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Farmer-assessment of three soil fertility improving technologies in the Brong Ahafo Region of Ghana

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Abstract

In 2000, a case study was conducted in the Brong Ahafo Region of Ghana to examine farmers' experiences using *Mucuna pruriens* var. *utilis* as an improved short season fallow which was introduced to farmers three years ago. The survey was carried out in three districts of the Brong Ahafo Region of Ghana, each representing a different agro-ecological zone: Atebubu (Guinea Savannah), Sunyani (Derived Savannah) and Asunafo (Semi-Deciduous Forest). Farmers' experience on *Mucuna* was qualitatively compared with the use of chemical fertilizers and animal manure which are the other two soil fertility improving technologies.

On an average, *Mucuna* was used by farmers since 2.2 years while experiences with the use of animal manure and mineral fertilizer exist for 3.2 years and 5 years, respectively. According to farmers' opinion, the application of animal manure and mineral fertilizer is more effective in short-term yield improvement. *Mucuna* fallow was ranked higher for its long-term effects on soil fertility and on weed control, its availability at village level, low cost, and low labour demand. On average, farmers had to weed their crops once to twice per season in *Mucuna* based systems while they weeded twice to three times if mineral fertilizer or animal manure was applied. However, uncontrolled bushfires are seen as a high threat to the success of the *Mucuna* fallow especially in the Savannah Zone, being one reason for the very low area under *Mucuna* cultivation. Only 0.4 ha per farm was dedicated to *Mucuna* while animal manure and mineral fertilizer was applied on 0.5 ha and 1.5 ha per farmer, respectively. Farmer-to-farmer dissemination of the *Mucuna* technology was lowest at 8.8% while more than 30% of the farmers who had applied animal manure or mineral fertilizer had received their information about the respective technology from other farmers. Restricted availability of animal manure (64%) and high costs of mineral fertilizer (88%) are the main reasons not to use these technologies.

Key words: soil fertility, *Mucuna*, animal manure, fertilizer, farmers' perception

Introduction

Land use systems in West Africa are presently forced to change dramatically. Population growth has shortened the fallow periods leading to soil degradation which endangers the natural resource base. More intensified cropping systems are needed to produce higher yields on existing crop land and to manage increased marginal land in a sustainable manner (Amanor 1996). Mineral fertilizer are often beyond the economic reach of small scale farmers, and, consequently research activities during the last two decades have attempted to develop low cost technologies. One way to remedy nitrogen deficiency and declining soil fertility was the development of alley cropping. While this technology proved to be technical feasible and superior to traditional slash-and-burn systems (Kang and Akinnifesi 2000) its adoption rate was disappointingly low. Criteria more important to the farmers like labour demand and availability were not considered and led to a total failure (Dvorak 1996). Lessons learnt from participatory approaches involving farmers from the very beginning in the process of technology development are now an agreed standard in research and extension programs (Waters-Bayer 1989).
In 1996, the Sedentary Farming Systems Project (SFSP) was launched to address a possible soil fertility decline in the Brong Ahafo Region of Ghana which is considered to be the food basket of the nation. Following a Participatory Technology Development approach different technological options were offered to farmers to test and modify them according to their own needs and priorities. Among the technologies offered to farmers, *Mucuna pruriens* var. *utilis* (L.) D.C. grown during the short rainy season as an improved fallow followed by maize received the highest response by farmers so far. However, despite striking agronomic benefits even under on-farm conditions, little was known about the farmers' perception. Furthermore, it was important to know how farmers compare *Mucuna* systems with the application of animal manure and mineral fertilizer, two major technologies to improve soil fertility known to farmers in the study area since longer time.

Materials and Methods

Study area and selection of farmers

The study was conducted during October and December 2000 in three districts of the Brong Ahafo Region of Ghana: (i) Asunafo in the Forest Zone with tree based mixed cropping systems being dominant, moderate soil fertility and weed pressure; (ii) Sunyani in the Forest Savannah Transitional Zone with maize and cassava based mixed and monocropping farming systems, good access to markets and agricultural inputs, and the existence of semi-urban agriculture including external input vegetable and poultry production; (iii) Atebubu in the Guinea Savannah Zone with predominant yam based cropping systems, low soil fertility, high weed pressure through *Imperata cylindrica* (L.) Beauv. infestation and regular uncontrolled bushfires during the dry season.

Adoption of the Mucuna system

Quantitative data of participating farmers practicing *Mucuna* systems were collected from the Sedentary Farming System Project (SFSP) since 1997. However, actual figures might underestimate the real numbers as only farmers were captured who were known to the project and extension staff. Corresponding figures for the other two technologies investigated were not available.

Evaluation of farmers' perception of three soil fertility improving technologies

Farmers' perception of the *Mucuna* fallow technology was compared to that of mineral fertilizer and to the application of animal manure. A total number of 213 farmers were randomly selected for the survey and identified by Agricultural Extension Agents (AEAs) of the Ghanaian Ministry of Food and Agriculture (MoFA). They were stratified into the following groups: users of *Mucuna*, users of animal manure, users of chemical fertilizers, and non-users of either technology. A farmer had to have practiced a certain technology at least once to be part of any of the groups not making a difference if they continued or stopped using it. Farmers practicing a technology for the first time were not included in the survey. Farmers could be part in several groups (e.g. *Mucuna* rejecter and animal manure user).

A structured interview was conducted to collect quantitative and qualitative data on socio-economic characteristics of the farm households, land use systems, type of resource management technologies and farmers' perception.

Farmers' perceptions of the soil fertility improving technologies were investigated from an assessment of each technology against 14 criteria (for details see Table 1) on a 3-point scale as follows:

(0) disagree, (1) indifferent, (2) agree.

A farmer was considered to be satisfied with the technology for a given criterion if 2 points were obtained and unsatisfied for less than 2 points. The percentage of satisfied farmers was calculated for each criterion and technology. Farmers were considered to be overall satisfied with a technology if the mean percentage over all criteria were higher than 50% (total satisfaction index).

The magnitude of the difference in the satisfaction score between either two of the technologies would reveal the criteria for which farmers give preference. A positive sign gives an indication that technology A is preferred to technology B while a negative sign indicates a preference of technology B to technology A. The greater the difference the more a technology is preferred..

Results

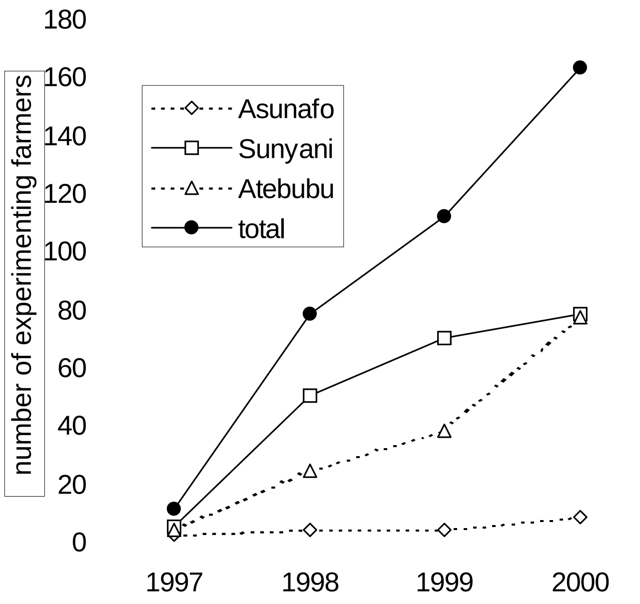

Figure 1: Number of experimenting farmers with *Mucuna* fallow systems in three districts of the Brong Ahafo Region of Ghana.

Dynamics of the adoption of Mucuna fallow

Mucuna technologies were first introduced in the Brong Ahafo Region in the framework of the Sedentary Farming Systems Project (SFSP) in 1997. As part of a Participatory Technology Development process *Mucuna* was offered among other technologies to farmers as one possible option to improve soil fertility. No incentives were given to the farmers except an initial amount of *Mucuna* seeds (3 kg). However, with the increased demand for seeds the project was forced to buy parts of the seeds back from farmers.

Starting with less than 5 farmers per district the number of experimenting farmers with *Mucuna* systems rose to more than 70 three years later in both Sunyani and Atebubu. In contrast, the interest of farmers using *Mucuna* in the Forest Zone of Asunafo was still negligible (Fig. 1).

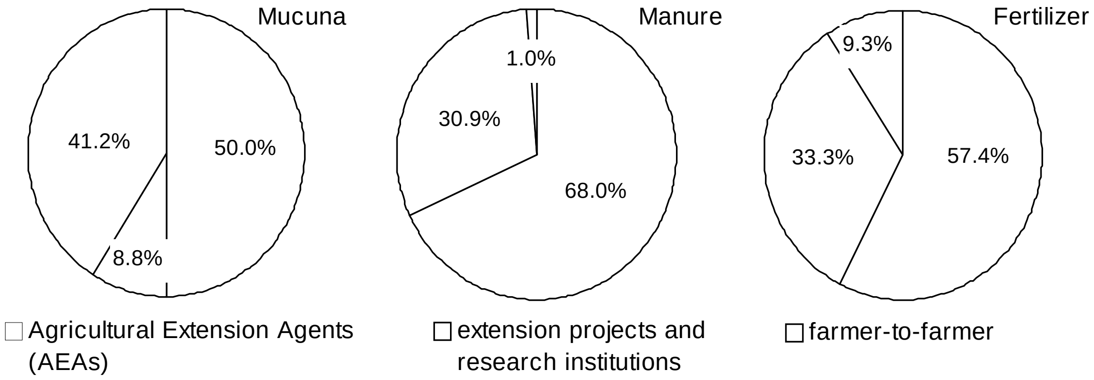

Figure 2: Source of information about three soil fertility improving technologies. N_{Mucuna}= 68, N_{Manure}= 97, $N_{Fertilizer}$= 108.

The intensity of adoption so far remained low as the farmland under *Mucuna* fallow per farmer averaged only 0.4 ha. In contrast, animal manure and mineral fertilizer was applied on 0.5 and 1.5 ha, respectively. Farmer-to-farmer dissemination of the *Mucuna* fallow technology was lowest with 8.8% as compared to the cases of animal manure and mineral fertilizer (30%). More than 40% of the farmers using *Mucuna* received their information through extension projects (e.g., SFSP) and research institutions while this source of information was of minor importance for the other two technologies (Fig. 2). Farmers have used *Mucuna* fallow systems for 2.2 years on an average while experiences with the use of animal manure and mineral fertilizer exist for 3.2 years and 5 years, respectively.

Farmers' perception of soil fertility technologies

On average, the total satisfaction index was 86% for the *Mucuna* technology, well above the 50% threshold. The total satisfaction index for the other two technologies also passed the threshold with 75% for animal manure and 52% for mineral fertilizer (Table 1).

Table 1 Satisfied farmers in percent for predetermined criteria having experience with *Mucuna* fallow (N = 68), animal manure (N = 97) or mineral fertilizer (N = 108) in three districts (Asunafo, Sunyani, Atebubu) of the Brong Ahafo Region of Ghana in the year 2000.

Technology	Criteria														
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	**Mean**
Mucuna	52	97	99	97	96	97	85	85	97	99	100	94	94	15	**86**
Manure	91	85	94	77	40	22	86	37	98	92	100	98	95	30	**75**
Fertilizer	97	51	55	19	7	2	90	18	92	2	97	96	59	44	**52**

C1: Positive short- term effect on soil fertility/yield; C2: Positive long- term effect on soil fertility; C3: Does not decrease soil fertility in the long run; C4: Technology is easily available; C5: Does not worsen a weed problem; C6: Effective in weed control; C7: Does not worsen a pest or disease problem; C8: The technology does not require much labour; C9: The technology does not bear a high risk of failure; C10: Cheap; C11: Appropriate for rented land; C12: Technology fulfilled my expectations; C13: Willingness to use the technology again; C14: Bushfire is a threat for the success of the technology on my farm.

Farmers having experience with animal manure were not satisfied with 4 out of the 14 criteria (29%) while farmers having experience with mineral fertilizer were not satisfied with 6 out of the 14 criteria (43%) and only slightly more than half of the farmers were satisfied with another three criteria (21%). This stands in contrast to farmers having experience with *Mucuna* fallow systems. Farmers were satisfied with all the criteria except that bushfire was seen the most serious threat to this technology. In addition, only about half of the farmers experienced with *Mucuna* were satisfied with the short term effect on soil fertility and yield improvement (Table 1).

The greatest difference in the satisfaction score between *Mucuna* fallow and the application of either animal manure or mineral fertilizer was its effect on weed control, that *Mucuna* does not worsen a weed problem and that it does not require much labour. Farmers also ranked *Mucuna* fallow higher compared to mineral fertilizer for its low costs. However, farmers were much more satisfied with the short-term effect on soil fertility and yield improvement through the application of animal manure and mineral fertilizer. Bushfire was assessed to be a more serious threat to the success of a *Mucuna* fallow than to the other technologies (Fig. 3).

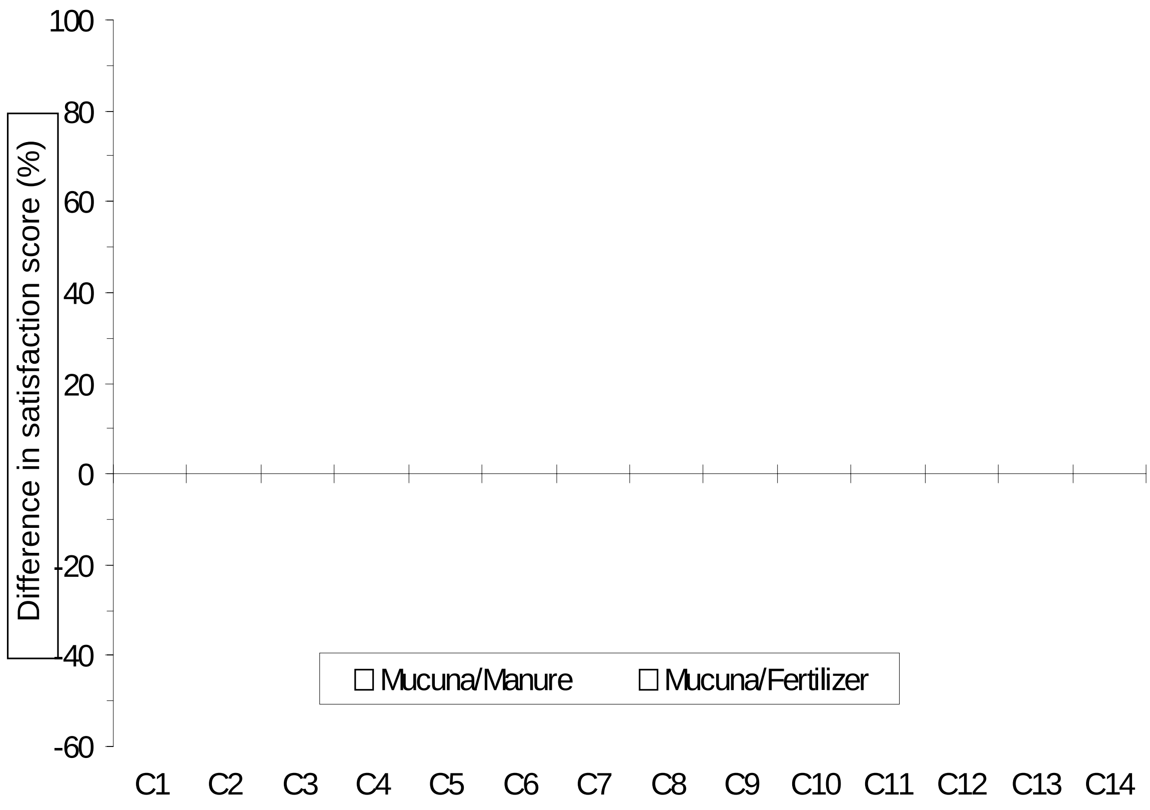

Figure 3 Difference in the satisfaction score by farmers between *Mucuna* fallow and animal manure and between *Mucuna* fallow and mineral fertilizer. Positive values are indicators that *Mucuna* is preferred to the compared technology. The greater the difference the more *Mucuna* is preferred or inferior to the other technology.

Criteria:

C1: Positive short term effect on soil fertility/yield; C2: Positive long term effect on soil fertility; C3: Does not decrease soil fertility in the long run; C4: Technology is easily available; C5: Does not worsen a weed problem; C6: Effective in weed control; C7: Does not worsen a pest or disease problem; C8: The technology does not require much labour; C9: The technology does not bear a high risk of failure; C10: Cheap; C11: Appropriate for rented land; C12: Technology fulfilled my expectations; C13: Willingness to use the technology again; C14: Bushfire is a threat for the success of the technology on my farm.

Discussion

Adoption

The speed of adoption of *Mucuna* fallow in the present study was much slower than in southern Benin several years ago where after its introduction in 1987 the number of adopters rose to estimated 14000 in 1997 (Honlonkou et al. 1999). This can be explained by the strong involvement of Sasakawa Global 2000 in Benin which pushed the *Mucuna* technology with strong incentives to the farmers. It was guaranteed that seeds were bought back which created an artificial market. After Sasakawa Global 2000 withdrew the number of adopters declined (Honlonkou et al. 1999). The intension of the SFSP was not to push a certain technology but to develop technologies together with farmers. This explains the very low number of experimenting farmers in Asunafo. In predominantly tree-based cropping systems *Mucuna* fallows can hardly be integrated without a major disturbance of the existing system. An earlier survey in the study area revealed the importance of the cropping systems for the potential of *Mucuna* based systems. Although weed pressure is higher and soil fertility is lower in Atebubu as compared to Sunyani farmers are more occupied with farming activities dedicated to yams in the succeeding rainy season in Atebubu. Both the effects of suppressing weeds and to raise succeeding maize yield levels vanish with increased rainfall events because existing *Imperata* rhizomes resprout and accumulated nutrients might be leached to deeper soil layers. Moreover, maize is not an important crop to most of the farmers in Atebubu. The situation is different in Sunyani with maize based cropping systems. Most farmers plant maize with the beginning of the major season rains. Therefore, the effects of a preceding *Mucuna* fallow to suppress weeds and to supply nutrients to succeeding crops can ideally be utilized (Anthofer 2000).

The low area of farmland under *Mucuna* with 0.4 ha per farmer suggests that there are constraints to a wider integration of the technology within the existing cropping systems. This is further supported by the mode of dissemination. A strong indicator for the adoptability of a technology is whether farmers extend it to each other and adopt without any inducement from an outside agency.

Only about 9% of the farmers having used *Mucuna* fallow received the information about this technology from peer farmers while the large majority received it through extension personnel or through projects and institutions. However, *Mucuna* fallow systems are still new to farmers and they might still carefully observing the effects.

Farmers' perception

Farmers were satisfied with *Mucuna* fallow for more criteria than for animal manure and mineral fertilizer because it is a multi-purpose technology which is preferred by resource-poor farmers. Technologies characterized by delayed benefits but which are cost saving in the short term are normally acceptable to farmers (Smith 1992). Its adoption can be expected to be more rapid in situations where limitations like low soil fertility and high weed infestation coincide in one place (Kiff et al.1996). Although all the technologies fulfilled the expectations of their users only 60% of the farmers having experience with mineral fertilizer were willing to use it again. 88% of the farmers rejecting mineral fertilizermentioned the high costs being the main reason not to use it again. Farmers who were not willing using animal manure again pointed out the restricted availability as the main obstacle (64%).

In the presence of available land resources, farmers aim to maximize labour productivity rather than land productivity (Baum et al. 1999). The Brong Ahafo Region is the third least populated region in Ghana with less than 100 persons km^{-2} (Amanor

1996). Therefore, any technology will be assessed for its labour demand and productivity by the farmers. On an average, weeding in maize followed a *Mucuna* fallow was practiced 1.51±0.08 times while the weeding frequency in maize fertilized with animal manure or mineral fertilizer was significantly higher, 2.43±0.08 and 2.6±0.1, respectively. This is in line with farmers' assessment on the weed control effect of the different technologies. *Mucuna* is highly effective in controlling weeds, does itself not worsen a weed problem and does not require much labour. In contrast, both animal manure and mineral fertilizer even worsen the weed pressure. Despite the labour requirement for establishing a *Mucuna* fallow, both animal manure and mineral fertilizer were assessed to be more labour intensive since the majority of farmers' fields are far from their homestead which causes transportation problems. In addition, the application of manure or mineral fertilizer without farming tools except a cutlass is very time consuming, especially when the doses have to be split. On the contrary, *Mucuna* can be grown *in situ* and requires no further labour than for sowing and one weeding.

Unlike results of a similar study in Benin (Honlonkou et al. 1999) *Mucuna* was also considered to be suitable for rented land. An explanation might be the different land tenure conditions. The majority of tenant agreement in the study area is a fixed rent for 3-4 years which assures the farmer to enjoy the benefit of a *Mucuna* fallow. Furthermore, the respondents are either land owners or tenant farmers who decided to use *Mucuna*. Tenant farmers who found *Mucuna* not an appropriate technology because of their tenancy arrangement were not captured in the survey.

Conclusion

Mucuna is a multi-purpose technology with a delayed benefit. Although animal manure and mineral fertilizer give more immediate effects in increasing crop yields, they are labour intensive and offer no additional benefits to the farmers like a *Mucuna* fallow which is also effective in weed control beside its effectiveness in improving soil fertility. Although the full benefit of a *Mucuna* fallow is only realized one year later with the harvest of the succeeding crop its labour saving effects might compensate for this disadvantage to make it attractive to small-scale farmers.

The major obstacle to a wider adoption of *Mucuna* is the risk of uncontrolled bushfires. This can only be avoided if common efforts are undertaken to combat their sources.

Acknowledgements

References

Amanor KS 1996 Managing trees in the farming system – the perspective of farmers. Forestry Department, Kumasi, Ghana.

Anthofer J 2000 Farmers' experiences with *Mucuna* cover crop systems in Ghana. http:\\www.cgiar.org/spipm/news/ccropmtg/resultsa/psd2/PSD2.htm

Baum E, Gyiele LA, Drechsel P and Nurah GK 1999 Tools for the economic analysis and evaluation of on-farm trials. IBSRAM Global Tool Kit Series No. 1, IBSRAM, Bangkok, Thailand.

Dvorak KA 1996 Adoption potential of alley cropping: final project report. Resource and Crop Management Research Monograph No. 23, IITA, Ibadan, Nigeria

Honlonkou AN, Manyong VM and Tchetche N 1999 Farmers' perceptions and the dynamics of adoption of a resource management technology: the case of *Mucuna* fallow in southern Benin, West Africa. International Forestry Review 1(4), 228-235.

Kang BT and Akinnifesi FK 2000 Agroforestry as alternative land-use production systems for the tropics. Natural Resources Forum 24, 137-151.

Kiff L, Pound B and Holdsworth R 1996 Covercrops – A review and database for field users. NRI, Chatham, UK,

Smith J 1992 Socioeconomic characterization of environments and technologies in humid and subhumid regions of West and Central Africa. Resource and Crop Management Research Monograph No. 10, IITA, Ibadan, Nigeria.

Waters-Bayer A 1989 Participatory Technology Development in ecologically-oriented agriculture: some approaches and tools. ODI, Agricultural Administration Unit, London, UK.