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Genetic Resource Policies

Promising Crop Biotechnologies for Smallholder Farmers in East Africa: Bananas and Maize

Brief 24

Biodiversity of Bananas on Farms in Uganda

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Uganda is among the world's leading countries in terms of banana production and consumption. Bananas occupy the largest cultivated area among staple food crops in Uganda and are primarily grown on small subsistence farms (plots of less than 0.5 ha). In addition to being a major food staple, bananas are an important source of income, with excess production sold in local markets. Average per capita annual consumption of bananas in Uganda is the highest in the world, estimated at close to 1 kg per person per day. Bananas are consumed as fruit; prepared by cooking, roasting, or drying; and fermented for the production of banana juice and alcoholic beverages (beer, wine, and gin).

Most of the banana varieties grown in Uganda are endemic (indigenous) to the East African highlands—a region recognized as a secondary center of banana diversity. The East African highland banana is a unique genomic group, selected over the centuries by farmers. As many as 84 distinct varieties of endemic East African highland bananas, classified into five clone sets, are grown by farmers in the region (Karamura 1998). In

Table 1—Variety and use group diversity in number of banana varieties at the household and village levels

	Number of banana varieties			
Unit of analysis/elevation	**Minimum**	**Maximum**	**Mode**	**Mean**
Household, varieties				
Low elevation	1	19	4	6.72
High elevation	2	27	6	9.07
Household, use groups				
Low elevation	1	5	4	2.85
High elevation	1	5	3	3.36
Household, cooking varieties				
Low elevation	0	14	4	4.01
High elevation	1	18	3	6.38
Village, varieties				
Low elevation	13	32	20	22.41
High elevation	17	38	38	28.54

Note: Household subsample sizes are 419 in low elevation areas and 98 in high elevation areas; the total number of communities is 27.

addition, several unimproved, exotic banana varieties from Southeast Asia and a few recently developed hybrids are also locally grown. Differences between endemic and non-endemic varieties are associated with differences in observable characteristics, genome, and common use, but not with improvement status.

The biological diversity of bananas in Uganda is understood at the taxonomic levels of genomic group, use group, and variety. This diversity is impressive at all geographical scales of analysis—the household farm, the village, and the region. Although banana specialists in East Africa have long made this observation, the sample survey undertaken as part of the research described here establishes this fact statistically for the major banana-growing regions of the country. Survey data confirm the high level of banana diversity both in the country as a whole and on individual farms (Table 1). A total of 95 banana varieties are currently grown among the households sampled in Uganda, with the majority (86 percent) consisting of endemic types. Banana varieties, which are locally named and differentiated by characteristics that are observable to farmers, were classified in this research into synonym groups according to established banana taxonomy, resulting in five groups or types defined by use (cooking, beer-making, sweet, roasting, and multi-use).

Differences in consumption preferences, genetic composition, and the manner in which that genetic makeup interacts with the environment mean that no single variety equally supplies the attributes demanded by farm families (Bellon 1996). The typical household in Uganda grows, on average, as many as 7 banana varieties simultaneously in the banana grove, with a maximum of 27. Farmers consider different banana varieties to have distinct advantages and disadvantages in regard to both consumption needs and production requirements. Another reason farmers maintain so many varieties simultaneously is that they serve as living stocks, reducing the reliance of farmers on cumbersome, longer distance exchanges of planting material to obtain the desired range of varieties and traits. Many households grow three or more use groups of varieties. Endemic cooking bananas are the most widely grown use group in the sample, with 97 percent of households growing at least one cooking variety. The diversity within this group is also striking. Most farm households grow three or more distinct cooking-banana varieties, with an average of five. The number of distinct varieties per village ranges from 13 to 38, with an average of 23.

Major varieties appear to be fairly uniformly distributed across households. The varieties most frequently grown by farmers are generally the same as those that are most widely planted. Among them, endemic cooking bananas predominate, highlighting the greater importance farmers place on local banana types compared with introduced varieties. Nevertheless, even the most widely grown banana varieties account for less than 10 percent of all banana stands in the entire sample. This indicates the tremendous clonal diversity maintained by farmers across the major banana-producing regions of Uganda.

The criteria used to select among varieties depends on the region and whether the farmer is oriented toward subsistence or commercial production. Insight into the specific traits that motivate farmer selection of a given variety is limited and primarily derived from on-station research trials rather than on-farm surveys. The relationship between morphological or trait diversity and the utility of these traits to farmers is also poorly understood (Gold et al. 1998; Karamura, Hartman, and Kaplan 1999). To address these limitations, survey data were used to gain greater insight into the role of farmers' perceptions of the importance of specific banana attributes in their decisions regarding which varieties to grow, in particular the number and mixture of varieties.

A full taxonomy of banana clones was used to construct measures of diversity (as defined by the number and evenness) at the variety and use group levels on farms of smallholder, semi-subsistence banana-producing households in Uganda. The relative importance assigned to different attributes by farmers influences the trade-offs they make when choosing the type and number of varieties to grow, which is believed to affect banana diversity on farms. Key attributes sought by farmers include resistance to black Sigatoka, weevils, and Fusarium Wilt, as well as cooking and beer-brewing quality.

Diversity indexes were constructed and used in an economic model to explore the associations between the observed levels of diversity across varieties and use groups and the importance that households place on specific variety attributes. The findings underscore the importance of variety attributes in explaining the decisions of banana growers in Uganda. The higher the

number of attributes rated as very important, the greater the number and evenness of varieties grown. In addition, the more important cooking quality is to the household, and the less important beer-brewing quality, the greater the diversity of use groups. This suggests that a focus on beer brewing for cash, rather than food, reduces the range of groups. Specialization by use group has implications for resistance evolution in pests and diseases and adoption of particular varieties because use groups vary in resistance. Furthermore, the differential vulnerability to pests and diseases among varieties probably explains the effects of these biotic stresses on the diversity of banana varieties and use groups maintained by farmers. Vulnerability was measured in this study both in terms of farmers' perceptions of the frequency of occurrence of pests and diseases in their plantation and the relative importance of the biotic stress. Although trade-offs across use groups are found when cooking and beer-brewing quality are considered, production traits are generally more important than consumption attributes in explaining variety diversity. Maintaining diversity could be a deliberate strategy for managing abiotic and biotic pressures in this relatively labor-intensive production system with low levels of chemical inputs.

Results

The survey results indicate that wealthier farmers holding more value in livestock assets are more likely to grow larger numbers of distinct varieties and use groups, which are more evenly distributed. An association was also found between the experience of the primary household decisionmaker on banana production and the variety and diversification of use groups. By contrast, the decisionmaker's gender is not associated with the diversity. The availability of large stocks of diverse banana planting material in the community is positively associated with greater number of varieties on individual farms. When the range of variety attributes demanded by subsistence farmers is limited, dissemination of planting material (either improved or landrace) can have a positive effect on crop biological diversity. The results also suggest positive associations between the age of the plantation and both variety and use group diversity. The older the plantation, the longer the time span families have had to accumulate diverse banana types within and over generations of managers. Market sales induce farmers to grow a wider and more even range of banana varieties and use groups. Buying bananas is associated with less variety diversity and more use group diversity because farmers depend less on their own stocks for food.

Bananas are vegetatively propagated, and a unique system of reproduction and dissemination of planting material exists among farmers. Banana production in Uganda is primarily driven by subsistence needs rather than commercial goals. On the one hand, the overwhelming importance of attributes and the extensive biological diversity on farms in Uganda suggests that newly improved banana varieties will not displace local varieties in the near future. Still, judicious introduction of newly improved banana varieties will be important if, in addition to relieving productivity and market constraints to banana production, protecting biological diversity in the East African highland banana is of policy concern.

Genetic transformation is one way to maintain the diversity of types that farmers recognize and find useful, since this technique maintains the original traits of a variety while adding additional desired trait(s) (Sági, Remy, and Swennen 1997). On-farm diversity has implications for adoption of transgenic bananas. Even if many farmers adopt a new variety, the variety may constitute only a small share of the total banana population because no single variety dominates with respect to all uses or attributes. On the other hand, uneven, spatially discontinuous adoption could be beneficial in terms of managing pest and disease evolution, extending the usefulness of the inserted trait and the economic advantage farmers earn from adopting transgenic varieties.

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Further Reading

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