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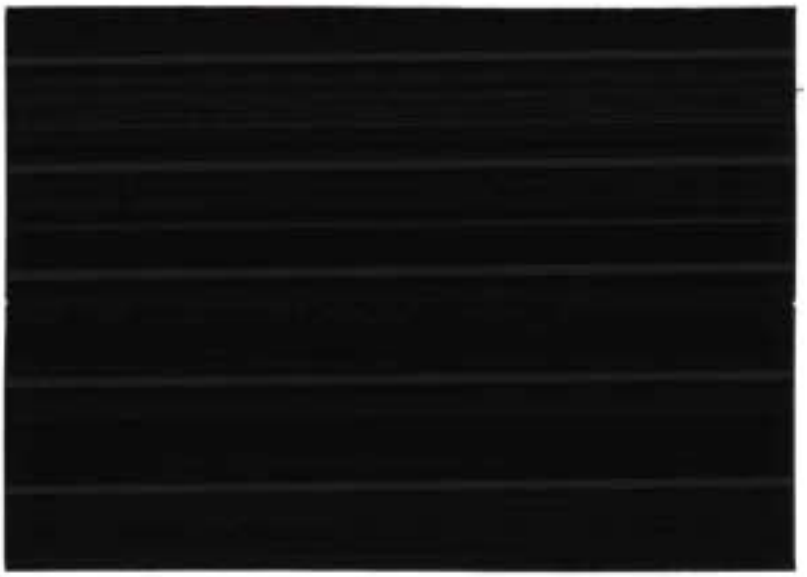

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Survey of the post-harvest activities and constraints of Ugandan banana farmers

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ABBREVIATIONS

BHC	British High Commission
CIAT	Centro Internacional de Agricultura Tropical
DS	Diagnostic Survey
EAH	East African Highland
GIS	Geographical Information System
IDRC	International Development Research Council
IITA	International Institute for Tropical Agriculture
KARI	Kawanda Agricultural Research Institute
MUARIK	Makerere University Agricultural Research Institute, Kabanyolo.
NARO	National Agricultural Research Organisation
NBP	National Banana Programme
NGO	Non-Governmental Organisation
NGSS	Non-grain Starch Staple
NRI	Natural Resources Institute
RRA	Rapid Rural Appraisal
UNEP	United Nations Environment Programme

SUMMARY

A survey of Ugandan banana farmers was carried out over a four month period in 1993 as part of the Ugandan National Banana Programme. The aim of the survey was to establish post-harvest constraints for banana utilisation and identify potential for technical intervention which would assist these farmers.

The farmers identified the principal constraints to their farming activities as relating to availability of labour and access to good markets for their produce. Farmers were aware of banana production constraints, including pests, disease and weeds but did not refer to post-harvest issues until asked specifically about these activities.

The survey found no evidence of significant losses of fruit due to poor harvesting, handling or transportation. The main cause of losses of mature fruit occurred due to wind breakage, theft and to ripening in periods of over-production when fruit would not be harvested.

Five key products are made from bananas in Uganda. The two food products, dried banana and banana pancakes do not provide significant income generation for most farmers. Dried cooking/beer banana is most common in Eastern districts but can be important throughout all the survey sites in famine periods.

The three beverage products, juice, beer (tonto) and spirit (waragi) have considerable importance throughout most of the survey area for home consumption, cultural events and/or income generation. Several aspects of the beverage production appears to be in need of research in order to decrease production labour requirements and improve quality, consistency and shelf-life of the products.

Twenty six recommendations for post-harvest research are made in this report based both on the post-harvest survey, a marketing/waste utilisation study and other sources. Three key research areas are considered high priority due to the likelihood of the research have the most immediate impact on the food security or income generation capacity of the average banana farmer. These research themes are as follows:

1. Trials should be conducted on the sun drying of matooke and the utilisation of banana flour prepared from the dried product.

2. Aspects of banana juice production and stabilisation should be investigated with the aim of reducing labour requirements for juice extraction and improving the quality and shelf-life of the juice.

3. Aspects of banana beer production and stabilisation should be investigated with the aim of improving the quality and shelf-life of the beer.

BACKGROUND

1. In November 1990, at a meeting of research scientists in Kampala, it was proposed to set up a National Banana Programme (NBP) to identify the major constraints to the Ugandan banana growing industry. The key Ugandan institutes participating were Kawanda Agricultural Research Institute (KARI) and Makerere University. The International Institute for Tropical Agriculture (IITA) and the Natural Resources Institute (NRI) had been invited to attend. NRI was selected as the discipline leader for socio-economics and post-harvest handling and marketing within the NBP (Poulter, 1990). The structure of the NBP was developed and agreed upon in two follow up meetings (Karamura, 1991; Poulter and Marter, 1991).

2. The first phase of the programme was a rapid rural appraisal (RRA) carried out between June and August 1991 (Rubaihayo, 1991). Two socio-economists from NRI participated in this phase (Cropley and Gilling, 1991). The second phase built on the results of the RRA in the form of a diagnostic survey (DS) which was planned at a series of meetings during the first half of 1992 (Cropley, 1992; Wainwright and Aked, 1992). As a result, 120 banana farmers were randomly selected from throughout the principal banana growing districts of Uganda. Multi-disciplinary surveys were carried out at these farms between July 1992 and November 1993.

3. As part of the post-harvest component of the survey, it was suggested in April 1993 that NRI would assist with collection of data during the final six months of the DS. These proposals were accepted by the co-ordinator of the NBP and the Director of National Agricultural Research Organisation (NARO).

4. Thus in July 1993, the author visited Uganda to participate in the DS. The primary aims of the post-harvest component of the DS were firstly to establish the nature and range of post-harvest practices concerning bananas and secondly to establish if there is potential for technological interventions to improve post-harvest activities to the benefit of banana farmers. The terms of reference for this survey are given in **Appendix I**.

5. The NRI also undertook a separate but complementary marketing study of matooke and banana beer and urban banana waste utilisation which is described in a separate report (Digges, 1994).

6. The data was collected by means of in-depth interviews with the DS farmers on post-harvest issues. Dr Aked was assisted during the survey by Mr J Ssemwanga who

is registered for a PhD at Silsoe College, UK. Mr Ssemwanga is studying quality aspects of Ugandan bananas and he conducted his research with the DS farmers supervised by Dr Aked.

7. This report describes the key results of the post-harvest component of the DS. The information resulting from the DS was used to prepare research proposals for the third phase of the programme. This phase III is due to commence mid 1994 funded by the International Development Research Council (IDRC) and the Rockefeller Foundation.

LITERATURE

8. There is a paucity of literature concerning post-harvest aspects of banana in Uganda. General post-harvest aspects are discussed in the report of the rapid rural appraisal (Rubaihayo, 1991) and in DS research bulletin produced at Makerere University (Rubaihayo, 1993).

9. An article was written on beer production in Uganda (Masefield, 1938) which describes the two fundamental processes of making beer from bananas and from sorghum (the latter being practised principally in the North and East of the country even today). Some student studies of beer production in selected districts were carried out in the early 1970's at Makerere University (Kalibbala-Bekalaze, 1973; Nsimeki, 1973) and a recent report on beer making in one district has been published based partly on the RRA of the NBP (Davies, 1993).

10. Some aspects of banana juice extraction are outlined in the MSc thesis by Kyamuhangire (1990). A paper was presented on banana beverage processing at the First Crop Science Conference for Eastern and Southern Africa, Kampala, Uganda, 13-19 June, 1993 (Kyamuhangire *et al.*, 1993). Some economic aspects of banana production and consumption are presented in a report from Makerere University (Sserunkuuma *et al.*, 1992).

METHODOLOGY

Choosing the sites and farms

11. The post-harvest survey is part of the wider banana survey conducted as part of the National Banana Programme in collaboration with the International Institute for Tropical Agriculture (IITA). One hundred and twenty farmers were selected to participate in the programme. Every discipline worked with this set of farmers so as to enable the data to be cross-linked and analysed together.

12. The sample set was collected by a two tier scheme developed by IITA (Gold et al., 1994) and the NBP. Firstly sites were selected from a sample frame drawn up using a stratification technique. The Geographical Information System (GIS) developed at the IITA agroclimatology unit and UNEP and CIAT demographic, topographic and climatic data bases enabled this stratification on the basis of the length of the rainy season (3-5, 6-8, >8 months), population density (< or > 50/km^2) and elevation (1000-200, 1200-1400 and > 1400 metres above sea level).

13. Up-to-date banana production figures were not available to use as a parameter, however, the main banana growing areas were demarked by the co-ordinator of the NBP. The banana growing areas were divided into cells according to the stratification. 21 cells (sites) were picked at random from the stratification grid. Strata representing less than 5% of the total banana production zone were excluded from this sample. This excluded the high elevation zones so three supplementary sites were chosen from these areas (Sites 1, 7 and 24).

14. The second stage involved scientists from IITA and the NBP consulting with the local district agricultural officers for the selected sites to identify important banana growing areas. The village nearest the physical centre of each cell where banana production appeared to be an important part of the community agriculture was selected for study. The team made a transect drive through the village in order to describe the farming systems before making a random selection of five farms. A decision was made to exclude farms with less than 100 mats (stools) or where the plantation was less than two years old. Farms which had been abandoned were also excluded.

15. A map showing the location of the 24 sites is included in **Figure 1**. **Appendix II** gives further details about the site locations (districts, sub-counties and parishes).

16. During the post-harvest survey conducted between August - November 1993 each DS farmer was visited once. At five farms the farmers or their wives were unavailable on the days allocated for that site. When this was the case, an alternative farm was selected as close to the unavailable DS farm as possible.

Pre-testing

17. The survey tool was a semi-structured questionnaire (**Appendix III**). Pre-testing consisted of evaluating the questionnaire with different farmers and noting any problem in interpretation, comprehension and logical sequencing of the questions. This was followed by revision of the questionnaire and then re-evaluating it with new farmers.

Structure of the questionnaire

18. The questionnaire was divided into seven parts.

a) General "passport" information
b) Information (largely socio-economic) about farming in general and banana growing in particular (**Section A**)
c) Marketing matooke (**Section B**)
d) Harvesting and handling (**Section C**)
e) Preparation of matooke (**Section D**)
f) Beverage production (**Section E**)
   i) juice
   ii) tonto
   iii) waragi

g) Other products/use of banana waste (**Section F**)

19. In **Section A**, it was intended to explore the overall perception of the farmers of the major constraints that they face as farmers generally and then as banana farmers in particular. By asking these questions at the beginning, it was hoped that any post-harvest problems could be put into context. In most cases, where a question was asked about problems or preferences, the answers provided by the farmer were noted and then they were asked to rank them according to their importance to the farmer. This type of ranking question was used throughout the questionnaire.

Concomitant research on banana quality

20. Doctoral research student, Mr Ssemwanga and the author had two different programmes of research to carry out. However for future information linkage and certain practical reasons the two survey programmes had to be based at the same sites i.e. the Diagnostic Survey

sites/farms.

21. Mr Ssemwanga's research consisted of three parts; a short questionnaire, and two techniques to elicit vocabulary from the farmers concerning the factors governing their choice of matooke varieties both for consumption and for trade purposes;

Technique A - Varietal Characterisation

22. A series of cards bearing the names of different matooke varieties are presented to the farmer. The farmer selects the varieties that he/she is familiar with. Then they are presented with three cards and are asked to pair up the two more similar varieties and explain what the similarities are between the pair and what are the differences from the 'odd-man out'. These selection criteria are then set on a scale using a ruler, with either end of the ruler representing the poles of the selection criterion e.g. for the criterion, size of fingers, one end of the ruler would be smallest fingers and the other end, largest fingers. The farmer is then asked to lay the cards on the ruler according to each selection criterion in turn. The varieties with the smallest fingers would lie closer to one end of the scale and vice versa. By using a 100cm ruler, the position of the cards could be rapidly read off as a proportion of the scale.

Technique B - Sensory Analysis

23. Different varieties of matooke are cooked using the traditional steaming method and the farmer is asked to taste them in turn and comment in as much detail as possible about their sensory perceptions of the matooke. Initially, there were considerable problems with this methodology, including the matooke cooling and hardening very quickly, multiple distractions to the farmer during the tasting trials and the length of time taken with the farmer was over-long. However practise and refinement of the technique finally lead to a more efficient methodology. A key step in this process was having a portable tasting booth built to eliminate some of the external distractions experienced by the farmer. Different containers were tested until it was possible to keep the matooke sufficiently hot after cooking throughout the day.

24. The preliminary results of this research are outlined in a report by Ssemwanga (**Appendix IV**).

Language and protocol

25. Because the DS was an on-going activity, it was not

necessary for the team to clear farmer visits with the district or local agricultural officer (except in the localities used for pre-testing). At each site, there were, however, an enumerator and assistant who were in charge of certain aspects of DS data collection. It was therefore, important to make contact with these people as a matter of protocol. It made a considerable difference to the farmer acceptance of our visit, if the enumerator and or the assistant were present. They were also useful in certain districts where none of the team spoke the local languages (particularly the Eastern districts of Kapchorwa and Mbale).

26. Two assistants were part of the post-harvest research team;

a) Mr Frank Ssekagiri, a graduate in Sociology undertook to translate for the author in a number of local languages and act as general assistant during the survey.

b) Mr Godson Kamukama, a driver who had worked extensively with the DS teams and was therefore able to assist the team in locating the farms and the enumerators and/or assistants in each site. He was also able to assist with translations in Runyankole and Rukiga.

Remuneration to the farmers

27. During the pre-testing and actual survey work, when it was requested, farmers were given extension advice by James Ssemwanga (who has previous experience as an extension worker). Issues of the magazine 'African Farmer' were given to the farmers and it was explained that the magazine is produced by an American NGO, The Hunger Project, who are trying to help African farmers network with one another as well as provide information on the results of relevant research concerning rural activities in Africa. It was explained that they could write to The Hunger Project to be put on a mailing list for future editions. The farmers showed a lot of enthusiasm and it seemed an appropriate exchange for the information they had given the team.

28. Farmers were also given bars of toilet soap as an expression of thanks, particularly to the women farmers who participated in our work. When we wished to take photographs of our work in progress with the farmers, most farmers will first ask for a self or family portrait. A Polaroid camera, proved very useful in satisfying this demand.

RESULTS

Pre-testing

29. In total, the methodologies were tested at seven different farms in three different districts (Luwero, Mpigi and Mityana). The largest banana plantation was 10 acres and the smallest 0.5 acres with a mean of 2.7 acres. 5/7 farmers made juice, 2/7 made tonto (banana beer) and one made waragi from fermented bananas (kasese). The questionnaire format was substantially revised as a result of pre-testing so as to make the sequencing of the questions lead more naturally from one section to another.

Diagnostic Survey

Passport data for the DS farms

30. Data from a total of 117 farms was collected. Of these, 112 were farms participating in the on-going Diagnostic Survey. Five alternative farms were chosen to replace the DS farmers who were not available on the days when the team visited.

Languages used during survey	Site Codes (see Figure and Appendix for location)
English	2,4,5,6,7,9,10,11,12,14,19, 20,21,22,23,24
Kup-sabiny	24
Luganda	1,6,8,9,10,11,12,13,14,15,1 6,17,18,19,20,21
Lumusaba	23
Lusoga	22
Rufumbira	15
Rukiga/Runyankole	1,15
Runyankole/Rukiga	2,3,4,5
Runyoro	16
Rutoro	7

Table 1: Interview languages used during the Diagnostic Survey

31. Ten languages were used in interviews throughout the survey and these are listed, along with the sites where

they were spoken in **Table 1**. It was possible to conduct 23 of the 117 interviews primarily in English so that it was not necessary for an interpreter to be used.

32. Interviewees were generally the head of household but otherwise were a close relative or someone intimately associated with the running of the farm. Sometimes more than one interviewee was present. The age, sex and education level of the head of household and the interviewees are given in **Table 2**. Of the total number of interviewees, 53.3% were men and 46.7% were women. A higher proportion of the men (39.6%) had been educated to secondary level or above compared with the women (21.1%).

	Head of House-hold	**Interviewee 1**	**Interviewee 2**
	tally	tally	tally
Number of men	104	68	13
Number of women	13	49	22
Education (male)			
None	7	3	2
Primary	48	36	8
Secondary	26	21	3
Tertiary	12	8	0
Education (female)			
None	6	9	7
Primary	6	28	12
Secondary	0	8	2
Tertiary	1	4	1
	years	years	years
Mean age (male)	47.16	43.9	32.92
Mean age (female)	45.69	35.6	34.09

Table 2: Breakdown by sex of the age and education levels of the heads of households and survey interviewees.

33. There was a wide variation in the amount of land owned by farmers visited in this survey. If the data is

grouped into frequencies (**Figure 2**), it is apparent that the modal area for the survey farmers falls within 5-10 acres. If the data for farmers who own more than 100 acres is excluded, then the mean for 1993 was 16.4 acres.

34. This data could be compared with figures quoted to the enumerators in 1992 for the DS passport data. Again excluding data greater than 100 acres, the mean area was 15.3 acres. Acreage given over to bananas was less variable (**Figure 3**). The modal area falls in the frequency class of 0-2.5 acres. The mean, excluding areas greater than 25 acres in 1993 was 5. This compares with 4.5 acres for data collected in 1992.

35. The discrepancies between the 1992 and 1993 data are in part due to a slightly different data set, however, the same farmers had often quoted different areas from one year to the next. In most cases this was not due to actual changes in the area but was more likely due to the estimation factor (most farmers do not know exactly how much land they have in terms of acres/hectares).

36. Farmers recognise a wide range of 'varieties' of banana in their plantations ranging from 2 to 22, with the mean number of varieties mentioned by farmers being 13.

37. Farmers collected water from a wide range of sources including boreholes, dams, rivers, springs and swamps. The source often differed between the dry and wet seasons. The mean time quoted for collecting water (going and coming back) was about 35 min in the wet seasons and 1h in the dry season, however this varied considerably between farmers with collections times ranging in the dry season between 5min and 4h.

Farming constraints

38. Of the many constraints mentioned by the farmers, lack of sufficient cheap labour predominated the first and second rankings for 22.2% and 21.7% respectively (**Figure 4**). Labour was considered deficient for a number of activities including land clearance, maintenance of the plantation (weeding, desuckering). Marketing constraints were ranked as most important by 14.5% of farmers. This included both a lack of market access as well as the problem of low prices being offered in the local markets. Weeding is considered to be one of the most labour consuming activities (first - 9.4%; second - 13.0%)and drought ranked highest as an environmental problem (first - 8.6%; second - 4.3%).

39. When the same question was posed strictly concerning banana farming (**Figure 5**), banana weevil (*Cosmopolites sordidus*) was ranked first by many of the farmers (22.2%),

with weeds and un-specified pests and diseases being ranked first by 14.5% and 12% of the farmers respectively. Labour for managing the plantations was ranked first by 11.1% of the farmers. The main environmental constraints were drought and declining soil fertility. Marketing problems were ranked first by 4.3% of the farmers and ranked second by 7% of the farmers. 3.5% of farmers ranked lack of labour for producing banana beer as second most important.

Income generation

40. **Figure 6** shows the 11 most important sources of income for farmers participating in the DS survey. Matooke is the most important cash crop for 25.6% of the farmers. Banana beer was third most important (12.8%) after coffee (16.2%) and the sale of waragi ranked sixth most important for 4.3% of the farmers along side cattle sales, and sales of unprocessed beer bananas ranked eighth at 3.4%. Sale of matooke and coffee also were ranked as second most important for farm income generation by 18.8% and 17.1% respectively of DS farmers.

41. 25.7% of the farmers grow matooke primarily for home consumption but the majority grow for both home consumption and selling. Only five farmers said that they grow matooke primarily for commerce. Of those selling fruit, 70.2% sold from the farm with bicycle traders or occasionally trucks making collections. The rest took the fruit to market themselves by bicycle (46.7%) or on their heads/backs (37.8%) or motorised transport (8.9%). Three households usually hire someone to carry the fruit to market for them.

Harvesting and Handling

42. Farmers were asked how they decided that a bunch of matooke was ready for harvesting. In the first instance, farmers often merely said that they could "just tell". When pressed on this point, most farmers gave four or more visual indicators that they use. Most frequent is the appearance of ripening in the first few fingers, followed by drying of the leaves, fattening and rounding of the fingers and shrinkage of the male bud. Other factors included falling of the female flowers, lightening of the fruit colour and splits appearing in the older fruit. Some farmers also have an idea of the age of the bunch and know how long they expect that variety to take to mature.

43. No farmer admitted to post-harvest losses of their fruit so an alternative question was posed, concerning losses of mature bunches before harvesting could be carried out. 90.7% of farmers noted some kind of loss, with wind breakage cited most frequently (81.5%), theft

was second most frequently cited (36.1%) and ripening third most frequently cited (35.2%). Losses from wild animals (predominantly baboons, monkeys and wild pigs) were predominantly from the central sites of Mubende, Kibale and Kiboga.

44. Very few farmers felt that the activity of harvesting was a problem. When asked directly, most admitted that heavy bunches occasionally fell and were sufficiently damaged as to be unmarketable, however, this was rare provided sufficient care is taken. 41.1% of the farmers felt that they were constrained by the lack of on-farm transportation, either to carry matooke to the homestead or to carry beer varieties to the ripening place. A few farmers pointed out that some physical damage could be caused by the subsequent transportation of the fruit to market on bicycle or by truck. A few also recalled the occasional danger of slipping over when carrying a large bunch on their back or head, leading to bunch damage.

45. Farmers were asked to indicate varieties which seemed to be more susceptible to physical damage than others. The varieties Mujuba/Muvubo, Musakala, Enjagata and Kisansa (and in Kapchorwa, Mudwale, Murure and Zulume) came up the most frequently. In nearly all cases, this was due to the lax nature of the bunches of these varieties, which made the hands susceptible to detaching from the rachis. This effect is compounded if the fingers are long.

Storage

46. 32.1% of the farmers held the fruit at their homestead for up to a week after harvest for various reasons. Most commonly this was because the house-hold could not consume all the fruit harvested in one day or when the fruit was harvested in advance for a buyer. Windfalls are occasionally held at the home but were more frequently left in the plantation until needed. In the districts of Mbale and Kapchorwa, it was common for farmers to leave the matooke for a few days after harvest in order that a slightly sweeter flavour could develop. This was also encountered once in Kibale district.

Staple foods

47. Matooke was the most important staple food for 79% of the farmers with sweet potato, cassava and beans ranking second, third and fourth respectively. Sweet potato was the second most important staple food for 31.6% of the farmers with cassava, matooke, maize and millet ranking second, third, fourth and fifth respectively. Farmers indicated varietal preferences for preparing matooke (best and worst).

48. 69.6% of farmers said that matooke was available to eat at all times of the year. The remainder experienced periods when matooke was not available due predominantly to extended period of drought or sometimes to severe plantation damage from wind.

49. Nearly all survey house-holds prepared matooke on a regular basis. Across the survey sites, the mean number of meals of matooke eaten in the week previous to the interview was 7.8, with a range of 1.6 - 12.4. At six sites (13, 15, 16 18, 21 and 22) the mean number of meals eaten in the previous week was less than five.

50. Food preparation generally is the preserve of women in the household and only one farmer in the survey mentioned a male preparing matooke, in this case a son of the farmer. The majority of cooks in the farming household, steam the matooke after wrapping the peeled fruits in banana leaves. The steamed fruit is mashed part way through the cooking to form a smooth paste and it is eaten hot with stew/sauce as the main meal of the day.

51. Some women farmers reported simply boiling the matooke on occasions which is quicker than preparing the steamed matooke. In this case, the bananas are usually peeled first but sometimes the peels are left on to prevent the fruit breaking apart. Katogo is almost as popular as steamed matooke. This dish involves cooking the whole peeled matooke in a meat, bean or ground-nut stew and is a common breakfast dish. Matooke is very occasionally roasted in the skins but roasting is normally the method for preparing ripe gonja (roasting bananas) which hold a firmer texture after cooking.

52. The process of steaming matooke is laborious. Women mentioned that peeling was particularly tedious due to the latex from the fresh peelings. Collection of sufficient firewood was the most frequently mentioned problem. The whole process can take up to three hours from the initial peeling. The steaming requires close attention to ensure that the water level is adequate and the firing sufficient. There is always a danger of being burned and squeezing the steamed matooke can be painfully hot. Quite a few women denied having any problems with cooking matooke. Sometimes they indicated that it has been so much part of their everyday life and is their duty as a wife that they cannot conceive of it as a problem.

Products from bananas

53. Throughout the entire survey, only seven products were mentioned by farmers and these are presented in **Table** 3 below along with the percentage of farmers interviewed

who made a particular product. Four of these products are beverages and three are food products. A description of these products along with further survey data is to be found under individual product titles below. The inter-relationship between the beverage products is illustrated in **Figure 9**.

type of product	% of farmers making the product
juice	75.0
tonto	47.4
waragi	23.3
omubisi	0.9
kabalaga	8.6
banana flour	10.3
cake	0.9

Table 3: Banana products made by Ugandan farmers

Banana juice and beer

54. Banana juice is consumed directly as a fruit beverage after appropriate dilution or is converted into beer or 'omubisi'. The latter is the Lugandan word for banana juice, however, one farmer used the term for juice to which unroasted sorghum had been added as a preservative. The juice is made from "beer-type" banana varieties as opposed to "matooke" or "cooking-type" varieties.

55. There did not seem to be a consistent reason for preferring one variety over another for beer making. The variety kisubi produces very sweet juice (and consequently relatively concentrated alcohol), however, the fruits are small. Larger fingered varieties such as kayinga and various mbidde types (East African Highland varieties) were preferred in some cases for their higher yield (see **Para 105**). Other varieties were singled out as being easy to extract juice from, for example, kabula. Choice was determined in some regions by agronomic factors, for example, the variety grows well in that area.

56. Both juice and beer were made throughout the survey sites (**Figure 8**). The only clear cut reason for not making beer and other alcoholic beverages is where the house-hold is Muslim.

Ripening

57. Green fruit is harvested and ripened prior to juice extraction. Use of immature fruit was cited as a major reason for failure of the fruit to ripen properly. There are two principal different ways of ripening used in Uganda. These are the pit and the rack methods which are described below.

58. It appears from the survey sample (see **Table 4**) that if juice only is to be made, then a rack over the kitchen fire is used or in some house-holds where juice is made infrequently, bunches may be left to ripen 'naturally' in the house/store. It is not worth digging and preparing a pit for the relatively small quantities of fruit used just for juice preparation. This is not necessarily the case for house-holds producing commercial quantities of juice.

59. For beer production either a pit or a rack is used depending on the location, although is was noted in the RRA report that areas of high rainfall tend not to use the pit method because of the potential for pit flooding.

60. The mean ripening times quoted were 4.9 days for the pit method and 5.3 days for the rack method. Some farmers had noticed varietal differences in ripening rates. Others indicated that different varieties ripened together, took the same length of time.

The pit method

61. The bananas are place in an inverted, conical pit which has been lined with fresh and dry banana leaves on the inside and outside respectively. The bananas are then covered firstly with banana leaves and then with a layer of soil. The pit may or may not be fired by burning dried leaves/grass in the pit just prior to placing the bananas inside. Other farmers build a 'smoking tunnel' into the pit which is fired at one end to allow smoke to pass into the 'banana chamber'. Of the 26 survey farmers who use the pit method, 17 fired their pits.

62. On the second day, the top covering of soil is removed to allow accumulated gases to escape and to bring down the temperature. Experience dictates the level of temperature control and the ripening time required. If the temperature is allowed to rise too high and for too long then the fruit is 'boiled' and is useless for juice extraction. The reverse problem was cited in several cases, where the fruit fails to ripen properly. Reasons given included poor covering of the pit or inadequate firing/smoking. Several farmers mentioned that in the dry season, heat seems to be lost more rapidly from the

ground, however, some farmers said that ripening was quicker in the dry season due to higher temperatures.

	Farmers making juice only (38 total)	Farmers making tonto only (55 total)
Method used for ripening banana fruit	Percentage	Percentage
Pit	5.3*	43.6
Rack over kitchen fire	0.0	25.5
Rack built outside	65.8	30.9
left in the house	18.4	0.0
Left in the kitchen	10.5	0.0
Bananas peeled before extraction	89.5	45.5
Bananas not peeled before extraction	10.5	54.5
Extraction vessels used		
Saucepan	100	0.0
Wooden canoe	-	50.9
Pit lined with banana leaves	-	43.6
Pit lined with cow hide	-	3.6
Pit lined with cement	-	1.8

* One of these two farmers sells juice

Table 4: Aspects of banana juice production in Uganda

The rack method

63. Whole or split bunches are laid on a rack covered with layers of dry and green banana leaves and the bananas are covered on top with more banana leaves. A fire is lit under the rack and the warmth and smoke stimulate the fruit to ripen. Regular attention is required to ensure that the fire is burning properly. Insufficient firewood can mean under-ripening or patchy ripening. Too fierce a blaze can actually roast the fruit. Often the rack is built over the kitchen fire, however, farmers who produce beer regularly may build an external rack for the purpose. In this case, the ripening process can easily be disturbed by winds or rain affecting the temperature and smoke exposure of the fruit.

Juice extraction

64. The extraction of juice is dependent on a physical process. Fibrous plant materials, for example, cut grass are vigorously worked into the ripe pulp of the fruit until a point at which the juice separates from the pulp. The nature of this physical separation is not understood.

65. When the end product is to be unfermented juice drink, then frequently the fruit is peeled prior to juice extraction (**Table 4**) This is partly because small quantities of juice are usually pulped manually and the presence of the peel can make this a difficult operation. There is, however, a strong varietal influence affecting the decision to peel or not, for example, thinned skinned Ndizzi/Kabalagala do not need peeling whereas thicker skinned Kayinga is usually peeled. The squeezing is usually carried out in a large metal saucepan by the children or women of the house-hold.

66. When larger quantities of juice are required, for example for beer making, then the fruit may be left unpeeled (**Table 4**) The extraction container varies from place to place. Most common is a wooden canoe which has been described several times before [Masefield, 1938; Davies, 1990]. Alternative methods are based around construction of a pit. The pit is then waterproofed with a lining which is most frequently, fire treated banana leaves. In cattle farming areas, this material might be cow hide. At one farm, a concrete pit had been constructed (**Table 4**).

67. Failure to get the juice to separate properly was frequently mentioned and a range of factors that could be behind this failure were discussed. 64.6% of farmers cited over-ripe fruit as a primary cause of failure. A lack of commitment to the pulping process was cited by 30.4% of the survey farmers. Various climatic factors

were also mentioned although there was some apparent inconsistency with some farmers experiencing failure most commonly at the start of the rainy season, while others had problems in the dry season. Farmers citing the latter problem felt that there was probably less juice in the fruit during the dry season. 10.1% farmers said that a hail storm in the plantation caused subsequent extraction failure. Use of immature or wet grass or using soap before participating in the pulping were also factors cited on occasion. Some farmers mentioned a local belief in witchcraft which lead to farmers blaming failure on un-friendly neighbours.

68. A variety of fibrous plant materials are used to assist pulping. Grasses were most frequently utilised. In 88% of the survey farms, speargrass (*Imperata cylindrica*) was used, however, other grasses (couch, emburara, egunga, bukuli, tete, *Cympopogon*) were used as alternatives or papyrus flower heads. Yellow banana leaves are commonly used when only small quantities of juice are being prepared (the chlorophyll can come out of green leaves which can discolour and impart an unacceptable flavour to the juice).

69. The pulping process requires a considerable input of energy. If larger quantities of juice are to be prepared, a young, strong man is frequently used for this operation and maybe hired if there is no-one suitable in the family. Mashing is usually done by the feet and it can take up to an hour before juice appears. This juice is highly concentrated, however, frequently water is added to the pulp/juice mixture to further assist with the extraction. The juice is separated from the pulp by piling the pulp/grass mixture at one end and pressing on the top. The juice is crudely filtered in this manner.

Juice quality and shelf-life

70. A poor quality juice was most frequently associated with the near failure of the juice to separate during extraction. This can lead to three main quality problems, a slimy texture, a curdled appearance and a brown colour. Some farmers mentioned a lack of taste as well. If poorly ripened fruit are used the juice can be astringent and not very sweet, where-as using the rack method of ripening and not peeling the fruit can cause the juice to have a smokey flavour. Some house-holds use lemon-grass (tete) to extract the juice. This imparts a distinctive flavour which is favoured by some and unacceptable to others who avoid using this grass. *Cympopogon* also flavours the juice and is usually avoided for this reason if possible.

71. Juice has an extremely short shelf life. Farmers put it at between half and two days (mean 1.6 days), however

a few said that they can keep it up to a week, provided it is stored in an airtight vessel. Most commonly, the juice is boiled which extends the shelf life for a variable period. The addition of fresh sorghum or ginger or boiling with tea leaves was mentioned as possible 'preservative' factors. The mean 'preserved' shelf-life is 13.6 days, however, the mode is 2 days.

Fermentation

72. For making beer, the juice is further diluted. It is then put in fermentation vessels. These vessels are usually the woodern canoes used in juice extraction but in some regions, clay pots or calabashes are used. The juice is then mixed with coarsely ground roast sorghum, or in some areas in the East, sorghum, millet or maize residues from previous fermentations may be used in addition. One farmer mentioned the use of crushed male banana buds (**Table 5**).

73. The vessel is then covered with banana leaves and spent grass from the pulping process. The vessel is placed in a pit which may be lined with spent pulp/grass to allow the build up of warmth around the vessel or alternatively the pit may be fired to provide initial warmth or both procedures may be carried out. The fermentation takes between 1 and 3.5 days depending on the season and other factors. As with fruit ripening, farmers differed in their explanation of seasonal effects. Some found that fermentation was slower in the dry season and others found it slower in the wet season.

74. The majority of farmers reported that they did not experience any problems with the fermentation stage of beer preparation. The main problem reported was an extended period of fermentation due either to too little heat or to insufficient sorghum. The latter could occasionally cause failure altogether or lead to the development of unpleasant flavours. Availability of sorghum was considered as an important limiting factor in beer making.

75. After fermentation, the beer is normally filtered. There are numerous types of filter used but the one most commonly encountered was a calabash funnel lined with grass. The beer has a short shelf life. The product keeps fermenting 'on the shelf' and personal preference determines at what stage it is considered undrinkable. 32% of farmers suggested that a week was the longest beer could be kept satisfactorily.

Fermentation vessel	% of farmers making beer (55 total)	Fermentation additive	% of farmers making beer (55 total)
Wooden canoe	85.5	Roast, ground sorghum	90.5
Clay pots	9.1	Maize fermentation residues and roast, ground sorghum	3.8
Calabashes	3.6	Millet fermentation residues and roast, ground sorghum	1.9
Polythene lined pit	1.8	Sorghum residues from previous fementations	1.9
		Crushed male buds from banana plant	1.9

Table 5: Aspects of the fermentation of Ugandan banana beer

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76. Almost all farmers who make beer, sell it to bar owners, generally on credit (67.4% exclusively, and 20.4% for either cash or credit). Sales of beer are affected by numerous factors. In periods of scarcity, beer sales are generally affected by the amount of money in peoples pockets which is related to the harvesting and sale of seasonal crops. Farmers are more likely to receive cash from the bar owners under these circumstances. People tend to drink more in the dry season. In periods of local over-production, quality factors are of primary importance in being able to sell beer, in particular the alcohol content. Bar owners will sample the beer before accepting it. Very strong beer is particularly attractive to bar owners, who can dilute it with lower quality beer and sell more medium strength beer.

Waragi

77. Waragi from tonto is made mostly in western and central sites whereas kasese is most popular in the

central sites and Kabarole District. Very little waragi is made in the eastern sites (**Figure 8**). Traditionally, alcoholic beverages in the east tend to be made from maize or millet.

78. Waragi prepared from tonto was made at more sites (19) in the survey than the kasese type (13 sites) although some farmers make both types. In Kabarole District, some farmers suggested that it was easier to make kasese and that they were shifting away from tonto production.

79. Kasese is prepared by leaving the ripened, peeled bananas either wrapped in a plastic bag or inside a metal drum to ferment on their own. After one to two days water is added and the bananas are squeezed and then left again to continue the fermentation. After a further four days, the bananas are pulped and the juice filtered off for distillation.

80. Waragi is usually distilled in 200 litre metal drums. The drums are fired underneath with firewood. Copper tubing leads from the top of the drum and has a coiled section which is placed in water to condense the alcohol vapour. Nearly all farmers who make waragi noted several problems. The equipment is expensive and the majority of survey farmers hire a still rather than owning their own one. The official licence adds to the expense although many farmers are operating illegally without one.

81. The distillation process consumes considerable firewood. In kasese production, it can take 4-5 hours to get one jerrycan of waragi. The process needs to be carefully regulated. Some farmers had problems with water vapour being carried over, diluting the waragi. Most farmers had heard of cases of stills exploding and killing or injuring the operators and were themselves very concerned about this potential danger. Frequently, getting sufficient water or transporting the equipment to a water source is problematic.

82. As with beer, farmers usually sell waragi to local bar owners on credit terms. Farmers can sell their waragi to operators from Uganda Distilleries, however, the prices paid are lower than can be obtained from selling locally because the operators levy their fees for collection. One farmer used to take his waragi to Kampala to sell directly to Uganda Distilleries but claimed that the bureaucracy delayed payment for so long that it was not worth his while continuing that practice.

83. The alcoholic concentration, aroma and taste of the waragi are quality factors of importance in obtaining good sales. Some farmers suggested that their major limitation

was a lack of transport/access to alternative markets. The major advantage to waragi production above beer is the almost indefinite shelf life of waragi so that the unsold product can be kept and sold when prices are optimal.

Food products

84. Only three 'processed' banana products have been recorded throughout the survey and the majority of the farmers do not make any of them (**Table 1**). One survey farmer makes banana cake. Kabalagala pancakes are commonly found throughout parts of Uganda. In this survey, kabalagala production was found at farms scattered mostly through western and southern sites and was not found being made by DS farmers in the eastern sites (Figure 8). These pancakes are made from ripe desert bananas, for example, ndizzi, which are pounded with cassava flour, shaped into rounds and fried. Occasionally, when available, baking powder can be added to lighten the texture.

85. Farmers who do not make kabalagala mentioned several reasons including the expense of the ingredients such as oil. In Kiboga, cassava flour was scarce because of an epidemic of cassava mosaic virus. Local competition could make it un-profitable. Most frequently, farmers said that they were too busy to make kabalagala and had no need to do so or that they did not have the necessary skills.

86. Most drying of banana is found in the eastern sites, particularly in Kapchorwa District where matooke varieties can be prepared this way. After peeling and slicing the green (or sometimes ripe) fingers into lengths, the fruit is spread on the roof of the house or the ground to sun dry. When sufficiently dry, the pieces are pounded or ground to form a flour. The flour is subsequently prepared for eating by mingling in hot water.

87. People generally indicated that drying bananas was a practice that they recalled being common in their parents generation during periods of severe famine. During these periods, it was beer bananas that were prepared, as these would be remaining after the matooke had all been eaten fresh. Many survey farmers indicated that they did not know how to go about preparing banana flour, although they also felt that it was not necessary, given a sufficient supply of fresh green matooke. All the farmers who do dry bananas, mentioned the problem of spoilage from moulds which occurs if there is rain during the drying period.

Uses of banana waste

88. Banana wastes and left-overs are used commonly throughout the DS sites as a mulch in the banana plantation, in particular the leaves and split pseudostems. These plant parts and other wastes are also important as animal feed. Most popular is feeding matooke peelings to goats and/or sheep (at 61.5% of farms) or to cattle (at 37.6% of farms). Pigs are fed with cooked matooke leftovers (at 18.8% of farms) or cooked peeling (at 16.2% of farms). In hilly areas where pasture land is scarce, cattle are frequently fed with banana pseudostems (e.g. in Kabale, Bushenyi and Kapchorwa Districts and also in Kabarole and Mbale Districts). Other less common feedstuffs include whole green or ripe matooke fingers and chopped male buds to goats, sheep and cattle and cooked matooke to chickens.

89. Farmers were asked whether feeding banana tissues to livestock had any adverse effects on the health of the animals. The majority of farmers had not noticed any problems. Of the 23 who were aware of a potential problem, most mentioned that feeding goats, cattle or sheep with too many fresh peelings or pseudostem could cause diarrhoea. A couple of farmers also thought that too many peelings in the diet of goats or sheep could reduce milk production. A lot of farmers believe that the animals self-regulate the amounts that they eat, provided they are given a choice of food.

DISCUSSION

Methodology

90. All surveys are limited by a variety of constraints and this one was no exception. A semi-structured questionnaire had been chosen because it was felt that there would be greater flexibility in exploring interesting areas that came up during the interviews. In retrospect, it is clear that combining research on quality aspects of matooke and a lengthy questionnaire covering all post-harvest activities inhibited this flexibility. There simply was not time to follow up a new area of interest without compromising the rest of the questionnaire. As it was, the survey team spent between 2-4h with each farmer, leading to a high risk of farmer fatigue. Despite this, farmers were, on the whole, extremely helpful and their replies were consistent throughout the interviews.

91. There was a definite time advantage in working with farmers who were participating in an on-going survey. The

farmers had, in general, committed themselves to assisting the research and were accustomed to the use of questionnaires. In a few cases were farmers initially reluctant to participate, particularly in the sensory evaluation of cooked matooke but these people agreed to assist after the rationale for the research was discussed with them. Considerably more time was required in explanation when working with new farmers (who replaced DS farmers absent when the team visited the site).

92. The potential disadvantage of working with the DS farmers was that their perceptions of constraints and potential solutions may have been influenced by the multi-disciplinary on-farm activities of the DS scientists. For example, weevil trapping activities would heighten farmer awareness of this particular pest problem leading to many farmers ranking weevils as the primary constraint to growing bananas (Para. 40). Furthermore, some farmers expressed their fatigue with answering yet more questions about banana farming. There is the danger that this fatigue would lead to farmers giving 'off-the-cuff' responses to try and reduce questioning time.

93. These possible problems were kept in mind during the interview sessions. Effort was made to be as sympathetic as possible to the situation of the interviewees, for example, rescheduling visits in a site to maximise convenience for the farmers. It was necessary to be continually alert throughout the interview for irrelevant or inconsistent answers and to tactfully bring the interview back on track or probe for an understanding of unclear information. Farmers co-operated better when they realised that there was genuine, intelligent interest on the part of the interviewer.

94. Some of the questions in the interview were the same as those asked in the DS passport data in 1992. Many questions were also duplicates of those in an original post-harvest questionnaire which had been distributed in 1992. For those farms where the 1992 questionnaires had been completed, it was possible to compare the answers with those collected in the 1993 post-harvest survey. There were differences in responses to the same questions at certain sites which may reflect a poor understanding of certain questions by the enumerators who interviewed the farmers for the original questionnaire.

95. The biggest discrepancies were with certain types of numerical data where estimations of area, distance or time taken were required (for an example, see the results section - passport data for area data). Some of this data is 'sensitive', for example, information on land holdings may have deliberately been distorted by the farmer who suspected the use to which the information might be put.

Unfortunately the only way of over-coming these problems would be for the scientists to take the measurements themselves but the scale of the survey precluded this approach. It was in anticipation of these kinds of problems that the questionnaire was designed to minimise the number of quantitative estimates that would be required to be made by the farmer.

96. An important point to be kept in mind when considering the applicability of the survey results to all banana farmers in Uganda, concerns the amount of land owned by the farmers interviewed in this survey. According to a World Bank country study (IBRD, 1993), 85.1% of farm households have 5 acres or less and 95.5% have 10 acres or less. Of the farmers interviewed in this survey, 21% had 5 acres or less and 50% had 10 acres or less. This may be representative of banana farmers in Uganda, however there is the possibility that by selecting farmers with at least 100 banana stools, there is a bias towards larger and potentially more prosperous farmers.

Farmer constraints

97. Although farmers did not mention the time taken to collect water as a general farming constraint, the collection of water clearly requires a considerable time input for many households (Para 38). More specific to banana post-harvest operations, the collection of water was mentioned as a time constraint when preparing to cook matooke, when making beer and when distilling fermented banana juice to make waragi. The distance of the local water source is therefore an important factor to consider if particular farmers are to be encouraged to expand or develop processing technologies that use water.

98. Farmers perceive all their major constraints as being in the production phase with the exception of marketing. This may genuinely reflect a lack of post-harvest problems or it may indicate that farmers are less aware of constraints in post-harvest operations as problems. Labour issues dominated the list of constraints given by farmers. Several farmers mentioned that the influx of Rwandan refugees in the 1970's had provided a relatively cheap pool of labour, however, now these refugees had either returned home or settled on their own farm land. This situation may change again with the current civil war in Rwanda. The possible influence of AIDS or other illnesses on labour availability was not mentioned in any interview.

Post-harvest losses

99. The main causes of post-production loss of bananas are fundamentally pre-harvest i.e. wind toppling of

mature, bunch bearing plants, theft and animal damage. It is clear that the inability to market fruit in periods of high local production is directly linked to fruit being left in the plantation to ripen. The price of the fruit in more remote areas can fall to a nominal value. In Kampala, a bunch can fetch between 2000-3000 shillings, however, farmers in site 4 (Mbarara) for example, sometimes had to sell for as little as 200 shillings for a bunch. Their nearest banana market was about 18 miles away in Ibanda. With this sort of situation or when an area is prone to excessive windfall, it is important to consider what alternative uses excess or damaged fruit can be put to that could preserve the fruit for home consumption or generate income.

100. A few farmers mentioned the adverse effects of pre-harvest infection by Sigatoka diseases on the fruit development and quality, corroborating a similar observation made during the RRA (Rubaihayo, 1991). Food prepared from bunches from infected plants is hard and can have an unpleasant flavour.

101. Post-harvest diseases were not mentioned by farmers at all. Matooke is cooked while still green, so that latent diseases such as anthracnose, do not have a chance to develop. It is surprising, however, that no mention was made of beer bananas rotting during the ripening process. It is possible, that the temperatures reached in either the pit or on the rack, inhibit the development of the fungi.

Harvesting and handling

102. The majority of farmers are generally not handling large numbers of bunches and were not concerned about post-harvest damage of their fruit. Apart from the occasional damaged bunch from poor harvesting or a fall when transporting the bunches on farm or to the market, this was not a constraint to being able to sell at the market or to traders. With the larger, more commercially minded farmers, it is usually the traders who carry out the harvesting. The onus is therefore on the trader, to ensure that sufficient care is taken to allow presentable fruit to reach the market. It does not appear therefore that there are any obvious interventions concerned with harvesting technique that might make a significant impact.

103. Banana bunches are very bulky and the primary constraint in many post-harvest activities is actually transporting the fruit from one place to another. On-farm, a wheelbarrow could assist but the cost/benefit is not obvious to the farmers who mentioned it. Owning or hiring suitable, motorised transport for bulk transportation by road to market, is not an option for

most small farmers. Although several farmers talked about the need to set up farmer co-operatives which might allow group purchase of transportation, others had had previous co-operative experience which had foundered because of lack of trust or commitment between founder members.

Staple foods

104. Matooke is the most frequently consumed and preferred food of nearly all the farmers participating in the survey. The traditional method of preparing steamed matooke is both laborious, time consuming and uses more firewood than simply boiling the fruit. The fact that the end product is prized over boiled matooke, suggests that farmers would be resistant to efforts to alter this method of preparation to save labour or fuel. This might not be the case in the urban situation. One retired senior civil servant in Kampala mentioned that in the 1960's, an electric 'matooke' pressure cooker was available. It might be worth considering whether the saucepans used for food preparation throughout Uganda, could be modified to form a pressure holding vessel, which could reduce the cooking time.

105. The export levels for bananas are very low. Uganda is land-locked and is currently reliant on air-freight for perishable commodities. The cost of air-freighting, limits export to low volume or high value products such as 'Ndizzi' (apple) bananas. It is clearly in the interest of Ugandan banana farmers that there is a expansion of such exports. It is, however, essential that the market opportunities are determined before farmers are encouraged to grow more 'Ndizzi'.

106. These small bananas have very thin skins which make them highly susceptible to physical damage. They are also prone to certain physiological disorders e.g. a condition which renders part of the pulp hard and chalky. The expansion of the export industry would definitely require research into the appropriate maturity level for harvesting, the best ways to handle these fruits in the Ugandan farming context and other quality issues for these fruits.

Banana beverage production

107. Farmers indicated that they preferred certain varieties because they give higher yields of juice. It is not clear, however, what the farmers actually meant by yield. Although Kayinga was frequently mentioned as having a higher yield than Kisubi, this conflicts with findings from research carried out at MUARIK. These results showed the reverse, with Kayinga yielding about

10% less juice than Kisubi as percentage weight for weight of the ripe pulp squeezed (Gensi, Personal Communication).

108. There are a number of constraints to the production of banana juice. The actual extraction of the juice is extremely laborious. Some older interviewees said that they no longer have the strength to squeeze the fruit themselves. The possibility of making a machine to pulp the bananas was mooted during many of the interviews and there was considerable interest from the farmers. Juice extraction is prone to failure for a whole variety of reasons. It would be useful to look it detail at the extraction process to try and understand which factors are of critical importance to the success of juice extraction. This investigation would need to look at the ripening process, as over-ripened fruit was cited as an important cause of failure.

109. Some farmers knew of particular plant extracts to add, which could rescue a juice making session that was looking as if it might fail. These plants appeared to be chosen for their high levels of astringent sap. This might be linked to the fact that it is easier to extract juice from under-ripened fruit than fully ripened fruit (although in this case the juice has less sugar and tends to be astringent to the taste).

110. Another obvious area for technical investigation is the short 'shelf-life' of the juice. This aspect makes it difficult to market and it is more sensible to turn it into beer before selling. It is possible that simple procedures might prolong the juice life, for example, storage of the boiled juice in air-tight bottles that have been sterilised in boiling water. Banana juice naturally contains a high percentage of sugar ranging between 18-29% (Kyamuhangire *et al.*, 1993).

111. Where juice is being produced commercially, some farmers reduce the volume of the juice by evaporation to increase the sugar concentration to a level inhibitory to the growth of micro-organisms. This also causes the loss of volatiles essential to the characteristic aroma/taste of the banana juice. The same concentration effect could be achieved by actually adding sugar to the juice and diluting before sale (Kyamuhangire - personal communication).

112. For further commercial exploitation of banana juice, it would be necessary to consider other possible stabilisation methods such as the use of sulphur dioxide as a preservative. Some research has already been carried out on all these aspects of banana juice by Kyamuhangire (1990). In this case the variety used was 'lady fingers',

an AAB type available in Australia where this research was conducted.

113. Banana beer also suffers from a shelf-life problem although it is not quite as critical as banana juice. This is one of the main reasons why farmers will convert beer into waragi. Beer is, however, of great cultural significance in the main banana growing areas of Uganda as well as being a popular drink. The short shelf life therefore is not likely to lead to the cessation of production in favour of waragi, however, it does limit the market potential.

114. The economic significance of beer making to a brewing household was explored in a short case study by Davies (1993). He concluded that monthly brewing could contribute over 150% of additional household income that could be earned by a Senior Agricultural Assistant in 1990.

115. It was noted by Digges (1994) that the banana beer supply areas for Kampala are in districts very close to the city e.g. Mpigi, Luwero. Farmers usually have to sell on credit, the cost of failure to sell the beer to consumers falls on them rather than the bar owners. As with juice, any attempt to further commercialise beer production to small scale industrial level, would necessitate the development of a means of preserving the beer.

116. The actual fermentation process does not seem to be prone to failure and is usually very rapid. The major constraint appears to be the availability and quality of sorghum. Using the incorrect volume of sorghum can be deleterious to the quality of the beer. The local temperature also affects the speed of fermentation. Extended fermention can occur in both the wet and dry seasons depending on the area. Cooling winds can occur in the dry season, so exposed farms might be affected more by this factor than generally cooler weather of the rainy season.

117. The constraints to beer production mentioned by farmers in this survey, have hardly changed since the early 1970's (e.g. short-shelf-life, sorghum availability, variable quality). During that period, an interest was shown by researchers at Makerere University, Kampala in the potential of banana beer to be 'improved'. Several local surveys were carried out by students in the Department of Agriculture, for example, in South-Western Uganda (then Ankole District) and Mubende District [Nsimeki, 1973; Bekalze, 1973]. The students concluded that increased technical knowledge about the production of beer ('mwenge') and also the development of improved

varieties of sorghum were essential to expand the market potential, both internal and external to Uganda.

118. The major constraints to waragi production appear to be primarily related to the quality and moveability of the distillation equipment. There is strong argument for improving the design of the stills, however, the cost of the materials already used was frequently mentioned as a limiting factor so design of an alternative still would need to carefully consider the cost implications.

Banana food products

119. It seems initially surprising that in a country with such an important banana culture, there are few processed banana food products. This may be due in part, to the palatability and general availability of the fresh fruit. There does, however, appear to be a lack of awareness of the large range of banana processing techniques possible. The drying of matooke or beer bananas is rare and linked to famine periods. In this survey, all the farmers who had direct experience of drying bananas, talked about preparing flour. On the whole, banana flour seems to be less favoured than other alternatives such as cassava flour or posho. It is interesting that Bekalaze (1973) talks about farmers preparing dried chips of beer bananas rather than flour. These chips are cooked by firstly pre-soaking for 6h and then boiling, mashing and eating with beans.

Uses of banana wastes

120. Most parts of the banana plant can be used in a variety of ways by farmers. The RRA report (Rubahaiyo, 1991) notes the use of pseudostem sheath for thatching. Dried leaves may also be used for this purpose. Fibres are also used for basket making and along with leaves for wrapping food for cooking or storage. All parts of the plant are used for mulching, including the wastes left over after the preparation of beer, although some farmers noted that these residues can attract swarms of bees into the plantation.

121. The DS questionnaire concentrated on the use of banana parts as animal feed and found that nearly all farmers who have livestock, make use of banana wastes as feed. A proportion of these farmers were aware of potential animal health problems associated with feeding livestock too much fresh banana plant material. This is a possible area for research to determine suitable feeding regimes and make recommendations for maximum levels of fresh banana materials in animal diets.

CONCLUSIONS AND RECOMMENDATIONS

122. This survey has identified certain key areas where there are post-harvest constraints to Ugandan banana farmers. It is therefore possible to make recommendations as to the key areas of research and/or technology transfer that need to be addressed by research scientists and development agencies over the coming years.

Matooke preparation/Use of 'excess' matooke

123. The preparation of steamed matooke is the favoured way of consuming cooking banana in Uganda. The method is, however, labour intensive and consumes more valuable fuelwood than other methods such as boiling. In rural areas, there appears to be little incentive for people to try and process matooke into any other form when there is plenty of fresh matooke available. The situation is different in times of 'over-production' or after a severe windfall where the fresh fruit available is in excess of what can be eaten or sold. There is an urgent need therefore, to develop processing technologies that could absorb this excess fruit.

124. The traditional famine strategy of drying is one such option. The development of products from matooke for human consumption will, however, only benefit the rural farmer if the product is either a) sufficiently cheap, labour non-intensive and palatable to be accepted as a starchy staple into the diet of the household or b) there is a favourable urban market for either dried matooke or products prepared from matooke flour.

Recommendations:

a) A study should be conducted on the steaming of matooke to try and improve the efficiency of the cooking process, for example, a simple pressure cooker could be developed.

b) A socio-economic study should be conducted to assess the impact on the rural economy of encouraging farmers to dry matooke.

c) Sun drying trials for matooke should be carried out. The storage life of the dried matooke and ways of enhancing storage life would also need investigation.

d) The potential of dried matooke as an animal feed supplement should be investigated. This should commence with a feasibility study.

e) The dried matooke should be prepared as a flour and this flour used to create a range of products. The acceptability of these products should be determined and potential markets assessed.

Post-harvest handling/Export opportunities

125. In the current state of development of the Ugandan banana industry, there is little reason to invest in developing better methods of post-harvest handling for matooke or beer bananas. The levels of post-harvest losses for matooke are currently low, on farm and throughout the internal market chain (Digges, 1994). Where, however, there are export opportunities, for example, with 'Ndizzi' there are a number of needs to be addressed to ensure that the commodity meets the quality demands of the importing countries.

Recommendations:

a) The export market potential for fresh Ugandan bananas should be clearly established so that appropriate technological interventions can be made through-out the post-harvest chain.

b) Research is required to establish the ideal handling regime for 'Ndizzi' fruits, for example;

i) field operations that may enhance post-harvest quality, for example, selective dehanding or removal of leaves that might scar the growing fruits.

ii) optimal harvesting maturity and how to assess this in the field.

iii) appropriate packaging to protect the fruit from fundamental and cosmetic damage.

iv) optimal holding temperatures and ripening schedule.

c) The cause of and solution to physiological disorders in the fruit needs to be investigated, for example, 'chalky pulp'.

d) Adequate steps should be taken to ensure dissemination of the relevant post-harvest handling techniques for 'Ndizzi'.

e) A market information system needs to be established that is readily accessible to the banana farmers.

f) On-going trials for improving the sun-drying of 'Ndizzi' should be continued.

Banana beverages

126. The production of banana juice and beer is the most popular form of banana processing in Uganda. Beer production is a key source of income for many banana farmers. Farmers identified various constraints throughout the whole process of fruit ripening, juice extraction, juice fermentation and juice/beer stabilisation. Production of waragi is an important source of income to some farmers and is also associated with numerous constraints associated with the distillation process.

Recommendations:

a) An assessment of the socio-economic impact of reducing the constraints faced by rural farmers in making banana beverages. Important questions which need to be answered include:

i) would there be a bigger market for banana juice or beer if they had a longer shelf-life?

ii) what would be the implications of any improved technologies on the division of farm labour inputs?

iii) Is there sufficient production capacity to sustain a large banana beverage industry throughout the year.

b) Optimal ripening strategies for beer bananas should be determined. This would include;

i) the establishment of the ideal maturity stage for harvesting

ii) establishment of the most appropriate on-farm methods for ripening for recommendation to farmers.

iii) establishment of optimal ripening conditions for industrial scale juice production.

c) Methodologies should be developed for improved banana juice extraction.

d) Low cost technologies which would be readily available to the farmers for preserving the juice need to be developed.

e) The role of sorghum in the fermentation of banana juice needs investigation.

f) A study needs to be conducted to see how the availability of quality sorghum affects the potential expansion of beer production.

g) Development of low cost technologies which would be readily available to the farmers for increasing the shelf-life of banana beer.

h) A case study is needed to assess the urban market demand for high quality banana juice or beer made in the industrial sector.

i) A study is needed to look at the design of stills for the production of waragi from the perspective of both efficiency of the distillation and safety of the operators.

Livestock feeding

127. The use of parts of the banana plant for livestock feed is common throughout both rural and urban Uganda. The impact of banana wastes on the nutrition of livestock has been researched in several countries and no doubt the potential danger of 'scours' from overfeeding with these materials has also been investigated.

Recommendations:

a) Information on the impact of using banana plant tissues as livestock feed needs to be collated and if sufficiently comprehensive, should be used to draw up recommendations for feeding regimes. These recommendations should be disseminated in an appropriate form to livestock farmers.

b) If the recommendation in a) above fails to reveal sufficient information, then there is a need for basic research to be conducted within Uganda on these issues.

Snack foods

128. It was noted in the marketing study by Digges (1994) that snack foods appear to be popular in urban areas, however, apart from roast Gonja and kabalagala pancakes, there were no banana snacks available. Adoption of such foods would provide alternative markets for banana.

Recommendations:

a) Research should be conducted to develop the kabalagala pancake into a consistent, shelf stable product. This work would ideally be conducted in collaboration with interested small scale entrepreneurs.

b) The development/production of alternative banana snacks such as deep fried banana chips or even novel products developed perhaps from banana starch should also be considered. As with proposal a), development would ideally be conducted within the private sector with support from public sector research establishments.

Waste utilisation

129. The marketing study by Digges (1994) indicated that the large quantities of banana wastes generated in Kampala are largely mixed with other house-hold wastes and dumped. Only a small proportion is kept separate for use as livestock feed.

Recommendations:

a) A full case-study should be conducted, to determine if there is an economically viable case to be made for the separation of organic (including a high proportion of matooke materials) wastes from inorganic wastes by the Kampala City Council. The resulting organic waste should be considered for returning to matooke farmers as mulch or for use as an animal feed by peri-urban farmers where there is zero-grazing.

b) If the case-study in a) concludes that waste separation is economically viable then the best technologies available will need to be trialed for efficient separation and utilisation of the wastes.

Prioritisation of research activities

130. All the research recommendations made above are based on a combination of the identification of post-harvest constraints in the banana farming system and gaps in the knowledge base. To assist banana farmers, research needs either to lead to an improvement in their food security or to an increase their income or preferably both. The author has therefore selected for prioritisation in the NBP, the research options which appear most likely to benefit the farmers in those ways. These are as follows:

1. Para. 124, recommendation c). (food security)

2. Para. 124, recommendation e). (food security/income generation)

3. Para. 126, recommendation b) i) and ii), c) - g) (income generation).

131. These areas of research concern banana processing technologies with which the farmers are largely familiar but which have considerable potential for improvement. The

likelihood of improved technologies being adopted by the farmers is thus increased. The research is also likely to provide useful information which could ultimately support the industrialisation of banana processing in Uganda.

ACKNOWLEDGEMENTS

My thanks go to all members of the National Banana Programme who helped me in the course of this survey, in particular Dr Eldad Karamura, Mrs Deborah Karamura and Mr William Kyamuhangire. I am grateful to the British High Commission for the loan of a Landrover and for general assistance with the formalities of my stay in Uganda. I am indebted to my colleagues/assistants in the post-harvest team i.e. Mr James Ssemwanga, Mr Frank Ssekagiri and Mr Godson Kamukama for their enthusiasm and commitment to the survey and finally I would like to thank Mr Geoffrey Bockett who assisted me with the logistics of my visit in so many ways.

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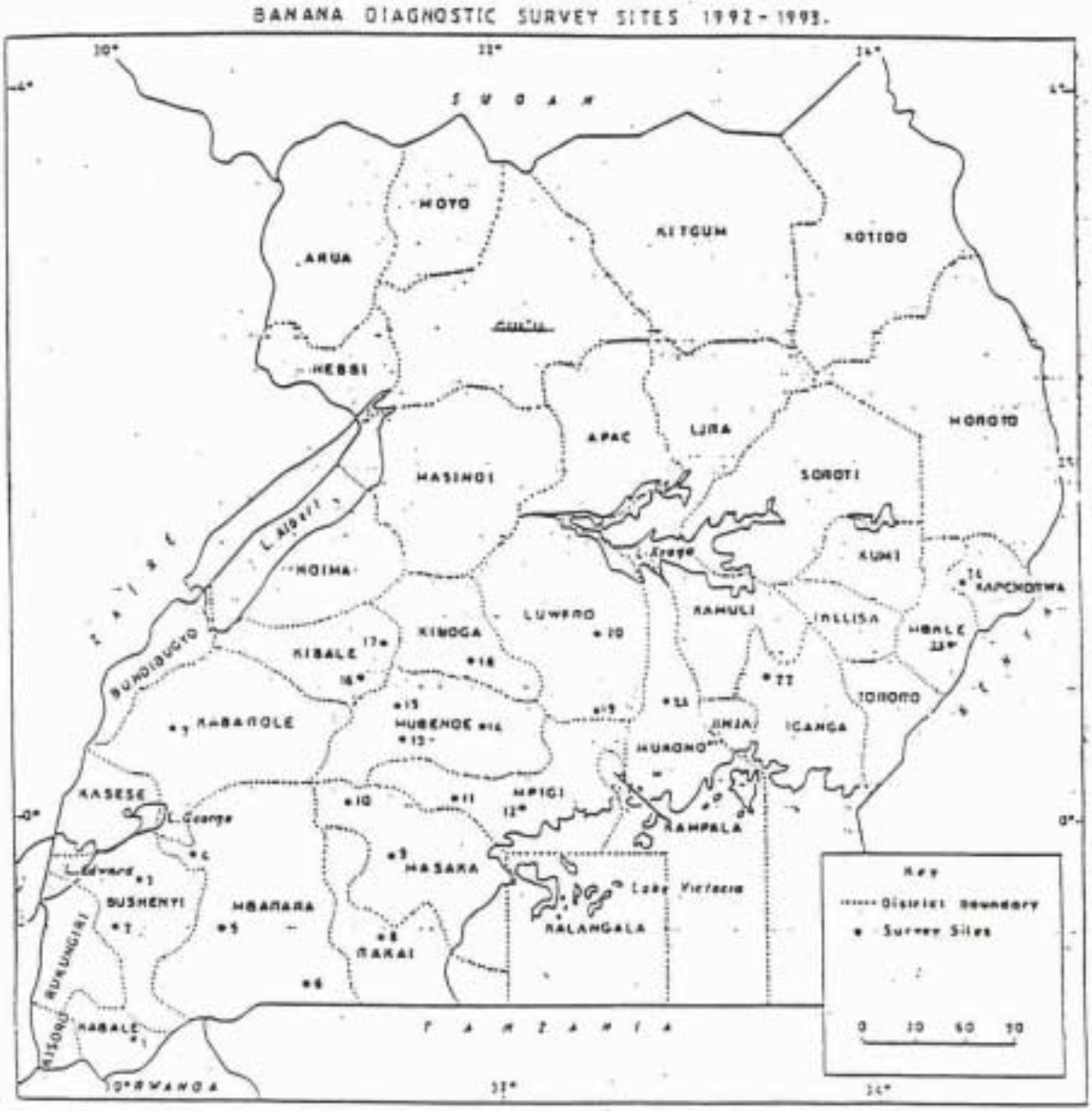


Figure 1: The location of the 24 survey sites chosen for the 1992/3 diagnostic survey of Ugandan banana farmers.

AREA OF LAND OWNED BY FARMERS IN THE DIAGNOSTIC SURVEY (1993)

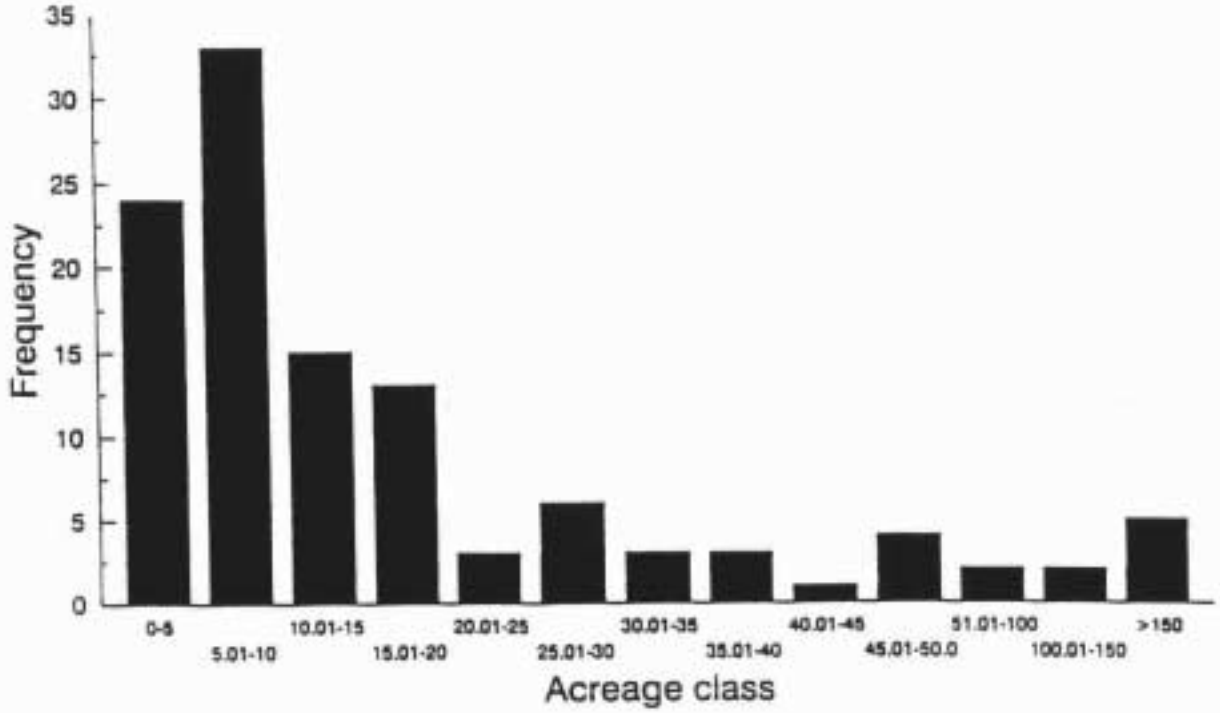


Figure 2: The area of land owned by farmers who participated in the diagnostic survey. The areas are estimates given by the farmers when interviewed between August - November 1993. The area data (in acres) has been sorted into frequency groups. The frequency classes are 5 acre intervals up to 50 acres. The final three classes cover much larger intervals (50 acres or > 150 acres).

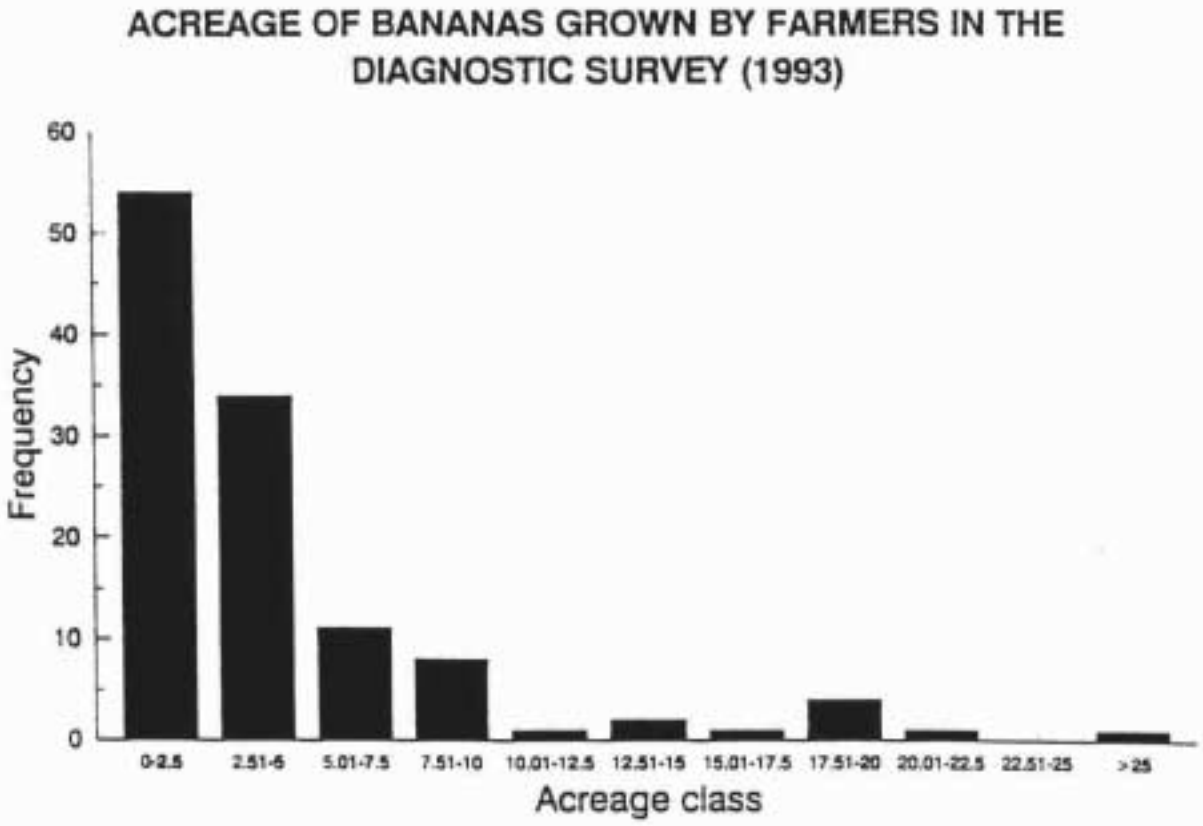


Figure 3: The area of land given over to bananas by farmers who participated in the diagnostic survey. The areas are estimates given by the farmers when interviewed between August - November 1993. The area data (in acres) has been sorted into frequency groups. The frequency classes are 2.5 acre intervals up to 25 acres. The final class covers areas greater than 25 acres.

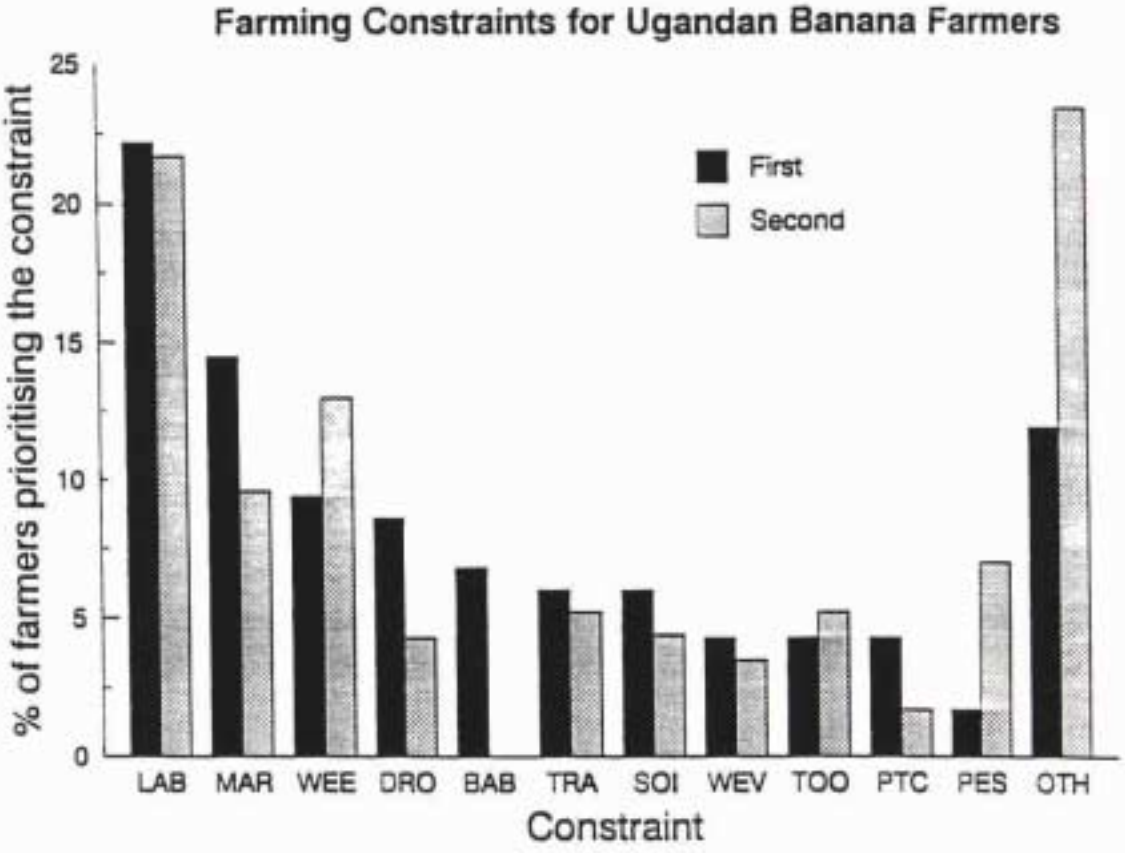


Figure 4: The general farming constraints identified by Ugandan banana farmers participating in the diagnostic survey (August-November 1993). After listing the constraints, the farmers were asked to rank them in order of importance. The figure gives the percentages of farmers who ranked a particular constraint either first or second.

Codes

LAB	insufficient labour for a range of farming activities
MAR	poor market openings/low prices at market
DRO	drought
WEE	weeds and expense of herbicides
BAB	crop damage from wild animals
TRA	transport for crops to market
SOI	low soil fertility
WEV	banana weevils
TOO	lack or expense of farm tools
PTC	expense of pesticides
PES	general pests and diseases
OTH	all other constraints mentioned

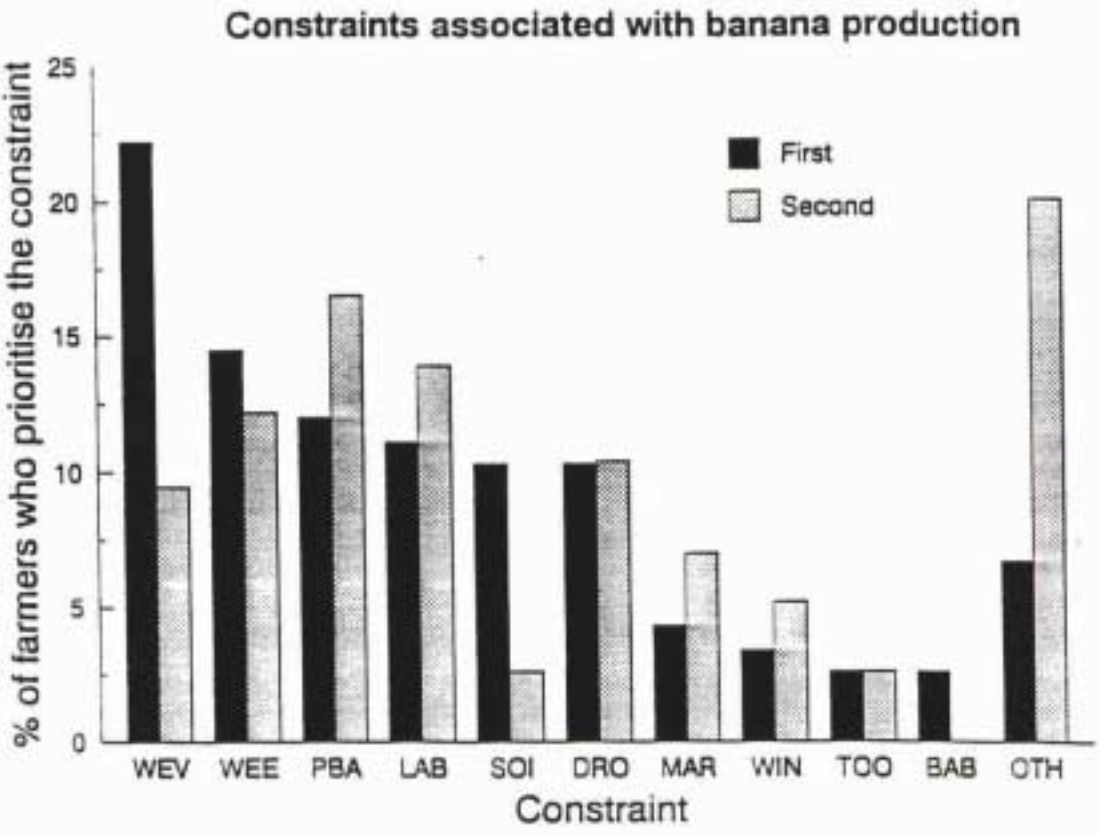


Figure 5: The farming constraints associated with banana production as identified by Ugandan banana farmers participating in the diagnostic survey (August-November 1993). After listing the constraints, the farmers were asked to rank them in order of importance. The figure gives the percentages of farmers who ranked a particular constraint either first or second.

codes

WEV	banana weevils
WEE	weeds in the plantation
PBA	general banana pests
LAB	insufficient labour to manage plantation properly
SOI	low soil fertility
DRO	drought
MAR	poor market for bananas/low prices for bananas
WIN	wind damage to plantation
TOO	lack/expense of tools to manage plantation
BAB	crop damage from wild animals
OTH	all other constraints mentioned

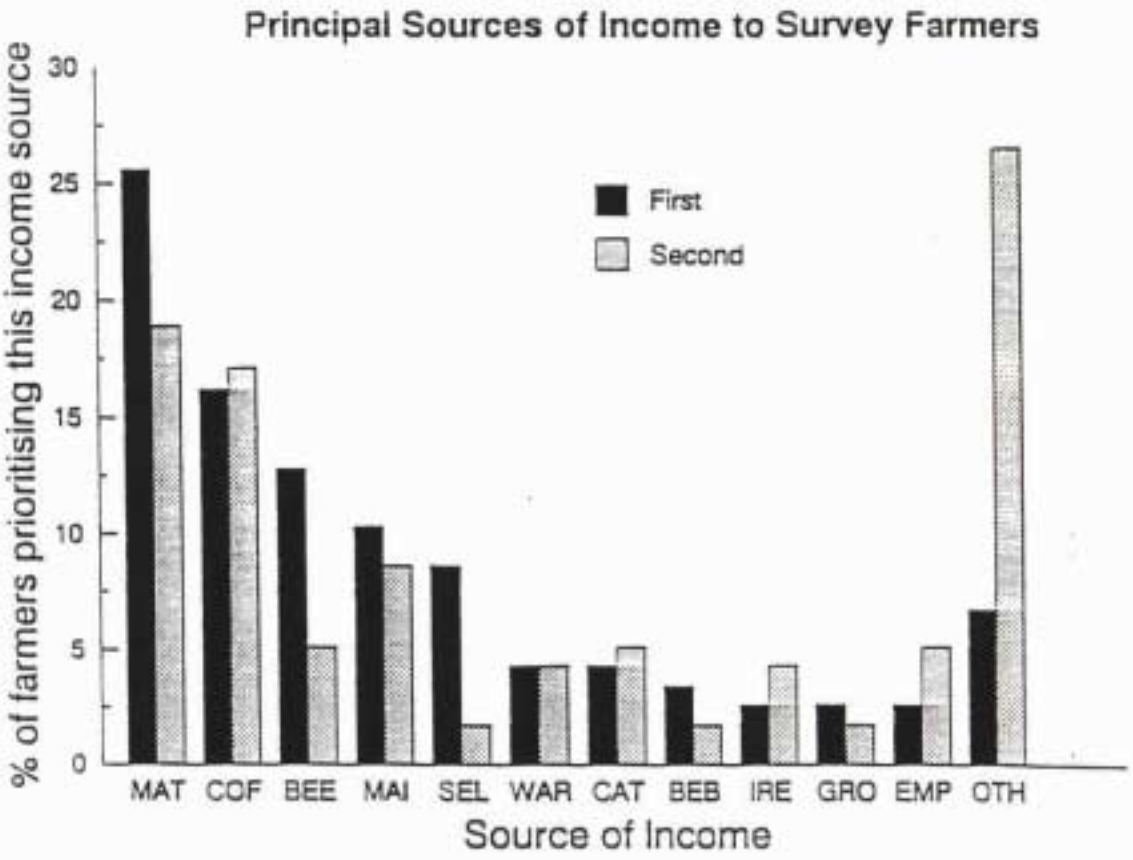


Figure 6: The principal sources of income identified by Ugandan banana farmers participating in the diagnostic survey (August-November 1993). After listing their sources of income, the farmers were asked to rank them in order of importance. The figure gives the percentages of farmers who ranked a particular source either first or second.

Codes

MAT	matooke	CAT	sale of cattle
COF	coffee	BEB	sale of beer bananas
BEE	banana beer	IRE	Irish potatoes
MAI	maize	GRO	ground nuts
SEL	self-employment	EMP	non-farming employment
WAR	waragi	OTH	other

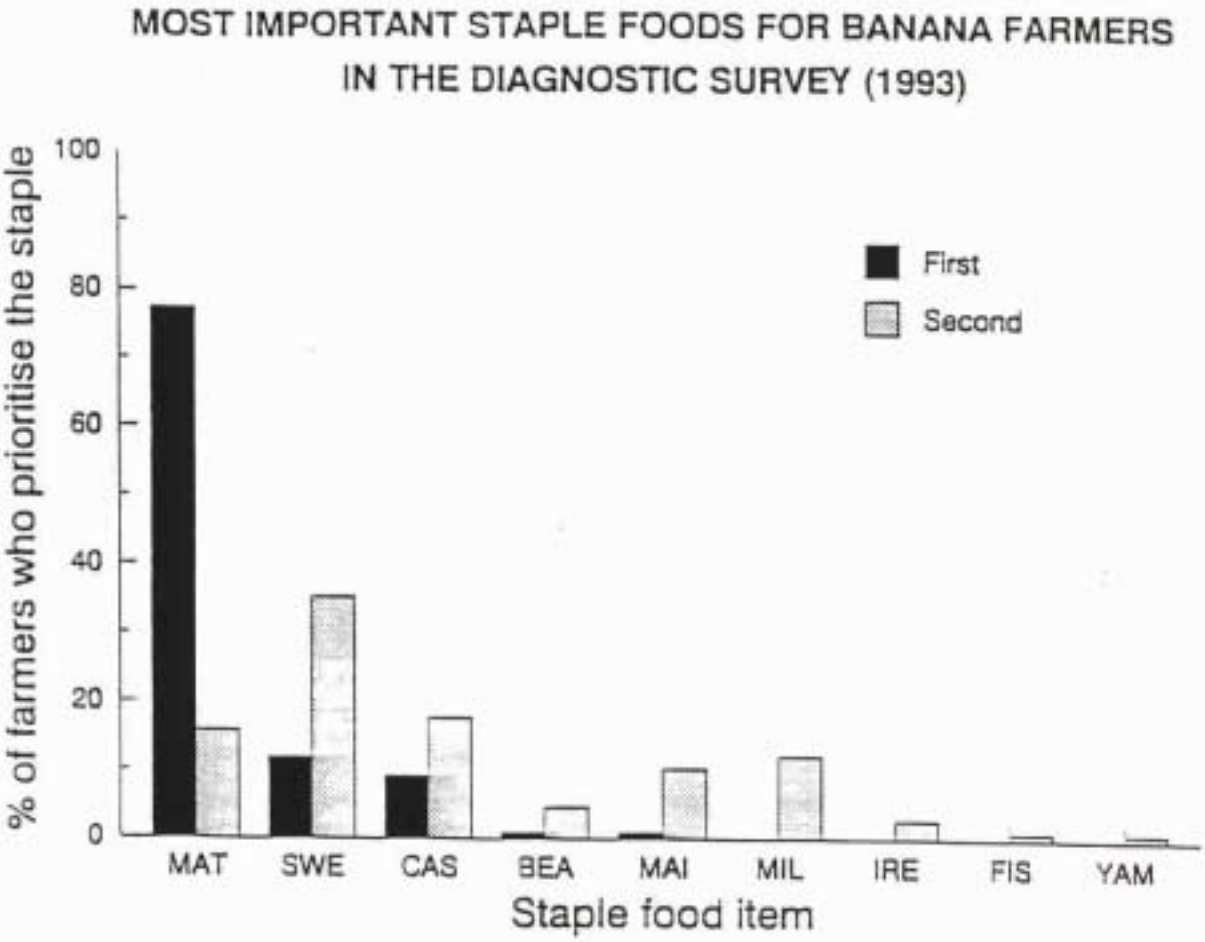


Figure 7: The most frequently consumed staple foods identified by Ugandan banana farmers participating in the diagnostic survey (August-November 1993). After listing the constraints, the farmers were asked to rank them in order of importance. The figure gives the percentages of farmers who ranked a particular food either first or second.

Codes

MAT	matooke
SWE	sweet potato
CAS	cassava
BEA	beans
MAI	maize
MIL	millet
IRE	Irish potatoes
FIS	fish
YAM	yams

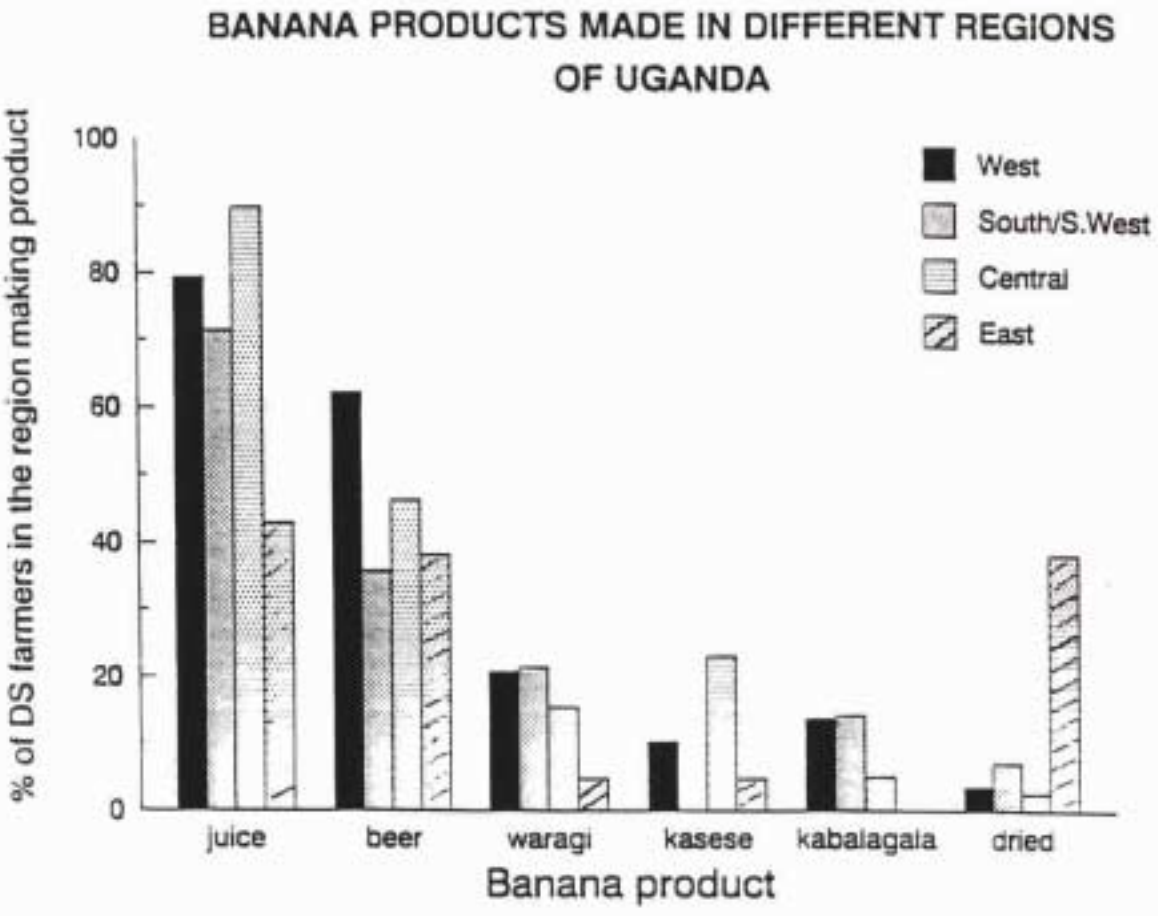


Figure 8: A regional breakdown of the banana products made by farmers participating the the diagnostic survey (August-November, 1993). The western region comprised 6/24 of the sites (1,2,3,4,5,7), the south/south-western region comprised 6/24 of the sites (6,8,9,10,11,12), the central region comprised 8/24 sites (13,14,15,16,17,18, 19,20) and the eastern region comprised 4/24 sites (21, 22,23,24). In this figure, waragi is the term used for the banana spirit made from distilling banana beer. Kasese is another type of banana spirit made from the direct fermentation of the ripe bananas. Kabalagala is a pancake made from ripe bananas and cassava flour.

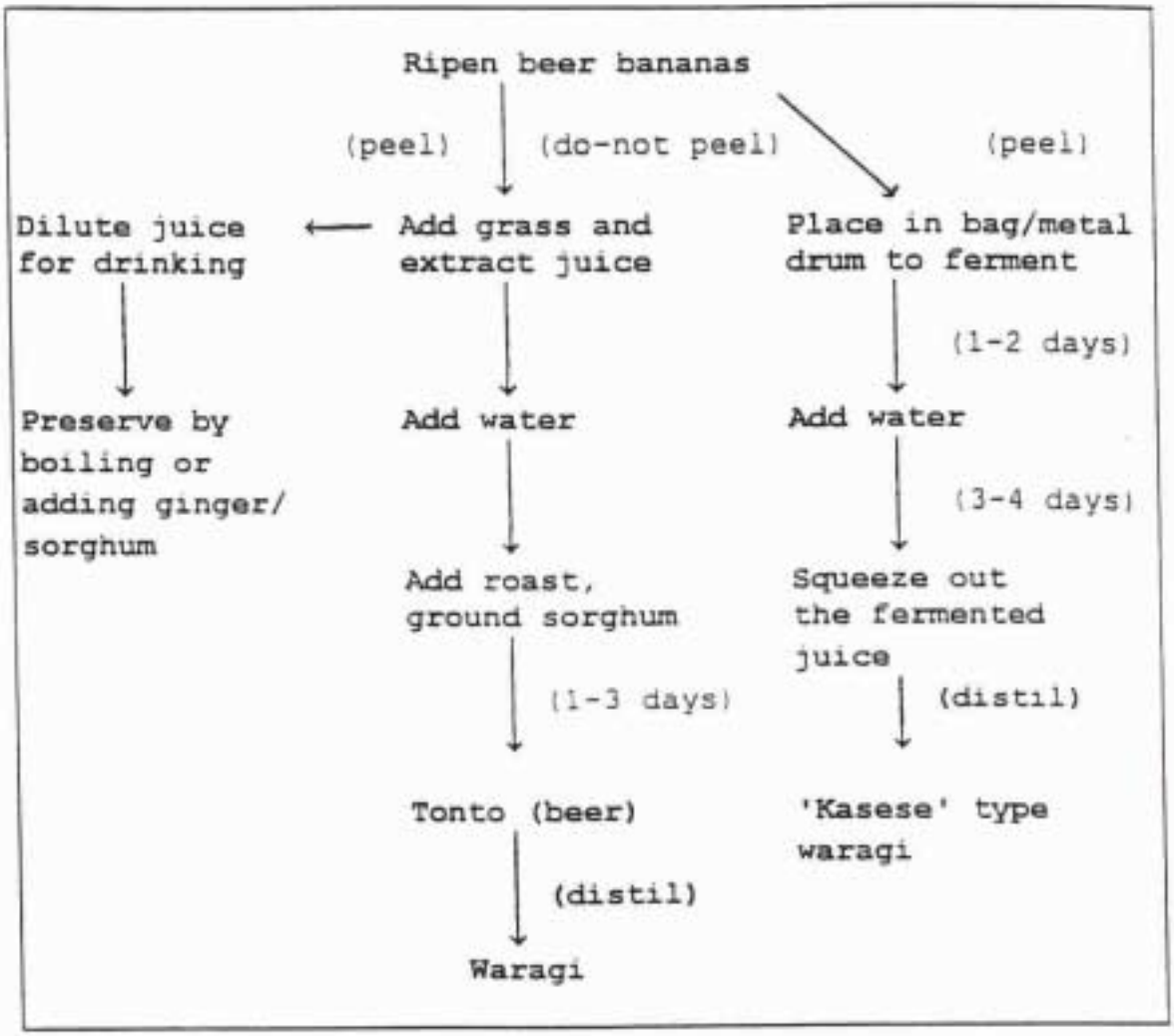


Figure 9: The inter-relationship between banana beverage products in Uganda

APPENDIX I

Terms of Reference

Post-harvest Technologist support to the Diagnostic Survey of Bananas in Uganda

Title: Post-harvest Technologist

Location: Kawanda Research Station

Duration: 6 months

Background:

1. Natural Resources Institute has been closely linked with the Ugandan National Banana Programme (NBP) in both Phase I (Rapid Rural Appraisal) and Phase II (Diagnostic Survey - DS). NRI was asked to lead in the areas of Socio-economics and Post-harvest and has liaised with scientists at Makerere University in both these areas during the preparation and implementation of the DS.

2. It has been recognised by NRI and national staff involved with the NBP, that "on the ground" participation by an NRI specialist would facilitate meeting the objectives of the post-harvest component of the DS. It is proposed that a specialist from NRI should be posted to Uganda to work with the NBP from July 1993 until the end of the DS in December 1993.

3. The specialist will be based at Kawanda Research Station, with close links with Makerere University and will form part of the wider programme provided by NRI in support of the post-harvest, non-grain starch staple sector.

4. The input will be funded as part of the NRI Non-grain Starch Staple Post-harvest Technology Transfer Project - Uganda.

General Objectives:

5. To provide support to the post-harvest component of the Diagnostic Survey of the National Banana Programme in field data collection and analysis.

Specific Objectives/Terms of Reference

6. The technologist will be required to carry out the following activities;

a) facilitate the collection of completed "once-only" questionnaires from all farms in each of the DS sites,

b) assist in the distribution and collection of "multi-visit" questionnaires over a 6 month period,

c) carry out in-depth, semi-structured interviews on farmer perceptions of post-harvest constraints at DS farm sites and at additional farms and sites as required, chosen by appropriate randomisation techniques,

d) assist in appropriate data entry and analysis in collaboration with other DS disciplines,

e) collaborate and facilitate in the development of post-harvest research projects identified during the DS,

f) assist in the formulation of proposals for Phase III of the NBP,

g) supervise field activities of Ph.D. student, Mr James Ssemwanga in support of the NBP,

h) report as required.

Qualifications and experience required:

7. The candidate will have the following;

a) degree in a biological science,

b) post-graduate qualification in an aspect of agriculture or food science,

c) at least two years experience in the post-harvest technology of perishable, tropical crops and in particular, banana.

Reporting

8. In Uganda, the technologist will report to the co-ordinator of the NBP through the NRI Farming System Specialist. In the NRI the specialist will report to Dr N Poulter, Root and Tuber Programme Manager.

9. Quarterly and final reports will be prepared.

APPENDIX II

Location of Sites used in the Diagnostic Survey (1992-3)

SITE CODE	DISTRICT	SUB-COUNTY	PARISH
1	Kabale	Bukinda	Nyabirerema
2	Bushenyi	Mitooma	Rushoroza
3	Bushenyi	Ryeru	Nyabubare
4	Mbarara	Rukiri	Nyarukika
5	Mbarara	Bubare	Katojo
6	Mbarara	Rugaga	Kyarubambura
7	Kabalore	Buhesi	Rwensenene
8	Rakai	Kagamba	Kagamba
9	Masaka	Mateete	Manyama
10	Masaka	Ntusi	Ntusi
11	Mpigi	Kabulasoke	Kakubansiri
12	Mpigi	Buwama	Jalamba
13	Mubende	Kitenga	Kalonga
14	Mubende	Bulera	Kalama
15	Mubende	Madudu	Kabulamuliro
16	Kibale	Nkooko	Kitegula
17	Kibale	Matale	Kalangala
18	Kiboga	Bukomero	Kalokora
19	Luwero	Nyimbwa	Sambwe
20	Luwero	Butuntumula	Bamugolodde
21	Mukono	Kayunga	Ntenjeru
22	Iganga	Bulongo	Buyoola
23	Mbale	Butiru	Bumagambo
24	Kapchorwa	Kaseren	Sipi

APPENDIX III

Semi-structured Questionnaire

POST-HARVEST ASPECTS OF UGANDAN BANANA PRODUCTION

FARM CODE _____ **QUESTIONNAIRE NO.** _____

Date _____ Time (start) _____ Time (finish) _____

Enumerator _____

Interviewers 1. _____ 2. _____

Name of interpreter _____ Job of interpreter _____

Language of interview _____

District _____ Village _____

Head of Household

Name _____ Gender _____ Age _____

Name of Interviewees	Gender	Age	Relationship to Hea of Household
1. _____	_____	_____	_____
Educational level: Primary [ ] Secondary [ ] Tertiary [ ]			
2. _____	_____	_____	_____
Educational level: Primary [ ] Secondary [ ] Tertiary [ ]			

Number of people supported by the head of household

Male _____ Female _____

SECTION A - GENERAL

1. How long has the family been living on the farm? _____

2. Total size of all holdings _____

3. What type of water source is used?

   dry season _____

   wet season _____

4. How long does it take to collect water (method)

   dry season _____ wet season _____

5. Main sources of household income

	Agriculture [ ]	Livestock [ ]	Outside employment [ ]	Business [ ]
Rank				

6. The 4 main crops grown on the farm (rank in order of area grown)

Crop	Rank

7. What are the biggest problems overall for you as a farmer?

Problem	Rank

8. What are the biggest problems you have specifically with banana production and marketing?

Problem	Rank
_____	_____
_____	_____
_____	_____

9. What area of banana are you growing? _____

10. What varieties of bananas do you grow (rank first 6 in order of area grown).

1. _____	_____	2. _____	_____
3. _____	_____	4. _____	_____
5. _____	_____	6. _____	_____
7. _____	_____	8. _____	_____
9. _____	_____	10. _____	_____
11. _____	_____	12. _____	_____
13. _____	_____	14. _____	_____
15. _____	_____	16. _____	_____
17. _____	_____	18. _____	_____
19. _____	_____	20. _____	_____

11. Is matooke available to eat at all times of the year _____

12. If no, when was the last time that matooke was unavailable?

_____

13. How old are most of the banana plants? _____

14. Is the area of banana increasing, stable or decreasing? _____

SECTION B - SELLING MATOOKE

15. Do you grow bananas primarily for commerce or for home consumption or both?

_____

16. Where do you sell matooke? _____

17. How do you transport matooke _____

18. Distance from main road (where you can catch a taxi) _____

19. Distance from local market _____

20. To whom do you sell matooke? _____

21. In a good season, how often do you sell matooke _____

22. Are you likely to sell more or less matooke this year compared with last year?

_____

23. Why?

_____

24. Do you ever fail to sell your excess matooke? _____

25. If yes, why? _____

_____

_____

26. What would help you to sell more matooke? _____

_____

SECTION C - HARVESTING AND HANDLING

27. Do you lose any fruit before it can be harvested (e.g. theft, ripening, animals)?

Cause of loss	Rank
_____	_____
_____	_____
_____	_____

28. Are there any difficulties with harvesting and handling the fruit on farm?

_____

_____

29. During which stages does fruit often get damaged?

When	Nature of damage
During harvesting [ ]	_____
During on-farm transport [ ]	_____
During transport to trading site or market [ ]	_____

30. Do certain varieties get damaged more than others during harvesting and handling?

Variety	Damage	Reason
_____	_____	_____
_____	_____	_____
_____	_____	_____

31. Do you store harvested fruit and if so, for how long?

_____

SECTION D - PREPARATION OF MATOOKE

32. What are your staple foods?

Food	Rank	Food	Rank
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

33. How many matooke meals has your family had:

In the past two days _____

In the past one week _____

34. Is this:
- Normal [ ]
- Less than normal [ ]
- More than normal [ ]

35. Who normally prepares matooke in your family? _____

36. How do you prepare matooke for food?
- Steaming [ ]
- Boiling [ ]
- Katogo [ ]
- Other methods [ ]

_____

37. How can you tell that it is ready?

1. _____ 2. _____
3. _____ 4. _____
5. _____ 6. _____

38. What are the difficulties with making matooke?

Difficulty	Rank

39. Rank the varieties of matooke which you grow in order of preference

Variety	Rank	Variety	Rank

40. What is the worst variety for making matooke? _____

41. Why is it the worst variety? _____

42. Why do you grow this variety? _____

43. How do you tell that matooke is ready to harvest?

1. _____ 2. _____

3. _____ 4. _____

SECTION E - BEVERAGE PRODUCTION

44. What drinks do you make from banana and when did you last make the product/s?

Product	Last time made

i) JUICE

45. What are the main varieties used to make juice for drinking?

Variety	Rank	Why

46. What are the main varieties used to make juice for beer?

Variety	Rank	Why

47. Which ripening method is used? _____

48. If the pit is fired how is this done? _____

49. How long does it normally take to ripen the fruit? _____

50. Does the ripening time vary according to variety, or season? _____

_____

51. Does the fruit ever fail to ripen properly?

Nature of problem	Possible reason

52. Are the fruits peeled before squeezing for:

Juice _____ Beer _____ Waragi _____

53. What containers/equipment are used for juice extraction?

_____

54. What materials are added to the banana mash to help with juice extraction?

_____

55. Is it ever difficult to extract the juice?

_____

_____

56. Do you think the method for juice extraction could be improved?

_____

_____

57. Is the quality of the juice ever unsatisfactory?

_____

_____

58. What do you do to preserve the juice? _____

_____

59. How long does the fresh juice remain drinkable? _____

60. How long does the juice last after preservation? _____

61. Do you ever sell any juice? _____

62. To whom do you sell juice? _____

63. Where do you sell juice? _____

ii) **BEER**

64. Do you hire anyone to help with beer production? If yes, for what part of the process?

65. What containers are used for the fermentation?

66. What is added to the juice before fermentation?

67. Where do you put the fermentation vessel and how do you prepare this place?

68. How long does the fermentation normally take?

69. Does the length of fermentation vary according to the season?

70. Do you strain the beer, and if so, with what?

71. For how long does the beer normally remain drinkable?

72. What difficulties do you have with fermentation of the beer?

73. To whom do you sell beer?

74. On what terms do you sell beer?

75. How do you transport the beer to the sale place?

76. How often do you make and/or sell beer?

77. What factors affect the amount of beer that you sell?

78. What would help you sell more beer?

iii) **WARAGI**

79. What type of waragi do you make (from tonto or fermented bananas)?

_____

80. If you make waragi from fermented bananas, which varieties do you use and why?

Variety	Rank	Why
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

81. If you use fermented bananas, how long is the fermentation carried out?

_____

82. Do you use your own still or hire someone elses? _____

83. What difficulties or problems are there when making waragi?

Difficulty/problem	Rank
_____	_____
_____	_____
_____	_____
_____	_____

84. To whom do you sell waragi? _____

85. On what terms do you sell waragi? _____

86. How do you transport waragi to the sale place? _____

_____

87. How often do you make and/or sell waragi? _____

88. What affects the amount of waragi you can sell? _____

_____

SECTION F - OTHER PRODUCTS

89. What other banana based products do you make?

Product	Rank	Why

90. If you do not make any other products, why not? _____

_____

91. Are there any difficulties with making these products?

Product	Difficulty

92. Do you have any livestock and if so, what?

_____

93. What parts or waste from banana is fed to the livestock and is there any preparation before using the parts as feed?

Part	Animal	Preparation

94. Are there any problems with feeding banana waste to animals and if so, what?

Part	Animal	Problem

APPENDIX IV

Preliminary Report on Matooke Quality

SUMMARY OF SURVEY REPORT-FARMERS

by James K. Ssemwanga

Project Title: Delineation of the important postharvest and eating qualities of *matooke* cooking bananas.

Background

One strategy of combating Black Sigatoka disease, a major factor in the decline of banana productivity in East Africa over the past 25 years, is to introduce resistant or tolerant cultivars. In order to select a cultivar that will have acceptable postharvest qualities we need to establish what quality characteristics are important to the clientele, based on the currently available varieties.

It is assumed that consumers perceive differences in varieties both in the raw and in the cooked product, some readily apparent (e.g size factors), others not so much so; some perhaps not even real differences, especially in the cooked product. Furthermore it is important to establish which of these differences are crucial when farmers or consumers are to make a choice between two or more different cultivars for planting or buying.

The objectives of this survey were:

1. to test the users' ability to discriminate between different varieties of the cooked product.

2. to identify the key quality parameters of both raw and cooked *matooke* as perceived by the consumers themselves.

MATERIALS AND METHODS

Sampling

The work reported here was designed as an integral part of an ongoing project, the National Banana Research Programme (NBRP). This imposed the condition that farms visited had to be the same farms as those already selected in the project and being worked on by other scientists.
The survey area was spread over most matooke growing regions of the country but for logistical reasons excluding the West Nile region. It was divided into homogeneous agro-ecological zones, considering such factors as rainfall, elevation, banana production and use levels. From these zones 24 representative sites were selected and altogether 111 farms were visited on 23 sites out of the

24 covered by the NBRP. 7 different languages were used which sometimes meant working through a translator.

Materials

To try and standardise the test conditions a mobile test booth was made from wooden panels and white cloth curtains. A white table and stool were also provided for the tester. The sensory test was always conducted outside where there was ample sunlight. At least 30 different varieties were used in eliciting sensory terminology from farmers. The number of times a varietiy was used depended on how frequently it happened to be available when samples were being acquired.

Methods

A three-part questionnaire was used; the first part sought demographic information as well as information on harvesting and preparation methods used by the family. The second part involved a triangle discrimination test and elicitation of sensory quality attributes using a variant of the Free Choice Profiling technique. In here the subject was first presented with three samples of cooked *matooke*, all on the same 155cm diameter paper plate, two of which were identical and different from the third and asked to identify the odd sample. Because it was not possible to vary the intensities of the various attributes they were sensing difference in terms overall difference rather than difference in say colour or texture only. Whether or not they were able to identify it correctly they were then presented with four different samples, one at a time, and asked to eat and describe them. Comments on appearance were encouraged by pointing out to the subject that they were free to comment even before eating but no direct hints were given that we expected comments on appearance, texture or flavour. Subjects were allowed to ask for more sample if they needed it.

The third part of the questionnaire involved elicitation of quality attributes using Kelly's Grid method. Taking only those varieties that farmers had at their farm and knew well, their names were written on card pointers. The next step was for the subject to score all the varieties on a continuous 100-point scale on each attribute they had mentioned, taking one at a time, by placing the card with the name of a particular variety along a 100-cm ruler with the pointed side of the card towards the ruler to show the precise point of the score. To clarify the scoring technique a demonstration was carried out for each respondent but using varieties not on their farm.

From the many terms generated a general picture of what sensory attributes were important in acceptability of *matooke* was determined. Usually in Free Choice Profiling procedure, the same respondents score samples on attributes indicated by the terms they have generated themselves. In this particular study a sensory evaluation was arranged for untrained panellists at the University in which six varieties were assessed on 11 of these attributes including overall acceptability. The six varieties were selected by first of all taking the results of Kelly's grid and establishing which

attribute was mentioned most frequently and was mentioned at all sites. Then all varieties encountered in the survey were listed in order of their score on that particular attribute. Taking the range and dividing it into quarters two varieties were selected from each quota as an attempt to use a representative sample of varieties in terms of the most frequently mentioned attribute.

RESULTS

Attributes elicited with Kelly's Grid

101 out of the 111 farms visited participated in Kelly's grid. 43 different attributes were elicited with this method ranging from 2 to 10 per farm (Mean: 5.3; Mode: 6). The number of attributes elicited from an individual depended to some degree on the number of cards and combinations thereof used and hence the number of varieties that individual conceded to being familiar with. This was compensated for by supplementary information obtained elsewhere in the questionnaire. Details of attributes and terminology found to be used by farmers and traders in the entire survey are in Appendix 1.

Analysis

First, the number of farms at which a particular attribute was mentioned was expressed as a percentage of the total sample referred to here as "sample percentage". Then the number of farmers mentioning a particular attribute in a site expressed as a percentage of the total number of farms participating in that site was calculated and the percentages averaged over all the sites, referred to as "average site percentage". The results of both analyses are shown in Figure 1.

A third parameter, "site percentage", was the number of sites at which an attribute was mentioned expressed as a percentage of the total number of sites. This was introduced because not all sites were included and the number of respondents per site was not equal. "Site percentage" and the "average site percentage" for each attribute were used as a basis for clustering the attributes into two. One cluster had nine attributes while the other had thirty-four (see Fig.2 which is an output from Genstat 5 statistical package). Only the nine, appearing in Table 1, were retained for further analysis as they had high figures for both percentages, indicating that they were important for a majority of sites and a majority of respondents within those sites.

Attributes peculiar to an area could be mentioned at most as many times as the number of farms in that area and were more likely to have low frequencies. Thus for example "Starchiness", has a sample percentage of 5% but has a high average site percentageof 83%. This high average site percentage can be interpreted as a high degree of consensus among the people of that site as far as the attribute is concerned. However, at the site where this attribute was mentioned interviews were

conducted through an interpreter and the term "starchy" could have been his own interpretation of various different terms in the local language. 76% of the respondents mentioned "softness/hardness". It is mentioned at all 23 sites and on average by 75.8% of the respondents in each of those sites. "Bunch size" and "finger size" are mentioned at 23 and 22 sites with average site percentages of 61.6% and 62.1% and sample percentages of 23% and 22% respectively while "compactness" of bunches features at 20 sites with 55.8% average site percentage and a sample percentage of 20%.

Sex and age of respondent

None of the attributes varied with sex or age of respondent when a chi square was done at 0.05% significance level.

Occurrence by region

The sample was divided into four regions, Eastern, Central, South Western and Western. In the central region the quality of "early palatability" was mentioned more frequently than in other areas although the difference was not statistically significant (X^2 = 13.93, 2 df at 0.05%). The central region is a heavy user of matooke although production and productivity is known to be going down. The heavy users must sometimes find difficulty in putting together a *matooke* meal. It is therefore important to them in case of need and special occasions such as visits that they can harvest a bunch from their limited selection and be able to eat it even if it was not yet fully mature.

Farmers differentiated this attribute from "maturity period" which they described simply as the time it took a bunch to mature from booting whereas "early palatability" referred to having the right consistency at an early stage. It would appear therefore that there are cultivars that can be quick maturing but before they have fully matured they cannot be eaten and there are those that are slow maturing but can be eaten before they are fully mature.

"Good commercial performance" varied with region (Chi^2 = 11.32, 2 df at 0.05%), being more important in the west than in the rest of the country. It is reported that production has shifted to the west as well as to the east hence the more commercial outlook amongst farmers there. Although it emerged elsewhere in the survey (involving traders) that good commercial performance depended on bunch size, finger size and length, bunch compactness and nice general appearance, these qualities themselves did not vary significantly with region.

Variation with distance to the market and to the main road

The sample was divided into three according to how far they lived from the main road or to the

nearest market. The first category was 0-5km, considered to be a walking distance, the second was 6-20km or riding distance and the third above 20km or requiring the use of a motorised vehicle.
The term "market" is used in this survey to refer to the location to which a respondent could take a bunch of *matooke* for sale and "main road" to refer to that place where a respondent could catch a taxi or some other form of public transport to go to a an urban centre.

There were no significant differences in the occurrence of attributes between those who lived near the market or main road and those who lived further away.

Sensory attributes

Altogether 105 farmers participated in the sensory evaluation of cooked *matooke* and the number of adjectives elicited from them ranged from 2 to 11 per farm (mean = 6.13; mode = 7).

Odd sample identification

73 out of 105 respondents were able to identify the odd sample which was a highly significant result at the 5% level.

Attributes

Subjects used 38 different adjectives to describe the quality of the cooked product some of which could have been merely referring to different levels of the same attribute. For example both the terms "soft" and "hard" might have been used by a farmer to refer to texture. It has not been assumed that one is the opposite of another because in several instances the opposite of "soft" was described as "brittle" or "crumbly" or "lumpy". Whereas "soft—hard" would indicate the texture of a sample in terms of how difficult it was to macerate, "soft---crumbly" would indicate how closely bound the sample was and "soft—lumpy" would indicate how uniform a sample was. For this reason the terms have been left as they were collected without combining those that seem to refer to the same thing except where it was explicitly indicated to be so.

As with the raw product attributes a "sample average" and an "average site percentage" were computed for each sensory attribute and appear in Figure 3. A similar cluster analysis was done and one group with high percentages had 15 attributes, which appear in Table 1, while the one with relatively low percentage combinations had 23 attributes in it. Results of the cluster analysis are shown in Figure 4. Again if there were any attributes peculiar to specific sites their numbers depended on how many farms were in those sites.

"Yellow colour" was the most universal one, being mentioned at all the sites by 81% of the subjects. The lowest one was "sheen", having been mentioned in two sites by 17% of the subjects there. Softness and hardness were mentioned at 22 sites by 78% and 67% of the respondents respectively.

Occurrence by sex

Out of the 30 terms used to describe quality of cooked matooke only one, lumpiness, varied significantly with sex of respondents ($Chi^2 = 4.38$, 1df at 0.05%) being mentioned by more men than women. Lumpiness however, is more likely to be connected with the artefacts of preparation than with variety.

Occurrence by age group and region

None of the attributes showed any variation with age group or region. The numbers of respondents in each age group and region is given in the following tables.

Level of use

Respondents were asked how many matooke meals they had had in the previous one week, this being considered the maximum period of time in their past for which they could remember what meals they had had. They were also asked to state whether they considered that to be their "normal", "less than normal" or "more than normal" number of matooke meals per week. The sample was then divided into two, low users who had seven or less meals and high users who had eight or more. Those who fell in the low user group but had said that this was less than normal were transferred to the high user group and those who were in the high user group and said this was more than normal were transferred to the low user group.

Solidness featured less frequently than expected among the low user group ($Chi^2 = 7.19$, 1df at 0.05%). Low users would have as their main diet other foods like millet, maize flour, cassava and sweet potatoes all of which are considered by consumers to be more solid than *matooke*. To these consumers *matooke* is not solid anyway so they mention the attribute less frequently. All other attributes were mentioned irrespective of the level of use of *matooke*.

Appendix 1

LIST OF ATTRIBUTES OF VARIETIES AND TERMINOLOGY USED TO DESCRIBE MATOOKE QUALITY[$]

([$] includes reasons given for growing/trading in a variety or reasons given for (dis)liking a variety. Figures refer to attribute codes.)

01	watery
02	cannot eat immature
03	is ceremonial
04	has big bunch
05	has small bunch
06	has large fingers
07	has small fingers
08	can eat immature
09	is not watery
10	poor taste
11	is soft
12	is hard
13	was found in plantation when acquired
14	available at time of planting/trading
15	accidentally/unknowingly
16	can eat immature
17	food security
18	too lax configuration
19	good commercial performance
20	poor commercial performance
21	quick maturing
22	slow maturing
23	has bad omen
24	bad colour
25	good colour
26	difficult to peel
27	Dries as soon as peeled
28	Is prolific
29	Is astringent
30	Can make juice out of it
31	Quickly loses heat/hardens when served
32	Easily damaged by hailstone
33	Is hardy
34	Poor texture
35	Poor flavour
36	Easily debands/defingers
37	Has long fingers
38	Has short fingers
39	Is not hardy
40	Easily toppled by wind
41	Small bunches after maiden crop
42	Few fingers
43	Bad aroma
44	Susceptible to pest attack
45	Undesirable finger shape
46	Low pulp:peel ratio
47	Nice taste
48	Man of the plantation
49	Does not keep overnight
50	Too much latex
51	Easy to peel
52	Sometimes does well on good soils
53	Does not fruit during dry season
54	Too compact
55	Is brittle
56	Has deep (Nice) yellow colour
57	Has black spots (seeds)
58	Has black patches
59	Has uniform texture
60	Has good aroma
61	Has pale patches
62	Is salty
63	Is sweet/sweetish
64	Is sticky
65	Is lumpy
66	Is solid
67	Bunch length
68	Hand/Cluster size
69	Saw it elsewhere performing well
70	Fingers per hand
71	Dry/moist
72	Is floury/not floury

73	Has hard centres (emittima)
74	Smells "latexy"
75	Is starchy
76	Is crumbly
77	Has uniform colour
78	Fatty
79	Melts in mouth
80	Slippery
81	Lasts long in plantation/does not
82	Fruity flavour
83	Bitter/not bitter
84	Course
85	Rough
86	Quick ripening
87	Most available
88	Does not ripen quickly
89	Number of hands per bunch
90	Sheen
91	green—oily finger colour
92	Dark—pale green finger colour
93	Nice for katogo*
94	Straightness of fingers
95	Ease of cooking
96	Shrinks on cooking
97	Resistant to draught
98	Rate of sheen loss
99	Missing values
100	Bruisability
101	Ease of packing
102	Persistense of female flower buds
103	Browns when peeling
104	Ripens as whole bunch at once
105	Wilts quickly
106	Fingers not uniform in size

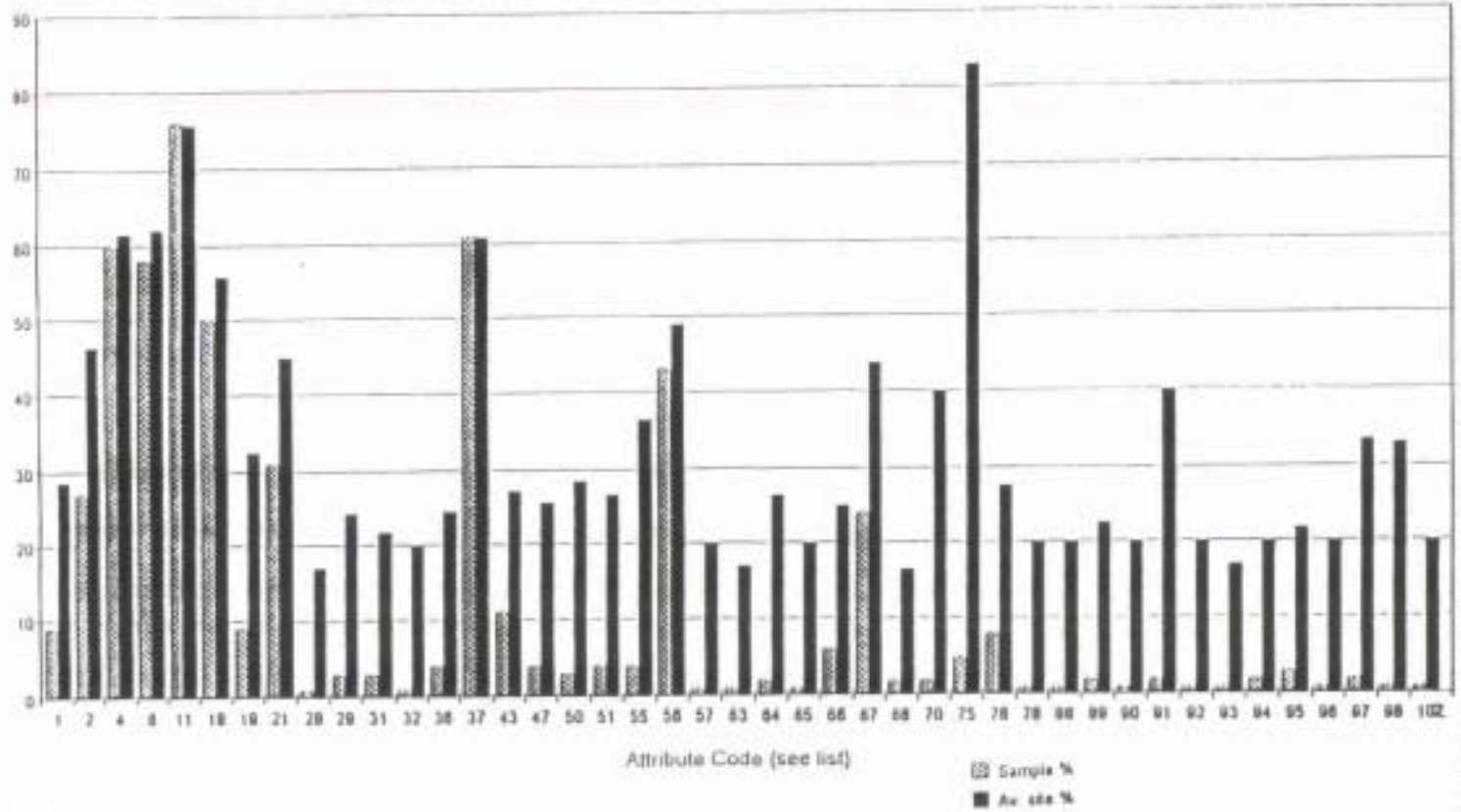
* Katogo is a dish where *matooke* is boiled together with a partially pre-cooked source and the fingers are not mashed.

Table 1 Showing attributes and terminology used at a majority[1] of sites by a majority of respondents in those sites.

Attributes mentioned in the absence of the cooked product		Attributes mentioned in the presence of the cooked product (sensory)	
Code	Description	Code	Description
02	Early palatability	11	Soft
04	Bunch size	12	Hard
06	Finger size	29	Astringent
11	Softness	35	Poor flavour
18	Compactness	43	Bad aroma
21	Maturity period	47	Nice taste
37	Finger length	55	Brittle
56	Deep yellow colour	56	Yellow colour
67	Bunch length	58	Black patches
		60	Good aroma
		63	Sweetness
		64	Stickiness
		65	Lumpiness
		66	Solid
		76	Crumbly

[1] *Majority as determined from a cluster analysis of the attribute's frequency percentages (see section an analysis).*

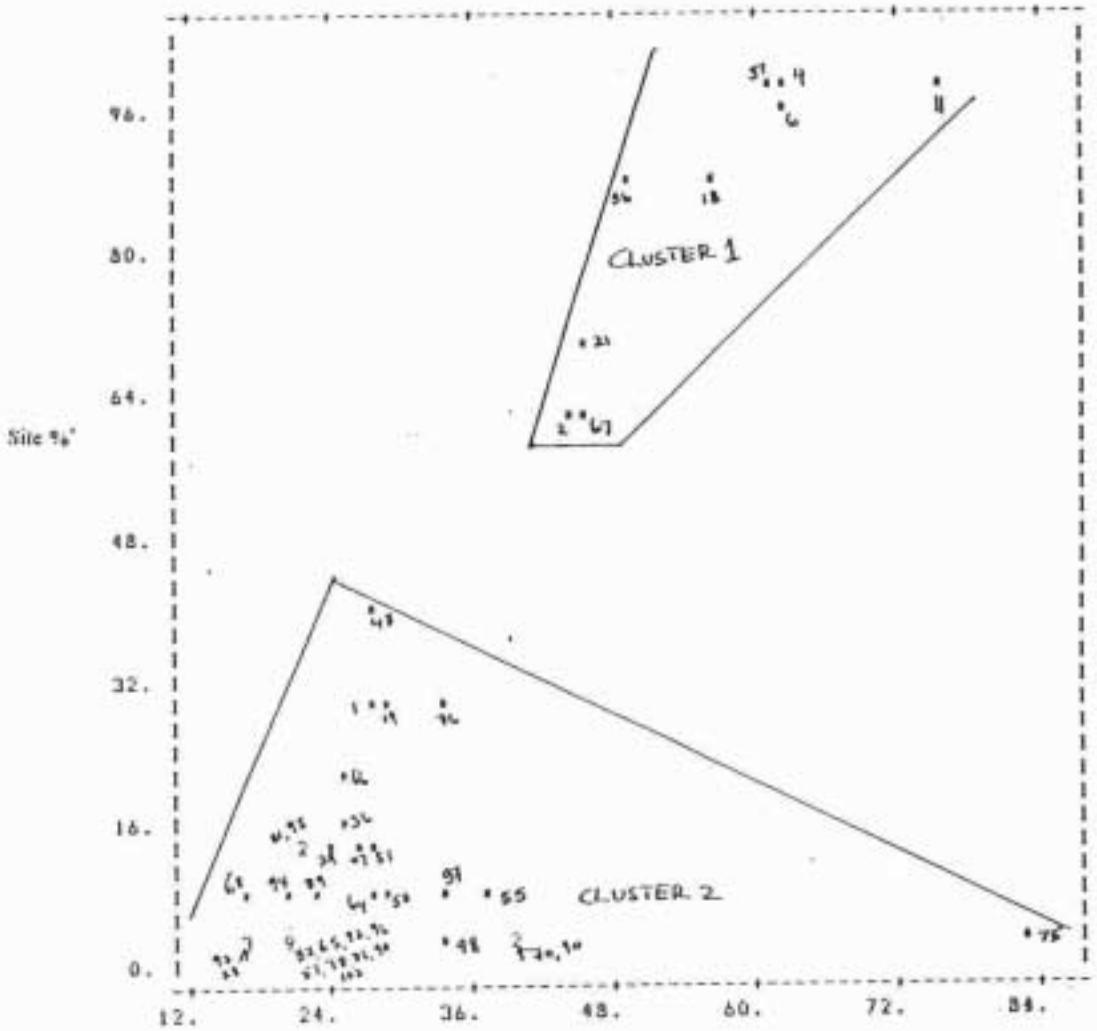
Figure 1 Showing occurence of attributes elicited by Kelly's method.



List of Attributes

Code	Attribute
1	watery
2	Fairly palatable/oily
4	has big branch
8	has large fingers
11	is soft
18	too fast coagulation
19	commercial attraction
21	quick watering
28	Is prolific
29	Is astringent
31	Heat retention
32	Easily damaged by fertilizer
36	Easily deboned/delingers
37	Has long fingers
43	Bad aroma
47	Nice taste
50	Too much latex
51	Easy to peel
55	Is brittle
58	Nice yellow colour
57	Has black seeds
63	Sweetness
64	Is sticky
65	Is lumpy
66	Is salted
67	Branch length
68	Hand size
70	Fingers per hand
75	Is starchy
76	Is crumbly
78	Fatty
86	Quick ripening
89	Hands per branch
90	Sheen
91	green---oily finger colour
92	Dark---pale green finger colour
93	Nice tie fatings*
94	Straightness of fingers
95	Ease of cooking
96	Shrinks on cooking
97	Resistant to drought
98	Rate of sheen lost
102	Persistence of female flower bud

Figure 2. Showing 2 clusters of attributes elicited in the absence of the cooked product (Kelly's Grid method).



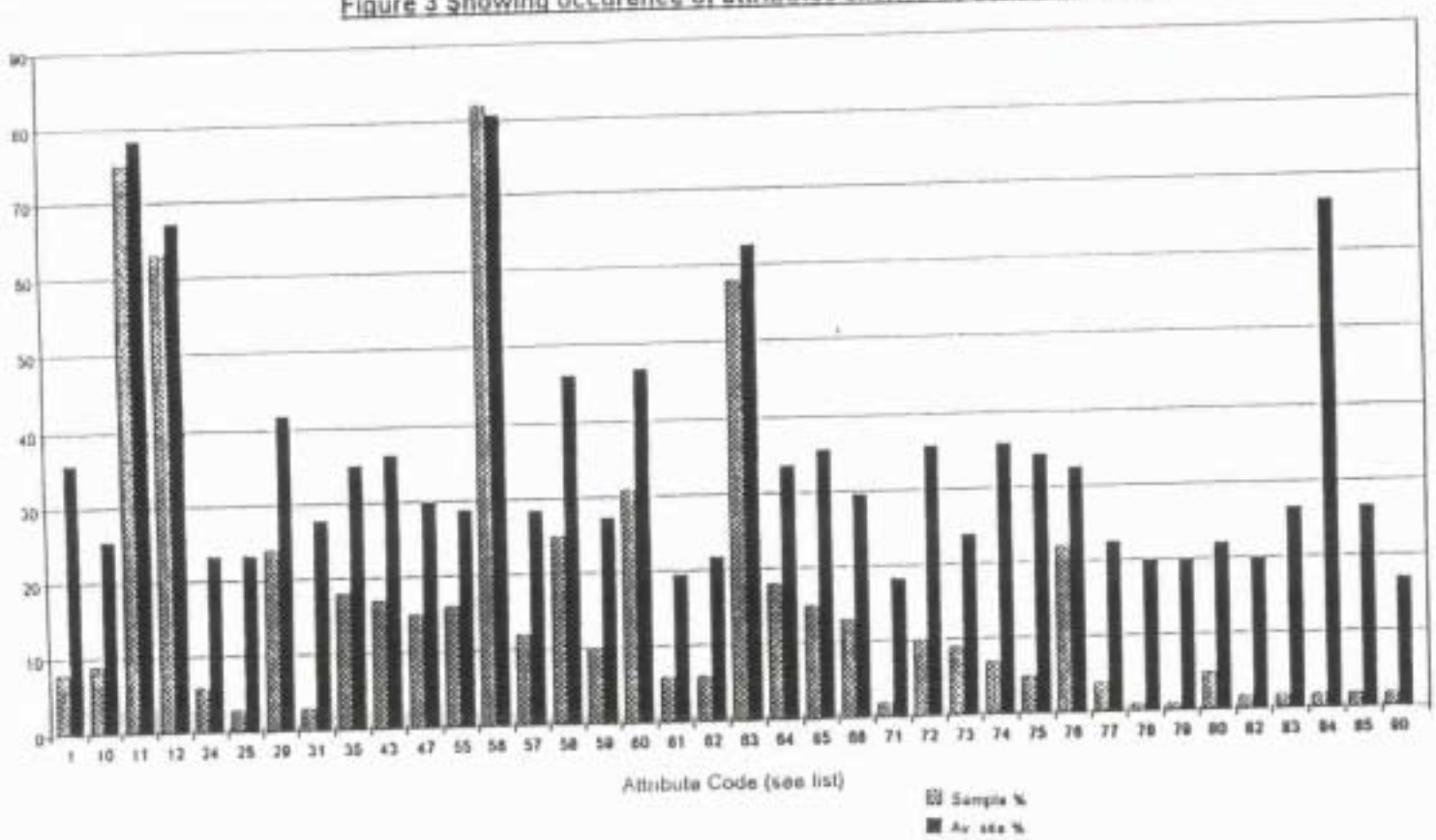
List of Attributes

Code	Attribute
1	Watercress
3	Early palatability
4	Bunch size
6	Finger size
11	Softness
18	Bunch compactness
19	Buyer attraction
23	Quick maturing
28	Is prolific
29	Is astringent
31	Heat retention
32	Easily damaged by customer
36	Easily debunched/dropped fingers
37	Has long fingers
42	Bad aroma
43	Nice taste
50	Too much latex
51	Easy to peel
53	Is bristly
56	Nice yellow colour
57	Has black seeds
61	Sweetness
64	Is sticky
65	Is hoapy
66	Is solid
67	Bunch length
68	Hand size
70	Fingers per hand
73	Is starchy
74	Is crunchy
75	Fatty
84	Quick ripening
89	Hands per bunch
90	Sleeve
91	Green—oily finger colour
92	Dark—pale green finger colour
93	Nice for fishpack
94	Straightness of fingers
95	Ease of cooking
96	Shrinks on cooking
97	Resistant to droughe
98	Rate of shoot loss
102	Persistence of female flower bud

* (see text for explanation of parameters)

$ (see appendix)

Figure 3 Showing occurence of attributes elicited by sensory method.



List of Attributes

Code	Attribute
1	Watery
10	Poor Taste
11	Is Soft
12	Is Hard
24	Bad Colour
25	Good Colour
29	Is Astringent
31	Heat retention
35	Poor Flavour
43	Bad Aroma
47	Nice Taste
55	Is Brittle
56	Deep Yellow/Pale Colour
57	Has Black Spots (Seeds)
58	Has Black Patches
59	Uniform Texture
60	Good Aroma
61	Has Pale Patches
62	Is Baby
63	Is sweet
64	Is Sticky
65	Is Lumpy
68	Is Solid
71	Dry/Moist
72	Floury/Not Floury
73	Has Hard Cores
74	Smells Tasty
75	Starchy
76	Crumbly
77	Uniform Colour
78	Fatty
79	Melts in Mouth
80	Slippery
82	Fruity Flavour
83	Bitter/Not Bitter
84	Coarse
85	Rough
90	Sloven

Figure 4 Showing 2 clusters of sensory attributes elicited in the presence of the cooked product