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Plantain (*Musa* spp.) Cropping Systems of Southern Cameroon

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Keywords: constraints, perceptions, plantain systems, yield losses

Abstract

Plantain (*Musa* spp.) cropping systems of Southern Cameroon can be separated into those based on forest clearing and those based on land already used. Plantain is a major crop starting the forest clearing cycle. It is more than other food crops grown for commercial reasons. However, varietal choice for auto-consumption is different from that for sales. Nevertheless, farmers prefer to plant mixtures of cultivars. All systems rely on the use of natural resources with purchased inputs virtually absent. Labor is mainly provided by household members, capital use is limited to specific operations such as tree felling, digging holes, planting and harvesting. Knowledge on pests and diseases is very limited. Farmers are unaware of infection pathways of nematodes such as *Radopholus similis*. Contrary to that, farmers are very aware of the causes of yield loss with an overall realistic assessment of totals yield losses, estimated at 50%. The systems could be improved by simple agronomic measures such as regular planting distances to increase densities, separation of cultivars into early versus later producing types to reduce weeding labor. Most important appears to be raising awareness of the major pests and diseases and simple measures to reduce or eliminate nematode and banana weevil (*Cosmopolites sordidus*) infestation. Research is required to determine fertilizer response curves, response of different plantain cultivars to planting density, response to weeding frequency and other agronomic measures to increase yields and to increase profitability.

INTRODUCTION

Plantain (*Musa* spp.) is the most important food cash crop in Southern Cameroon. Among the starchy staples it is, after yam (*Dioscorea* spp.), the most preferred by customers (Temple et al., 1996; Dury et al., 2002), and accordingly, it is expected that the demand for plantain will increase in the future (Dury et al., 2000). At the same time it is a major component in the traditional subsistence food production systems (Achard et al., 1998; Bikié et al., 2000). Plantain is important for food security in Cameroon (Temple et al., 1997), where consumption can reach 100 kg/capita/year and it is currently developing into a major export crop to Southern neighbors. Although Cameroon produces >1,000,000 t/year of plantain (Ngalani, 1996), very little research has been conducted on this crop and very little is known about the currently used cropping systems.

For farmers, plantain offers a good opportunity to increase their income; however, yields are low due to a complex of pest and diseases. Recent trials and observations did not produce yield data similar to previously published statistics on yield levels in Southern Cameroon (C. Mekoa and S. Hauser, pers. commun.; Hauser, 2007). While such discrepancy may be connected to the survey methodology (Hauser and Van Asten, pers. commun.), it may as well be connected to increased pest and disease severity, new pests and diseases and the arrival of invasive weeds (Hauser and Mekoa, 2009).

To guide research, identify the most important constraints in the production system and to devise new technologies which may enable farmers to draw on the potential of plantain as a food cash crop it is required to have valid information on the current production systems. This paper reports the results of two surveys conducted in Southern Cameroon to establish the current status of plantain production systems. As such it is

largely descriptive. However, the results shall be used to identify major constraints and determine critical points of intervention for research to increase production.

MATERIAL AND METHODS

Two surveys were conducted in Southern Cameroon in late 1999 and in late 2001. In both surveys farmers were asked to describe how they produce plantain in the context of overall land and labor use and to compare systems of the past with the practices commonly applied today. These open-ended questions were summarized to describe the major cropping systems. The open-ended descriptive part was followed by a set of largely closed questions. The first survey was done in 36 villages with 235 respondents. Questions were geared towards the extent of plantain production; the type of land used, the cultivars planted, the level of commercial plantain production, perceived biotic constraints, and the type and level of plant protection exercised by farmers. The second survey was conducted in nine villages with 153 respondents to obtain information on: the household situation of plantain growers; their labor endowment and education; the size of the plantain operation; the perceived labor and capital use in the cropping system; reasons for varietal choice; perceived reasons for good versus bad yields; perceived causes; and severity of yield losses.

RESULTS

The Systems

Plantain cropping systems of Southern Cameroon can generally be separated into those based on planting in newly cleared secondary or primary forest versus those based on planting in land cleared from young bush regrowth that has been cropped at least once before. Plantain, next to egusi melon (*Cucumeropsis mannii*), is the major crop starting the cycle of forest clearing. However, forest clearing for plantain is done in a wide range of different ways. Traditionally, forest clearing remained incomplete, retaining large trees, trees with particularly hard wood and species producing economic timber (if not ready for harvest) or those with nutritional or medicinal value. The other extreme, more frequently observed nowadays, is complete clearance, often to establish long-term perennial crops, yet using the land initially for a crop of plantain. The different types of forest clearing retain different levels of shade.

Independent of the type of clearing, most farmers burn slashed biomass, either before or after planting. Cumbersome trees, specifically those of no commercial value yet with large crowns and hard wood are killed by piling slash around their bases and burning to destroy the bark. These trees die slowly during the cropping phase. They do not shade as much as living trees with a full canopy, which may be an advantage for the plantain but, depending on the tree species they start shedding branches, causing damages to the plantain.

Farmers, if not land constrained, prefer to plant plantain in newly cleared old secondary or even primary forest as the first crop, along with some root and tuber crops such as cassava (*Manihot esculenta*) and cocoyam (*Xanthosoma spp.*). The system is very labor demanding at clearing but does not require much maintenance work during the first year if the burn was complete. Farmers often do not return to such fields within the first six to nine months after planting because the weed pressure is low and none of the crops is ready for harvest.

This system is encountering profound changes in many areas because over the last two decades the number of fields established by households has apparently increased substantially because the fallow length has been reduced. This is aggravated by the arrival of aggressively spreading invasive weeds such as *Chromolaena odorata* (Hauser and Mekoa, 2009). With the onset of the cocoa (*Theobroma cacao*) crisis (prices dropped and inputs became more expensive) many households expanded into second season cropping and had several fields/season. This lead to a strong fragmentation of the forest and established large numbers of weed seed sources, from where weed seeds could farther

invade new clearings, even after cropping had been abandoned for many years. Another response was a shortening of fallow length in the bush fallow cycle, leading to the continuous presence of weed species in the fallow phases. Nowadays the recovering bush regrowth is largely composed of the weeds, dominantly *C. odorata*, associated with the main crop (Hauser and Norgrove, 2001). Newly cleared and burned forest fields ('essep') get immediately invaded by *C. odorata* as the burning (January–February the latest) falls into the seed production and dispersal phase. Other light demanding weeds spread along the roads and paths leading to new fields (*Sida* spp., *Stachytarpheta* spp. and grasses). Therefore the labor requirements for weeding have increased and leaving the fields unattended up to nine months is no longer a viable option.

Home garden systems are largely opportunistic planting of a few suckers in open spaces around the houses yet are not a general feature of the home stead. Plantains in such situation can be very productive as they often receive considerable nutrient inputs through ash and refuse from the kitchen. In Southern Cameroon, this form of compound farming has not received research attention and there are no data on the production and yield of home garden plantains.

Integrated live stock plantain systems in the surrounding of the house do not exists. Roadside cropping is a new system similar to the typical forest field but in immediate vicinity to main roads. Here, old bush or forest of any age is cleared and planted to plantain at relatively high density. The system is probably a consequence of farmers trying to avoid the large labor demand for transporting suckers to and bunches from the usually far away 'essep' fields. An additional factor is a shift of labor from food crop production to processing or sales of non timber forest products, such as palm wine, fruits, nuts and rattan. People working in this sector spend a considerable time at the home and close to the road when processing and selling. They still find the time to establish plantain fields, yet cannot afford the long travel times to typical 'essep' fields. Thus they produce close to the market.

Intercropping plantain in the typical mixed food crop field ('afub owondo') is a field usually established by women to primarily provide food for the family. Fallow of two to seven years is most frequently used for this field and sites have often been cropped several times with variable fallow periods between crops (Büttner and Hauser, 2003). Women usually do not establish forest fields because they encounter more problems than men in clearing trees; however, they express a strong preference to plant plantain in newly cleared forest. Women plant some plantains into the usual mixture of groundnut (*Arachis hypogae*), cassava, maize (*Zea mays*) and some other species of minor importance. The plantain is not a major crop in this system. Groundnut, followed by cassava is the most important component (S. Hauser et al., pers. commun.). Groundnut and maize are harvested at three months after planting. Cassava is harvested usually from nine until 18 months after planting, which is about the time plantain would start to flower and mature. No reliable data is available on plantain productivity in such systems.

Plantain as a Crop at Plantation Establishment

In former times, when cocoa establishment was important, plantain was planted as an early shade crop over young cocoa and to use the land in the early phases of plantation establishment when the plantation crop, such as cocoa or oil palm (*Elaeis guineensis*) were not producing any revenue. However, nowadays cocoa establishment does not play a major role in Cameroonian agriculture. Very common is the establishment of medium (0.5–2.5 ha) and large scale (>2.5 ha) oil palm plantations. This is not exclusively smallholder agriculture but an activity of high income citizens establishing in their home village or on purchased land a type of retirement fund. Oil palm requires three to five years from planting to commencement of production. Weeding is therefore cost intensive on such large fields until production offsets the initial investment and maintenance labor requirements. Plantain, although not very fast in production, appears an ideal crop to be planted together with the oil palm because it can be weeded at a low frequency (3–4 times/year) and is has no particular phase in which weeding is essential. Over the first

three years of plantation establishment, plantain and perennial would be maintained with plantain production, about one to three years after planting. This is sufficient time to get the oil palm into the production phase. Plantain production would thus produce some income to compensate for the cost of oil palm establishment.

Plantain as a Crop at Plantation Abandonment

The decline of cocoa prices caused income losses and abandonment of many cocoa plantations. These plantations have been cleared of economic timber species to generate some revenue, while others have been cleared completely for other purposes such as plantain and other crops usually grown after forest clearing. In some cases farmers have cleared all timber tree species from cocoa plantations, reducing shade to levels where plantain can successfully be grown between the remaining cocoa. Due to the high risk and low profitability of cocoa and the perceived high fertility status of old shaded cocoa plantations (similar to old secondary forest) more farmers may in the future clear shade trees in cocoa plantations completely and establish plantain.

Demography and Education of Plantain Growers

Two surveys were conducted on a total of 388 farmers (114 women and 274 men). The average age was 44 years both for men and women, yet the range for men was larger (19–94 years) than for women (20–79 years). Most plantain growers were farmers all their life (37%), followed by villagers who did not find employment in towns and returned to the village to seek income (32%). About 25% of the respondents were retired employees from the nonagricultural sector and 5% of the growers were currently employed outside the agricultural sector. Most farmers had primary school education (63%) followed by those who completed secondary school (29%).Very few farmers had either no school education at all (6%) or attended post secondary institutions (1%).

Choice of Land

Ninety-six percent of the farmers choose the land for a plantain field by the length of the fallow and 14% of these considered soil properties. Only 3% choose the land by the soil properties alone. All female plantain growers used fallow age as criteria. Men used soil quality more frequently (23%) as women (10%). Forest fallow was strongly preferred (73%). A lower proportion of men (24%) preferred fallow land over forest, while 42% of the women preferred fallow land over forest.

Land Preparation

Land preparation is by slash and burn and to some extent by slash and mulch. Slashing uses 100% manual labor, tree felling is to 78% done manually, while 22% of the farmers used a chainsaw. Between 82% (second survey) and 96% (first survey) of the farmers burned either before (60–65%) or after (80–88%) planting suckers. Accordingly, 27–31% burned before and after planting suckers. Farmers growing plantain in mixed food crop fields with groundnut burn all biomass and remove the remaining debris. A considerable difference between men and women was found with most women burning before planting, because women planted plantain as an intercrop in groundnut fields more frequently. Most farmers (77%) did not prepare planting holes of defined dimensions but dug the holes to fit the sucker. The width and depth of holes had a wide range: 10–80 cm (width); and 15–60 cm (depth), with a maximum at 30 cm (Fig. 1). The estimated hole volumes had a maximum at 32 L.

Field Size, Distances and Plant Numbers

The average number of fields/farmer was 1.3, with women having more frequently more than 1 field (42%), than men (22%). More than 80% of fields were smaller than 1 ha. Very small fields (<0.1 ha) were frequent and included home gardens and mixed food crop fields (Fig. 2), which usually are around 0.1 ha. On average, 720 plantains/field were planted, with large differences between men (980 plants) and women (270 plants). Men

had more frequently larger numbers of plantains planted than women (Fig 3). Most fields were close to the village yet a considerable proportion of fields were farther than 30 min walk (estimated 3 km) away from the home. Some fields required more than 2 h walking to reach (Fig. 4).

Procurement of Planting Material

Eighty-two percent of the farmers exclusively used their own suckers and did not purchase or trade suckers. Ninety-one percent of the farmers used suckers from their own older plantations, which were almost exclusively old 'essep' (forest) fields (98%). Six percent of the farmers traded suckers with neighbors and friends, 3% exclusively used this source of suckers. 13% purchased suckers with 5% using exclusively purchased suckers. Two sources of planting material were used by about 9% of the farmers.

Cultivars

A total of 32 cultivar names were reported: 18 were classified as French plantain, seven as False Horn and six as True Horn, all of the AAB genome. However, there is a risk that due to language differences the same cultivar was quoted more than once. All farmers usually grow a mix of cultivars. However, 15 farmers could not name any cultivar present in their fields due to uncertainty and 11 had currently only one cultivar planted. Most frequent was a mix of four cultivars (32%) and mixes of three to five represented 78% of all fields (Fig. 5). The most frequently grown cultivar is 'Essong' (85%), a Giant French, followed by 'Ebang' (78%), a False Horn, 'Elat' (76%), a Medium French and 'Assanda' (29%) a True Horn.

Crop Management

Of the farmers, 16–18% amended the planting hole with materials believed to benefit plantain growth such as ash from previous burning and unburned biomass. Thirty-five percent of the farmers fertilized the plantain while growth, mainly by mulching with weeds. One farmer applied fertilizer.

Plant Health Management

Pesticides, including local preparations such as ground manganese-carbon batteries were applied at planting by 4% of the respondents. Purchased pesticide of a known brand and active ingredient was used by two farmers. About 6% of the farmers did not quote any quality criteria by which to select suitable suckers. At least one quality criterion was used by 84% of the farmers and 10% used two criteria. The most frequently quoted criterion was absence of banana weevil (*Cosmopolites sordidus*) galleries (65%), followed by: good growth of the sucker (27%); a white bulb (6%); absence of disease (1%); and absence of rotting tissue (one farmer). No specific disease was mentioned. One farmer mentioned absence of nematodes.

Suckers were planted without any treatment by 91% of the farmers, 8% treated the suckers in some locally designed way, largely by rolling the sucker in wood ash after the removal of the roots. The treatment is believed to kill banana weevils. One farmer pared all suckers. Most farmers (94%) kept the suckers for some days before planting, 28% planted immediately with 22% either keeping or planting immediately, depending on the situation. Most farmers planted suckers with a vertical orientation (79%) and 48% planted suckers at 60–45° inclination, with 27% of the farmers using both methods.

Perceived Constraints to Plantain Production

Farmers encountered the following problems in plantain fields: uprooting (after flowering); pseudostem break; plant death (before flowering); plants with a bunch but no green leaves; poor plant suckering; and other, nonspecified problems, which were all of abiotic nature. Generally women encountered problems more frequently than men (Fig. 6). Only 3% of the farmers experienced no problems at all, followed by 4% who encountered only one of the problems (Fig. 7), while a majority of the farmers had at least

three problems concurrently. Most farmers estimated that less than 10% of plants were affected by the three main problems causing yield losses (Fig. 8). However, the types of damage had different distributions, plant death had a strong bias towards the lower proportions of affected plants, i.e., affected fewer plants than pseudostem break and uprooting. Uprooting had a distribution less biased towards low proportions of affected plants indicating that more farmers observed uprooting of a relatively large proportion of plants. Crosschecking these estimates revealed that 7% of the farmers had combined losses of over 100%. Sixty percent of estimates were below 50% losses and 33% of estimates ranged between 50 and 100%. The estimated overall loss of yield was 49%, with slightly lower losses reported by men (48%) than by women (52%). However, only 81% of the farmers gave an estimate of overall losses.

Of the farmers who encountered the above problems 94% used suckers from uprooted plants, 91% used suckers from plants uprooted before flowering, 83% used suckers from plants with a broken pseudostem, 66% used suckers from plants that had died before flowering, 62% used suckers from plants with a bunch but no green leaves, and 23% used suckers from plants with poor suckering.

Only one respondent quoted nematodes as reason for plantain uprooting. Most often high winds followed by a range of reasons such as bad soil, drought, excessive rain, insufficient planting hole size and soft soil were quoted. Farmers uniformly attributed pseudostem break to banana weevil attack. No specific reasons for any of the other causes of yield loss were given.

Only 44% of the farmers gave reasons for low yields. Poor soils, followed by lack of maintenance (weeding) and insufficient means (labor and capital) were quoted most often (Fig. 9). Reasons for high yields were given by 41% of the farmers, with most of them attributing good yields to good soils, followed by regular maintenance (weeding). Use of pesticides, technical knowledge and the use of supports to prevent uprooting and breaking were not perceived as contributing factors to high yields.

Labor, Costs and Commercial Aspects

Family labor is the dominant means of establishing and maintaining plantain fields (93%). Hired labor (1%) and communal labor (6%) contribute marginally. Farmers identified and allocated costs (Fig. 10) to six major operations in plantain cropping and maintenance. For all operations, the no cost category was quoted the most often. Tree felling was least often reported to be at no cost. For digging holes and planting a small proportion of farmers reported relatively high costs, probably reflecting the few farmers planting large fields and the requirement to do this work relatively fast, i.e., with hired labor. Weeding was quoted most often in the no cost and in the lowest cost category.

Most farmers grow plantain primarily as a cash food crop (56%), with men having a stronger commercial orientation (64%) than women (45%). Growers with a commercial interest had more plants/field than those who grew for consumption. Consumption orientated growers had a strong varietal preference for ‘Elat’ and several false horn types. Commercially orientated growers preferred ‘Essong’.

DISCUSSION

Plantain production is characterized by low external (purchased) input due to the perceived high cost of pesticides and fertilizer and the lack of knowledge on their profitable use (Büttner, 1996; Büttner and Hauser, 2003). For Southern Cameroon no pesticide based plant protection systems or recommendations exist. Fertilizer response curves were not established and consequently there are no reliable fertilizer recommendations. Thus farmers use forest land perceived to have superior properties to support plantain growth. As a consequence plantain production, although in many cases used to introduce a long term perennial crop, has to be considered one of the driving forces of deforestation. The alternative to cost and labor intensive forest clearing, using young fallow, and compensating for the lower soil fertility by input use is obviously not an option as farmers clearly prefer to invest heavily in clearing labor, rather than saving

on labor and investing in inputs.

Where young fallow land is used to grow plantain, this happens in an opportunistic way with plantain as a minor intercropping component. The system is largely used by women, who plant fewer plantains than men and who encounter higher losses than men. It appears that the given preferences are confirmed by the fact that the fallow age is the major criterion for choosing land for plantain and that perceived fertility of the soil plays a minor role. Considering that transport costs can be as high as 60% of the final plantain price in an urban market (Ntsama Mbarga, 2006), the option of using young fallow, which is frequently found in urban vicinities may be a major task for future research. Road infrastructure is weak and production close to markets, as already exercised by those who do roadside cropping, will give farmers a higher proportion of the urban market prices. Thus research on fertilizer use on the less fertile soils combined with efficient weed control measures may offer options to farmers in urban vicinities and contribute to preservation of forest. There is no data or experience on any of the other systems to assess their productivity in comparison with the typical forest fields.

The land preparation is still at a very low level of mechanization with only chainsaw work being of importance. Here however, it has to be considered that mechanization options, apart from heavy machinery use (bulldozer), are very limited when establishing fields in the forest. Accordingly labor saving is a major feature of all following operations, such as digging planting holes which is apparently more oriented at the size of suckers rather than an appropriate standard size. On the other hand there are no published results on the effects of planting hole size on plantain yields. Burning of the biomass, partially twice is an indication that biomass management in any other form is not beneficial or not affordable. Another explanation for the frequent use of fire is the potential of weed control through severe burns (Hauser, 2006), which may help reduce the weeding requirements in the first months after establishment. Farmers do draw almost exclusively on family labor to establish and maintain plantain operations, which may limit their access to labor forcing to minimize labor investment. The strong bias of the distribution of distances to the fields towards the shortest distances further confirms farmers' labor minimizing efforts.

Crop management and varietal choice indicate that farmers cater for both home consumption and sales. Because the cultivars preferred for consumption are different from those preferred for sales fields contain a mix of cultivars of different fruit quality and length of growing period. This was informally explained by wanting to have bunches for both purposes over a long phase. However, farmers do not seem to consider that weeding needs to be continued in a field irrespectively of how many plants have already produced. It may be more efficient to establish within one field areas with only one cultivar to meet the specific needs of cultivars and to terminate all labor once the majority of plants of one cultivar has produced. Thus separation of cultivars may be a future research and dissemination matter. Many of the true and false horn cultivars are relatively small compared with the giant French types and could be planted at higher densities which would, at the same number of plants reduce the area to be weeded. However, suckers and young plants of different plantain cultivars cannot be distinguished and farmers do not exactly know what cultivars they planted, which explains partially the fact that some farmers could not quote any cultivar currently planted in their fields.

Crop management is opportunistic, using in situ provided materials while purchased inputs are virtually absent. This is not a specific feature of plantain systems but a general feature of Southern Cameroonian agriculture (Büttner and Hauser, 2003), with the exception of some high value vegetables in peri-urban systems (Gockowski and Ndoumbe, 2004).

Plant health management is based on opportunistically provided materials without proven efficiency (ground manganese-carbon batteries and rolling of suckers in ash). The results indicate a lack of specific knowledge and awareness of pests and diseases specifically nematodes, their symptoms, their effects on plantain and the process by which plants are infected. There is no awareness that some pests and diseases are

propagated with the suckers. Efficient farmer education and introduction of efficient and easy methods to clean planting material appear to be of very high importance.

Farmers were not certain on the reasons for good or bad yields. This is surprising as one would expect that there is wide spread indigenous knowledge or at least believes on such matters. The majority of those who had an opinion were convinced that soil quality has the major impact, followed by weeding. There are indications that soil chemical properties have very little if any effect on bunch yields (Hauser et al., 2008) but other soil properties could be decisive in yield formation. For Cameroon no data on such factors could be found. The importance of regular weeding seems well known yet farmers do not take seriously the risk of yield loss through weeds. The investment in weeding is virtually zero (Fig. 10). Because there are no data on yield loss caused by weed competition in Southern Cameroon, new research will need to produce recommendations on optimal weeding frequency and methods.

CONCLUSION

Plantain cropping systems in Southern Cameroon require major inputs from research and extension services since farmers' awareness of pest and disease symptoms, and infestation pathways need to be improved. The commercialization of the crop has potential, yet farmers have not adjusted their planting pattern and cultivar choice to cater to the market and to reduce the labor requirements for field maintenance. Extension services should help with the introduction of simple agronomic measures to improve production, while basic research on fertilizer density and weeding frequency responses is needed to increase the profitability of the systems. Alternative systems to those based on forest clearing need to be developed in the long term to ensure sustained production.

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Figures

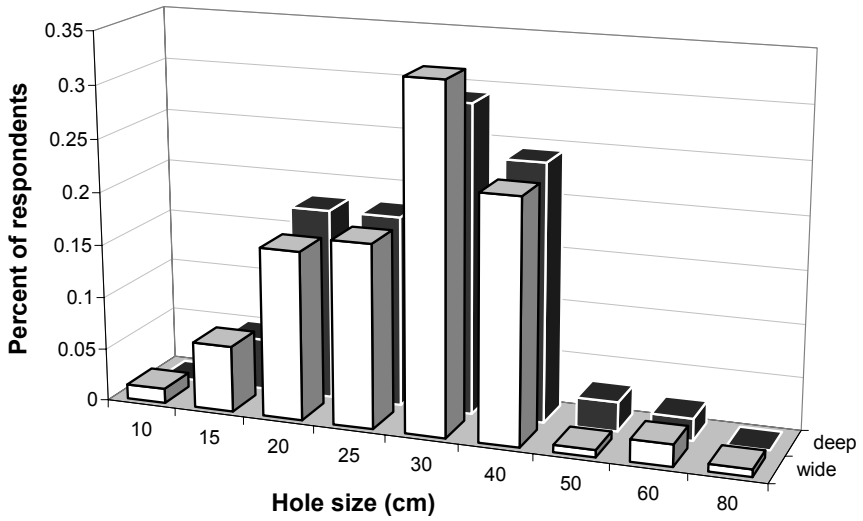

Fig. 1. Distribution of responses on planting (*Musa* spp.) hole size for plantain in Southern Cameroon.

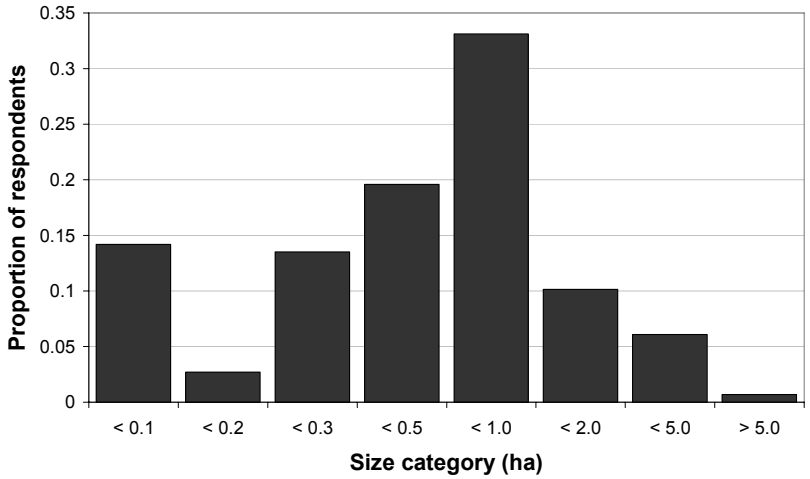

Fig. 2. Distribution of plantain (*Musa* spp.) field size in Southern Cameroon.

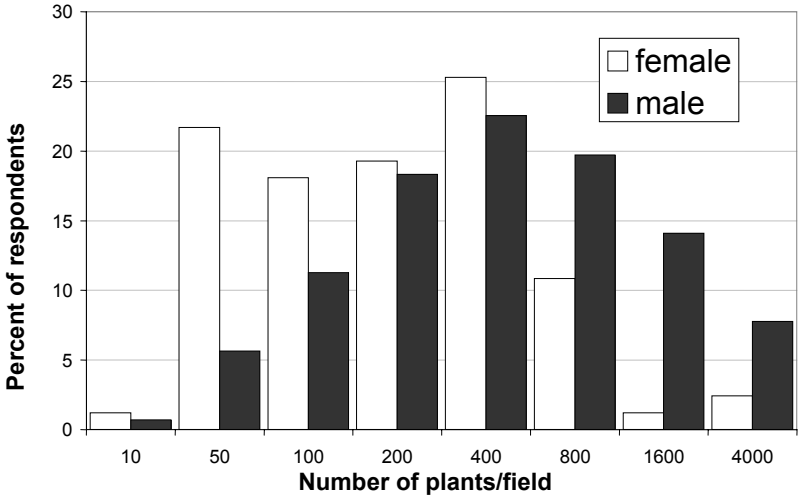

Fig. 3. Frequency distribution of the number of plantains (*Musa* spp.) planted in a single field by men and women in Southern Cameroon.

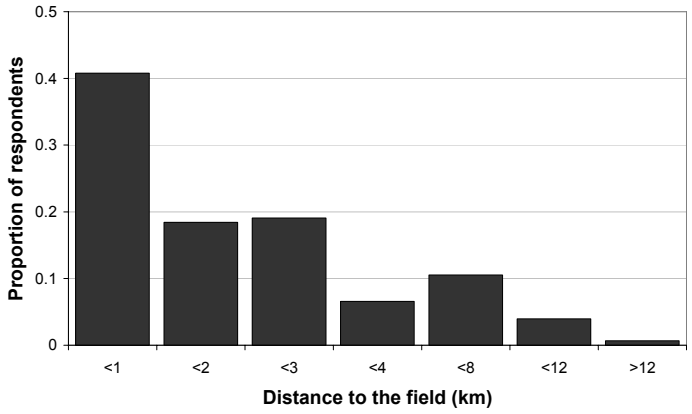

Fig. 4. Distribution of distances between homestead and plantain (*Musa* spp.) fields in Southern Cameroon.

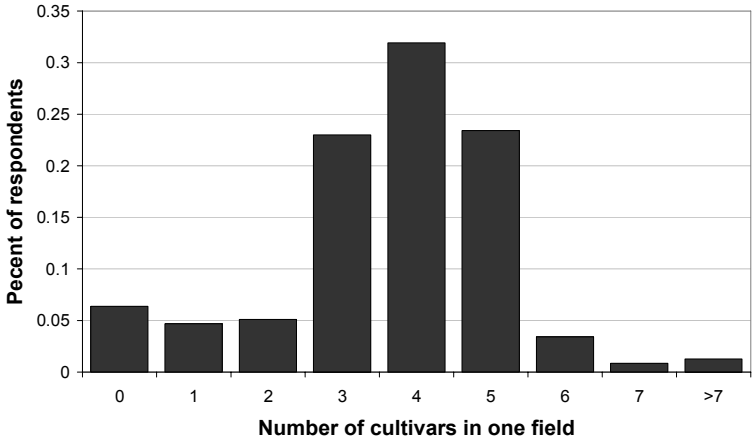

Fig. 5. Frequency distribution of the number of cultivars mixed within plantain (*Musa* spp.) fields in Southern Cameroon.

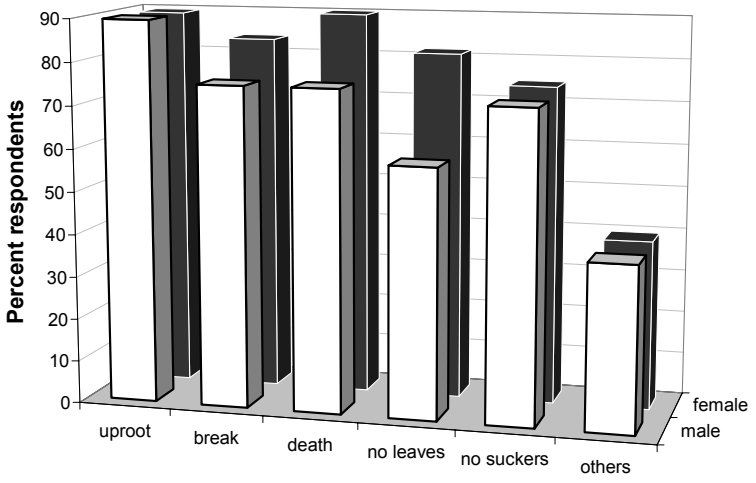

Fig. 6. Frequency distribution of production constraints encountered by male and female plantain (*Musa* spp.) growers in Southern Cameroon.

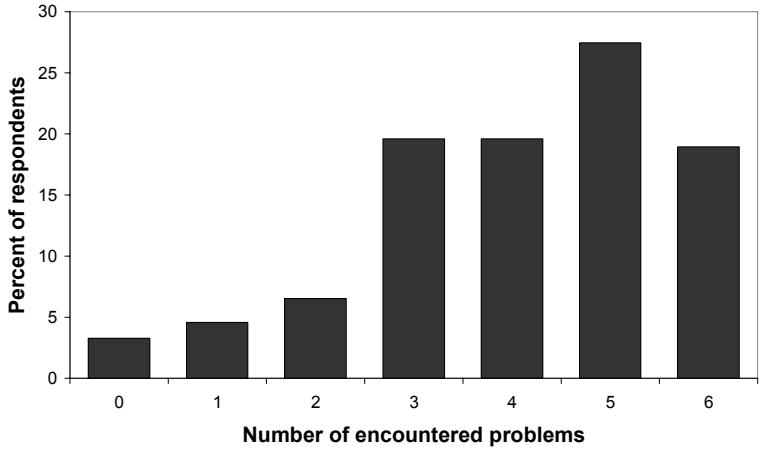

Fig. 7. Frequency distribution of the number of different problems encountered by plantain (*Musa* spp.) growers in Southern Cameroon.

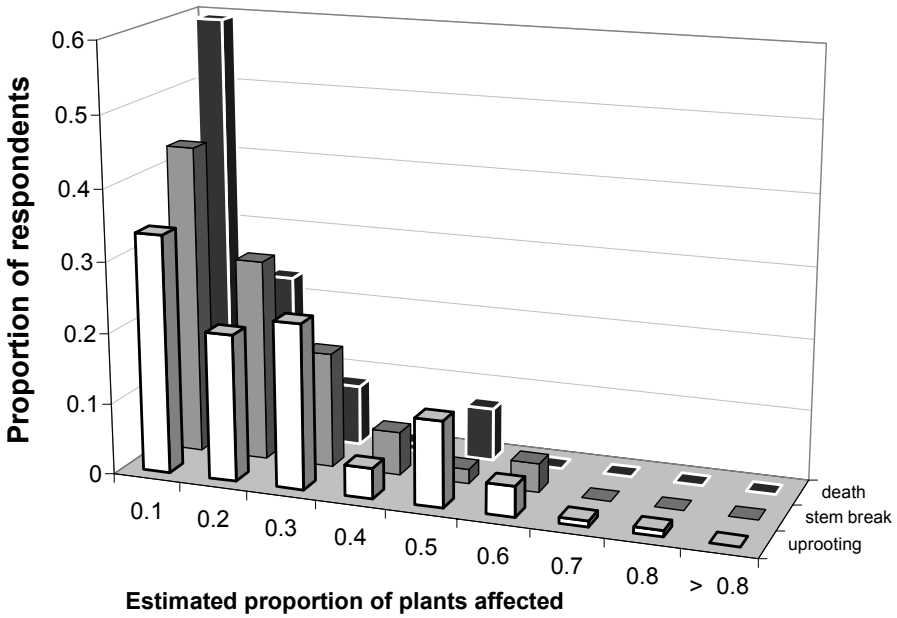

Fig. 8. Frequency distribution of the estimated proportion of plantains (*Musa* app.) affected by uprooting, pseudostem break and death in Southern Cameroon.

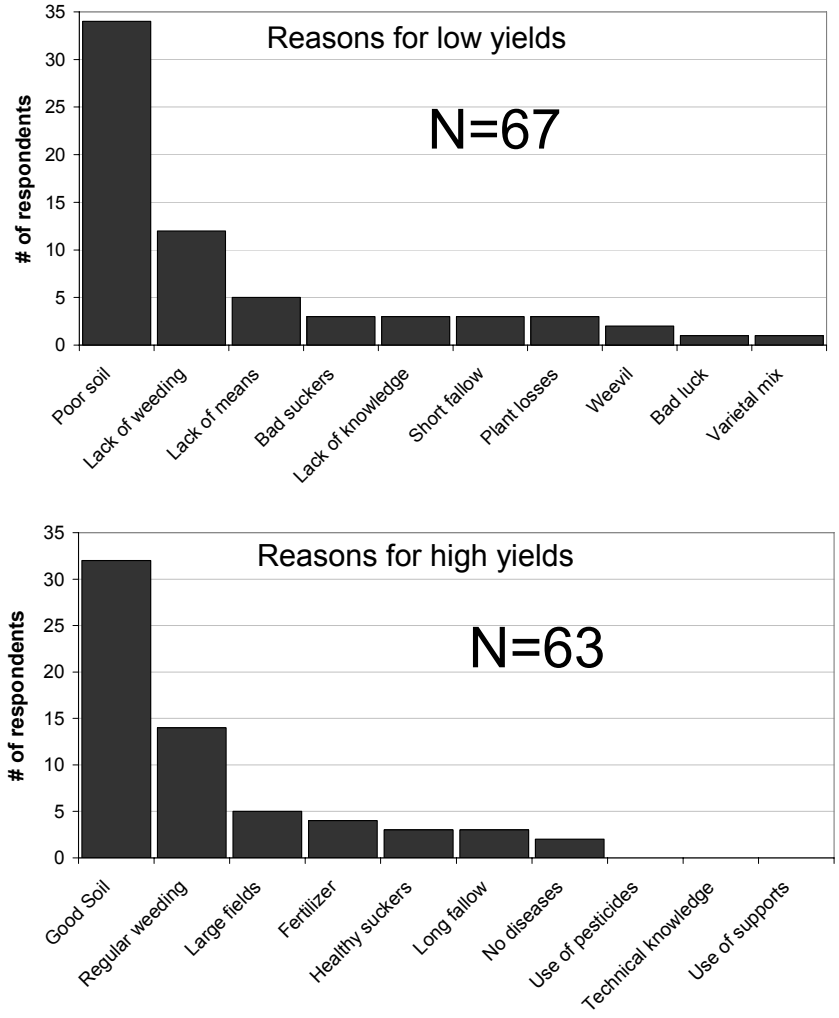

Fig. 9. Frequency distribution of perceived reasons for low yields (up) and high yields (down) of plantain (*Musa* spp.) in Southern Cameroon.

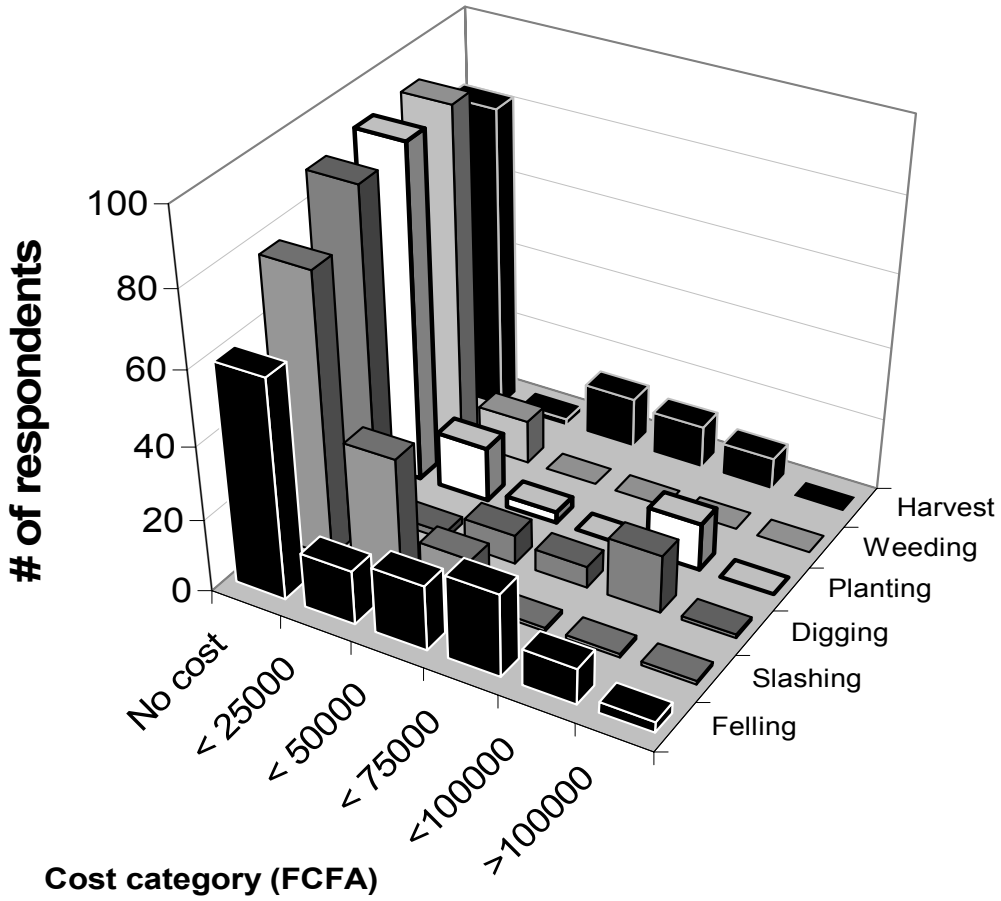

Fig. 10. Frequency distribution of cost categories for the major operations in establishment and maintenance of plantain (*Musa* spp.) fields in Southern Cameroon. 696 FCFA = €1.