Agrodiversity of Banana (Musa Spp) production in Bushwere, Mbarara district, Uganda

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Abstract:

A study was carried out in Uganda PLEC-site of Bushwere to establish an inventory of banana biodiversity, assess the effects of biophysical and management diversity on banana cultivation.

Banana was found the most important crop as major source of food and income for farmers. Banana plantations covered about 33% of household land area, which was above national average per homestead. About 38% of plantations were planted near homesteads mostly on hilltops and backslopes of the landscape. A total of 30 varieties were identified in 24 field types in the study area, with more varieties on older than recently cultivated plantations. Management interventions included soil and water conservation and various ways of organic inputs management. The cropping system was found to be sustainable with the greatest agrodiversity compared to other systems.

Introduction

Banana growing in Uganda dates way back to 13 A.D (Karugaba and Kimaru, 1999). It has been sustained by the cultural, social and economic values that the Ugandan peoples attach to the crop and the naturally sufficient rainfall and good soils in areas that grow it especially the central, southern and southwestern regions of the country. Growth of the banana industry has been achieved through expansion of land area of production. Uganda is often referred to as a Banana Republic, producing 8.6 million metric tonnes (30% of world's production) and is a leading banana producer and consumer in the world (Rubaihayo, 1991). Ninety percent of what is produced is consumed locally.

Uganda banana industry supports many different people including 75% of farmers (Ministry Agriculture, 1989), traders, transporters, hotels and restaurants and breweries. It therefore contributes greatly to government revenue especially through taxation. There are several species of bananas grown in Uganda including *Musa sapienta* and *Musa paradisca.*. The *Musa sapienta* species is the most diverse in varieties and is the most widely spread. According to Karamura (1994) Uganda has over

100 cultivars of bananas, implying a rich genetic resource. However, increasing population pressure on land resources, socio-economic transformations like preferences by markets and biophysical factors particularly in hilly and mountainous areas seem to pose threats to the expansion and agro-biodiversity of bananas while at the same time increasing diversity in management aspects. There is also a lot of diversity in distribution of these cultivars, according to farmer and market preferences. Management of the banana crop also varies between farmers. This paper outlines the rich biological, biophysical and management diversity recorded in banana production in Bushwere demonstration site, Mwizi sub-county, Mbarara district.

Overall objective

To establish the agrodiversity potential of banana growing in a rugged highland area

Specific objectives:

To assess the effects of biophysical diversity on banana biodiversity

To inventory the biodiversity found in the banana based field types: Establish the inventory of banana biodiversity based on identified field types.

To establish the management diversity of banana cultivation

Methodology:

The detailed methods and materials were as described in PLEC News and Views No. 14 (Nov. 1999) which are summarized in the following steps:-

Sample area selection considering landscape diversity, age of plantation and cooperation of participating households.

Agrodiversity assessments on $20m^2$ plots and entire plantation if very small. The assessment included; identification of clones by local expert farmers, counting stools of each clone and other components as outlined in Biodiversity Advisory Group (BAG) quidelines were assessed on $5m^2$ and $1m^2$ plots. Informal discussions were also carried out in the field with household members of participating farmer or owners of the fields in order to capture the organizational diversity, management regimes and utility of the biodiversity found in the sample area. Data obtained were analyzed using SPSS and Excel computer packages.

Results and Discussions

Importance

Banana is a major food and cash income generator for Bushwere PLEC site. Every household in the area has at least a piece of land under banana cultivation. This makes the crop to be increasingly taking up more land coverage from other crops as numbers of households increase. The average banana hectarage per household was 0.5 ha which is 33.3% of the cultivable land available to each household (Figure 1). This is slightly above the national average proportion cultivable land under banana growing (30%) according to UNEP (1990). This can be attributed to the crops ability to sustain food supply and at the same time earn household income all the year around. As indicated in figure 2, banana ranks highest (23%), followed by beans (22%) and Irish potatoes (15%). Minor crops (19%) include several different crops like ground nuts, field peas, soya beans, pineapples, tomatoes, cabbages and sugar cane in terms of contributing to household income.

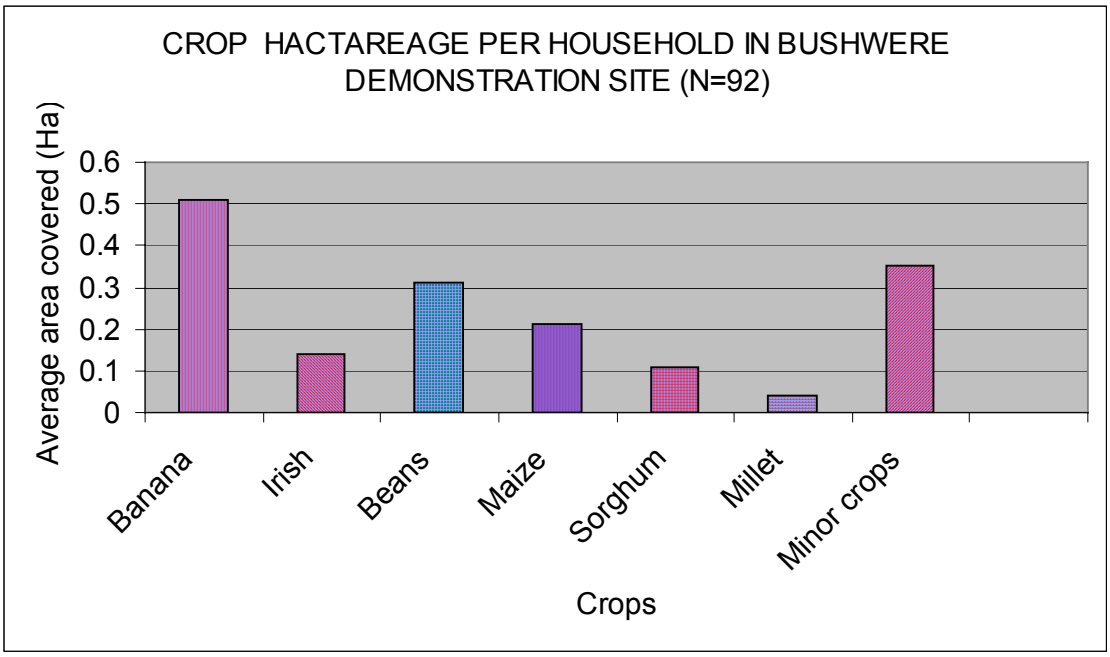

Figure 1: Average crop hectarage per household in Bushwere (N=92)

Figure 2: Contribution of different crops to household income (N=92)

Spatial Distribution

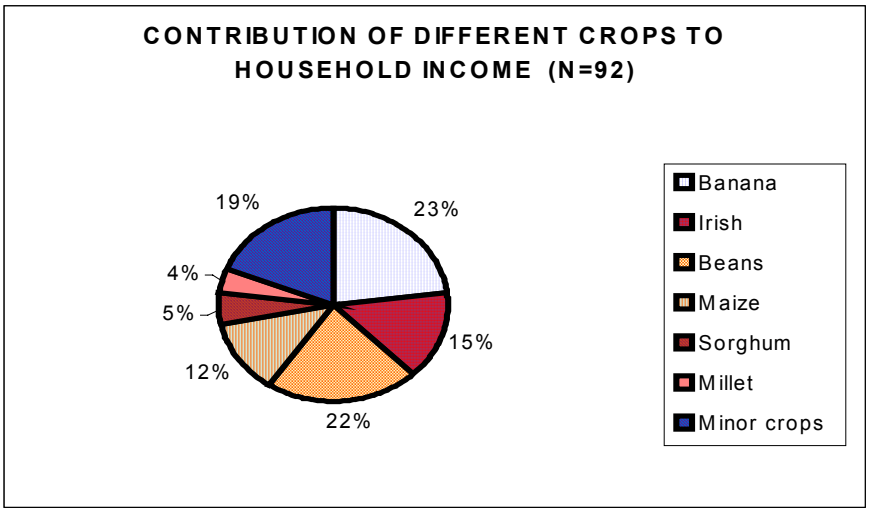

Figure 3 shows relative distance of the plantations from home. Majority (38.2%) of them are just near home within a distance less than 500m while 23.5% are far from home and few (14.7%) are very far i.e. beyond 1km from home.

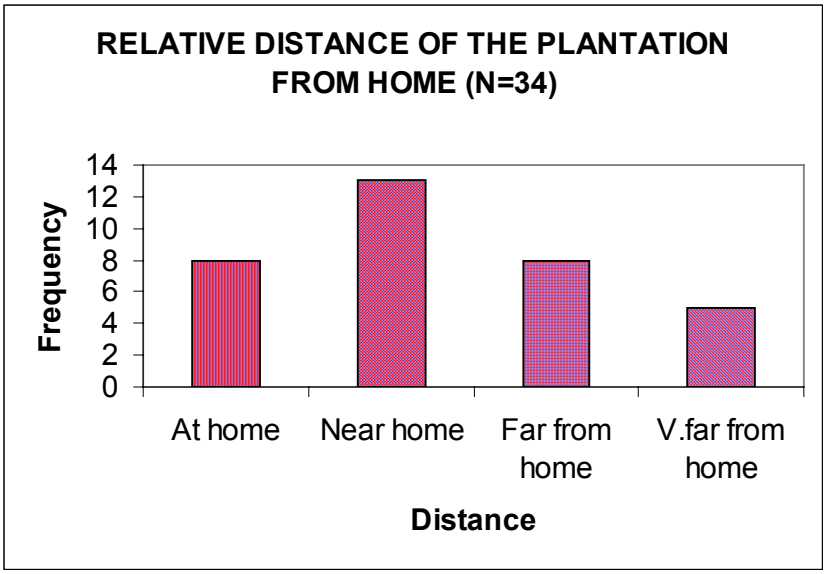

Figure 3: Relative distance of banana plantations from home (N=34)

Table 1 gives spatial distribution of banana plantations by landscape types. It is important to note that banana crop is grown on all landscape types: hilltops, back slopes and valleys. Majority (40%) were found on hilltops, 37% on back slopes and 23% in valleys.

Table 1: Banana gardens distribution by landscape (N=57)

Age groups (years)	**Number of plantations**			
	Hilltop	**Back slope**	**Valley**	**Total**
≤ 2	1	4	0	5
3-5	5	2	0	7
6-10	4	1	0	5
11-20	3	5	0	8
21-40	3	6	4	13
< 41-45	7	3	9	19
Total	**23 (40%)**	**21 (37%)**	**13 (23%)**	**57 (100%)**

The plantation in valleys are all over 20 years old. Recent expansions extend to the back slopes and hill tops in response to population growth. Younger families migrate to hill tops and backslopes, and as indicated in figure 1 and figure 3, every new household puts up a banana plantation and preferably as near the homestead as possible.

Diversity of varieties/clones

Functional Grouping

Farmers grouped banana varieties* of their area into four groups using the functional properties which were later scientifically matched with genome categorization as indicated in Table 2. Distinguishing features of the different groups and genomes were described by Karamura and Pickersgill (1999).

Table 2: Farmers' grouping of banana varieties* and their scientific genome categories (N=57).

Functional group	Utility	Genome	Group name in Bushwere	No. of cultivars*
Cooking banana	Steamed (matooke) Boiled (katogo)	AAA-EA	Enyamwonyo	39
Beer type	Juice, beer & dry gin from ripened fruit.	AB ABB AAA-EA	Kisubi Kayinja & Musa Embiire (Mbidde)	1 2 7
Dessert banana	Eaten ripe	AB AAA (Gros michel) ABB	Kabaragara (Ndizi) Bogoya Kisamunyu (Kivuvu)	1 1 1
Roasting type	Roasted green or ripe	AAB	Gonje (Gonja)	1

*The terms "varieties", "clones" and "cultivars" are used interchangeably.
Names in brackets are equivalents in Luganda dialect (Karamura, 1994).

Abundance of different Varieties

Table 3A shows the list of varieties and their abundance, encountered in the sample areas of 57 farms. There are at least 53 varieties, 11 of which are widespread, in almost every plantation and over 12 are rare or very rare to find. The rest shown in table 3B were reported as also occurring in Bushwere parish, but were not encountered in the sample. Most abundant and widespread of varieties were 7-10 of the cooking, 2-3 of the

juice/beer, and only one of desert (kabaragara) types. On national level, there are over 131 varieties of which the juice/beer, desert and roasting varieties constitute 35 varieties and the rest are cooking type Rubaihayo, 1989 quoted by Muranga (1998).

Enshenyi cultivar is most dominant in the area because of the cultivars special ability to give high numbers of suckers so that as farmers look for planting materials the Enshenyi is picked more frequently than the rest.

Farmers reported that Enshenyi gives a normal sized big bunch that is acceptable both at home and on the commercial market. Availability of planting material and acceptability of the bunch size and quality were the main factors for selection, except a few cultivars like Oruhuna and Enzinga which have some cultural values and are thus purposefully grown by a few people who have such knowledge. Outside the varieties observed in 57 sampled farms in Bushwere, …..more varieties were mentioned to exist outside the sample farms.

Table 3A: Banana cultivar abundance in Bushwere (N=57)

Banana cultivar (Local names)	Av. No. stools/400 m^2	Distribution in village
1. Enshenyi	28	****
2. Embiire (enkara)	9	****
3. Kabaragara	4	****
4. Enzirabahima	4	****
5. Enjagata	2	****
6. Embiire (entukura)	2	****
7. Entaragaza	2	****
8. Enzirabushera	2	****
10.Rwamigongo	2	****
11.Enyaruyongo	2	****
12.Nyakyetengwa	1	**
13.Makunku	1	**
14.Embururu	1	**
15.Enyarukira	1	**
16.Embiire (enyabutembe)	1	**

17.Butobe	1	*
18.Kayinja	1	*
19.Nyakinika	>1	Very rare
20.Embiire-engumba	>I	Rare
21.Mujuba	>1	Rare
22.Kaitabunyonyi	>1	Rare
23.Bogoya	>1	Rare
24.Burikwezi	>1	Very rare
25.Embiire-engoote	>1	Very rare
26.Kisamunyu	>1	Very rare
27.Musenene	>1	Very rare
28.Enzinga	>1	Very rare
29.Gonje	>1	Very rare
30.Katwaro	>1	Very rare

Wide spread= found in almost every plantation; **Common= found in about 50% of plantations; Occasional= found in 1 to 2% of plantations; Rare and very rare= found in less than 1% of plantations

Distribution of clones in different farms

The survey indicated that all plantations generally have a high number of clone; more than 18, but older plantations (over 20 years of age) have higher number of clones than the younger ones. This implies that probably younger generations are becoming more selective in choice of cultivars to grow. Alternatively, it could be an indication that some varieties are disappearing and thus becoming rare.

Figure 4: Distribution of clones by age groups of plantations (N=57)

Table 4: Proportion of "useful" species per field type in Bushwere demonstration site

FIELD TYPE	**NUMBER OF SPECIES**		
	TOTAL	USED	PROPORTION (%) USED
Beans/Maize/Banana-Hilltop	35	12	34
Banana (Trenches + Grass strips)-Ravine	64	21	33
Banana/Beans/Maize/Coffee-Backslope	55	18	33
Beans/Maize/Banana-Ravine	79	24	30
Cymbopogon/Loudentia-Hilltop	75	22	29
Irish potato/Beans/Maize-Hilltop	68	19	28
Beans/Maize-Hilltop	49	13	27
Banana (Trenches + Grass strips)-Backslope	54	14	26
Beans/Maize-Backslope	64	16	25
Maize/Beans/Cassava-Hilltop	72	17	24
Banana/Beans-Backslope	42	10	24
Sorghum/Maize-Backslope	99	22	22

Banana/Beans-Valley	43	9	21
Irish potato/Maize-Backslope	82	17	20
Irish potatoes-Hilltop	60	12	20
Maize/Beans/Cassava-Backslope	75	14	19
Irish potato/Maize-Hilltop	52	10	19
Bananas pure-Valley	72	14	19
Peas-Backslope	59	11	19
Millet/Maize-Backslope	55	15	15
Peas-Hilltop	58	7	12
Combretum/Hyperrhenia/Cymbopogon-Hilltop	88	9	10
Pteridium/Combretum-Backslope	86	8	9
Loudentia/Hyperrhenia-Hilltop	62	4	6
Total	**270**	**50**	**19**

The data above implies that the highest total number of plant species (99) was encountered in the sorghum based field type followed by the natural vegetation field types. The lowest total numbers of species diversity (35) were in the beans/maize/ banana field type [and other Banana-based field types (42-64)], which are grown in clean tilth gardens and carefully and frequently weeded in order to maximize crop yields. Banana and beans are both very sensitive to any competition. This re-emphasizes the effect of management on species richness, as discussed earlier. On the other hand, the highest proportion of "useful" species (i.e reported as being used by individual farmers are found in Banana based field types 30-34% which probably shows that there is deliberate conservation of useful species by the farmers in banana fields.

Management diversity

Management of banana plantations in Bushwere is dominantly through by soil and water conservation, mulching, weed management, soil fertility maintenance and intercropping.

Soil and water conservation

Despite the high susceptibility of the plantations to soil erosion resulting from common runoffs due to the steep sloping nature of the land, many farmers (58.8%) are not practicing any form of soil and water conservation. However, there is evidence that some

people (33.8%) have constructed soil and water conservation trenches in their plantations. Diversion channels and soak pits are used by few farmers.

Mulching

Use of materials from other biodiversity like crop residues and grass is not common (20% and 18% respectively). Instead almost all the banana plantations are self-mulching (banana leaves and fibres). No mulching (27%) was recorded in young plantations which were still being intercropped with annual crops like beans, maize and millet. Talking with farmers revealed that grass and other mulch materials are not available to most people. Even use of crop residues as banana mulch is constrained by the long distances between annual crop fields and the banana plantations. The few 20% mulched with crop residues are most likely to be those near home-steads since threshing of crops like beans and peas is done at home. The residues are thrown in banana plantations that are nearby

Weed management

Table 5 shows the several ways of weed management in banana plantations. Both heaping and scattering weeds in the plantation are equally commonly practiced (38.2%).

Table 5 Weed management practices in banana plantations (N=68)

Weed management practices	**Frequency**	**Percentage**
Heaping	26	38.2
Scattering	26	38.2
Burying	4	5.9
Removing from plantation	12	17.7
Total	68	100

Farmers reported that heaping is practical mostly during the rainy seasons and for stubborn weeds like commelina to speed up rotting and reduce frequency of weeding. Scattering is done during the dry seasons when drying of weeds is rather rapid and sprouting problem minimal. Some people 5.9% dig ditches and bury the stubborn weeds like commelina, turning them into manure. The microclimate under banana crop is humid and conducive to vigorous growth of many weeds. Farmers being aware of this fact and also being concerned on the need to maximize banana yields, since the crop is

particularly important to them (for both cash and food security) they take weed control to be a major activity. They also take advantage of this microclimate to conserve other useful biodiversity in banana plantations as indicated in table 7, above

Few farmers (17.7%) removed weeds from plantations, because most farmers appreciate the fact that dead weeds contribute to manure and mulch, thus recycling plant nutrients to feed the banana crop.

Soil Fertility Management Practices

Majority of farmers (38%) have no means of maintaining soil fertility on plantations (Table 6). Application of crop residues and domestic rubbish as manure to the plantations are equally commonly practiced (14.7%). Use of both farmyard manure from livestock sheds and compost use were equally minimal (4%) in the study area. Most farmers do not own cattle and the few who have keep them on open grazing system just like the goats and chicken. They therefore do not have much manure to use. Only a few progressive farmers, including the PLEC demonstrators like James Kaakare, Fred Tuhimbisibwe, Charles Byaruhanga and others have learnt to make compost manure through interaction with ministry extension worker or PLEC demonstration activities or farmers associations that they belong to. Even these farmers complain that availability of different biodiversity in adequate amounts to make good compost manure is a big constraint.

Table 6 Soil Fertility Management Practices (SFMP) in plantations (N=68)

SFMP	**Frequency**	**Percentage**
Application of crop residues	10	14.7
Use of farm yard manure	3	4.4
Application of domestic rubbish	10	14.7
Use of compost manure	3	4.4
No SFMP	26	38.2
Total	**68**	**100**

Intercropping

While at landscape level, Bushwere seems to increasingly become covered by banana crop, this study found out that there are about 12 major intercrop types in the banana plantations (Table 7). These make up 73.5% of all banana plantations in the area. Only 26.5% is of the pure banana stand. Table 9 shows that Banana/Beans was the most common (26.5%) banana intercrop field type, followed by Banana/Coffee (11.8%), Banana/Beans/Maize (10.3%), Banana/Beans/Irish potatoes and Banana/Coffee/Beans/Maize (each with 5.9%), and Banana/Beans/Peas/Coffee (4.4%). The rest of the intercrops were equally occasional (1.5%).

Table 7 Major types of intercrops in banana farming and their distribution (N=68)

Intercrop type	**Frequency**	**Percentage**
Banana/Beans	18	26.5
Banana/Coffee	8	11.8
Banana/Beans/Maize	7	10.3
Banana/Beans/Irish potatoes	4	5.9
Banana/Coffee/Beans/Maize	4	5.9
Banana/Beans/Peas/Coffee	3	4.4
Banana/Beans/Maize/Cassava	1	1.5
Banana/Fruits e.g. Avocadoes	1	1.5
Banana/Coffee/Beans/Irish potatoes	1	1.5
Banana/Beans/Irish potatoes	1	1.5
Banana/Sweet potatoes	1	1.5
Beans/Sugar cane	1	1.5
Total	**50**	**73.5**

Discussion

Banana crop in Uganda is a typical example of biodiversity species which naturalise in introduced niches over a long period of time (approximately 2000 years). Ugandans have highly appreciated the banana crop such that almost every household grows it. The perennial nature and high cultivar diversity increases the crop's resilience (against droughts, hail storms, winds and declining soil fertility). This makes the crop play major

roles towards food security and income generation in homes, and subsequently to the national level/economy.

Bushwere demonstration site that was inhabited by people in early 1940s has about 54 banana cultivars, which are almost equally grown on every landscape position (hilltop, backslope and valley).
Management of the plantations in the site is mainly routine; pruning (leaves and fibres), desuckering and weeding. There is little done on improving and maintaining the soil fertility nor controlling pests (weevils and nematodes) and diseases. This coupled with low level of soil and water conservation is not good for sustainability of production of the crop particularly in such a fragile hilly area with very steep slopes. Lack of integrated management of plantations can lead to situations of loss of plants, especially susceptible cultivars of this important crop, from the area and /or decline in yields as it has been reported in central Uganda by Rubaihayo (1991).]

The above results, especially Tables 3,4 and 5 show that banana plantations even at the typically low levels of management, support a lot of biodiversity. Deliberate conservation of useful plant species is mostly done in banana based field types.

Deliberately conserved biodiversity is highest in banana system. The canopy structure in traditional banana plantations approximates the natural multi-storey system of tropical forests; similar to the Chagga homegardens of Tanzania. Most plantations, especially the well managed ones comprise of four storey levels as follows

Level 1: Tall trees e.g castor, avocado e.g. Mpiirwe

Level 2: Bananas and pawpaws

Level 3: Shrubs like red pepper, egg plants

Level 4: Short + creeping plants like tomatoes, cocoyams and amaranthus

Innovativeness in such a system promotes sustainable agro-biodiversity conservation.

Kaakare and a few others like Frank Muhwezi are skillful in spatial arrangement of different crops and plant species conserved in banana plantations. This reinforces the production system for instance several farmers in Bushwere plant *Musa paradisica* (Kabaragara) around the edges of the plantation for protection of cooking bananas against wind. Wind damage is a common problem in banana production of highland

areas. Pseudostems of *M. paradisica* are stronger than those of *M. sapienta* and especially the AAA-EA.

They also use other biodiversity species e.g Setaria, spp, cocoyams (amateyere) in stabilizing banks of soil and water conservation structures (trenches and soak pits) in bananas.

This is one of the reasons that the option of integrating stall feeding of livestock into crop (especially bananas) production has been more readily accepted by the PLEC collaborating farmers initially and others in general. This system encourages farmers to grow fodder species within and around the plantation. The byproducts of bananas like male buds, banana peelings are fed to livestock. In case of severe fodder shortage as in dry seasons, the pseudostems are chopped for cattle feeding. In return the cattle give farmyard manure to put in the banana crop for better nutrition and consequently higher banana yields. The household benefits from both livestock and banana crop through better feeding, and higher income. The example of such an integrated system is of James Kaakare, a PLEC demonstration farmer in Bushwere, who now boasts of better household welfare with his youngest daughter; 3 years old being bigger and healthier than his elder brothers and sisters. Unlike his first two daughters- now married, the younger five children all go to school.

Conclusion

The banana crop has rich genetic resource diversity. Banana based landuse stage has great potential that farmers can capitalize on for agrodiversity conservation and sustainable use. It however, requires technical skills in proper management including spatial arrangements, appropriate spacing of individual crops/plants relative to themselves and to others intercropped. It also required integrated pest and soil fertility management.

With the expansion of the banana culture and the national plan for modernization of agriculture which includes commercialization tendencies, efforts to maintain this agrodiversity of banana production are more crucial and urgent than ever before. Commercialization of crop production systems tends to lead to net nutrient export consequently resulting into drastic collapse of the ecosystem, if farmers are not adequately sensitized and facilitate to replenish nutriments with soil inputs. Integration

of livestock stall feeding into banana production is a promising option for enhancing, conserving and sustainable use of the already rich agrodiversity.

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