From: Bananas and food security - ed. by C. Picq, E. Fouré &
E.A. Frison, INIBAP, Montpellier, 1998; p. 401-412
ISBN 2-910810-36-4

Banana production systems in eastern and southern Africa

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Résumé – Les systèmes de production du bananier en Afrique orientale et australe

*Les bananes (*Musa *spp.) sont un aliment de base pour plus de 20 millions de personnes en Afrique de l'Est et la consommation* per capita *dans la région des Grands Lacs est la plus élevée du monde. Grâce aux ventes sur les marchés locaux, la plante fournit une importante source de revenu aux populations rurales à faible niveau de ressources qui en font aussi des utilisations variées, y compris médicinales, culturelles et industrielles.*

En Afrique de l'Est et en Afrique australe, la plante est cultivée dans des conditions agro-écologiques variées, des basses terres au niveau de la mer jusqu'aux hautes terres à plus de 2000 m d'altitude. Les conditions socio-économiques associées à la culture dans la région sont également diverses. En termes de production et de superficie cultivée, la région est dominée par les bananiers des Hautes Terres d'Afrique de l'Est sur le Haut Plateau Africain. En revanche la production de bananes plantain et de Cavendish prédomine aux basses altitudes où la surface consacrée à ces cultures est en augmentation.

La diversité agroécologique alliée aux effets des facteurs socio-économiques peut avoir des répercussions importantes sur la programmation des stratégies, compte tenu des effets possibles sur la sécurité alimentaire, la lutte contre les ravageurs et les maladies, la diversité des cultivars et les considérations liées au marché et au revenu. L'article tente de décrire les systèmes de production du bananier et du bananier plantain en Afrique de l'Est et en Afrique australe, dans le but de caractériser les systèmes sur le plan de la productivité et des contraintes de production, et les défis correspondants auquel la recherche bananière doit faire face dans la région.

Abstract

*Bananas (*Musa *spp.) are a staple food for over 20 million people in eastern Africa and* per capita *consumption in the Great Lakes region is the highest in the world. Through sales on local markets, the crop provides an important source of income for the rural poor who also use it in a variety of ways, including medicinal, cultural as well as industrial uses.*

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The crop in eastern and southern Africa is grown across diverse agroecological conditions ranging from lowlands at sea level to highlands above 2 000 masl. Equally diverse are the socioeconomic conditions associated with the crop across the region. The region is dominated both in production and acreage by the East African Highland bananas on the East African Plateau. Plantain and Cavendish production on the other hand predominate at the low altitudes where increasingly more land is being turned to the crop.
The agroecological diversity along with the effects of socioeconomic factors may have far-reaching implications to strategic planning, taking into account possible effects on food security, pest/disease control, cultivar diversity and market/income considerations. The paper attempts to describe the banana/plantain production systems in eastern and southern Africa, with a view to characterizing the systems in respect of productivity and production constraints and the attendant challenges to banana research in the region.

Introduction

Eastern and Southern Africa produces over 20 million tonnes of bananas annually which accounts for 25.58% of total world output (Table 1). The region is also the world's leading consumer of bananas with an annual *per capita* consumption rate of 400-600 kg. An estimated 30 million people subsist on bananas and related species as the principal source of dietary carbohydrate. Much of the production is by small-scale subsistence farmers for whom the cultivation of an all-year-round fruiting crop, with the ability to combat soil erosion on steep slopes is an obvious attraction.

In this region banana/plantains have become part and parcel of the socio-economic fabric of the subsistence communities. Apart from being a key staple food, the crop is increasingly becoming an important source of income for the resource poor farmers. Excess production is sold in local markets and is the main stay staple for urban workers. Both green cooking and table bananas are marketed for food. In some parts of the region such as Rwanda and Burundi, however beer banana production is a dominant commercial activity and in these countries beer banana constitutes 64% of annual beer

Table 1. Banana production in Rwanda and Uganda.

Uganda

	1970	1980	1990	1997
Area (ha)	1,051,500	1,275,000	1,506,000	1,803,000
Production (tons)	7,989,000	6,068,000	8,402,000	9,893,000
Yield (tons/ha)	7.60	4.76	5.58	5.49

Rwanda

	1970	1980	1990	1997
Area (ha)	150,100	224,600	392,000	420,000
Production (tons)	1,651,100	2,063,100	2,747,000	2,248,000
Yield (tons/ha)	11.00	9.19	7.01	5.35

Source: FAO 1997.

production. Beer banana production is also on the increase in Uganda and northern Tanzania where green-cooking high land bananas have failed for various reasons.

Bananas have also become an important component of mixed production systems on farm, especially in high population areas where land is limited. Here bananas provide fodder for zero- grazed animals, which in turn provide manure for the farm. Apart from mixed farming, the plant is readily inter-cropped with both perennial and annual crops, especially legumes thus contributing to a balanced diet for producers.

In the urban regions, the manufacture of banana fibre based handicrafts has become an important economic activity. Mats, baskets, lamp sheds, ropes plus a host of decorations are made and sold in the urban centres of the region. Other uses of banana are cultural and medicinal. A number of cultural values related to birth, marriages, deaths and other special ceremonies and rituals are associated with specific banana cultivars. Consequently a significant proportion of these cultivars are always maintained in family gardens for purposes of those ceremonies. Equally important and wide spread is the use of diverse parts of the plant to treat abdominal ailments such as ulcers, worm infections, etc.

Across the vast region, however the crop is different for different eco-regions and socio-economic settings, forming what should best be described as banana-based cropping systems, whose dynamics and characteristics are thus far poorly understood. A clear understanding of these systems is a pre-requisite for the development and execution of effective research plans.

Bananas in eastern Africa

The dates and route of bananas from their presumed native centre of diversity in South East Asia remain a subject of speculation (Karamura 1998). If elucidated, this information would assist our understanding of cultivars, their diversity and spread across the region. Of particular importance is the need to understand the possible evolution process of AAA East Africa highland bananas and the diverse clone sets and clones constituting the group. Was this group of bananas introduced as it is today in which case all clone sets and their representative cultivars could have been introduced at the same time? Or is it possible that a few AAA cultivars could have been introduced but which later “mutated” to produce today’s clone sets and their constituent cultivars? What is the possible role of local diploid AA bananas in the coastal regions of East Africa? In this dynamic situation, what role did farmers play in the evolution and spread of bananas in eastern Africa?

Price (1994) provides the most recent review of the origins and spread of bananas into Africa and traces the first records of bananas and their possible cultivation in the middle east to 327 BC. From this review, the general agreement is that the ancient middle east empires that stretched from North Africa to India often opened trade routes that provided the mechanisms for the movement/exchange of crops and their products. In the case of bananas and their entry into Africa, the entry point most speculated about is the north Eastern part of the region as bananas have been known in the lower Nile valley and delta for centuries. A few authors however dispute such hypothesis on the grounds that it cannot account for the range of cultivars (= clone sets?) presently found (Simmonds 1966) and also due to the lack of linguistic evidence (Vansina 1984).

The elucidation of this information is critical to strategic planning for Musa research. It is needed by breeders in their search for better adaptability of genetic materials and by pest control research strategists in search of novel methods to manage banana pests and diseases.

Another hypothesis postulates bananas could have been introduced to Africa via the Indian Ocean islands close to eastern African coast. Since these islands were inhabited by Indonesian migrants by the 5th century AD (Verin 1981) it is possible they could have carried materials from both South East Asia (AA and AAA) and the Indian subcontinent (ABB and AAB) (Price 1995). More introductions could have followed on repeated occasions by Arab, Indian and later still by Portuguese traders. Even as late as 1950s, more cultivars such as Pisang awak (=Kayinja) were introduced from Asia by returning African world war veterans.

Taxonomic status of *Musa* ssp. in eastern and southern Africa

Many standard texts have information about banana taxonomy (Purseglove 1972, Stover and Simmonds 1987). All the authors provide for three categories for the classification of edible bananas- group, subgroup and clones

According to this system, *Musa* AAA group has three subgroups—Cavendish, Gros Michel and Green-Red as proposed by Cheesman *et al.* (1933). Controversy still surrounds the classification of the Cavendish subgroup. Some divide the subgroups into clones (Daniells 1990); others view Dwarf Cavendish, Giant Cavendish, Grand Naine and Lacatan as morphotypes (Stover and Simmonds 1987, Lebot *et. al.* 1994) but all authors agree that the “clone” or morphotypes probably arose by mutations.

In the case of *Musa* AAB group, the subgroups derived are Plantains, Popoulu and Maia Maoli (pacific plantains), Mysore, Silk, Pome and Pisang Raja (De Langhe and Valmayor 1980, Swennen and Vuylsteke 1987, Lebot *et al.* 1994). Various workers have further divided these subgroups to clones and morphotypes (Lebot *et al.* 1994).

For all the East African highland bananas, *Musa* AAA subgroup Lujugira-Mutika (Shepherd 1957), the classification system remained unclear for a long time. In the subgroup Shepherd (1957) recognises two clones Mutika and Lujugira. According to Shepherd, Mutika had pendulous heavy bunches while Lujugira was characterised by sub-horizontal bunches with shorter less bottle-necked fruits. However, Karamura (1998) has proposed a fourth category for the subgroup due to the large variability within the subgroup, as follows:

Group:	AAA
Subgroup:	AAA-Lujugira-Mutika (= Highland bananas = matooke)
Clonet set:	Beer, Musakala, Nakabulu, Nfuuka and Nakitembe.
Clones:	Making up each of the clonesets

At the region level however the picture is not clear as the characterisation is not at all carried out for most NARS collections.

Cultivars and their distribution in eastern and southern Africa (ESA)

A number of authorities have provided very useful reviews of the cultivars and their distribution in ESA (Shepherd 1957, Stover and Simmonds 1987, De Langhe 1986, Karamura 1998). Almost all banana genomes are very well represented in the region but the intensity of cultivars of each genome varies considerably across the region (figure 1). The factors responsible for this variability are both ecological and socio-economic.

AAA East African Highland banana (AAA-EAHB)

These are by far the most widely distributed in the region stretching from Eastern Democratic Republic of Congo to the Southern fringes of the Ethiopian highlands, and down to Mbeya in Southern Tanzania. The AAA-EAHB is said to endemic to this region with no clear analogue elsewhere in the world. A key factor responsible for the group's distribution is the altitude. The plant will grow comfortably within 1 000-2 000 masl. Below and about that range the plant's growth tends to be retarded. Within that range the intensity of cultivation and the cultivar profiles are tend to be a matter of culture and other socio-economic forces. Simmonds (1959), Shepherd (1957) and later De Langhe (1986) provide descriptions of the group.

While it is easy to identify the group from other groups, within the group variability said to be caused by mutations is great. This variability has prompted further characterisation studies, resulting into the proposition of clone-sets (Karamura 1998).

In spite of its high production and large acreage, the crop remains largely under-exploited both in terms of research and development. It is largely a subsistence crop, important only for food security and without significant export markets. The high population pressure and associated land fragmentation coupled with increasing pest problems and natural resource degradation have all combined to limit the productivity of AAA-EAHB systems.

AAA dessert bananas

These include Dwarf Cavendish, Lacatan, Red Banana, and Gros Michel. The largest concentration of Cavendish dessert bananas is generally found in the low-lying (below 800 masl) coastal regions – in South Africa, Somalia and Ethiopia, where they are grown on large commercial farms, either by state parastatals (Ethiopia, Somalia) or by private farmers (South Africa). Gros Michel however is found around Lake Victoria region at a slightly higher altitude range, and forms an important table banana in that area.

Most cultivars of this group succumb to nematodes, black Sigatoka and Fusarium wilt although they are generally tolerant to weevil attack. In ESA these types of bananas are important in the local markets but exports remain low.

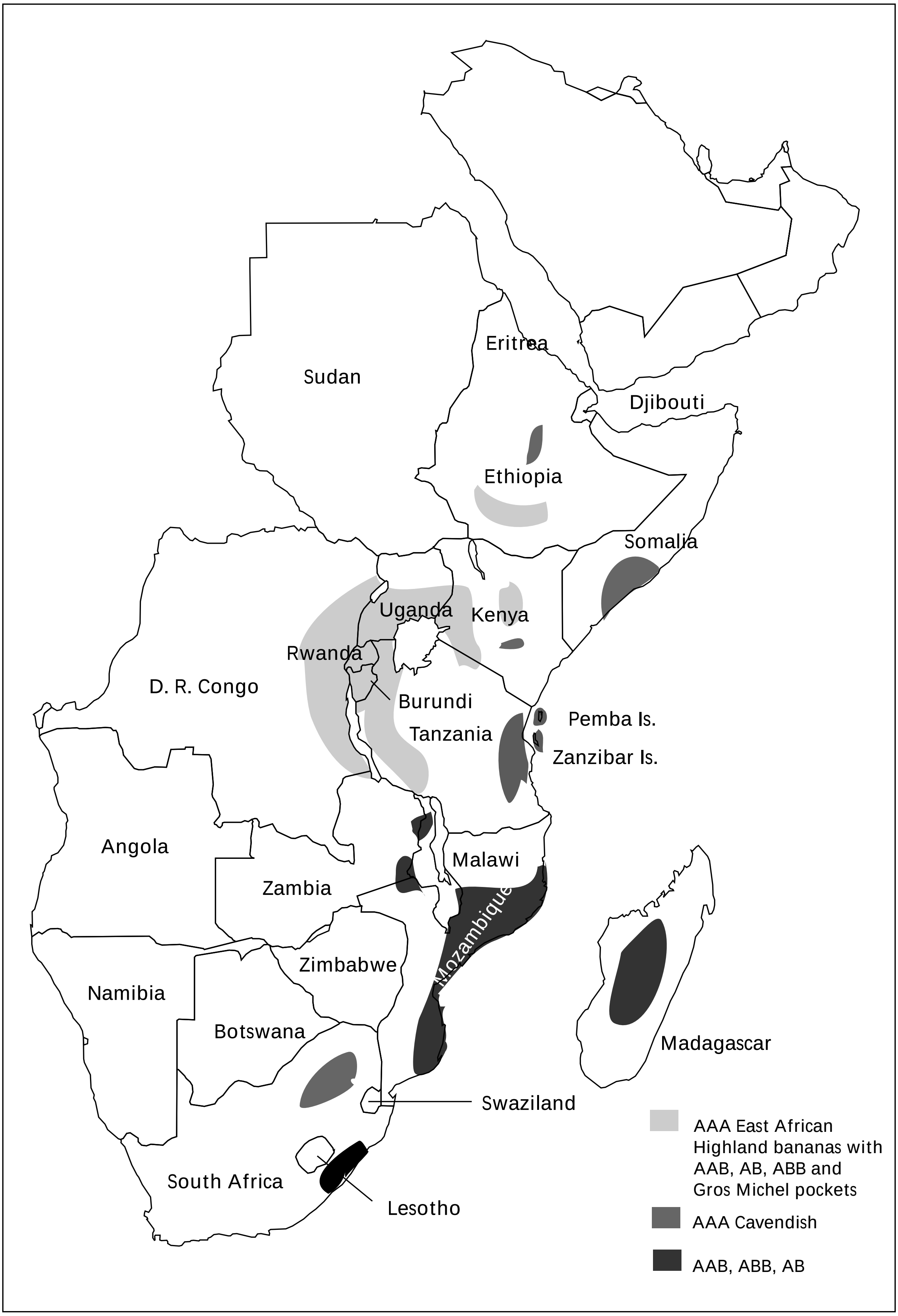

Figure 1. Major banana (*Musa* spp.) genomes in ESA.

AAB (Plantains and Prata)

In general these are also lowland varieties (0-600 masl) and grow very slowly above 1000 masl (De Langhe 1986). Except for Uganda and Kagera region of Tanzania where they are grown widely (but not intensively), plantains are more important in the coastal lowlands as well as in the inland low plains of Tanzania and Malawi. Plantains seem to be particularly susceptible to weevil attack. Another AAB banana called Prata (Brazilian) or Pome is also grown widely in the same ecological ranges, although in Burundi, it still does well in highlands (De Langhe 1986). The group is grown largely for subsistence purpose, save for a limited local market.

ABB cultivars

The most common cultivars in ESA are Bluggoe and Pisang Awak. The plants are quite elastic with respect to ecological conditions although they are more vigorous in regions below 1000 masl. The cultivars have been adopted in the region for use as beer bananas in Uganda, Rwanda, Burundi and Tanzania, largely because of their capacity to increase production even in sub-optimal conditions. Their acreage is on the increase in the region. In Rwanda and Burundi, the cultivars are the main stay for the beer industries. Further south in Tanzania, Malawi and Mozambique, the cultivars are used as cooking bananas.

The ABB cultivars are said reported to be tolerant weevil and nematode attack and tolerant—resistant to black Sigatoka but readily succumb to Panama disease. In general, the ABB group has great potential for banana—based beverage industries.

AB cultivars

This is a poorly studied set of cultivars and includes two clones

Ndiizi (= Kamaramasenge? = Kana'ana? = Kasukali?) and Kisubi. Ndiizi is principally a dessert banana but is also a heavy yielder of banana juice. Though morphologically similar to Ndiizi, Kisubi's' astrigent taste limits it to juice/beer production. Export potential for AB Ndiizi appears high once characterisation studies of the cultivars have been carried. At present cultivation of the AB cultivars remains scattered across the region.

Other cultivars

A number of cultivars have been imported into the region including improved materials such as FHIA hybrids. Some of these materials such as FHIA-01, FHIA-03, FHIA-17 and FHIA-23 are very promising indeed. Other plantain hybrids developed by the IITA have been introduced for evaluation in the region.

Another set of cultivars "indigenous" to the region have yet to be characterised. They include the two acuminata wild types in Zanzibar collections and acuminata cultivars around Moshi-Kilimanjaro region. These clones are said to be different from the AAA-EAHB of the lake region but these differences are not yet clearly understood. (Karamura, pers. comm.). Apart from the acuminata types of Moshi- Kilimanjaro region, the identities of diverse materials in the region's NARS collections have yet to be established.

Musa production systems and their characteristics in ESA

Musa production systems in ESA are diverse and complex. The complexity derives from the diversity in agro-ecological conditions as well as the socio-economic variability across the region. Consequently it is not possible to define concretely any one system except for the commercial/plantation system. Other systems are merely an assortment, a blend of several subsystems, even in one ecoregion.

For the ease of discussion, *Musa* production systems will be divided into three broad categories—backyard garden systems, subsistence systems and commercial plantation systems. Although these systems are extremely variable (except the commercial), each has distinct characteristics that broadly distinguish it from the others. The characteristics define the intensity and/or level of management associated with a given system, and range from crop management practices—planting materials used, irrigation, pest control practices, cropping system (mixed/intercropping) employed, levels of yields attained and associated end uses and incomes—to socioeconomic factors around the farmer, including their perceptions, options, priorities, availability of inputs and extension support and returns to investment. It therefore follows that, when planning a research and development programme for bananas/plantains in the region, due consideration should be given to the complexity of systems and associated characteristics. For each system, the attendant characteristics need to be defined before change technologies are imposed in order to determine/predict how they would affect the technology uptake pathways.

Banana backyard garden systems

Characteristically this is a low input system found throughout the region, but the intensity of which decreases as one approaches the subtropical regions. It is usually found in the peri-urban regions of Uganda, Rwanda, Burundi, Kenya and Tanzania where land is a key determinant of farm size (a few mats to 0.25 ha), or where other crops have higher commercial or subsistence importance than bananas/plantains, as in southern Ethiopia, Malawi, Mozambique and Zambia.

In this system, the farmers usually pay minimum attention to crop management practices (the selection or cleaning up of planting materials, pest control, irrigation and yields) as the purpose of the crop is usually to supplement other food sources. In some cases, backyard banana gardens are kept for non-food uses. In Uganda, for example, urban/peri-urban dwellers keep backyard banana gardens to provide green leaves for wrapping and cooking matooke (green-cooking AAA-EA bananas) as such leaves are ordinarily bought in the market. Consequently, cultivars which produces many leaves (e.g. Kayinja = Pisang Awak) and/or are resistant to black Sigatoka, are usually planted in backyard gardens. In Ethiopia, highland bananas are normally eaten as table bananas (not cooked green). They are rated much lower in terms of quality as a table banana than the Cavendish bananas (Seifu Gabre-Mariam, pers. comm.) and are not so important a stable food as the Ensete (*Ensete ventricosum*). Nevertheless highland bananas will be found around the homesteads in Southern Ethiopia where they are used as windbreaks to protect *Ensete* crops.

As mentioned above, banana backyard systems are characterised by low inputs, the farmers' main income being contributed by paid employment in the case of peri-urban situations and other crops in cases where bananas are a minor crop. As a result of this characteristic, banana backyard garden systems tend to be pest/disease foci, from where other banana stands in the vicinity may be infested. It follows therefore, that in planning an intervention activity in areas close to banana backyard garden systems due considerations should be taken into account.

Banana subsistence systems

Banana subsistence systems are by far the most common means of growing bananas and plantains in the tropical world and are responsible for over 87% of global banana/plantain production (INIBAP 1996). They are perennial, low-input, small (0.25-5 ha) and rural-based systems in Africa, Asia and Central America. In ESA, the systems dominate the Great Lakes region as well as the inland plateaux of the region. The over-riding purpose of these systems is food security, but commercial interests, as shown by rapidly expanding local banana markets, have become important (Rubaihayo 1991). Consequently, these systems have attracted a lot of technical attention, particularly with regard to pest management. In spite of this research effort, not much success has been recorded to date. Pests and diseases have intensified in some areas and in extreme cases eliminated whole system of susceptible cultivars altogether. As a result, yields have continued to fall below 10 tons per ha, providing a direct challenge to the ever-increasing population. (Table 1) This in turn has resulted into massive cultural displacements and associated socio-economic up-heavals (Karamura *et al.* 1996). Moreover, other changes, such as increased population pressure and attendant effects on land use, have resulted in the degradation of the natural resource base, which in turn aggravates the pest and disease impact in subsistence systems.

Another characteristic feature of this system is its complexity, in terms of cultivars grown, soils and terrain, pest/disease communities, management skills as well as crop uses, even in one eco-region. In a survey of Uganda banana-based cropping systems, Karamura *et al.* (1996) found an average of 12 banana cultivars per farm, plus a mixture of inter-crops. With limited cropland, and financial resources, farmers try to meet all their dietary needs from the same piece of land by mixed cropping and in most cases, mixed farming too. While these practices ensure food security and a balanced diet to these resource-limited rural communities, they do not readily lend themselves to improved/modern technologies such as mechanisation. This complexity therefore demands that any meaningful technology must take into account the ecological as well as the socio-economic aspects of the crop, pest/disease problems encountered as well as the complexity of the system.

Banana plantation systems

This system is by far the least complex (i.e., single cultivar, uniform management), but by no means the least important, as it accounts for 12% of global production (Robinson 1996) as well as for most of the dessert banana exported into temperate markets. With clearly defined commercial objectives, it is intensively managed from selection and treatment of planting materials, seed bed preparation, crop establishment and stand management (including pest and disease control) through to marketing and/or processing (Robinson 1996). Yields are in the range of 40-60 tons per hectare and profit is the ultimate objective. Consequently, production and income, as well as consumer/market requirements are predictable. This level of management ensures maximum yields through quality control of planting material, timely application of inputs and the benefit of an informed farming community. Additionally, the dessert bananas in the AAA genome group tend to be relatively tolerant or resistant to banana weevil attack. It is no wonder therefore that serious pest problems are rare in this system. Banana weevils in particular have never been considered serious in dessert banana plantations (Ostmark 1974).

This system is also characterised by well-defined crop cycles, usually lasting 2-5 years after which it is uprooted and prepared for replanting (Valmayor *et al.* 1991). This action provides a fallow effect and re-enforces other control measures.

The limited importance of pests and diseases in banana plantation systems (compared to backyard or subsistence systems) may be a reflection of the socio-economic differences between the stakeholders of the various banana cropping systems. Socio-economic factors, especially those which define management intensity, may play a leading role in determining the level of crop losses incurred and should be taken into account when planning crop management activities in banana-based systems. The validity of this argument is reinforced by the observation that semi-commercial banana farmers in a predominately subsistence banana region like East Africa not only have higher levels of management, but also much reduced pest problems. It therefore follows that technological change in banana subsistence farming communities will go hand-in-hand with socio-economic change. An informed farming community that ensures intensive crop management and highest returns to investment is largely responsible for the differences between this system and the other two. While commercial banana systems are attractive financially, they do not support cultivar diversity, being largely monocultivar. The significance of this becomes apparent in the face of a marauding disease such as Fusarium wilt. A case in question is the Race 4 (*Fusarium oxysporum* f. sp. *cubense*) which has led many farmers in South Africa to abandon banana farming. This is contrasted with the subsistence systems where cultivar diversity ensures that farmers have food security as not all cultivars succumb to the disease en masse.

Another consideration to be taken into account relates to the long-term effects on the environment. The use of chemical additives and heavy equipment to improve yields may have adverse effects on the environment if due care is not taken. Use of pesticides may alter the biotic composition of the specific eco-region while the use of heavy equipment may alter soil structures. In areas where irrigation is based on rivers, soil/water borne diseases are readily spread down stream (Zaag de Beer, pers. comm.).

Challenges to banana research planning in ESA

The above account attempted to briefly expose the complexities of banana-based systems in ESA. In the backyard garden systems, the over-riding challenge to research planning appears to be the value associated with bananas in this system. Consequently the resource commitment to the implementation of change technology programmes is expected to be low. Yet as already pointed out, the system serves as a breeding foci for pests and diseases, some of which will easily find their way into the subsistence systems with which they usually share boundaries. Possible solutions may include provision of pest-free planting materials as well as resistant cultivars. However, such technical solutions will need to be reinforced by supportive policies.

Another important challenge to research planning in banana systems in ESA relates to the absolute lack of information at a local level. For most countries, baseline information about the local banana systems have not been collected and the production constraints characterised [This situation exists locally in many backyard garden and subsistence systems]. In such cases it becomes difficult to establish how important bananas/plantains are in the local economy. Without this information, it is difficult to influence policy in favour of bananas research support. Research administrators are more likely to support competing priorities (e.g. other less environment-friendly staples) than bananas/plantains due to the lack of information on the latter. Where possible, efforts should be mounted to establish/estimate production, acreage (yield), consumption as well as the key constraints through surveys that involve all levels of stakeholder and ensures broad participation. In particular, the import-substitution role of bananas should be elucidated.

Except for one or two countries in the region, the most important challenge to research planning and execution is the limited resources to carry out an agreed research agenda. In most countries the financial commitment to banana research is negligible and so is the number of trained scientists allocated to the crop. On their own therefore, most NARS lack both the financial and human resources for banana research.

Many of the NARS address banana research not as an entity programme but with the broad horticultural fruits program where banana is arbitrarily allocated a priority rating below that of citrus and other fruits. Fortunately for banana research in ESA, the production constraints are similar across the region and the realisation of this fact helped to identify region level priorities which in turn prompted the need to co-operate at that level. Moreover by agreeing to work on common problems of regional importance, the NARS were able to raise the critical mass for resources (human and financial) needed to address the identified priority constraints. The success of this cooperation will depend on the participation of stakeholders in identifying and addressing the real needs —food security, family income and environmental protection.

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