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Evaluation of farmers' best practices for on-farm conservation of rare banana cultivars in the semi-arid region of Lwengo sub-county, Uganda

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Abstract

Farmers have since humanity nurtured the plant genetic diversity from which they derive their livelihood and as a basis for social transformation. In the process they have been able to continually develop and improve management practices for the conservation of their genetic resources. The socio-economic transformations, however, come with negative impacts to the biological as well as to the cultural environment. These have irreversible effects on the genetic diversity in terms of genetic erosion and even total loss of populations. The farmers are in most cases overwhelmed by these impacts that they solely may not be able to continue with the critical practices for the conservation of the diversity. Institutional and policy support ought to join hands with farmers if these resources are to be sustainably utilised and enjoyed by the future generations. Support, however can only be mobilised after there is a clear understanding of which practices are important for the conservation of the resources. This study was to identify and understand the best practices for conservation of rare banana landraces in Uganda's semi-arid area of Lwengo sub-county, with an ultimate objective of promoting and supporting the practices through the relevant policy channels. Using the Four Square Analysis methodology a total of 66 banana cultivars were recorded in the sub-county. Out of these 19 were considered by the farmers to be rare cultivars. A total of 21 management practices were identified. The Principal Component Analysis (PCA) showed that out of the 21 practices 9 were very critical for the survival of rare landraces. The correlations indicate that only 8 of the 19 rare cultivars seem to have a direct relationship with the 9 practices, meaning that the 8 rare cultivars rely on particular practices out of the 9 for their survival and continued existence.

Key words: Farmers, Genetic diversity, management practices, *Musa* spp

Introduction

On-farm biodiversity conservation in which a farmer is taken as the main key conserver and user of genetic resources has attracted a great deal of research during the last decade (Jarvis and Hodgkin, 1998). A lot has been achieved in understanding the farmers' practices especially in terms of their inventory, improvement, dissemination and adoption (Brush, 1995; Zimmerer, 1996; Louette, 1999; Brookfield *et al.*, 2002). However, the current global concern is that the farmers' practices and crop or variety choices can rapidly change in response to market preferences and new introductions which may lead to loss of landraces. In spite of this, some farmers grow the modern cultivars without completely giving up traditional landraces (Brush, 1995; 1999). This could be attributed to the fact that the landraces possess certain valuable qualities such as better survival especially in marginal environments like arid or semi-arid areas, high protein content and/ or taste. At the same time these landraces and their wild relatives serve as the world's repositories of crop genetic diversity. Appropriate management practices that could be used by farmers in conserving the rare crop cultivars on their farms become a crucial matter.

Uganda has had a long tradition of banana cultivation dating back to the 13th century (Dale, 1955). The cultivation of this crop has become woven into the socio-economic and cultural life of the communities in East Africa at large. Bananas constitute a very important crop in Uganda, being grown by 75% of the country's farmers on 40% of the total arable land (Gold *et al*, 1999). It is a cash crop as well, contributing 8-22% of rural revenue (Bagamba, 1994). In terms of gross value of production, bananas are the fourth global food commodity after rice, wheat and milk. The crop has a high industrial potential through juice, local and assorted value added food

stuffs (Gensi *et al*., 1994; Aked and Kyamuhangire, 1996). Compared to other staple crops, bananas give the highest return in carbohydrate per caloric input (labour, manure, etc), while continuous fruit production ensures year round food security and income to farmers. Recent innovations have made the crop more profitable to the grower world wide. For instance, in Philippines, the most expensive clothing materials are made out of banana threads. This is a potential industrial area in which Uganda, as one of the world's largest producers (Third Monitoring Survey, Ministry of Finance, 1995/96) should invest. A number of studies, however, have revealed that poor management of banana plantations has caused severe yield decline (Rubaihayo *et al*., 1994b Gold *et al*., 1993; Bagamba, 1994) and this is likely to contribute to loss of the diversity there-in. Uganda is part of the secondary centre of diversity for bananas (Karamura *et al*., 1994, Karamura, 1998) where cultivars of different uses, different quality attributes as well as varying degrees of susceptibility to biophysical stresses have accumulated for years. Utilisation of the potential of this germplasm is only limited by our present understanding of the crop, thus the need to ensure that diversity is not lost for future use.

The hypothesis for this study was that over generations farmers have evolved practices that ensure retention of diverse cultivars in the farming system. The practices have been mentally documented and information verbally passed on from generation to generation. The study was to determine the 'best practices' for conserving rare cultivars in the semi-arid banana growing zone of Lwengo sub-county in Masaka district., with an understanding that conservation practices are those that are particularly used for rare cultivars. The ultimate goal of the study is to develop a framework for analysis of 'best practices' for conservation of banana landraces on-farm, and also determine those practices that can be promoted and even scaled up/replicated in other regions, where applicable, for purposes of ensuring that banana land races are conserved on-farm. The objectives of the study were to identify and understand the best practices for conservation of rare banana landraces in Uganda's semi-arid area of Lwengo sub-county with an ultimate intention of promoting and supporting the practices through the relevant policy channels. The other objectives were to determine the contribution of the best practice towards maintaining diversity and to determine whether there is a relationship between the cultivars and the practice.

Materials and methods

Site and Farmer selection

A number of criteria were used to select sites in different regions for this study. The criteria were to ensure that the aims and objectives of the study were adhered to despite the variability of different environmental surroundings of different sites. The criteria included; on-going on-farm biodiversity activities at the sites, accessibility, eco-regional suitability (semi arid), existence of farmer group organisations, and future applicability of results (beneficial to community). Lwengo sub-county lies in the semi arid area of Uganda, it has on-going INIBAP/NARO banana conservation activities (INIBAP, 2003), the farmers were already organised in farmer groups and this gave a good possibility for application of the results to benefit the community. Three villages were identified for household surveys together with the selection of participants for the group evaluation meetings. Through the mobilization of the sub-county extensionist, three groups each comprising of twenty people were formed. The groups consisted of old and young men and women from different village locations of the study areas. Each group participated in the study of evaluation of practices on separate days.

Evaluation of Practices

Through a participatory evaluation approach the farmers listed all the cultivars that they grow in the area including those that had disappeared. Two analyses were then carried out; the first one was the four square analysis (Figure 1) which involved farmers identifying rare and threatened banana cultivars. A chart was used with four squares appropriately labelled as a) variety grown by many households (represented by many houses) and on a large area in terms of acreages (represented by a big circle), b) variety grown by many households (represented by many houses) and on small area (represented by a small circle) c)

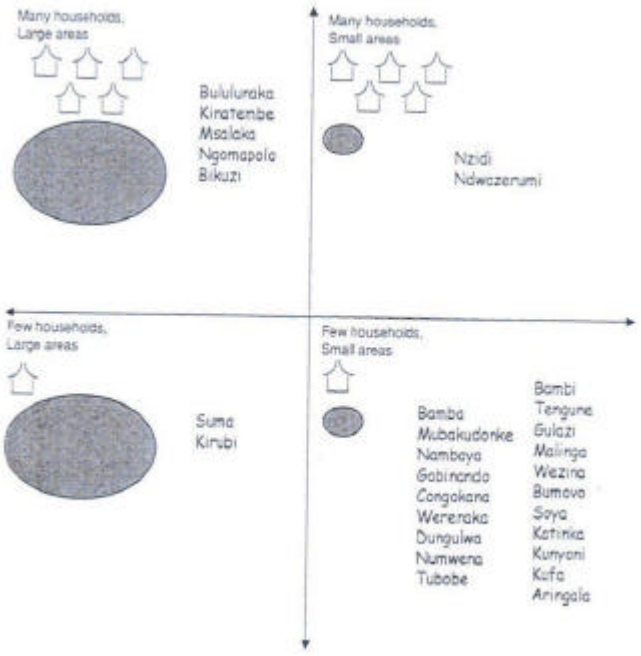

Figure 1. Four share analysis for identification of rare cultivars

Score Code		
Large area/ many households	–	Score 0
Large area/ few households	–	Score 1
Small area/ many households	–	Score 1
Small area/ few households	–	Score 3

variety grown by few households (represented by a few houses) but on large area (represented by a big circle), d) variety grown by few households (represented by a few houses) and small area (represented by a small circle). Based on their perceptions, farmers had to allocate each cultivar in the right location of the right square. Data obtained from the four square analysis was coded for each cultivar as below.

The second type of analysis was the best practice analysis which involved listing practices which farmers have been applying to maintain cultivars and particularly those used to conserve rare cultivars. This time scores were awarded to both the practice used to maintain the particular cultivar in relation to the distribution of this cultivar in the square analysis. Scores were not given to practices for cultivars that were grown by many farmers on large areas of land, since in terms of diversity, these cultivars were not considered threatened; neither were scores given to practices of normal crop husbandry or low importance, as such practices were not considered crucial to these rare cultivars. A score of three was given to a practice for each cultivar that is grown by few households on small areas of land and for which the practice was of high importance. A score of one was given to a practice for each variety that is grown by few households on large areas of land and for which the practice was of high importance. A score of one was given to a practice for each cultivar that was grown by many households on small areas of land and for which the practice was of high importance. The scores for each practice were then added up to have a score for the overall conservation value of the practice.The coded data was transformed for principal component analysis (PCA) to assess the value of the practices and to assess whether a relationship existed between cultivars and practices.

Results

A total of 66 cultivars were recorded as grown in Lwengo Sub-county, the analysis revealed 19 of these as rare cultivars (Table 1). The cultivars grown on large areas by many households were claimed by the three groups of farmers to be commercial cultivars (Figure. 2). A trend towards monoculture was noted for specific cultivars which are increasingly becoming commercial. The small area and many households category was dominated by the juice/beer cultivars (Figure. 2). The majority of the named cultivars fell within small area categories, with those under few households higher in number than those under many households. Few cultivars grown by many households were those for different purposes and uses and therefore had a bearing in their maintenance within the community (Table 3: Mbwazirume, Muvubo, Ndizi, Nsowe and Bogoya). The cultivars noted as rare differed according to the group interviewed but the overall agreement was that 19 cultivars shown in Table 2 were rare in the study site.

Farmers reported 21 management practices (Table 2) as necessary for conserving rare cultivars. Out of these the PCA showed only 9 had average loading above 0.5 (Figure 3). These include; desuckering, detrashing, Soil & water conservation, manuring, isolation, intercropping, loosening soil, transferring sucker from one stool to another location within the garden and ash dusting. Transferring and loosening soil were two of the practices reported by all the three groups, as being useful in preserving rare cultivars (Figure 4).

Relationship between farmers' practices and rare cultivars

Results in Figure 5 and Table 3 show the relatedness of rare cultivars and the practices that conserve them. Though this analysis was done for each farmer group separately, still it reveals how much of the relationship exists between cultivars and practices. Namunwe (M1), Nandigobe (K4), Ntukula (B5), and the plantains (P2 & P4) indicated a slight correlation with isolation and loosening soil. Mbwazirume (K2) and Nakyetengu (N5) indicated a correlation with continuous relocation, transplanting and manuring. Nsowe (B1), Kyamalindi (B3), Nalwezinga (F15), Kiwuuna (F14) and Mukubakkonde (N3) indicated a slight correlation with culture and medicinal practices. Hence these practices seem to have a direct contribution towards the towards the conservation of the above named cultivars. Other cultivars do not show any correlation with any practice.

Discussion

Throughout generations, farmers know that they need a constant and diverse supply of germplasm to meet their household needs or livelihoods (Karamura *et al*., 2004). For this reason, they have continuously developed strategies to conserve this diversity through a number of management community based practices. However, a number of cultivars within farmers' germplasm gradually disappear or become rare due to being unable to compete with others in the agro-ecological system and they need special niches while others are only needed for special social functions. Depending on their field experiences and the diversity available to them, farmers have come to know how different cultivars behave and how they can easily maintain them, if they are promising, depending on farmers' needs.

In this study nineteen cultivars were found to be rare. The plantains are very rare cultivars and yet they are very tasty and good on many cultural functions. Most framers have a stool or

Table 1. Rare cultivars in Lwengo Sub-County, Masaka- Uganda

Name of cultivar & their codes	Genome group	Sub group	Use
1. Kyamalindi (B3)	AAA	Lujugira-Mutika	Beer
2. Nsowe (B1)			
3. Ntukula (B5)			
4. Kattabunyonyi (N3)			Cooking
5. Kiwuuna (F14)			
6. Kisansa (M 4)			
7. Mbwazirume (K2)			
8. Mukubakkonde (N 4)			
9. Nakyetengu (N5)			
10. Nandigobe (K4)			
11. Nalwezinga (F15)			
12. Naminwe (M1)			
13. Ntobe (N 2)			
14. Salalugazi (N7)			
15. Siira (F 13)			
16. Bogoya (D1)		Gros-Michel	Dessert
17. Bogoya Red (D2)		Green-Red	
18. Gonja-Mamba (P 2)	AAB	Plantain	Roasting
19. Gonja-Manjaya (P4)			

• **Large area (>10 mats)** • **Many Households (>50)** e.g • Nakinyika • Kibuzi • Musakala	• **Small area (< 10 mats)** • **Many Households (>50)** e.g • Sukali Ndiizi • Mbwazirume • Muvubo • Nsowe • Bogoya
• **Large area** • **Few Households** **e.g.** • Kayinja • Kisubi	• **Small area** • **Few Households** **e.g.** • Gonja-Mamba • Nakyetengu • Etc.

Figure 2. Four square analysis for classification of banana cultivars based on production by area and households

Table 2. The community based identified practices and their PC average loading in contribution towards the conservation of rare cultivars

Code No.	Practice*	Loadings from group 2	Loadings from group 3	Loadings from group 4	Average loading per practice
1	Cultural	0.1333	-	0.0538	0.0936
2	Medicinal	0.1333	-	0.0000	0.1333
3	Isolation	0.8530	-	-0.6469	0.7500 *
4	Transplanting	0.7570	0.6477	-0.6469	0.6839 *
5	Manure application	0.8612	-	-0.6469	0.7541 *
6	Special niche	0.8530	-	0.0538	0.4534
7	Loosening	0.4935	0.8537	-0.7131	0.6866 *
8	Bands	0.1459	-	-	0.1459
9	Desuckering	0.0000	0.9035	-	0.9035 *
10	Removing corms	0.0000	-	-	0.0000
11	Ash dusting	0.2407	0.8014	-	0.5211 *
12	Ditches	0.0000	-	-	0.0000
13	Weeding	0.0000	-	-	0.0000
14	Relocation (continuous)	0.0000	0.6477	0.0538	0.3508
15	Intercropping	-	-	-0.7131	0.7131 *
16	Planting in swamp	-	-	0.0000	0.0000
17	Soil & water conservation	-	0.9035	0.6469	0.7752 *
18	Selling fingers not bunches	-	-	0.0000	0.0000
19	Mulching	-	-	0.0779	0.0779
20	Use of concortation	-	0.2055	-	0.2055
21	Detrashing	0.7767	0.9035	-	0.8401 *

* 9 best practices above loading 0.5.

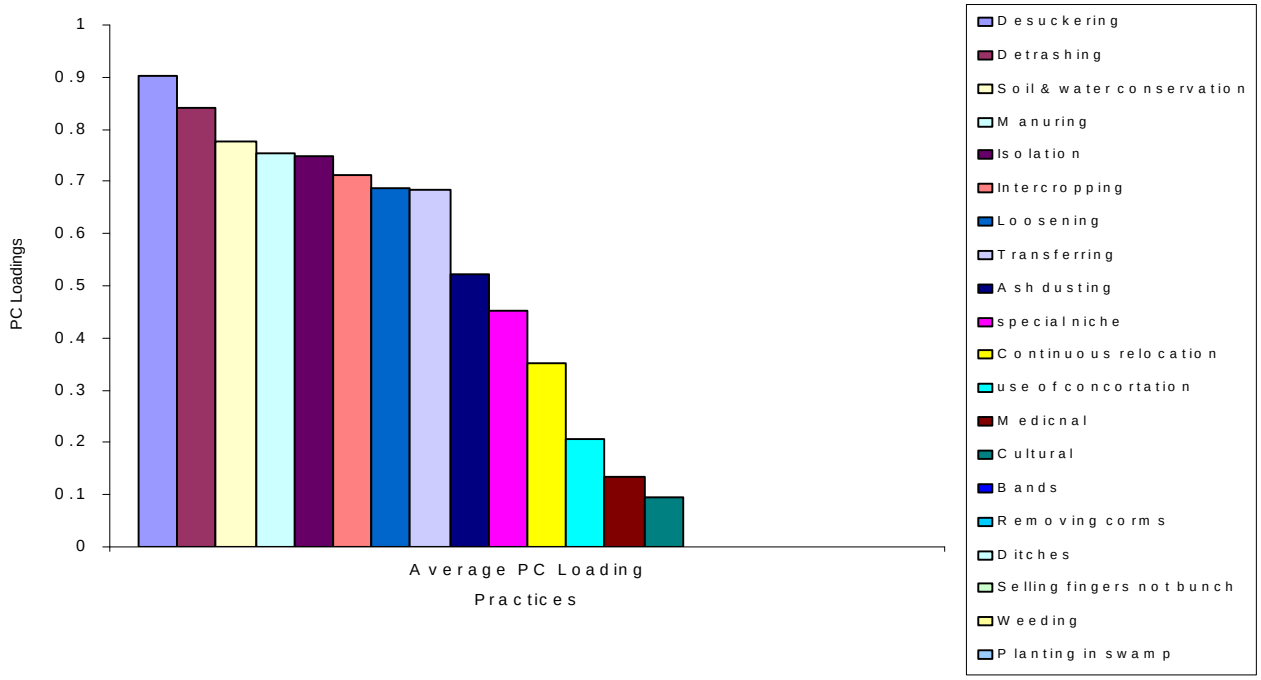

Figure 3. Average PC loadings of farmer practices for conserving rare cultivars *in-Situ*.

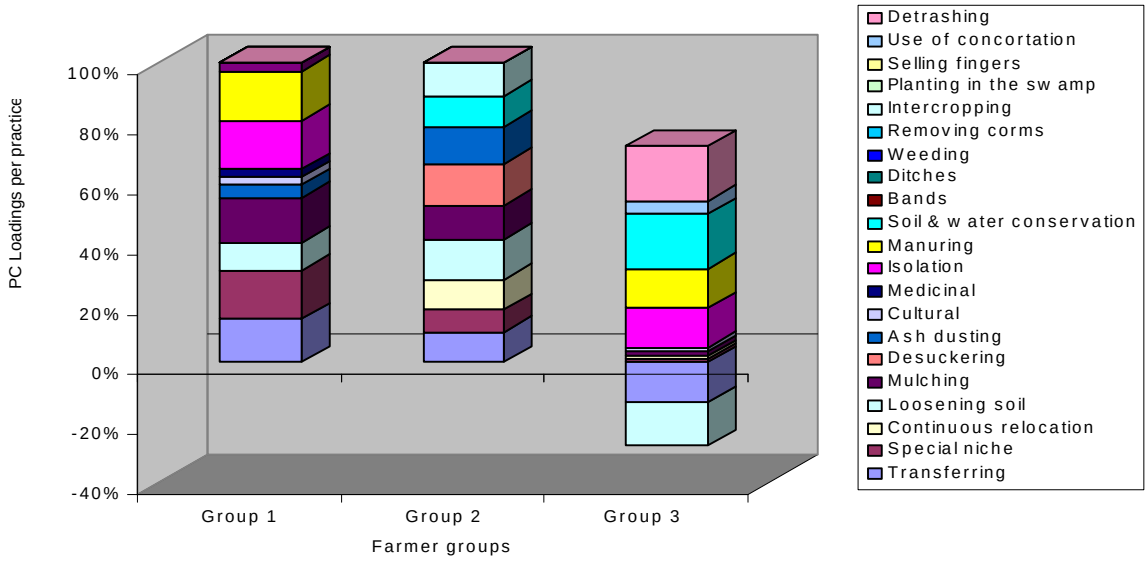

Figure 4. Group comparison of farmer practices for conservation of rare banana cultivars *in situ*

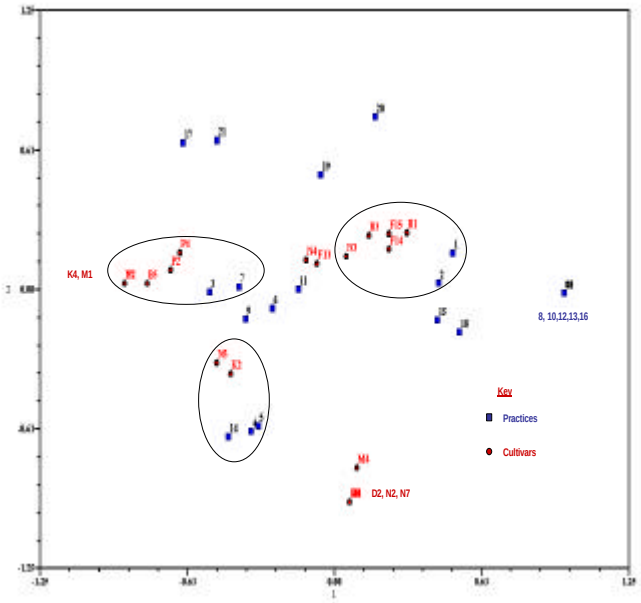

Figure 5. Relationship between farming practices and rare cultivars in Masaka *Musa In Situ* site (for all 3 groups of farmers)

two of these plants. The plantains are very difficult to maintain because, they are very susceptible to pests, they have a poor rooting system, and their suckering ability is very poor. They therefore need a special niche and loosening soil around to open up for their rooting system.

Mbwazirume and Nakyetengu are East Highland bananas which cannot compete with other cultivars in the banana plantations. Nakyetengu is dwarf so it can do better as a monoculture crop or it can be planted on edges of plantations. It is not well understood why Mbwazirume cannot compete with others but it does better in a monoculture stand. Hence in this study the best practices for them are continuous relocation, transplanting and manuring.

Nsowe (B1), Kyamalindi (B3), Nalwezinga (F15), Kiwuuna (F14) and Mukubakkonde (N3) indicated a slight correlation with culture and medicinal practices. These cultivars are specifically maintained for cultural functions. Nsowe is a cultural beer cultivar in Masaka, which is used in different social functions, the same with Mukkubakkonde while Nalwezinga is medicinal cultivar. There is need to study further relationships between the rare cultivars and their associated practices.

Considering some of the practices to be promising best practices for the conservation of rare banana landraces of Uganda, it is important to look at the values they have for the plants. Continuous relocation is essential when the older stool is not producing as much as in the beginning because of exhaustion of the soil and pests (weevils and nematodes). If the farmer does not do this practice, the stool will ultimately disappear and the landrace will die out.

Manuring involves fertilizing the stools with mostly organic manure around but off the stool. If the farmers do not do this, the production of the crop drops, the plant loses vigour and the farmer gets discouraged and the landrace is abandoned. Special Niches on the other hand are special locations for specific requirements such as high soil moisture supply which can be harvested from roofs and compounds and be provided to the plant. If the farmer does not provide extra moisture for non drought resistant plants, the plant will suffer moisture stress, the production will then drop and the farmer will be discouraged and will give up the landrace. Loosening soil is done around one meter radius of a stool using a hoe after one

Table 3. Descriptions of banana conservation practices identified in Lwengo

Practice	Description
Detrashing (Okusalira)	Removal of senescing or dead leaves and pseudo stem sheaths.
Desuckering (okuttira)	Reducing the number of suckers on a stool.
Manuring (Okujimusa)	Enhancing the fertility of soil by addition of manure or fertiliser.
Transplant (Okusimbuliza)	Transferring suckers from one stool to another location.
Bands (Okubibira)	Heaping soil around stool.
Sale of Fingers (Emyera)	Individual fingers separated from bunch or clusters and bulked.
Ensalosalo	Trenches dug at intervals to reduce water loss and soil erosion effect
Continuous relocation (Okusengulasengula)	The transplanting of one banana sucker to another location in the same garden to make a new stool of bananas of the same clone
Planting in swamp	Planting in swamp of cultivar that is very susceptible to low soil moisture
Special niche	Specific location in homestead where nutritional requirements (e.g. manure) will be provided and close observation of the cultivar development and characteristics made.
Isolation	Planting a cultivar at specific location, usually at boundary to allow it develop either away from competition, shade or in case of prolific cultivars where its spread is controlled.
Loosening soil	Refers to loosening of soil around stool (Okutemeratemera), by digging not too deep so that water can infiltrate and hard soil cakes avoided.
Cultural	Whereby a cultivar is required for specific function in the traditional beliefs of the people e.g. at death or birth of person of specific sex, matrimonial, protection, etc
Medicinal	Whereby a product of a specific cultivar
Removing corms	Digging out root stock of a harvested bunch and destroying it.
Ash dusting	Applying ash around the stool
Mulching	Use of plant material, including banana aged parts e.g. leaves to cover soil to reduce water loss and need for weeding. Some distance around stool left free of mulch.
Use of concortation	Use of mixtures of animal urine and other selected plant material and ash, processed for a specified period, and applied to individual stools.
Soil and water conservation	Soil and water are conserved through using bands system or water ditches
Intercropping	Mixed cropping with various annual crops in young plantations or other perennials in mature plantations
Weeding	Weed removal either by hoe or hand

or two rain showers. The purpose is to allow more infiltration of water in the soil. If this is not done, there will be minimal moisture infiltration leading to low production and eventually the farmer becomes discouraged. The practice in addition facilitates easy emergence of suckers from the ground. Isolation involves separating certain landraces and planting them in pure stands. This is to avoid competition from other, better competing landraces. This is generally done with short growing landraces to avoid over shading and this is also useful for poor competitors related to nutrients and moisture. Such farmers' practices of application of manure and loosening soil around a banana stool were found to be of multiple benefits like improvement of soil fertility and moisture, root biomass development and consequently banana yields(Zake , et.al 2000).

Therefore judging from the values of the different practices, it is inevitable to carry out some of those practices for specific cultivars if farmers are interested in them because of the different households' needs. However, there is need to research more on the relationships between the rare cultivars and their associated practices in terms of environmental and economic benefits. This will provide more information to justify dissemination of such practices.

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