

Land tenure and differential soil fertility management practices among native and migrant farmers in Wenchi, Ghana: implications for interdisciplinary action research

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Abstract

In the past, farmers in the forest-savannah transitional agro-ecological zone of Ghana relied on the bush fallow system for maintaining the productivity of their farmland. However, in recent years population growth-induced pressure on land has increased and farmers have developed various other strategies for improving the productivity of their farmlands. Such strategies have been identified in the context of an interdisciplinary action research project and include rotations with cassava (*Manihot esculenta*), pigeon pea (*Cajanus cajan*) and cowpea (*Vigna unguiculata*). Using a social science model for understanding technical farming practices, this article explains the differential adoption of these locally developed soil fertility management strategies. It transpires that native and migrant communities are captured in a social dilemma situation, which has negative consequences for soil fertility in that promising innovations are not utilized optimally. Based on this research experience, this article concludes with a discussion of the implications for co-operation between natural and social scientists in the context of interactive action research. It is argued, amongst other things, that the essence of such co-operation lies in the critical questioning and influencing of each other's key assumptions and disciplinary research agendas.

Additional keywords: bush fallow, cowpea, pigeon pea, cassava, maize

Introduction

The forest-savannah transitional agro-ecological zone of Ghana has a great potential for the production of staple crops, particularly maize and yam. However, the production of these crops appears to be hampered by a low soil organic matter content, which subsequently leads to poor soil moisture relations and to low soil phosphorus (P) and nitrogen (N) contents.

In the past, resource-poor farmers growing food crops in the transitional zone of Ghana relied on the extensive bush fallow system for maintaining the productivity of their farmlands (Nye & Stephens, 1962). This system allowed P and N (the most limiting nutrients) to be restored. However, population growth-induced scarcity of suitable farmland has led to the shortening of the fallow period. A study carried out on the cowpea (*Vigna unguiculata*) production system in the forest-savannah transitional agro-ecological zone in Wenchi District revealed that soil fertility decline is of critical concern to the farmers in this zone (Offei & Sakyi-Dawson, 2002). The study showed that one way by which farmers in this area attempt to regenerate the fertility of their farmland is to crop the land to cassava (*Manihot esculenta*) for 18 to 24 months after which period the land – according to farmers – is rejuvenated. However, this assertion is dramatically opposite to the common belief that cassava has a high demand for plant nutrients. Research data quoted by De Geus (1973) indicate that for a tuber yield of 40 tons ha⁻¹, 85–90 kg N; 27–29 kg P and 232–260 kg K are removed from the soil. Thus in Ghana, where the average cassava tuber yield is estimated at 12.7 tons ha⁻¹ (Anon., 2004), about 27–29 kg N; 8–9 kg P and 74–83 kg K can be removed from the soil. Howeler (2002) concludes that the idea that cassava is a ‘scavenger’ crop, efficient in nutrient capture and removal, results from the ability of cassava to grow in depleted and degraded soils where other crops fail. He further demonstrates that cassava removes less N and P than most crops per ton of dry product and a similar amount of K. In addition to cassava, other strategies used by farmers in the regeneration of their soils include the use of legumes such as cowpea and pigeon pea (*Cajanus cajan*) in their crop rotation systems. Pigeon pea is usually cropped to the land over a period of time ranging from 12 to 24 months after which the fertility of the soil is believed to be restored, using earthworm casts as indicator for soil fertility.

This article does not seek to test or explain the bio-physical merits, dynamics and efficacy of these farmer-developed strategies but aims at further exploring farmers’ soil fertility management practices and their relevant social context, with the purpose of grounding future action research in the needs of the local farming community.

In this article, innovations and technologies are regarded as consisting of both technical and socio-organizational arrangements and practices. The technical dimension refers to biotic and abiotic factors and practices such as crop varieties, machinery and rotations while the socio-organizational dimensions may involve financial, labour, tenure, knowledge and/or marketing arrangements. These two dimensions are interrelated since both provide the necessary space and conditions for the adoption and diffusion of a particular technology. Thus, one can only speak of a ‘complete’ technology if there is an appropriate mix and balance between technical devices and socio-organizational arrangements. Starting from these premises, this article seeks to understand the

social dimensions of the farmer-developed soil fertility management practices. First, it is shown that despite the fact that most farmers believe in the positive effects of using cassava and pigeon pea rotations for purposes of soil fertility regeneration, these practices are performed by only a section of the farming community. Subsequently, the underlying logic and dynamics of this differential application are explained with the help of Leeuwis and Van Den Ban's model for understanding the social nature of technical farming practices (Leeuwis & Van Den Ban, 2004). We then proceed with a discussion of the implications of these findings for the ongoing action research. Finally, we conclude with a reflection on the broader lessons that can be drawn with respect to interdisciplinary co-operation between natural and social scientists in the context of interactive action research trajectories. Before embarking on this trajectory, however, we first need to further introduce the research methods and approaches applied in it.

Materials and methods

Study area and population

The study was carried out in Asuoano (7°35' N, 2°05' W), a farming community in Wenchi District, Brong-Ahafo region, Ghana. This area falls within the forest-savannah transitional agro-ecological zone of Ghana. The soils in the area, which developed on Voltaian sandstones, are mainly Lixisols (Asiama *et al.*, 2000). These well-drained, friable and porous soils are sandy loams. Nutrients are concentrated in the topsoil organic matter and the soil mineral matter has little capacity to supply or retain nutrients (Adjei-Nsiah, 2002). The rainy season is from April to October with a short dry spell in August. The average annual rainfall is 1271 mm with an average number of 107 rainy days. While the total amount of rainfall seems to decrease slightly over the past 20 years, the total number of rainy days seems to increase slightly over the same period.

The village of Asuoano is about 23 km away from Techiman along the Techiman-Wenchi road. The village is strategically located due to its closeness to Techiman, one of the most important marketing centres in the West Africa sub-region. It has a population of about 760 people and a farmer population of about 270, of which some 25% are migrants. The community is made up of two groups of people: the natives, who are Akans, and the migrant farmers who mainly came from the Upper west region of Ghana. The migrant farmers consist of three ethnic groups: the Lobis, Walas and Dagabas. As a result of unfavourable climatic and soil resources in the Upper west region of Ghana (which is part of the Sudan Savannah agro-ecological zone) they migrated to the forest-savannah transitional agro-ecological zone where climatic and soil resources are more favourable for food production. There are two groups of migrants: those who settle permanently to farm either by renting land or through share cropping and those who migrate annually from the Upper west region to work as farm labourers during the month of January and return in June.

Research approach and methods

The study area was selected after an initial exploratory project study carried out according to the idea and principles of 'technography' (which according to Richards (2001) is an attempt to map the actors, processes and client groups in a technological landscape in such a way that analysts can see beyond the technology itself the problems technological applications are supposed to solve, and to understand what parties and interests are being mobilized in arriving at solutions) revealed the existence of local soil fertility management strategies, some of which seemed to contradict with dominant scientific beliefs (Offei & Sakyi-Dawson, 2002). The key researcher (who is the first author) was first introduced to the community by the Agricultural Extension Agent working in the study area. The first meeting offered the researcher the opportunity to introduce himself to the community and to carefully explain his objectives and proposed ways of working in both the diagnostic and subsequent stages of the action research project (Röling *et al.*, 2004). In doing so, the researcher emphasized that he regarded farmers as experts on the local farming system and that he had come to learn from farmers' knowledge and experience with regard to soil fertility, and engage in further collaboration to jointly enhance insights on that matter after an initial diagnostic study.

Subsequently, several community meetings and group discussions were held to further discuss farmers' perceptions and viewpoints about soil fertility management, as well as more general issues like climate, farming system, land tenure and production constraints. Later on, smaller groups were formed who worked on various diagnostic tools such as drawing of a community territory map (to identify the differences in soil fertility patterns), a transect walk (to reveal the diversity of the landscape) and analysis of soil fertility management strategies. The groups were formed by the community members themselves. The bigger groups divided themselves into smaller groups based on their knowledge and experiences about the community territory, community organizations and soil fertility management strategies. Membership of each group comprised both men and women. Group discussions (10–40 people) were held in the village centre and/or on farmers' fields. Farmers expressed their ideas by drawing farm maps, pie charts and seasonal calendars and by ranking and scoring.

In addition, two sets of individual interviews were conducted. In the first interview, which involved 40 farmers, the selection of farmers was done by means of stratified sampling. A list of farmers in the village was obtained from the village committee secretary and every tenth name from the list was selected for individual interviewing. The second interview, which involved 38 farmers, was conducted later to look at the farming characteristics of the various sub-communities in the village using a wealth ranking exercise. For this interview 6–10 persons were selected from each wealth category within each sub-community. The first interview was used to collect qualitative data whereas the second interview was used to collect quantitative data.

The individual interviews were semi-structured in nature and served both to get more quantitative data on farm size, household composition and the farming system, and to obtain a better qualitative understanding of the soil fertility management strategies and their underlying rationale. To this end, part of the interviews was more open and informal in nature. In the emerging dialogue and discussions, however, the vari-

ables of the Leeuwis and Van Den Ban's model for understanding farmers' practices served as an inspiration for further probing into the matters raised by farmers (Leeuwis & Van Den Ban, 2004).

It must be noted that both group meetings and interviews served not only to 'collect information', but also to create a conducive environment for further co-operation on joint experimentation on soil fertility management strategies with the various sub-communities. Attention was therefore paid to building trust and reaching agreements about issues like goals, role divisions, joint activities and agendas for experimentation.

Results

Land tenure and cropping system

Traditionally, ownership of land in the community is based on kinship, but vested in the traditional authority in the area which in this case is the chief of Wenchi. Presently various types of land tenure arrangements were encountered in the community. These include family land inherited through maternal lineage, family land inherited through paternal lineage, spouse's family land, rented or leased land, share cropping (a con-

Table 1. Land tenure arrangements among, and most important food crops grown by native and migrant farmers at Asuano in 2002.

	Native farmers (n = 22)	Migrant farmers (n = 16)
	----- (%) -----	-----
<i>Land tenure arrangements</i>		
Family land inherited via maternal lineage	68	0
Family land inherited via paternal lineage	36	0
Spouse's family land	27	0
Hired land	23	50
Taungya	9	25
Personally owned land	5	0
Share cropping	0	25
<i>Most important food crops</i>		
Maize	100	100
Cassava	100	88
Yam	100	94
Cocoyam	91	19
Pigeon pea	42	6
Plantain	32	0
Cowpea	23	44
Groundnut	13	14

tract arrangement between tenant and landlord over access to land for the cultivation of food crops), taungya (a system where the Forestry Services division of the Forestry Commission of Ghana gives out land to farmers to grow their food crops and in turn plant trees for the commission) and personally owned land. Apart from the chief of Wenchi no individual or family has the right to sell land or lease land on a long-term basis to any investor. However, land can be leased or rented to tenants or used for share cropping. Land can be leased for a definite period usually ranging from one to three years but occasionally five years, depending on the vegetation type and the financial need of the landowner. As transpires from Table 1, the current land tenure system implies that unlike the natives, the migrants who settle permanently cannot own land, but depend on other arrangements such as the renting of land, share cropping and taungya. It is worth mentioning that the percentage in most columns of Table 1 add up to more than 100% because there is more than one way in which an individual household can appropriate land for farming.

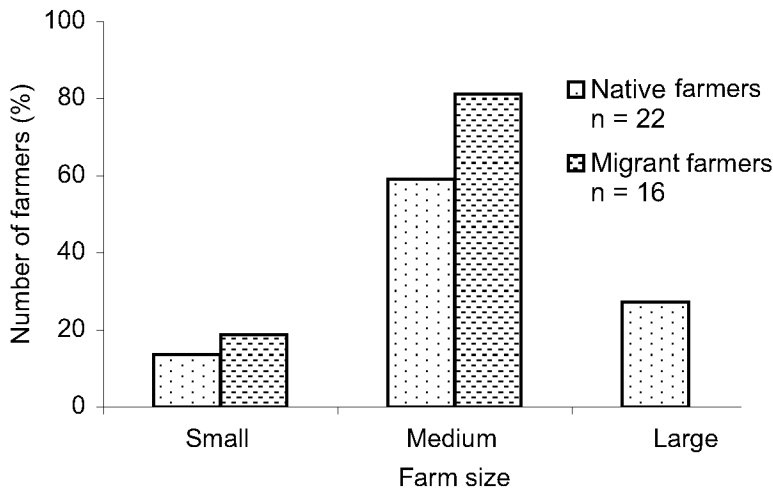


Figure 1. Distribution of farm size among native and migrant farmers at Asuoano. Small: 0–1 ha; medium: 1.1–3.5 ha; large: > 3.5 ha.

About 68% of the farmers at Asuoano have total farm sizes ranging between 1.1 and 3.5 ha (Figure 1). The distribution of farm size categories differs among the native and migrant farmers. While about 27% of the native farmers have farm sizes greater than 3.5 ha, none of the migrants has a farm larger than 3.5 ha due to the relatively high amount of money they have to pay for renting 1 ha of land.

An indication of the main food crops grown by farmers is given in Table 1. In terms of magnitude, maize is the most important cash crop. Among both the natives and the migrants, maize has the largest plot size of 1.6 and 1.2 ha, respectively (Figure 2).

Natives and migrants differ mainly with respect to the cultivation of longer duration crops such as plantain, pigeon pea and cocoyam. For cassava, which also stays on

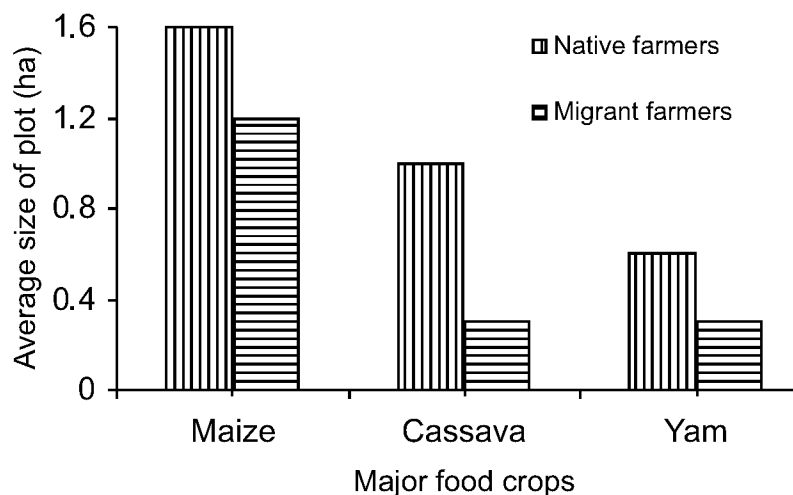


Figure 2. Land areas (ha) allocated to the major food crops at Asuoano.

Table 2. Proportion of land allocated to the leguminous crops grown by native and migrant farmers at Asuoano in 2002.

Leguminous crop	Native farmers	Migrant farmers
	----- (%) -----	
Pigeon pea	50	0
Groundnut	20	35
Cowpea	10	50
White kidney bean	10	0
Bambara groundnut	5	15
Mucuna	2	0
Other	3	0

the land for a longer period, the average acreage for natives is about 1 ha, while it is only 0.3 ha for migrants. This is closely related to social dynamics around land tenure.

Legumes form an important component in the farming system at Asuoano. Whereas the native farmers grow about seven different kinds of legumes, the migrant farmers grow only three different kinds of legumes (Table 2). Among the legumes cultivated by the natives, pigeon pea is grown on a larger scale in comparison with other crops because of its ability to regenerate soil fertility, its low production cost, its tolerance to pests and diseases, its cash income and its food value. It is generally grown on less fertile land and land with problematic weeds such as spear grass (*Imperata cylindrica*). About half of the land allocated to legumes by the migrant farmers is cropped to cowpea. Cowpea is usually grown in rotation with maize to improve the soil.

Farmers' views on the causes of soil fertility decline

Farmers use several terms to express the fertility status of a soil, whereby the terminology differs from one ethnic group to another (Table 3). For instance, among the Akans and the Walas, loss in fertility means that the soil is tired and therefore must be allowed to rest under bush fallow to regain its lost energy. Farmers use various indicators such as colour, water-holding capacity and soil texture to assess soil fertility. A black soil is considered fertile while gravelly and sandy soils are considered less fertile. Other indicators include the presence of earthworm casts (called earthworm faeces by farmers), growth of crops and weeds, a decline in crop yield and the emergence of certain plant species. For instance, the presence of weeds like *Chromolaena odorata* and elephant grass (*Pennisetum purpureum*) indicate a fertile soil while the presence of weeds like spear grass indicates a less fertile land. Farmers indicated that elephant grass and *Chromolaena odorata* provide shade and a moist environment for the activities of earthworms, which improve soil fertility.

Table 3. Terminology for soil fertility, used by farmers from different ethnic groups at Asuano.

Ethnic group	Soil fertility status	Farmers' terminology	
		Local language	Literal translation
Akans	High	Asaase a sraade wo mum	Land with plenty of fat
	Low	Asaase no abre	The land is tired
Dagabas	High	Tengban numo	The land is sweet
	Low	Anua yina	The sweetness of the land is finished
Walas	High	Koole kpenge	The land is strong
	Low	Koole yinge	The land is tired

Farmers pointed out five major factors as responsible for the decline in soil fertility: (1) the increasing population has led to smaller farms, which has resulted in the continuous cropping of the same piece of land, (2) the annual bush fires destroy the vegetation and the population of earthworms that improve the fertility of the land, (3) the felling of trees has exposed the land to the direct action of the sun, which causes the drying of the land, (4) the continuous cropping of only one crop on the same piece of land without rotating it with other crops as a major factor responsible for fertility decline, and (5) the rapid increase in the monetary value of land as a factor contributing to rapid decline in soil fertility. This monetary value is increased, on the one hand, by the circumstance that families owning land have become more interested in cash along with the greater role of money in the economy at large, and on the other hand by the increasing scarcity of land in view of population increase and migration of farmers from the Upper west region. For instance, people need money to pay for

emergency expenditures such as medical bills, funeral expenses, court cases and shelter. Farmers argue that in the older days land had no monetary value and therefore was being given out for share cropping. Hence, landlords could dictate what crop the tenant should grow and also how the land should be managed. However, nowadays landlords have begun renting land to tenant farmers for money. With land now being paid for, landlords can no longer dictate to farmers what type of crops they should grow. In order to maximize profits, tenant farmers began intensive cultivation of the land without sufficient soil fertility restoration measures.

Indigenous soil fertility management strategies and their use

Farmers mentioned bush fallowing, cassava rotations, planting of leguminous crops such as groundnut, cowpea and pigeon pea as practices that constitute good soil fertility management. Other good soil fertility management practices include crop rotations and construction of ridges and mounds. Farmers are of the view that inorganic fertilizers improve the yield of crops but do not improve the soil and therefore cannot be considered as an effective soil fertility management strategy. About 35% of the farmers use inorganic fertilizers (provided on credit by the Food Crops Project of the Ministry of Food and Agriculture) mainly on maize. Farmers cite high cost and risk of crop failure due to the unreliability of rainfall as the reasons for not using inorganic fertilizers. However, farmers were of the view that if they are provided with inorganic fertilizers on credit they would use them. While the farmers consider the use of animal manure as an effective soil fertility management strategy because of its long-term effect on the productivity of the soil, they conceded that they have not been using it because of its unavailability in the community.

Crop rotation in general

The farmers are of the opinion that different crops feed from different depths and on different foods in the soil. So when they rotate different crops on the same soil the yields of their crops do not go down.

Rotation with cassava

Farmers crop a piece of land for 3–4 years to maize and cowpea in rotations and when they observe decline in soil fertility, they crop the land to cassava for 18–24 months after which they resume their maize/cowpea rotation again. Farmers plant a particular variety called 'Boakentemma', which literally means 'able to yield a basketful of tubers'. Farmers claim they prefer this variety owing to its high yielding, its high litter fall as well as its ability to form a closed canopy early.

The farmers believe that if maize is grown after cassava, the maize grows faster, looks greener and yields more due to decomposition of cassava foliage and pieces of tubers that are left in the soil after the cassava harvest. They also mentioned that the roots of cassava are able to penetrate deep into the soil and bring nutrients from the subsoil to the soil surface through litter fall. Farmers also explained that the cassava canopy as well as the litter protect the soil from the direct action of the sun, increase water infiltration and enhance the earthworm population in the soil. The farmers

attributed this beneficial role of cassava to the fact that the variety of cassava they grow is the spreading type that forms a closed canopy and completely shades the soil from the direct action of the sun. The use of cassava for soil fertility regeneration is not peculiar to only Wenchi. Saïdou *et al.* (2004) also report of the extensive use of cassava for soil fertility regeneration in some parts of Benin.

Rotation with pigeon pea

After cropping a piece of land to crops like maize, cowpea and yam for about three to four years, farmers intercrop their food crops with pigeon pea during the last cropping year of the cycle. After harvesting the maize and the yam, farmers allow the land to remain under pigeon pea for 18–24 months after which the pigeon pea plants are cut down, burnt and the land cropped to maize or yams.

The pigeon pea canopy is perceived to protect the soil from the direct action of the sun and therefore prevents the soil from becoming hardened. According to the farmers, pigeon pea forms a canopy after one year and shades out obnoxious weeds by suppressing their growth. The farmers also explained that the leaf litter covers the soil, reduces soil erosion, improves infiltration, prevents heating of the soil and enhances earthworm activity. Crops grown on the land after pigeon pea, and especially maize, are perceived by the farmers to look greener, grow faster and yield more.

Bush fallows

When farmers observe a decline in fertility of their soils after cropping for three to four successive years, they allow the land to lie fallow for 2–3 years before they go back and crop the land again. According to the farmers, fallowing the land for 2–3 years allows the land to regenerate its fertility. They mentioned that as the land is allowed to fallow, young trees begin to grow and shade the soil so that the land is not exposed to the direct action of the sun thereby keeping the soil moist all the time. They also reason that during the fallow period the litter of the vegetation on the land fertilizes the soil as it decomposes.

Rotation with cowpea

Farmers rotate maize with cowpea, which has a growing period of about 60–70 days, because of its food value and marketability and to maintain the fertility of their farmlands. According to the farmers, maize grown after cowpea grows faster and yields higher even if inorganic fertilizer is not applied. They mentioned that the nodules formed on the roots contain energy, which is released for the growth of the maize when they decompose. Farmers also attribute the yield increase in maize after cowpea to an increase in fertility of the soil as a result of the decomposition of the cowpea foliage that is left on the land after harvest. However, they remarked that if the land is not immediately used for cropping after harvesting the cowpea the fertility of the land is lost since cowpea leaves decompose fast.

Construction of ridges and mounds

Farmers construct ridges or mounds on less fertile plots on forested land. On grassland farmers either plough the land and/or construct mounds or ridges. Farmers

construct mounds or ridges or plough their land for two reasons. Firstly, the farmers construct the ridges or the mounds to control problematic weeds that invade the land as a result of decline in fertility. Secondly, they construct the ridges or the mounds to improve the productivity of the soil. As they construct the ridges or mounds, the weeds and leaves on the land mix with the soil and fertilize the soil as they decompose.

Farmers reason that the decomposed weeds and leaves when mixed with the soil improve the fertility of the soil and increase the yield of maize planted. According to the farmers, the construction of the mounds and ridges also loosens the soil, which becomes compact after continuous cropping. This allows water to percolate into the soil when it rains. One farmer said “Mounds are like termite hills. Any crop grown on termite hills does better because they contain a lot of water”. Farmers are of the view that maize planted on ridges or mounds grows faster and yields higher.

While the contributions of legumes such as pigeon pea and cowpea to soil fertility improvement can be explained by their contribution of N to the soil through N fixation, the contribution of cassava to soil fertility improvement is difficult to explain because of its high demand for plant nutrients. In comparison with cowpea rotations, pigeon pea and cassava rotations are regarded by both native and migrant farmers as long-term soil fertility management strategies.

The differential use of promising strategies

Farmers still generally prefer to regenerate the fertility of their farmland through bush fallowing. Due to population pressure outlined earlier, however, they increasingly resort to other strategies with a remarkable difference between the native and migrant farmers in this respect (see Table 4). While the native farmers widely apply bush fallowing, rotation with cassava and rotation with pigeon pea, we see that migrants mainly use only short-term strategies such as mounding and the planting of short-duration legumes such as cowpea and groundnut. At the same time, most of them also continuously crop the same piece of land to maize for two years in both the major and minor seasons in order to get the maximum from the land, thus mining the soil of nutrients.

Table 4. Percentages native and migrant farmers at Asuoano in 2002, practising various soil fertility management strategies.

Strategy	Native farmers (n = 22)	Migrant farmers (n = 16)
Cassava	82	44
Bush fallow	77	19
Pigeon pea	59	6
Rotation with cowpea/groundnut	18	50
Mounding/ridging	14	100

Analysis and discussion

This section discusses the main outcomes and implications of our diagnostic study. It starts with an analysis of the differential use of the locally developed strategies that were identified. This is followed by a discussion on implications of the study for the ongoing action research, and some more general reflections on interdisciplinary co-operation.

Explaining the differential use of promising strategies

The cassava and pigeon pea rotation practices, especially, can be regarded as locally developed soil fertility management strategies that only recently captured the attention and interest of individuals within the formal research and extension system. How can we understand the differential use of these strategies across the various communities? More particularly, why is it that migrants do not widely apply seemingly promising rotation practices?

A model for understanding farmers' practices

In our analysis we make use of Leeuwis and Van Den Ban's model for understanding farmers' practices (Leeuwis & Van Den Ban, 2004). According to this model, farmers may have different sorts of reasons for engaging (or not) in specific practices, which can be captured under four composite variables.

1. The variable 'evaluative frame of reference' constitutes the balance between, on the one hand, farmers' knowledge and beliefs regarding the (likely) consequences of specific practices, and, on the other, their valuation of such consequences vis-à-vis a (complex) set of aspirations, resulting in the – implicit or explicit – consideration of 'advantages' and 'disadvantages'. Here it is likely that trade-offs occur between e.g. technical, economic, relational, cultural, political and/or emotional aspirations.
2. The second variable that shapes the application of farming practices is 'perceived self-efficacy' (Bandura, 1977), which centres on the confidence that an individual farmer has in his or her own capacities to perform a practice. Several dimensions of perceived self-efficacy can be distinguished, including perceived availability of skills and competencies, and perceived ability to mobilize resources and accommodate risks.
3. In addition to individual abilities, farmers' practices are also shaped by their assessment of the capacity of their social environment (e.g. agricultural service organizations) to adequately accommodate and support them. This is captured by the variable 'perceived effectiveness of the social environment', which relates essentially to the issue of *trust in others*.
4. Finally, farmers' practices are also shaped by pressures that they experience from other people with whom they relate. This fourth composite variable is labelled 'perceived social pressure', and can be seen to include dimensions such as the desires and expectations that other actors are seen to have regarding the performance of certain practices, the resources (including rewards and sanctions) that such others are perceived to mobilize in order to make farmers comply, and farmers'

valuation of the involved expectations, resources and relationships in view of a variety of aspirations.

Much more can be said about e.g. the dynamic interrelationships between variables, the dynamics through time, and the importance of routine and implicit 'reasoning'. For this we refer to Leeuwis & Van Den Ban (2004). Given the idea that technologies consist of technical and social arrangements and involve a network of interdependent actors, it would be a mistake to look only at the (non-)application of specific technical practices (i.e., rotation with cassava and/or pigeon pea) by migrants. Although this serves as an entry point, we need to place such practices in the context of interrelated practices, involving also other actors such as native landlords.

Analysing the differential use of rotations with cassava and pigeon pea

When looking at the farmers' evaluative frame of reference regarding cassava and pigeon pea, it is important to note that both native and migrant farmers maintain belief in the positive qualities of these practices for purposes of restoring soil fertility, and have similar views regarding the causal processes at work. Farmers generally associate these kinds of strategies with consequences like better soil fertility levels, increased yield expectations of crops that are planted afterwards, reduced labour requirements for weeding, less need for pesticides, higher income expectations and increased food security provided by pigeon pea and cassava. Although clearly the native farmers have more direct experience, 'technical knowledge' is not the limiting factor on the side of the migrants. Also, there is no indication that there are bottlenecks in terms of availability of technical skills and competencies (as related with perceived self-efficacy).

Zooming in on farmers' aspirations, we see that the consequences mentioned are valued positively by both native farmers and migrants. Thus, when looking at the technical practices and their consequences in isolation, migrants too tend to have a positive attitude towards them. However, in addition, migrants see several obstacles and risks that ensue mainly from the dynamics and practices surrounding contracts between landlords and tenants.

Most migrant farmers feel that they cannot raise sufficient money to include cassava and pigeon pea in their cropping system. This relates to the circumstance that migrants cannot own land, while landowners commonly demand immediate payment of rent before renting out land to tenants, amounting often to paying the total rent in advance. Migrants argue that applying cassava and pigeon pea rotations would only make sense if they rented land for longer periods, which is not possible in view of the immediate cash demands by landlords. They also reason that under the present conditions they do not have sufficient security to the land to justify investment in long-term soil fertility management strategies such as cropping the land to pigeon pea. A farmer once remarked: "I will never plant pigeon pea again because when I planted pigeon pea to improve the fertility of my farmland, the landlord asked me to quit the land because one of his sons was coming to farm on the land when he observed that the fertility of the land had improved". When asked about their awareness of the negative consequences of continuous maize cropping with regard to soil fertility, several migrant farmers answered in affirmative ways and said they preferred to do so because

they had to get back the money invested. In response to this, the landowners mention that they are reluctant to rent land to migrants on a long-term basis, because they fear the land will be badly degraded.

In this vicious circle, the fact that migrants need to pay the rent in advance stands out as a central element, which raises questions about the rationale of the landowners in this respect. Here two issues seem relevant. Firstly, it seems – also in view of the scarcity of land – that the indigenous farmers do not look at themselves as being permanently ‘in the business of renting out land’. Rather, they rent out land when an immediate cash need arises, for example, in order to pay for occasional happenings such as funerals, marriages and construction works. Secondly, inflation in Ghana is such that landlords prefer to receive the rent agreed upon as soon as possible, before it loses value.

The above shows that the reasons for the limited use of longer-term soil fertility management strategies by migrants are in the social realm. In terms of the model for understanding farmers’ practices, we can say that the two efficacy variables are most significant in explaining the limited use. That is, although migrants do – in principle – have positive attitudes (as a result of ‘evaluative frame of reference’) towards long-term measures, they do not feel able to mobilize sufficient resources to engage in long-term contracts (‘perceived self-efficacy’), and feel that the social environment poses obstacles to applying cassava and pigeon pea rotations (‘perceived effectiveness of the social environment’). To them, unfavourable community arrangements regarding land tenure and land security are most significant in this respect. In terms of the variable ‘perceived social pressure’, migrants are afraid of negative sanctions (i.e., losing the land to others who reap the benefits) when they invest in soil fertility. However, it would be wrong to conclude that landlords deliberately apply social pressure to prevent migrants from using long-term soil fertility management practices.

Applying our perspective on technology and innovation, we can say that, although the ‘technical’ practices seem well developed and convincing to both natives and migrants, no adequate social arrangements are in place for migrants to utilize them. In other words, for them the technology can be said to be incomplete, underdeveloped and/or unbalanced.

The above described situation seems to have negative long-term consequences for both the migrant farmers and the landowners, especially when taking into account that migrants cultivate about 40% of the total farmland in the community. Soil fertility seems to fluctuate around lower levels than necessary; landowners get back their land in a degraded state, while migrants have lower yields than locally common and may find it increasingly difficult to rent pieces of land of acceptable quality.

In many ways we can say that we are dealing with a social dilemma situation (Messick & Brewer, 1983) in that a tension exists between both the natives’ and migrants’ short-term individual interests (i.e., getting quick cash, respectively mining the soil) and the collective long-term interest of keeping soil fertility at a reasonable level. A crucial element in social dilemma situations is often a lack of *trust* in each other’s willingness to act in a more co-operative mode, in the social institutions that are in place to bring about such behaviour (Ostrom, 1990; Baland & Platteau, 1996). We can also recognize this in the case of Asuoano. Landowners often do not trust that

migrants will maintain the land, and therefore prefer to rent out land only for shorter periods, and against a high price. Migrants have little confidence that landowners will allow them to reap the benefits of investments made in soil fertility, and hence tend to mine the soil. Moreover, it seems that current contractual arrangements do not allow for the making of enforceable agreements in these respects, and neither are they able to handle issues like inflation.

Implications for the ongoing action research

After the technographic study by Offei & Sakyi-Dawson (2002) and initial discussions with 'the community', the agenda for the action research was mainly to investigate and further optimize long-term rotation systems including cassava and pigeon pea rotations. This is by means of a combination of farmer-managed and researcher-managed experimentation. However, on the basis of the subsequent further exploration of the social dimensions of these promising strategies, it has transpired that it is a mistake to think of the community as a homogeneous category (see also Guijt & Shah, 1998). More specifically, we can conclude that our action research strategy needs to be amended if we want to ensure that migrant communities also benefit from our efforts. Here two directions seem to be possible. The first is to start expanding activities in the technical realm to also include exploration and experimentation on short-term soil fertility improvement strategies such as mounding, rotation with short-duration crops such as cowpea and groundnut. The second is to intensify efforts in the social realm, and engage in the joint design of institutions to help resolve the social dilemma situation described in this article. Although perhaps most significant in terms of its potential impact, this latter strategy will be demanding and complex. It will require the negotiation of and experimentation with new kinds of contractual and/or land tenure arrangements, involving also supporting control and sanctioning systems. In essence, we are talking about institution building and the facilitation of new forms of collective action in an obviously sensitive domain, in which traditional leaders and distinct ethnic communities and their representatives are key stakeholders. As Röling & Jiggins (1998) suggest, this may require the establishment of a multi-stakeholder 'platform' that becomes the focal point for the facilitation of the necessary social learning and negotiation processes.

An important task for the future, then, is to find out whether conditions conducive to a productive learning and negotiation exist, or can be established (see Leeuwis, 2000; Leeuwis & Van Den Ban, 2004). Moreover, it will be necessary to explore what persons may be capable and acceptable to perform facilitation tasks, and whether or not there is any role to play for researchers and extensionists in this respect. We will report and reflect on these matters extensively in a later publication.

At the end of the diagnostic study, an agenda for field experimentation was drawn up with the various stakeholders in the community. The initial agenda was to set up field experiments on individual farmers' fields to evaluate the various soil fertility management strategies such as cassava, pigeon pea and cowpea rotations. However, during discussions with the community on the organizational aspects of experimentation, the migrants suggested the inclusion of other stakeholders in the two nearby

communities Beposo and Droboso where most of their landlords are located. Subsequently, it was agreed that, instead of establishing research plots on individual farmers' fields, joint learning plots be established in each of the three communities. Both changes, they argued, will contribute to the creation of a more effective context (i.e., a multi-stakeholder platform) for discussing issues related to land tenure arrangements along with technical matters. Moreover, discussions with the farmers about the technical experiments to be carried out in the future indeed resulted in the inclusion of short-term strategies for soil fertility management. Farmers modified the treatments to include other treatments like the performance of maize on lands previously under (1) groundnut/maize rotation and (2) continuous cowpea cropping in addition to the originally proposed treatments that included evaluation of maize performance on lands previously cropped to (i) cassava, (ii) pigeon pea, (iii) cowpea/maize rotation, and (iv) *Mucuna*/maize rotation. It was also agreed among the various stakeholders to establish two other experiments to evaluate the soil improvement qualities of different varieties of each of the two most important crops used in soil fertility regeneration, i.e., cowpea and cassava. To successfully and jointly carry out these experiments an agreement was reached among the various stakeholders that meetings be held once every fortnight for joint learning on the experimental plots.

Reflections on interdisciplinary action research

This study is part of a project aiming also to enhance co-operation between natural and social scientists. What conclusions can be drawn with regard to this matter?

What we have seen in this paper is how natural scientists' efforts to improve existing technical strategies were combined with a study on their social dimensions, whereby a social science model for explaining farming practices served as an entry point. In order to be able to conduct such a 'hybrid' study, the key researcher – originally trained as a natural scientist – followed several social science courses, and engaged in regular interactions with both natural and social scientists.

From the viewpoint of 'interdisciplinary science' (as distinct from that of the local communities) this way of operating has mainly resulted in a reformulation of underlying assumptions and research questions. The attention for diverse technical practices and their social logic has revealed that the community is not a homogeneous whole. More importantly, it has helped to generate relevant dimensions for classifying diversity among farmers in connection with soil fertility; in this case a classification based on land tenure position (associated with ethnic origin), rather than – for example – wealth, gender, farm size or agro-ecological location. In connection with this classification, our views of what were the most relevant problems and questions for research have altered considerably. In the technical sphere, attention shifted at least partly to the potential and limitations of short-term soil fertility management solutions. In the social science domain, it became clear that more detailed insight is needed into the dynamics of land tenure arrangements and their underlying logic, and into the opportunities and constraints that exist for facilitating a process towards the development of new institutional arrangements in the sphere of contracts between tenants and landlords. Thus, we see in essence that – in this action research setting – interdisciplinary

co-operation has helped us to generate new questions, that otherwise would not have been addressed.

Working with a 'hybrid' researcher and a multidisciplinary supervision group has proven to be quite advantageous for identifying relevant connections between the social and the technical realm. At the same time, we did not develop in this study some kind of 'transdisciplinary' language that transcended the original disciplines (e.g. inspired by systems theory) but remained largely to look at matters from several disciplinary perspectives. Perhaps as a result of this, the new questions formulated remain quite clearly within either a technical or a social realm. We believe they could – in principle – be further pursued by conventional disciplinary scientists. Although we cannot compare our way of operating with a more 'transdisciplinary' approach, we feel that the co-operation has been beneficial and relevant. Looking at interdisciplinary co-operation as a strategy for sharpening and improving the relevance of 'disciplinary' research questions, therefore, seems worthwhile. Moreover, it is an approach that fits well within the largely disciplinary institutions and reward structures that we all work in. We do not want to make a plea for the reproduction of these structures as such; we rather want to contribute to devising practical strategies for dealing with them and overcoming obstacles to interdisciplinary work.

Conclusions

We have shown in this article that promising and locally developed technical strategies for redressing soil fertility decline need to be accompanied by adequate social-organizational arrangements if they are to become balanced technologies that can be applied by different segments of the farming population in Wenchi, Ghana. Whether or not such new social arrangements can and will be designed remains to be seen. It requires that social dilemmas and the underlying latent conflicts and lack of trust are somehow overcome, which poses major challenges to stakeholders, researchers, extensionists and those who are in the position to take on a facilitating role.

With respect to interdisciplinary co-operation in an action research context, the experiences reported upon in this article suggest a useful strategy to link natural and social science insights, which may – in the early stages – include the following elements:

- exploration of differential farming practices in a certain domain;
- clarifying the social rationale of differential technical practices, leading also to the identification of associated social practices;
- using the available insights to find a relevant characterization of diversity within a community;
- reaching agreement on what segments of the community are supposed to benefit from the action research efforts; and
- critical reflection on earlier assumptions along with the (re)formulation and sharpening of research questions in both the technical and social realm.

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