naturally occurring spatial units in the landscape or on the farm and farm fields considered best places to plant different crops depending on prevailing environmental conditions and farmer's priorities and preferences (Nandwa, Obanyi & Mafongoya, 2011). In this study we recognise agroecological niches as including swamps, river banks and selected patches on farm plots for specialized crop cultivation. Also, we regard culturally enhanced biophysical conditions for crop and/or livestock production such as home or backyard gardens as agroecological niches.

Below, Artner, Siebert and Sieber (2010) have indicated that the impact of environmental change on small holder farmers in developing countries has well been documented just like institutional intervention programmes and creative adaptive practices at the micro and farmer levels. They cite various examples of farmer adaptive practices which include farm management and technical options (eg. combining crop farming with livestock raising), on-farm management (eg. variations in crop varieties), introduction of improved crop varieties and adoption of new technologies. But there is the need for more solutions that have the capacity of addressing household food security whiles dealing with the multiple dimensions of sustainable agriculture (Kremen, Iles & Bacon, 2012).

The International Union of Conservation of Nature (IUCN) emphasizes ecosystem-based adaption (EbA) approaches and strategies as natural responses to environmental change (including climate change) since they have the capacity to increase resilience and reduce people's vulnerability levels (Colls, Ash & Ikkala, 2009). EbA is defined by the Convention on Biological Diversity (CBD) 2nd Ad Hoc Technical Expert Group on Biodiversity and Climate Change as 'the use of biodiversity and ecosystem services to help people adapt to the adverse effects of climate change' (Secretariat of the Convention on Biological Diversity, 2009). EbA includes a range of sustainable management strategies, conservation and restoration of ecosystems which take into account the multiple social, economic and cultural co-benefits for local communities to adapt to the adverse effects of climate change (Colls et al., 2009; Secretariat of the Convention on Biological Diversity, 2009; Convention on Biological Diversity, 2010b).

In recent times there is growing recognition of the potential of EbA practices since healthy ecosystem is able to provide services that people, particularly the rural poor, depend on for their livelihoods (Colls, et al., 2009). For example, Kremen, Iles, and Bacon (2012), maintain that diversified farming systems (DFS) which involve "agroecological principles can contribute to creating a more sustainable, socially just, and secure global food system". Against this background, this study examines how local populations on the fringes of the Kogyae Strict Nature Reserve (KSNR) of the forest-savannah transition zone of Ghana use agroecological niches for food production to support household livelihoods in the face of environmental change.

2. Some Theoretical and Conceptual Considerations

According to Kremen et al., (2012) the term agroecology emerged more than 80 years ago to describe the ecological study of farming systems. The term evolved through history and was guided by major developments such as application of ecological principles to agriculture, the Green Revolution, research interest in indigenous knowledge relating to traditional farming systems, sustainable agriculture and conservation movements (Kremen et al., 2012). Thus, the term agroecology has multiple meanings: it can refer to an inter- or trans-disciplinary science or a set of diversified and sustainable farming systems/practices or political and social movement (Wezel, Bellon, Dore, Francis, Vallod & David, 2009; Kremen et al., 2012; Ernesto Méndez, Bacon & Cohen, 2013; Wibbelmann et al., 2013).

In spite of the lots of food produced under conventional agriculture, it is noted to be associated with many ecological problems. They include pollution from use of chemical fertilisers (nitrogen, phosphorus and nitrates), accelerated soil erosion caused by wind and/or water, pesticides in groundwater and on food, antibiotic-resistant strains of organisms, exposure of farmers to risk of agrochemical use and loss of crop diversity leading to loss of well-balanced diets (Altieri & Nicholls, 2000; Magdoff, 2007; Altieri & Nicholls, 2012). These problems together with others created by ever-increasing urban population and other socio-economic and political forces brought a new awakening as to how agricultural production could be managed sustainably (Dakers, 1992; Ernesto Méndez, Bacon & Cohen, 2013). The Subsidiary Body on Scientific, Technical and Technological Advice of the Convention on Biodiversity defined sustainable agriculture as "the ability of farmland to produce food and other agricultural products to satisfy human needs indefinitely as well as having sustainable impacts on the broader environment", (Convention on Biodiversity, 2010a).

Several concepts have been introduced by experts to highlight the importance of encouraging sustainable agricultural production. They include diversified farming systems (Kremen et. al, 2012), ecological agriculture/farming (Magdoff, 2007) and organic farming (Schugren-Meyer, 2010). These concepts emphasize the complexities of the ecological factors operating at varying scales that underpin agricultural production. Hence, they advocate for the application of ecological principles to agriculture in the sense that farming systems that are ecologically managed and which mimic strong natural ecosystems come without many negative externalities associated with conventional agriculture (Altieri & Nicholls, 2000; Magdoff, 2007).

An ecosystem is "a functional system of complementary relations between living organisms and the environment, delimited by arbitrary chosen boundaries, which in space and time appear to maintain steady yet dynamic equilibrium" (Gliessman, 2007. Pp 23). The living things and non-living things constitute the structure and the interactions among them demonstrate the dynamic relationships and functionality which depend on the flow of energy and matter (Resource Efficient Agricultural Production, 2003; Gliessman, 2007). The ecosystem can be applied to agroecosystem which refers to a site or integrated region of agricultural production such as a farm or a grouping of adjacent farms (Gliessman, 2007). Though based on ecological principles the agroecosystem is different from the natural ecosystem as the former is altered by human use for agricultural purposes (Altieri, 2002). In addition to the natural inputs the agroecosystem receives a range of human inputs and generates a set of outputs. Thus, the agroecosystem has relationship with the surrounding natural and social world; it forms part of the larger food system and has to be managed sustainably in order to contribute to sustainable agriculture. Sustainable agroecosystem management means striving to achieve ecosystem-like status whiles maintaining desired output levels (Gliessman, 2007).

The concepts which emphasize the application of ecological principles to agriculture have become more relevant today in view of growing changes in environmental conditions and demand for organically produced food items. Kremen et. al, (2012) defined diversified farming systems (DFS) as "farming practices and landscapes that intentionally include functional biodiversity at multiple spatial and/or temporal scales in order to maintain ecosystem services that provide critical inputs to agriculture, such as soil fertility, pest and disease control, water use efficiency, and pollination". Magdoff (2007) also used the term ecological agriculture, which he described as similar to agroecology, as involving practices that build the strengths of natural ecosystem or take advantage of the inherent strengths of natural systems to achieve agricultural productivity. The strengths of the natural ecosystem are efficient energy and matter flows, great biological diversity, self-sufficiency, self-regulation and resilience (Magdoff, 2007).

Ojiem et. al (2006) however introduced the concept "socio-ecological niche" which does not only emphasise ecological factors in agricultural production but also socio-economic factors that lead to the adoption of beneficial technologies. They view agricultural production as 'whole systems' involving the interplay and convergence of many ecological factors, as well as social, cultural, political and economic factors which are operating at varying scales. Ojiem et al (2006) further explained that the adoption of technologies by smallholder farmers are influenced by a wide range of biophysical (e.g. climate, soil fertility, etc.) and socio-economic variables (e.g. preferences, prices, production objectives etc.).

The concept of socio-ecological niche (Ojiem et al, 2006) can be represented diagrammatically to highlight the interactions between ecological factors and multiple social-economic factors that influence sustainable agricultural production (Fig. 1). The model suggests a complex set of factors, interactions and mechanism that operate within the national policy environment towards achievement of sustainable agriculture. Thus, the quest for a truly sustainable agriculture is complex. First, it requires deeper understanding of the complexities of the ecological factors that underpin agricultural systems (Altieri, 2004) as well as other socio-economic factors that influence agricultural production (Ojiem et. al 2006). Second, many conditions would have to be created by individuals, as well as, groups, agencies and institutions. In the context of this study and with respect to local farmers, it is imperative for them to adapt to the changing environmental conditions and respond appropriately to socio-economic dynamics in order to guarantee household food security.

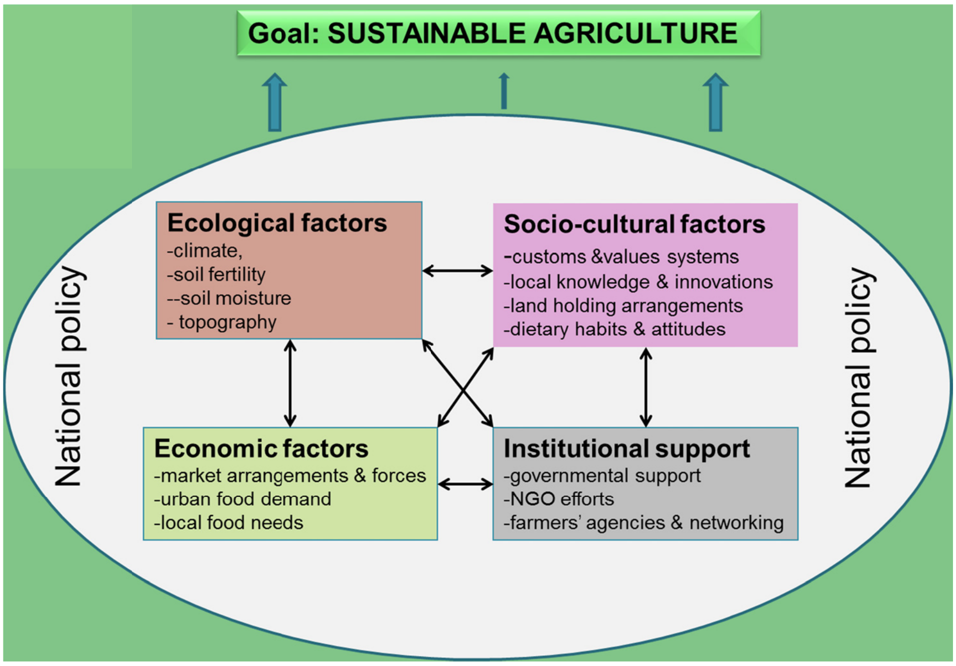

Figure 1. The concept of socio-ecological niche (Adapted from Ojiem et. al, 2006)

According to Kremen et al (2012) agroecological techniques are sites specific and, as a result, the adoption of agroecological principles and practices by local communities is largely achieved through horizontal communication and social networks usually in response to crisis situations. They cite the experience of Cuba following the cessation of agricultural subsidies from the Soviet Union when it collapsed in 1991 (Kremen et al., 2006). In Brazil, the implementation of agroecological principles was more of a movement emanating from concern about environmental deterioration and supported by institutions to promote family farms and food sufficiency among local farmers who were excluded from agricultural modernization (Wezel et al., 2009). The strategy involved participatory approaches based on Brazilian technical assistance and rural extension public policy of sustainable rural development under the ecological manifesto of "the end of future?" (Wezel et al, 2009).

The foregoing suggest that agroecological technologies are farmers' own adaptive innovations developed out of self-experience and/or learnt from colleague farmers but which may be infused with conventional knowledge and techniques derived from institutions. Institutional support is important in building farmers' adaptive capacities. According to Frank and Buckley (2012) for example, effective institutions are critical in ensuring that successful innovations are shared more widely since not all of them will be good innovators. Schugre-Meyer (2010) has also emphasized interdisciplinary collaboration between researchers, growers, consumers and other stakeholders in order to promote agroecological principles. From another perspective, Ernesto Méndez et al (2013) argue for a transformative agroecology which, according to them, goes beyond the farm-scale "to consider the broader forces—such as market and government institutions—that undermine farmers' cultural practices, economic self-sufficiency, and the ecological resource base".

3. The Setting and Methodology

3.1 Study Area

The study area covers the fringe communities of the (Kogyae-SNR) in the north eastern part of the Ashanti Region which falls within the forest-savannah transtion zone of Ghana (Fig 2). The reserve covers an area of 33,618 ha. It was created in 1952 by the colonial Gold Coast government as a bush forest reserve but in 1962, it was earmarked as a SNR by the Ghana Government under the Wildlife Reserves Regulations of 1971 (L.I. 710). The reserve is to preserve the natural vegetation and animal life and to check the southward extension of the savannah (Hagan, 1998). The reserve lies within the forest-savannah transitional agro-ecological zone which forms part of the middle belt of the country. The forest-savannah transtion zone forms part of the middle belt geographical region which is generally rural and characterized by low population densities, low levels of literacy, limited access to health and educational facilities, and many places lacking motorable roads (Dickson & Benneh, 1995; Ghana Statistical Service, 2000). Over the decades however, the middle belt has attracted migrant farmers from other ethnic groups in the northern part of the country including the Konkombas, Dagaris, Frafras and Gouronsi (Tonah, 2001). The region is noted for the production of a variety of basic food staples including yam, maize, cow peas, groundnuts cassava, millet and guinea corn (Dickson & Benneh, 1995; Titriku, 1999; Ofori, Nukpezah, Ayivor, Lawson, & Gordon, 2014).

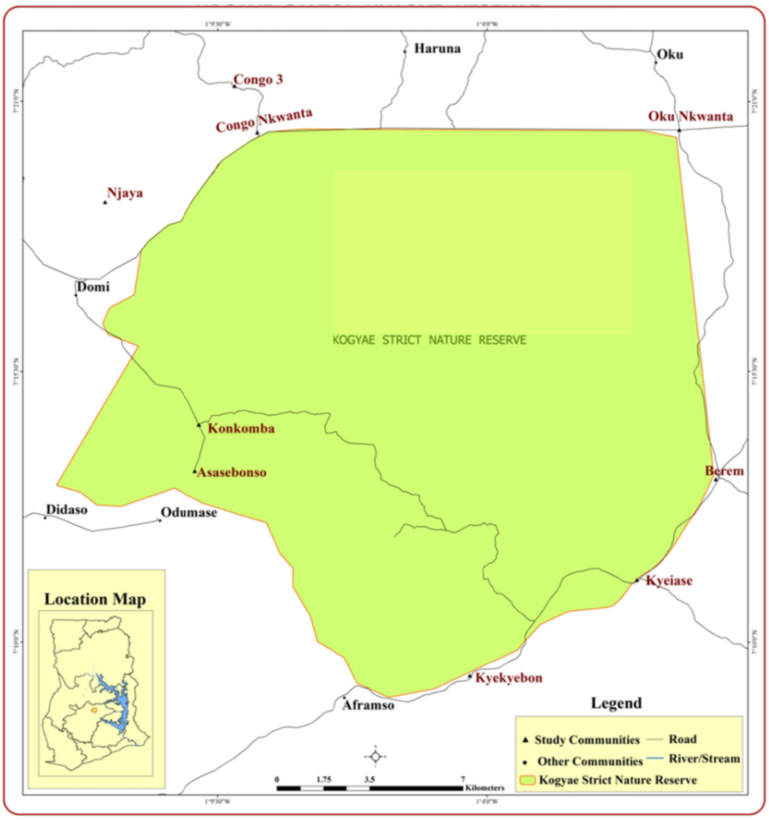

Figure 2. Map of study Area, fringe communities of the Kogyae Strict Nature Reserve

Decades of rotational bush fallowing, permanent field cultivation involving tractor plough, extraction of trees for woodfuel and commercial charcoal production, annual bush fires and sub-normal rainfall have contributed to changing environmental conditions in the region with adverse consequence on crop productivity. Observed changes in environmental conditions in the region are reduction in tree stocks, vegetative cover, and species diversity (Amanor & Pabi, 2007; Attua & Pabi, 2013) and declining trends in rainfall, occasional droughts and longer dry season (Minia 2004; Cudjoe & Owusu, 2011; Owusu & Waylen, 2012; Klutse, et al., 2013; Nkrumah, et al., 2014).

For example, Owusu and Waylen (2009) noted that between 1950 and 2000, rainfall totals for Ejura (the nearest agro-meteorological station to KSNR) dropped from 1800mm to about 1600mm. These changes have the potential of adversely effecting crop productivity and food availability among local farmers particularly maize producers (Fosu-Mensah, 2013; Klutse et al, 2013).

3.2 Methodology

The study focused on farmers in 9 communities whose farming practices utilize agroecological niches. Two (2) of the communities, Konkomba Village and Asasebonso, were within the special use zone of the reserve, whereas 7 (Oku Nkwanta, Congo Nkwanta, Congo No.3, Njaya, Berem, Kyeasi and Kekyebon) are on the fringes of the reserve (Fig. 1). The farmers were identified during focus group discussions (FGD) with cross section of members of the individual communities. During the discussions the community members understood agroecological niches as swamps, river banks and land parcels or patches on farm plots which are, in recent times, being cultivated with crops different from what they regard as known and common traditional crops.

The FGD centred on general farming practices, changes in environmental conditions and other issues affecting their farming activities. Farmers using agroecological niches were targeted for one-on-one interview using structured and open-ended questionnaires. Information gathered included, farming history, crop(s) grown, general husbandary and innovative practices, ownership and access to farm plots, productivity levels, benefits from farm, and sustainability of such farms. In all, a total of 102 farmers were interviewed.

Officials of agricultural institutions, including the Crop Research Institute of the Council for Scientific and Industrial Research (CRI-CSIR) at Ejura and the Sekyere Central District Directorate of the Ministry of Food and Agriculture (MOFA) were also consulted and interviewed for information on changing biophysical conditions, particularly, rainfall pattern and agricultural activities in the study area. Visits to some of the farming plots were also undertaken for on-the-spot observation of the field conditions, for example, farm size, terrain characteristics and common plants.

4. Results and Discussion

This section presents the findings and discussions of the study. It begins with views of the members of the study communities on conditions of the environment that support their farming activities, dwells on common farming systems and practices, and elaborates on home gardens and use of ecological niches for rice farming.

4.1 Farmers' Perception of Environmental Conditions

The attempt was made during focus group discussions to capture the views of the community members on conditions of the environment as they shared their experiences. They emphasized that decreased rainfall amounts in the area and rainfall variability is adversely affecting crop productivity. At Kyekyebon for example, it was revealed that a popular indicator of the on-set of continuous rains was the two weeks dry spell that followed the first 2-3 rains in early April. The dry spell, locally referred to as "asadwerewa owia", would alert farmers to quickly complete land preparation for planting to begin in late April and early May. The "asadwerewa" is a woody plant, *Bridelia sp.,* that bares berry-like edible fruit during the short dry period, and "owia" means sun or sunlight. Thus, the farmers associate the dry spell with the fruiting of the plant. They further indicated that, in recent decades there is usually delayed rainfall and no distinct brake between the normal growing period of April–June for maize and the harvesting period of July-August. They also mentioned that the rainfall could be torrential and excessive which adversely affect maize output.

The above observations by the farmers pertaining to rainfall and atmospheric conditions were corroborated by the officers of CRI-CSIR and MOFA during interview with them. The MOFA officer in-charge of the agro-meteorological station at Ejura indicated that over the past decade the onset of the rain that previously occurred between late February/early March and late March/early April and the dry spell that follows has shifted to April and May respectively. The officers indicated that before the late 1990s and early 2000s the early rains would continue and support maize such that it could withstand the dry spell in the second and third weeks of May, but this is no longer the case. According to them the dry spell experienced in 2008 and 2009 took a heavy toll on maize productivity the crops withered. Therefore, the common practice now is for farmers to plant cowpea immediately after the first few rains till May when they are assured of continuous and reliable rainfall before planting maize.

With respect to land cover the community members cited reduction in the density of vegetative cover and tree stocks which they attributed to bush clearance and continuous farming, extraction of wood for fuel and commercial charcoal burning, and bush fires. At Berem for example they explained that, *"grasses have taken over the land due to removal of trees for wood-fuel and continuous ploughing of the land with tractor for maize cultivation. The soils easily get saturated with water and are suitable for rice cultivation"*.

The observations by the farmers with respect to rainfall and atmospheric conditions, and vegetative cover, are in line with the findings of Minia et al (2004), Amanor & Pabi, (2007), Owusu & Waylen (2009), Cudjoe & Owusu (2011), Attua & Pabi (2013), Owusu & Waylen (2012), Klutse, et al (2013) and Nkrumah, et al (2014), which have been cited above.

In all the communities the farmers lamented on the insecurity associated with maize cultivation as a result of unpredictable and delayed rainfall during April. Out of the 102 farmers interviewed, 84 of them, representing 82.4% mentioned maize as the crop that is most sensitive to drought conditions.

4.2 Common Farming Systems and Practices

As already pointed out, the study area is noted for the production of major food staples including maize, yam, cassava, cow peas and groundnuts. Eighty eight (88), representing 86.3% of the 102 farmers interviewed, indicated they grow these crops both as cash and food crops. Yam is mainly grown under the traditional rotational bush following system involving slashing of the vegetation with the machete (cutlass) and burning. Yam mounds are raised with the hoe and may be intercropped with other crops such as cassava, maize and/or cowpeas. According to the officer in-charge of CRI-CSIR, the average yield per acre is 2000 tubers, but field trials of the ridge method of raising yam mounds (at 1 meter interval) produces 4000 tubers. The ridge technique involves the use of poles and ropes along which the yam vines grow on permanent fields. The officer indicated that this technique is gradually being adopted mainly by commercial yam growers.

The other popular crops mentioned in the preceding paragraph are grown mostly on permanent fields which are usually ploughed with the tractor. As in other major food crop producing areas of the country, there is widespread use of agrochemicals, particularly weedicides and herbicides, which aid land preparation and weed control. Only 1 out of the 102 farmers indicated not using weedicide/herbicide. Fertilizer application was common among maize farmers with 43 (68%) out of the 63 farmers using fertilizer on their farms. Farms with plantain and oil palm are encountered in the communities south of the reserve where the vegetation is more of forest. But these are few in view of the restrictions imposed by management of the reserve. Food crops can however be grown in the portions of the reserve earmarked as “special use zone”. The residents of these communities complained about limited access to land as a result of the creation of the reserve and re-echoed non-payment of compensation to the rightful landowners. As in most parts of the country land ownership is communal but non-members of the land owing group can have access to land through certain arrangements. Seventy one (71) out of the 102 farmers interviewed accessed their farmlands through leasehold and sharecropping arrangements as against 30 who had the right of use by belonging to the land owing group and through inheritance. There was only one case of outright land purchase.

4.3 Niche Farming

The use of swampy areas, river banks and selected patches on farm plots for specialized crop cultivation and culturally enhanced home gardens are understood as agroecological niche farming. Such farms are considered unique and different in the agricultural landscape.

4.3.1 Home Garden

With the exception of plantains, bananas and oil palm trees growing at the backyards of some houses in the communities, there was no well-kept and agro-diversed home garden. This is primarily due to the presence of livestock, mainly goats and pigs, which are kept by households which ravage crops. Stray animals have been a major potential source of conflict among residents in some of the communities with community leaders and the local government being less proactive in dealing with the issue (Ofori, et al, 2014).

4.3.2 Rice Cultivation

The use of swampy areas, river banks and low-lying areas of farm plots for rice cultivation was popular and common in all the communities. In an interview with the district Director of MOFA he indicated that rice cultivation has emerged as an important activity in the KSNR catchment and many communities in this part of the forest-savannah transitional zone. During the focus group discussions in the communities the participants mentioned that rice production is quite recent, dating back not more than ten (10) years, though there were cases of limited number of farmers planting rice in pockets on their farms before the mid-2000s.

The discussants mentioned that earlier efforts at rice cultivation were associated with the predominantly migrant settlers mostly in the communities north of the reserve. Thus, framers from the northern part of the country have a longer history of rice production. However rice production is now undertaken by both migrant settler farmers and Asante indigenes. Out of the 102 farmers interviewed, 78 (representing 87%) have been growing rice for not more than 8 years. In all, 72, representing 71.3% of the farmers interviewed, have lived in their respective villages for not more than 30 years which is indicative of significant representation of migrant farmers. Sixty four (64) of them were males and 38 were females.

At Berem in the south, farmers attributed increased rice production mainly to changes in vegetative cover and conditions of the soil which easily get saturated with water and making it suitable for rice cultivation. In the other communities, farmers explained that rice production has become attractive to them because of the unpredictable nature of the rainfall pattern and the increased risk of crop failure associated with maize production. The farmers said the following to explain the increasing shift onto rice production: “*the marshlands and low-lying areas which are saturated with water are ideal for rice production. By late July and early August which is the time for planting rice, there is adequate moisture in the soil which is further boosted by the second peak of the rainfall season, September-October, for the rice to flower and bear fruit.”* They also explained it is relatively convenient to store paddy and emphasized that, in spite of the poor nature of the roads, buyers come to the village level for the produce and they find the price they offer attractive. The MOFA Director also explained that maize farmers in this remote part of his area of operation are confronted with the difficulty of securing tractor plough services and therefore lean more towards rice production which does not require ploughing.

Five (5) varieties of rice are grown in the study area. They are locally described as: *Mr. More, Lapez, Tugyeme, Asante Buroni (Brown rice) and Aflao*. The characteristics of the rice varieties as provided by the farmers are indicated in Table 2. All the five varieties are cultivated by farmers of communities in the south whereas only two, *Mr. More* and *Lapez,* are gown in the northern communities. The most popular ones are *Lapez* and *Aflao* as they enjoy higher patronage from paddy buyers. The variety that is cultivated by the farmer is also influenced by the taste, and the most preferred variety the *Lapez.* Elsewhere in the district, *Mr. Hare* and *Guama* varieties are also grown.

Table 1. Characteristics of varieties of rice gown in study area

Variety	Gestation period (months)	Matured flower	Matured Stalk	Yield (sacks /acre)	Grain	Starch content	Ranked preference (taste & demand)
Mr. More	4	Yellowish brown (fresh flower is dark)	Tall, stocky (chest level)	13-15	Long, creamy & scented (perfumed)	Low (loose)	4
Lapez	3	Yellowish (fresh flower emits sweet scent)	Knee level, thin stalk	11-13	Long & whitish	High (sticky)	1
Tugyeme	3.5	Brownish	Knee level, thick stalk	11-15	Small, roundish & whitish	High (sticky)	5
Asante Buroni	3.5	Brownish	Tall, stocky (stomach level)	9-11	Long, lager & brownish	High (sticky)	2
Aflao	3	Yellowish	Tall, stocky (chest level)	9-11	Long, larger & whitish	High (sticky)	3

In the northern communities rice is cultivated mainly in marshy areas and along stream channels. Farmers in the southern communities also utilize such niche environments, as well as, portions of the farm plots which are relative low lying and get saturated with water. The latter case can be described as ensuring agrodiversity within farms through selective use of micro variations in biophysical conditions; a form of EbA. The farmers acknowledged that farming along the river channels and in the marshlands induces evaporation and the drying up of streams. But they were quick to mention that with the changes in conditions of the environment and under their socio-economic circumstances this is how they are able to cope with the situation.

Farm sizes in the south are relatively bigger than what is encountered in the communities in the north. The average farm size in the northern communities which are dominated by migrants is 1.63acres compared to 4.17acres in the south. Likewise women farmers in the indigene southern communities have larger farms, averaging 4.37, than their counterparts in the north with an average of 1.2. The largest farm size of 15 acres was owned by a woman at Kyeiase. This suggests that the women in the southern communities are better resourced.

Table 2. Sizes of rice farms in communities of KSNR

Location	Community	Range of farm size (acres)	Average farm size (acres)	Average farm size by location (acres)
North	Njaya,	1 - 3.5	1.10	1.63
	Congo No.3,	1- 5	2.75	
	Congo Nkwanta	2 - 3	1.40	
	Oku Nkwanta	2 - 3	1.25	
South	Konkomba	1 - 3	1.69	4.17
	Asasebonso	3 - 7	2.58	
	Kyeiase	2 - 15	5.89	
	Kekyebon	1 - 7	2.72	
	Berem	2 - 10	5.51	

All the farmers interviewed use weedicides on their farm plots, at least to prepare the land for planting. Sixty five (65), that is 64% of them, however apply fertiliser. The rest explained that they find it difficult buying fertiliser. On the whole, the farmers expressed concern about the cost of agrochemicals and the poor nature of the roads linking their villages to Ejura, a central market, and other market centres.

As in other parts of the country the Agricultural Directorate of the Sekyere Central District Directorate of the Ministry on Food and Agriculture is mandated to provide support for the farmers. During discussions with the director of the unit he emphasised the growing importance of rice cultivation in the communities. He indicated that the unit collaborates with the CRI-CSIR (in Ejura) and other district directorates of agriculture in information sharing that benefits the farmers. This covers rainfall pattern, use of agrochemicals, adaptive and high yielding crop varieties and other agronomic practices.

5. Conclusion

This study examined how local farmers in communities on the fringes of the KSNR utilise agroecological niches for agricultural production in the face of changing environmental conditions. The study noted that farmers are reducing their levels of dependence on maize by adopting the use of marshlands and taking advantage of low-lying patches on farm fields and farms to grow rice for household livelihood support. This development is in response to increased risk of crop failure associated with maize production as a result of unpredictable rainfall pattern and changes in vegetative cover of the land and soil conditions. The trend is viewed as a form of EbA and community-based adaptation (CbA) to changing environmental conditions. But, it is not just the changes in the environmental factors that are influencing the decision of the farmers. The relatively good storage properties of padi and the readiness of potential buyers to visit the communities and buy directly from the farmers, in spite of the poor roads, have also contributed to the trends in the farming practices of the communities. Thus, agroecological systems are part of the whole agricultural production system or socio-ecological niche which is always changing under the influence of the ecological resource base, as well as, social, cultural, political and economic forces. A key recommendation is the need for greater institutional support to boost rice production so as to help reduce the dependence of the country on rice imports which stood at 442,469 MT ($262.8m) in 2009, representing about 70% of national consumption (Amanor - Boadu, 2012).

Acknowledgments

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