THE QUALITY OF FARMER SAVED SEED IN GHANA, MALAWI AND TANZANIA

M Wright, L Delimini, J Luhanga,
C Mushi and H Tsini

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Natural Resources Institute
Central Avenue
Chatham
Kent ME4 4TB
United Kingdom

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TABLE OF CONTENTS

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SUMMARY AND RECOMMENDATIONS

Surveys were undertaken in three African countries on five crops with 1,860 samples being analysed for moisture content and germination. These results were related to the storage history of the seed as a means of establishing the suitability of maintaining seed stocks on-farm.

The results show that in general terms seed viability is maintained at a high level (above 70%) in the countries involved; Ghana, Malawi and Tanzania. Maize and cowpeas showed no problems whilst beans performance was more variable. Groundnut and soya, despite being often described as poor storers, also had sufficiently high germination over the periods that they were stored for. However, in Tanzania there is the suggestion that groundnuts do not store well in marginal production areas but the sample size was too small to be more certain.

Germination was used as a measure of success in these surveys. This is because it is very convenient and not too time consuming to measure. However, vigour (a measure of how well the plants become established in the field) may give a truer indication of the efficiency of seed storage.

Whilst it is clear that on-farm seed storage is very good and does not require any major changes, there is scope for improving current practices through adoption of best practices from the range of techniques currently used.

It should be noted that the three countries all have climates which are generally favourable to seed storage and so these findings may not hold true for other climatic zones.

It is recommended that:

- Similar work to that undertaken during these surveys is carried out in production areas where the climate is not conducive to seed storage. Ideally these would have a combination of high temperatures and high relative humidities.

- Studies should determine the relationship between the germination percentages of home saved seed to its vigour. This may give a fairer indication of the success of farmer seed saving strategies.

- That attention be given to those circumstances in which germination percentages are lower than 70% in order to look for improvements to the current practices. In particular, this applies to bean storage in Tanzania.

- These studies relate to seed saving after reasonable harvests. It would be valuable to investigate how well these traditional seed storage mechanisms function when harvests are poor (e.g. following drought) both in terms of maintenance of sufficient stocks of seed and in terms of quality of retained material.

- Although germination percentages have been shown to be good under small farmer conditions, it is clear that certain combinations of techniques are better than others. Examples of these would be selection of maize seed at harvest and drying seeds to a suitable moisture content. Extension services should be encouraged to adopt these as part of a 'best practice' package when advising farmers.

INTRODUCTION

1. It is recognised that approximately 80% of seed planted by farmers in developing countries is saved from the previous season. This home-saved seed is stored under a variety of conditions using a wide range of traditional techniques (Gata and Kativhu, 1991; Wright *et al*, 1994).

2. There appears to be a general feeling amongst plant breeders, extension workers and donors that seed stored on-farm suffers a significant germination decline, a view apparently supported by the fact that farmers frequently plant more than one seed per hole at planting time. All seeds lose germination potential during storage but it is assumed that decline is significantly worse under on-farm conditions. However, virtually no studies have been undertaken to establish the severity of loss, as required to determine the potential for any improvement in the seed storage system. Malabanan (1991) reports from the Philippines that of 102 samples of home saved rice seed taken from farmers, 28% had a germination of less than 70%. However, much of this reduction was attributed to a dormancy effect rather than a true decline. Tsega (1994) undertook a preliminary of survey of Ethiopian farmers, examining a total of 218 samples comprising 18 crop species. She found that after 6-7 months storage in traditional stores, only 11 (5%) of the samples had suffered more than a 10% loss in germination potential as compared to their germination at harvest time.

3. This study was undertaken to address the problem of limited data and to highlight any aspects of the farmers' seed storage system that are particularly important in any loss of germination quality. These areas could then be preferentially addressed in any subsequent programmes to improve on-farm seed storage.

4. The work was undertaken during 1994-95 in conjunction with collaborators from three national programmes on the following important food crops, as shown in Table 1.

5. The research took the form of a seed box survey whereby seeds were taken from farmers' stocks just prior to planting. At the time of sample removal a simple questionnaire was completed that related back to the storage history of the seed sample concerned; an example is given in Annex 1. Seed samples contained at least 400 seeds and were withdrawn, normally by the farmer, in a manner designed to be representative of the entire seed stock. Farmers were paid for the seed samples. Only a single sample of a given crop was taken from any one farmer (although more than one crop could be sampled from that farmer).

Table 1. Seed sampling responsibilities

COLLABORATING BODIES	CROPS	SEASON
Ghana: Ghana Seed Inspection Unit Grains and Legume Development Board	Maize Cowpea Soya	Main and short seasons
Malawi: Seed Services Unit of Chitedze Agricultural Research Station	Maize Beans Cowpea Groundnut Soya	Single season
Tanzania: Selian Agricultural Research Institute	Maize Beans Groundnuts	Main and short seasons

6. In order to be representative of the whole farming community, a maximum of five seed samples per crop were taken from any one village. Farmers were selected randomly to reflect that they store seed on-farm, they grew crops essentially for subsistence rather than for sale, and that the range of typical storage practices should be represented in the final sample population. Greater detail on sampling frames is given under each country's results.

7. Seed samples were taken to the laboratory and tested for germination and moisture content. Germination testing was carried out using the International Seed Testing Association protocols (ISTA, 1993), using four replicates of 100 seeds.

8. All results from the germination tests, moisture content determinations and the questionnaires were sent to NRI for analysis. Data was analysed using a general linear model with the GLM procedure of the SAS statistical package. Data from the four 100-seed replicates was averaged to give a single percent germination figure for each batch prior to statistical analysis. Percentage germination was analysed both in its original form and transformed using the angular transformation. However, in all cases, the conclusions were the same from both analyses and so only the results of the analysis of untransformed data is presented.

9. The objective of the project was to ascertain whether any problems existed with on-farm seed storage; it was essentially exploratory by nature and both the questionnaire and data handling reflect this. All factors except moisture content consisted of two or three categories. The nature of the data - using categories for a wide range of possibly important parameters - means that the analyses can, at best, give strong indications of any causal relationships. Where there were only very few samples in a category, that category was eliminated from the analysis or, in the case of age, merged with an adjacent category. Moisture content was measured on a continuous scale and included as a linear covariate. Interactions between categories were included in the models when they were significant. Throughout this report, statistical significance implies a significance probability of at least 5%, unless otherwise stated. The categories, with any significant interactions, are shown numerically in the relevant annexes and are treated descriptively in the results section of each country.

10. The success of the farmers' storage techniques has been assessed only in terms of the germination potential of the seeds. No attempt has been made to measure vigour. Table 2 gives a summary of the findings for the three countries.

11. Delouche (1982) argues that germination levels of 70% or above should be considered acceptable under small scale farmer conditions, although 80% should be aimed for. Using this criteria, it can be seen that, on average, the seeds investigated during the survey performed well. However, the mean figures in Table 2 disguise instances where seeds perform considerably less well as a result of the combination of techniques used by individual farmers. These combinations shall be targeted in this report.

12. Aside from the value of the quantitative data deriving from the 1,860 samples collected, the questionnaires represent a source of information of current farmer storage practices. These practices will be examined in each of the country chapters.

Table 2. Mean germination percentage of home-saved seeds collected during the seed box surveys, 1994-95.

CROP	GHANA		TANZANIA		MALAWI
	Short season	Main season	First survey	second survey	
Maize	88.9	86.1	90.6	80.7	92.4
Beans	-	-	81.1	64.8	91.8
Cowpea	77.9	77.9	-	-	89.4
Groundnut	-	-	54.2	-	84.5
Soya	-	75.0	-	-	85.0

13. In the text, figures are given for recommended maximum moisture content (m.c.) of seeds. These figures are only guide-lines since maximum acceptable m.c. will vary with temperature. These figures represent a moisture content that should be attainable under small farmer conditions that

would allow a farmer to store for up to a year with limited loss of germination. If farmers can dry their seeds more than this, then this should be encouraged. The only exception to this is soya which, if over-dried, cracks leading to germination loss. For this reason soya should not be dried to below 8% (Ellis *et al*, 1985). The maximum recommended moisture contents for the study crops are:

maize, beans, cowpeas	12%
soya	9%
groundnut	6%

14. A summary chart of findings is given in Table 3. This shows the statistically significant relationships between the variables and germination percentage. Findings from the groundnut samples in Tanzania are not included because the sample size was too small to allow any meaningful analyses. It is important to note that the table is valid only for the range of values exhibited in the samples. It is possible that additional significant links could be established if a larger sampling frame had been used or, in the case of moisture content, seeds with a wider range of values had been collected. This table, in conjunction with the annexes for each crop form the basis for discussions of the results.

Table 3. SIGNIFICANCE OF FACTORS AFFECTING GERMINATION OF STUDY CROPS[1]

COUNTRY	CROP (and survey)	VARIETY	FORM	CONTAINER	SMOKING	SELECTION TIME	ADMIXTURE	SEED AGE	REGION	MOISTURE CONTENT	MEAN GERM %
GHANA	Maize (Short)			***		***	***		***	***	88.9
	Maize (Main)	***						**	***		86.1
	Cowpea (Short)	§			N/A		§	**	***		77.9
	Cowpea (Main)	**			N/A	*	***		***	*	77.9
	Soya	***			N/A			***	N/A	***	75.0
MALAWI	Maize	***	***						N/A		92.4
	Beans				N/A		**		N/A		91.8
	Cowpea				N/A				N/A		89.4
	Groundnut	§	**	*	N/A		**		N/A	***	84.5
	Soya				N/A				N/A		85.0
TANZANIA	Maize (First)							***	***		90.6
	Maize (Second)	*			**	*		*	***		80.7
	Beans (First)	***			N/A	*		**	***	***	81.1
	Beans (Second)	***			N/A	***				**	64.8

[1] Probability: *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.1$ N/A: Not applicable

N.B. Although some parameters do not show significant relationships in isolation, they are sometimes significant as interactions. Where this is the case it is indicated with a § in the table.

GHANA

15. In Ghana, the work was carried out by two collaborating bodies, the Ghana Seed Inspection Unit (GSIU) of the Ministry of Agriculture based just outside Accra, and the Grains and Legume Development Board (GLDB) based in Kumasi. GSIU were responsible for collecting seed samples from the south of the country whilst GLDB collected from the centre and north of Ghana.

16. Maize and cowpea are staple foodstuffs throughout the country, whilst soya is rapidly becoming important in northern areas, often as a replacement crop for groundnut. Qualitative aspects of farmer seed storage techniques in northern Ghana can be found in Wright and Tyler (1994).

17. Seed was collected during both the short season (2 September - 12 October 1994) and the main season (15 February - 5 March 1995). The total number of samples collected is shown in Table 4.

Table 4. Samples collected during the seed box surveys.

	Number of samples taken for each crop					
Sampling period	Maize		Cowpea		Soya	
	GSIU	GLDB	GSIU	GLDB	GSIU	GLDB
Short season	50	50	50	50	-	-
Main season	100	100	100	50	-	100

GSIU - Ghana Seed Inspection Unit
GLDB - Grains & Legume Development Board

18. During both seasons, samples were collected from throughout the main production areas, as seen in Tables 5 and 6. For the purposes of this study, Greater Accra, Central, Eastern and Volta regions were considered as being in the south; all other surveyed regions were designated as northern.

Table 5. Distribution of samples collected, by region, during the short season.

REGION	NUMBER OF SAMPLES TAKEN PER CROP	
	Maize	Cowpea
Greater Accra	7	5
Central	16	16
Eastern	16	21
Volta	11	8
Ashanti	27	24
Brong-Ahafo	17	16
Northern	6	10
TOTAL	100	100

Table 6. Distribution of samples collected, by region, during the main season.

REGION	NUMBER OF SAMPLES TAKEN PER CROP		
	Maize	Cowpea	Soya
Greater Accra	-	12	-
Central	33	32	-
Eastern	56	47	-
Volta	11	9	-
Ashanti	69	32	12
Brong-Ahafo	31	18	17
Northern	-	-	30
Upper East	-	-	41
TOTAL	200	150	100

19. The seeds' moisture contents were established using a Dole 500 moisture meter. Germination tests were carried out following ISTA (1993) procedures. Four replicates of 100 seeds were planted on a paper substrate (for maize) or on moistened sterilised sand (for cowpea and soya) and kept at 25-28°C. The maize, cowpea and soya seedlings were evaluated after 7, 8 and 9 days respectively.

20. Results of moisture determinations, germination tests and responses to questionnaires are given in Annex 2 (Ghana short season) and Annex 3 (Ghana main season).

Results

21. The questionnaire results can be summarised to give an indication of current farmer storage practices and the relative prevalence of each strategy. These are tabulated in Tables 7 and 8 for maize and cowpeas respectively.

Maize - Farmer practices

22. The most pertinent points to come out of the survey are that the farmers tend to follow the same practices during both seasons, with a few important exceptions (Table 7).

Table 7. Proportion of Ghanaian farmers practising different storage techniques for home-saved maize seed.

VARIABLE	OPTIONS	PERCENTAGE OF FARMERS	
		Short season (n = 100)	Main season (n = 200)
VARIETY	Improved	66	53
	Traditional	34	47
FORM	On cobs	42	72
	Shelled	58	28
CONTAINER	In sacks	41	35
	Trad. store	32	59
	Other	27	6
SMOKED	Yes	10	19
	No	90	81
SELECTION	Harvest	62	42
	Pre-planting	38	58
	Other	0	0
ADMIXTURE	Pesticide	58	45
	Traditional	0	5
	None	42	50
SEED AGE	< 6 months	71	73
	6-12 months	26	27
	> 12 months	3	0
MOISTURE CONTENT	< 12%	13	79
	12.1-14.0%	30	21
	> 14%	57	0

23. During the main season, a higher proportion of traditional varieties are grown, maize is left on the cob and stored in traditional stores whilst during the short season maize is shelled and sack storage becomes more important. The weather conditions during the main season allow the majority of seeds to be stored at below 12% moisture content which is recommended for storage, whereas only a small proportion of seeds are dried to this level during the short season. Despite these differences in practices, mean germination levels are similar in both seasons (Table 2) and are quite acceptable at above 80%.

Maize - Germination potential (short season)

24. As noted in the introduction, the nature of the data only allows the important variables to be identified. These are shown in Annex 2a as Significant interactions and summarised in the points below:

a) Selection of seed at harvest time is always better than selection prior to planting though the benefits are more marked in the south.

b) Pesticide application is only of benefit in the north. Pesticide application is of greatest benefit on seeds selected at harvest.

c) Sacks are less effective than the other containers. Even when the seed is treated with pesticide, sacks are not as good as other storage structures containing either treated or untreated maize.

d) Moisture content (within the range exhibited by the samples) had a highly significant effect on germination; the higher the m.c., the lower the germination.

Maize - Germination potential (main season)

25. Significant interactions are noted in Annex 3a and summarised below:

a) Germination was significantly higher in the south of the country. In the north, improved varieties showed better germination potential than traditional varieties.

b) Seeds of improved varieties that had been stored a shorter time (< 6 months) had better germination than older seeds (6-12 months). There was no difference between older seeds of improved varieties and traditional seeds of either age group.

26. It is clear that the important components of the seed storage system do not, in this survey, appear to remain constant over the two seasons. However, some general points can be identified:

- seed selection at harvest gives best results;
- pesticide treatment is of benefit only in the north (though this may not hold true for areas infested with the Larger Grain Borer);
- sacks are not suitable containers for seed storage;
- seeds store better in the south of the country;
- there is little difference in germination between improved and traditional seeds if they are stored for more than 6 months;
- under farmer conditions, germination is maintained at a sufficiently high level.

Cowpea - Farmer practices

27. Twice as many cowpea samples were collected from the south than the north in the main season and so direct comparisons with the short season (when equal numbers of samples were collected) can only be made with care (Table 8). Most farmers store their seed threshed and in sacks (although half the farmers in the main season and a quarter of the farmers in the short season do not distinguish seed and grain until just prior to planting). About two thirds treat their seed with pesticide. It is clear that almost all the cowpea seeds used in the main season are harvested from the short season crop. Seeds are typically stored at below 12% moisture content, which is considered to be a safe value.

Table 8. Proportion of Ghanaian farmers practising different storage techniques for home-saved cowpea seed.

VARIABLE	OPTIONS	PERCENTAGE OF FARMERS	
		Short season (n = 100)	Main season (n = 150)
VARIETY	Improved	76	55
	Traditional	24	45
FORM	In pods	12	15
	Threshed	88	85
CONTAINER	In sacks	79	91
	Trad. store	4	0
	Other	17	9
SELECTION	Harvest	79	49
	Pre-planting	21	51
	Other	0	0
ADMIXTURE	Pesticide	67	64
	Traditional	3	1
	None	30	35
SEED AGE	< 6 months	64	97
	6-12 months	36	3
	> 12 months	0	0
MOISTURE CONTENT	< 12.0%	16	97
	> 12.0%	84	3

Cowpea - Germination potential (short season)

28. Mean levels of germination are the same for both seasons (Table 2) and appear satisfactory at above 75%. As noted in the introduction, the nature of the data only allows the important variables to be identified. These are shown in Annex 2b and those factors influencing germination levels are summarised in the points below:

a) The germination potential of improved seed declines significantly with age. Traditional seed, although having a lower initial germination potential, maintains its potential with time and is better than improved varieties after 6 months storage.

b) Improved varieties germinate better than traditional varieties in the south, though the reverse is true in the north. The traditional varieties are less variable than the improved varieties.

c) Pesticide use is beneficial in the north, though has an adverse effect in the south. The advantages of pesticide admixing are only seen in the improved varieties.

d) Pesticide use on younger (< 6 months) seeds is counter-productive though it has significant benefits on seeds that are stored for more than 6 months.

Cowpea - Germination potential (main season)

29. Details of the samples are given in Annex 3b. Important variables are shown under Significant interactions and summarised below:

a) Cowpeas stored in the south of the country have higher germination capacity than those stored in the north. There are no differences between varieties in the south; in the

north, improved varieties store better. The improved varieties are less variable than the traditional types.

b) Those seeds selected at time of harvest gave marginally higher germination than those selected just prior to planting.

c) Cowpeas admixed with pesticides store better. The benefits are only apparent for cowpeas stored in the south; virtually no advantage is seen for those stored in the north.

d) Moisture content (within the range exhibited by the samples) had a significant effect on germination; the higher the m.c., the lower the germination.

30. Important components of cowpea seed storage are, as with maize, not constant over the two seasons. Some general points can, however, be identified:

- cowpeas store better in the south;
- there is an important germination potential decline in seeds stored for more than 6 months;
- pesticide use has benefits for seeds stored for longer than 6 months;
- during the short season traditional varieties are more suited to the north, improved varieties to the south. Differences between varieties are less marked during the main season;
- time of seed selection appears to be unimportant;
- germination levels are frequently unacceptable (below 70%) for farmers in the north and for those

storing for more than 6 months. Problems are more pronounced during the short season.

Soya - Farmer practices

31. Details from the samples are given in Annex 3c. The questionnaires show that most farmers select their seed at harvest and store it in sacks after shelling it. The seeds are left untreated and are rarely saved for longer than a year.

Soya - Germination potential

32. Germination is typically good at above 70% even though only one quarter of the farmers store their seed at below the recommended maximum moisture content of 9%. Only two factors appeared to significantly affect germination quality:

a) Seeds stored for more than 6 months have reduced viability in comparison to those stored for less than 6 months.

b) The improved varieties tend to store better than traditional varieties.

MALAWI

33. In Malawi, the work was carried out by staff of the Seed Services Unit at Chitedze Agricultural Research Station, just outside Lilongwe. A single survey was undertaken between 14 - 25 November 1994 just prior to the onset of the planting rains. Samples were collected from several Agricultural Development Divisions (ADDs), shown in Table 9.

Table 9. Distribution of samples collected, by ADD, in Malawi.

ADD	NUMBER OF SAMPLES TAKEN PER CROP				
	Maize	Beans	Cowpea	Groundnut	Soya
Lilongwe	-	-	45	-	-
Kasungu	75	75	5	49	48
Mzuzu	75	75	3	52	50
TOTAL	150	150	53	101	98

34. Maize is the staple food of Malawians and beans, cowpeas and groundnuts are important crops throughout the country. Soya was also included because it is a relatively new crop, for Malawi, which is being actively promoted. It was felt that problems may exist with this crop to which farmers are not yet fully accustomed, particularly since it is inherently a poor storer (Delouche *et al*, 1973). Qualitative aspects of farmer seed storage techniques in Malawi can be found in Wright and Tyler (1994).

35. Malawi suffered a drought year during the 1992/93 season and seed stocks were still apparently low.

36. Samples were collected according to the agreed protocol and were placed in moisture proof sealed plastic bags for transportation back to the laboratory. Farmers were paid for all samples removed.

37. The seeds' moisture contents were established using a drying oven set at 130°C for maize, beans and cowpeas and at 103°C for soya and groundnuts. Germination tests were carried out following ISTA (1993) procedures. Four replicates of 100 seeds were planted on moist sterilised sand (except for maize which was placed on moist blotting paper) and kept in an incubator at 25°C. The seedlings were evaluated twice; the second evaluation which is recorded in the results was after the following periods of time: maize (7 days), beans (8 days), soya (9 days), cowpea and groundnuts (10 days).

38. Results of moisture determinations, germination tests and responses to questionnaires are given in Annexes 4a-4b (Malawi surveys).

Results

Maize - Farmer practices

39. Two thirds of the farmers sampled were using traditional varieties. In cases where improved varieties were noted, this was in fact recycled hybrid maize. Farmers commonly recycle hybrids in spite of the yield penalties normally associated with this practice.

40. Some farmers were found to be using the composite variety SV28. This was last officially multiplied in 1978 meaning that the farmers involved have dmanged to maintain it as a distinct variety for almost 20 years.

41. Most farmers stored their seed as cobbed maize in their traditional store (*nkhokwe*). The farmers did not distinguish seed and food maize and selection for seed was not carried out until just prior to planting.

42. Very little maize is treated and none is smoked. Virtually all the seed is stored at below the recommended maximum level of 12% moisture content.

Maize - Germination potential

43. The maize results are given in Annex 4a and important variables shown under Significant differences.

a) Traditional varieties show a higher degree of germination than the improved (recycled hybrid) varieties.

b) Seeds stored on the cob had better germination than seed stored as shelled grain.

c) Farmer saved maize seed shows excellent germination, usually in excess of 90%.

Beans - Farmer practices

44. The majority of farmers use traditional varieties. Virtually all beans are threshed and stored in sacks. Beans destined for food or seed are kept together and selection of planting material only takes place shortly before planting. Over half the farmers mix their beans with insecticide or a traditional admixture. Nearly all farmers store their beans at the recommended moisture content of below 12%.

Beans - Germination potential

45. The bean results are given in Annex 4b and important variables shown under Significant differences. These are described below:

a) The only important parameter was choice of admixture. Traditional admixes resulted in the highest germination and results showed no benefits from insecticide use.

b) Farmer stored beans showed excellent germination of over 85%.

Cowpea - Farmer practices

46. All farmers used traditional cowpea varieties and stored them threshed. Sacks were the commonest storage container. Many farmers treated their stocks with insecticides or traditional admixtures.

Cowpea - Germination potential

47. The cowpea results are given in Annex 4c. Due to the small data set and the variability of the results, no significant variables could be identified. Germination was very good at above 85%.

Groundnut - Farmer practices

48. Three quarters of the farmers use improved varieties. Groundnuts are stored mainly in sacks and selection of seeds takes place shortly before planting. Groundnuts are not usually treated in any way. Almost all farmers kept their groundnuts at below the recommended maximum of 6% moisture content.

49. Some farmers were found using Chalimbana, which had last been multiplied up in 1985. This again shows farmers' ability to maintain an improved variety under their own conditions.

Groundnut - Germination potential

50. The groundnut results are given in Annex 4d and important variables shown under Significant differences. These can be summarised as:

a) Traditional admixtures, though used rarely, appear to have a counter-productive effect on germination (although this is based on a very small sample size).

b) Groundnuts stored in their shells maintain their germination potential better than those that have been shelled.

c) Germination of home-saved seed was good with levels of above 80% being found in the samples.

Soya - Farmer practices

51. Soya was introduced to Malawi during the 1970s but is now widely grown and appreciated. Nearly all the soya grown is of an improved variety and is always stored threshed. It is typically stored untreated in sacks. Selection of seed only takes place just before planting. Nearly all samples showed a moisture content of below the recommended maximum moisture content of 9%.

Soya - Germination potential

52. The soya results are given in Annex 4e. No significant relationships between variables and germination could be identified. Germination was good with mean levels of above 70% being recorded.

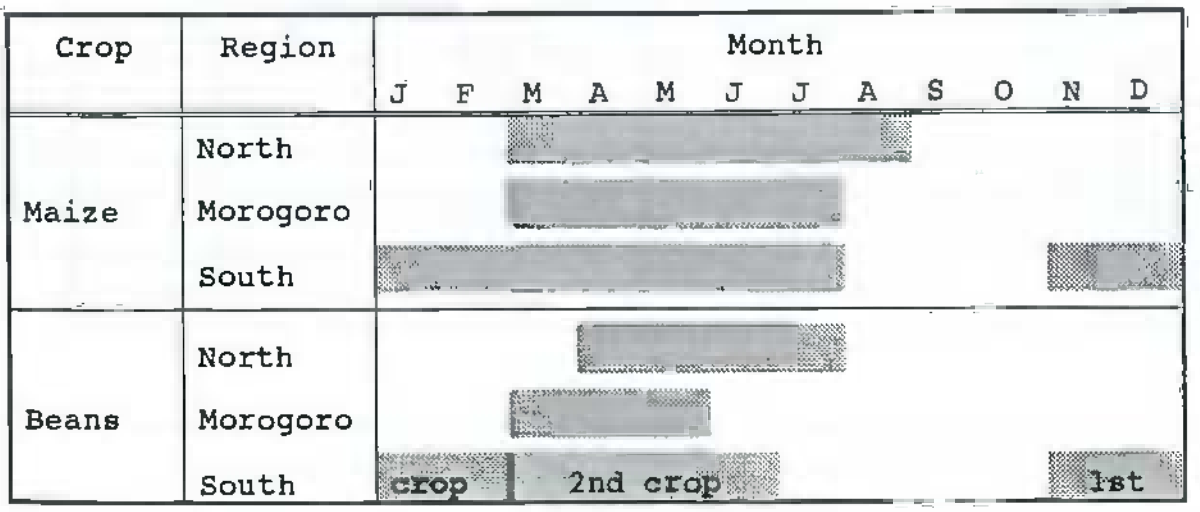
TANZANIA

53. In Tanzania, the work was carried out by staff of the National Bean Research Programme at the Selian Agricultural Research Institute (SARI), just outside Arusha.

54. Maize and beans are the most important sources of carbohydrate and protein for the majority of Tanzanians. Groundnuts were included in the survey as an example of an oilseed crop, which are often classed as poor storers (Delouche *et al*, 1973). Groundnuts are particularly important in the drier central areas of Tanzania as well as in Lindi and Mtwara in the south east. Unfortunately it was not possible to cover these regions during the survey.

55. Two surveys were undertaken, the first between 30 November 1994 and 30 January 1995, and the second between 14 February and 2 March 1995. The first survey coincided with long season planting in the Southern Highlands and the short season in Northern Tanzania. The second survey was just prior to the long rains in Northern Tanzania and the second planting of beans in the Southern Highlands (Figure 1).

Figure 1. Tanzanian crop calendar



56. The approved sampling protocol was not completely adhered to in the Tanzanian case with, on occasion, more than one sample of a crop type being taken from a given farmer, and more than five samples being taken from a single village. However, the trends shown by the results can still be considered as valid.

57. Samples were kept in paper bags and stored in boxes out of direct sunlight until they could be returned to the laboratory for germination testing. Tables 10 and 11 show the locations from which samples were collected during the two surveys.

58. The seeds' moisture contents were established using an Ag. Electronics 500 moisture tester (for maize) and a Protimeter Grain Master for beans and groundnuts. Germination tests were carried out following ISTA (1993) procedures. Four replicates of 100 seeds were planted on moist sand and kept at ambient temperatures. The maize, cowpea and groundnut seedlings were evaluated after 7, 8 and 10 days respectively.

Table 10. Distribution of samples collected, by SARI, in Tanzania - First survey.

REGION	NUMBER OF SAMPLES TAKEN PER CROP		
	Maize	Beans	Groundnut
Rukwa	10	10	5
Mbeya	45	50	8
Iringa	20	16	-
Morogoro	15	-	-
Arusha	37	64	4
Kilimanjaro	21	10	-
Tanga	12	10	1
TOTAL	160	160	18

59. For the purposes of this work, Rukwa, Mbeya, Iringa and Morogoro are considered to be in the south of Tanzania whilst Arusha, Kilimanjaro and Tanga are designated as north Tanzania.

Table 11. Distribution of samples collected, by SARI, in Tanzania - Second survey.

REGION	NUMBER OF SAMPLES TAKEN PER CROP	
	Maize	Beans
Rukwa	14	7
Mbeya	41	38
Iringa	13	14
Morogoro	11	16
Arusha	59	44
Kilimanjaro	22	27
Tanga	-	14
TOTAL	160	160

60. Results of moisture determinations, germination tests and responses to questionnaires are given in Annexes 5 and 6 (Tanzania first and second survey).

Results

Maize - Farmer practices

61. Farmer practices over the two survey periods are summarised in Table 12. Most farmers select their seed at harvest time. Most is shelled and stored in sacks. Smoking of maize is uncommon. Up to half the farmers treat their maize with insecticide. It would appear that farmers put aside sufficient seed from the July and August harvests to furnish both the subsequent November and March plantings (Figure 1). Only half to three quarters of the seed is stored below the recommended maximum level of 12% moisture content. Germination levels are still extremely good at 80% and above (Table 2) for both planting periods.

Table 12. Proportion of Tanzanian farmers practising different storage techniques for home-saved maize seed.

VARIABLE	OPTIONS	PERCENTAGE OF FARMERS	
		First survey (n = 160)	Second survey (n = 160)
VARIETY	Improved	40	58
	Traditional	60	42
FORM	On cobs	43	16
	Shelled	57	84
CONTAINER	In sacks	52	58
	Trad. store	26	33
	Other	22	8
SMOKED	Yes	9	14
	No	91	86
SELECTION	Harvest	61	91
	Pre-planting	36	8
	Other	2	1
ADMIXTURE	Pesticide	36	53
	Traditional	3	0
	None	61	47
SEED AGE	< 6 months	88	18
	6-12 months	11	81
	> 12 months	1	1
MOISTURE CONTENT	< 12.0%	43	76
	> 12.0%	58	24

Maize - Germination potential (First survey)

62. The important variables are shown in Annex 5a as Significant differences and are summarised below:

a) The south of the country (i.e. during its long rains) shows better maize germination than the north.

b) Seeds that are older than 6 months germinate less well than younger seeds and this effect is particularly marked in the north of the country.

Maize - Germination potential (Second survey)

63. Annex 6a shows the important variables as Significant differences which are described below:

a) Seeds show better germination in the north (i.e. during its long rains) than in the south.

b) Smoking maize, although not widely practiced, has real benefits for seed germination.

64. The most important factors do not remain constant for the two survey periods. Some general points can be made:

- The area of the country where the seeds are stored strongly influences seed germination;

- Drying of the maize through smoking can be useful, though whether this is used as a drying technique and/or an insect control mechanism is unclear from this survey.

Beans - Farmer practices

65. Farmer practices over the two survey periods are summarised in Table 13. Traditional varieties still predominate in the bean sector. These are frequently stored as mixtures of several varieties. All beans are stored threshed with most seed selection taking place at harvest time. Although about one third of farmers use insecticide, traditional admixtures are still common. There seems to be an indication that, as with maize, farmers put aside sufficient seed from the June and July harvests to furnish both the subsequent November and March plantings (Figure 1). Both surveys show that drying of beans is a problem. This is especially true during the second survey when all seeds were being stored at above the recommended maximum level of 12% moisture content.

Table 13. Proportion of Tanzanian farmers practising different storage techniques for home-saved bean seed.

VARIABLE	OPTIONS	PERCENTAGE OF FARMERS	
		First survey (n = 160)	Second survey (n = 160)
VARIETY	Improved	11	24
	Traditional	89	76
FORM	On cobs	0	1
	Shelled	100	99
CONTAINER	In sacks	36	77
	Trad. store	4	9
	Other	59	14
SELECTION	Harvest	57	81
	Pre-planting	41	18
	Other	2	0
ADMIXTURE	Pesticide	28	36
	Traditional	32	4
	None	40	61
SEED AGE	< 6 months	54	27
	6-12 months	46	73
	> 12 months	0	0
MOISTURE CONTENT	< 12.0%	25	1
	> 12.0%	75	99

Beans - Germination potential (First survey)

66. Results from the first bean survey are given in Annex 5b with the important variables shown as Significant interactions. These are summarised below.

a) Germination potential of seeds declined after 6 months of storage. This is particularly true for the improved varieties which dropped to only 51% (although it should be noted that the sample size of improved varieties was relatively small, n=18).

b) Germination is better in the southern areas of the country. The difference becomes less marked if seed of more than 6 months old is used.

c) There is an indication that those seeds selected at harvest performed better than those selected just prior to planting.

d) Moisture content (within the range exhibited by the samples) had a highly significant effect on germination; the higher the m.c., the lower the germination.

Beans - Germination potential (Second survey)

67. Results from the first bean survey are given in Annex 6b with the important variables shown as Significant differences.

a) Traditional varieties showed considerably better germination than improved varieties.

b) Those seeds selected at harvest showed superior germination to those seeds selected just prior to planting.

c) Moisture content (within the range exhibited by the samples) had a very significant effect on germination; the higher the m.c., the higher the germination (though germination is distinctly poorer than that shown in the first survey). This is an anomalous finding and is perhaps a reflection of the fact that all the beans are stored above the accepted safe moisture content.

68. Summing the findings of the two surveys, the important components for bean seed storage are:

- Traditional varieties (which includes mixtures) store better than improved varieties;
- Seeds selected at harvest germinate better than those selected just prior to planting;
- Seeds show germination decline after 6 months of storage;

- Drying of seeds to below 12% moisture content is important to maintain a higher germination potential.

- Although mean germination levels are good for the first survey (above 80%), it is clear that there are problems with (i) seeds stored for the March planting period and (ii) seed storage of improved varieties. These problems appear to be greater in the northern areas of Tanzania.

Groundnut

69. Results of the survey are given in Annex 5c. The number of samples taken was too small to undertake any meaningful analysis of results and, since samples were not taken from the main production areas, it is difficult to make any general observations on farmer practices.

70. However, from the limited data it would appear that germination of groundnut seed is a significant problem in those areas surveyed. Further investigations would be needed to confirm this and to establish the situation in the main areas of production.

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CONTACT ADDRESSES OF COLLABORATORS

Mr L Delimini
Ghana Seed Inspection Unit
Ministry of Agriculture
PPRSD
P O Box M37
Accra
GHANA

Dr J Luhanga
Chitedze Agricultural Research Station
P O Box 158
Lilongwe
MALAWI

Dr C Mushi
Selian Agricultural Research Institute
P O Box 6024
Arusha
TANZANIA

Mr H Tsini
Grains & Legumes Development Board
P O Box 4000
Kumasi
GHANA

Annex 1 - Typical seed box questionnaire

SEED BOX QUESTIONNAIRE - MAIZE *COUNTRY*

Region..... Village.....

Farmer..... Date.....

Maize variety.....

RING APPROPRIATE ANSWER

1.	Is variety:	Improved	Traditional	
2.	Is it:	On cobs	Shelled	
3.	Stored:	In sack	Traditional store	Other*
4.	Stored:	Above fire	Not smoked	
5.	Selected:	At harvest	Pre-planting	Other*
6.	Admixed:	Pesticide*	Traditional	None
7.	Age of seed:	< 6 months	6-12 months	> 1 year

TO BE DETERMINED IN LABORATORY:

Moisture content.....

Germination percentage (1)

(2)

(3)

(4)

Average = ...

* Please specify overleaf

Annex 2a - Ghana maize (1st survey)

KEY		Mean Germ %	n =
VARIETY	1. Improved	90.1	66
	2. Traditional	86.5	34
FORM	1. On cobs	88.7	42
	2. Shelled	89.1	58
CONTAINER	1. Sacks	86.7	41
	2. Traditional store	89.2	32
	3. Other	91.9	27
SMOKED	1. Yes	88.1	10
	2. No	89.0	90
SELECTION	1. Harvest	90.4	62
	2. Pre-planting	86.5	38
	3. Other		0
ADMIXTURE	1. Pesticide	91.4	58
	2. Traditional		0
	3. None	85.5	42
SEED AGE	1. < 6 months	88.5	71
	2. 6-12 months	90.2	26
	3. > 12 months	87.3	3
REGION	1. North (GLDB)	87.8	50
	2. South (GSIU)	90.0	50
m.c.	< 12.0%	86.9	13
	12.1 - 14.0%	90.0	30
	> 14.0%	88.9	57

SIGNIFICANT INTERACTIONS

Non-transformed data for germination % - Least squares means

	Admixture	
Selectn	Pesticide	None
Harvest	92.6	88.1
Planting	83.6	84.3

	Admixture	
Region	Pesticide	None
North	88.1	82.3
South	88.1	90.1

	Admixture	
Contain.	Pesticide	None
Sack	82.7	77.8
Trad.	91.2	89.2
Other	90.4	91.6

	Selection	
Contain.	Harvest	Planting
Sack	87.2	73.3
Trad.	92.8	87.6
Other	91.0	91.0

	Region	
Selectn	North	South
Harvest	86.4	94.3
Planting	84.0	83.9

Annex 2b - Ghana cowpea (1st survey).

KEY		Mean Germ %	n =
VARIETY	1. Improved	79.6	76
	2. Traditional	72.4	24
FORM	1. In pods	72.6	12
	2. Threshed	78.6	88
CONTAINER	1. Sacks	77.6	79
	2. Traditional store	66.8	4
	3. Other	81.9	17
SELECTION	1. Harvest	79.0	79
	2. Pre-planting	73.7	21
	3. Other		0
ADMIXTURE	1. Pesticide	80.2	67
	2. Traditional	76.3	3
	3. None	72.7	30
SEED AGE	1. < 6 months	78.9	64
	2. 6-12 months	76.1	36
	3. > 12 months		0
REGION	1. North (GLDB)	74.3	50
	2. South (GSIU)	81.6	50
m.c.	< 12.0%	74.3	16
	12.1 - 14.0%	79.5	63
	> 14.0%	75.7	21

SIGNIFICANT INTERACTIONS

Non-transformed data for germination % - Least squares means

	Admix	
Variety	Pesticide	None
Improved	78.5	69.9
Trad.	68.7	73.9

	Region	
Variety	North	South
Improved	62.1	86.3
Trad.	75.0	67.7

	Region	
Admix	North	South
Pesticide	76.6	70.6
None	60.5	83.4

	Variety	
Age	Improved	Trad.
< 6 mths	86.9	69.7
6-12 mths	61.5	72.9

	Admix	
Age	Pesticide	None
< 6 mths	69.3	87.3
6-12 mths	77.9	56.5

Annex 3a - Ghana maize (2nd survey)

KEY		Mean Germ %	n=
VARIETY	1. Improved	86.0	106
	2. Traditional	86.4	94
FORM	1. On cobs	85.9	144
	2. Shelled	86.7	56
CONTAINER	1. Sacks	85.5	69
	2. Traditional store	86.8	118
	3. Other	83.4	13
SMOKED	1. Yes	82.6	38
	2. No	87.0	162
SELECTION	1. Harvest	83.9	83
	2. Pre-planting	87.7	117
	3. Other		0
ADMIXTURE	1. Pesticide	86.3	89
	2. Traditional	88.3	10
	3. None	85.8	101
SEED AGE	1. < 6 months	88.2	146
	2. 6-12 months	80.5	54
	3. > 12 months		0
REGION	1. North (GLDB)	79.1	100
	2. South (GSIU)	93.2	100
m.c.	< 12%	84.7	157
	12.1 - 14.0%	91.4	43
	> 14.0%		0

SIGNIFICANT INTERACTIONS

Non-transformed data for germination % - Least squares means

	Region	
Variety	North	South
Improved	79.8	92.6
Traditiona	73.5	93.5

	Age	
Region	< 6 mths	6-12 mths
North	78.6	74.8
South	93.7	92.5

	Age	
Variety	< 6 mths	6-12 mths
Improved	88.6	83.9
Traditiona	83.7	83.3

Annex 3b - Ghana cowpea (2nd survey)

KEY		Mean Germ %	n =
VARIETY	1. Improved	81.1	82
	2. Traditional	74.1	68
FORM	1. In pods	71.2	23
	2. Threshed	79.1	127
CONTAINER	1. Sacks	77.9	136
	2. Traditional store		0
	3. Other	77.6	14
SELECTION	1. Harvest	79.8	73
	2. Pre-planting	76.1	77
	3. Other		0
ADMIXTURE	1. Pesticide	80.8	96
	2. Traditional	67.5	2
	3. None	72.9	52
SEED AGE	1. < 6 months	78.1	145
	2. 6-12 months	73.2	5
	3. >12 months		0
REGION	1. North (GLDB)	71.7	50
	2. South (GSIU)	81	100
m.c.	< 12 %	77.7	144
	12.1 - 14.0%	87.4	5
	> 14.0%		0

SIGNIFICANT INTERACTIONS

Non-transformed data for germination % - Least squares means

	Admixture	
Selectn	Pesticide	None
Harvest	78.6	73.6
Planting	76.7	70.6

	Admixture	
Region	Pesticide	None
North	70.5	68.9
South	85.2	75.3

	Region	
Selectn	North	South
Harvest	71.1	81
Planting	67.9	79.5

	Region	
Variety	North	South
Improved	72.6	80.6
Traditiona	66.3	79.9

	Admixture	
Variety	Pesticide	None
Improved	79.5	73.7
Traditiona	75.7	70.5

	Selectn	
Variety	Harvest	Planting
Improved	78.7	74.5
Traditiona	73.5	72.8

KEY		Mean Germ %	n =
VARIETY	1. Improved	78.1	67
	2. Traditional	68.6	33
FORM	1. In pods	74.7	21
	2. Shelled	75.1	79
CONTAINER	1. Sack	75.2	94
	2. Traditional store	71.0	1
	3. Other	71.8	5
SELECTION	1. Harvest	75.1	86
	2. Pre-planting	74.4	14
	3. Other		0
ADMIXTURE	1. Pesticide		0
	2. Traditional	74.3	4
	3. None	75.0	96
SEED AGE	1. < 6 months	76.6	53
	2. 6-12 months	73.8	45
	3. > 1 year	57.5	2
REGION	1. North (GLDB)	75.0	100
	2. South (GSIU)		0
m.c.	< 9.0%	74.0	25
	> 9.0%	75.3	75

SIGNIFICANT DIFFERENCES
Non-transformed data for germination %

General linear model - Least squares means

Age - 1	76.5
Age - 2+3	69.3
Variety - 1	78.4
Variety - 2	67.4

KEY		Mean Germ %	n=
VARIETY	1. Improved	89.6	45
	2. Traditional	93.7	105
FORM	1. On cobs	94.0	106
	2. Shelled	88.5	44
CONTAINER	1. Sacks	89.2	48
	2. Traditional store	94.0	102
	3. Other		0
SMOKED	1. Yes		0
	2. No	93.1	124
SELECTION	1. Harvest		0
	2. Pre-planting	92.4	148
	3. Other		0
ADMIXTURE	1. Pesticide	91.3	12
	2. Traditional	96.3	6
	3. None	92.4	132
SEED AGE	1. < 6 months	92.2	81
	2. 6-12 months	92.7	69
	3. > 12 months		0
m.c.	< 10.6%	92.2	76
	10.6 - 12.2%	92.7	74

SIGNIFICANT DIFFERENCES
Non-transformed data for germination %

General linear model - Least squares means

Variety - 1	88.1
Variety - 2	92.4
Form - 1	93.2
Form - 2	87.2

Annex 4b - Malawi beans.

KEY		Mean Germ %	n=
VARIETY	1. Improved	91.5	25
	2. Traditional	91.9	125
FORM	1. In pods	88.0	1
	2. Threshed	91.9	148
CONTAINER	1. Sacks	91.7	135
	2. Traditional store	96.4	4
	3. Other	91.7	11
SELECTION	1. Harvest	95.0	2
	2. Pre-planting	91.7	145
	3. Other		0
ADMIXTURE	1. Pesticide	90.5	38
	2. Traditional	95.8	30
	3. None	91.0	82
SEED AGE	1. < 6 months	90.2	49
	2. 6-12 months	92.6	98
	3. > 12 months		0
m.c.	< 10.0%	90.1	40
	10.1 - 12.0%	92.7	102
	> 12.0%	93.8	8

SIGNIFICANT DIFFERENCES
Non-transformed data for germination %

General linear model - Least square means

Admix - 1	89.8
Admix - 2	95.1
Admix - 3	90.8

KEY		Mean Germ %	n=
VARIETY	1. Improved		0
	2. Traditional	89.4	53
FORM	1. In pods		0
	2. Threshed	89.4	53
CONTAINER	1. Sacks	89.4	41
	2. Traditional store	89.5	10
	3. Other	89	2
SELECTION	1. Harvest	91.7	15
	2. Pre-planting	88.9	37
	3. Other		0
ADMIXTURE	1. Pesticide	88.7	21
	2. Traditional	92.9	17
	3. None	86.5	15
SEED AGE	1. < 6 months	89.9	47
	2. 6-12 months	85.3	6
	3. > 12 months		0
mc	< 11.0%	90.3	21
	11.0 - 13.0%	88.8	32

SIGNIFICANT DIFFERENCES

Due to the small data set and the variability of results, no relationships can be detected.

KEY		Mean Germ %	n =
VARIETY	1. Improved	84.2	75
	2. Traditional	85.3	26
FORM	1. In pods	86.5	44
	2. Shelled	83.0	57
CONTAINER	1. Sack	85.1	64
	2. Traditional store	83.9	35
	3. Other	76.5	2
SELECTION	1. Harvest	55.0	1
	2. Pre-planting	84.8	100
	3. Other		0
ADMIXTURE	1. Pesticide	88.0	1
	2. Traditional	79.0	5
	3. None	83.8	95
SEED AGE	1. < 6 months	85.2	59
	2. 6-12 months	83.5	42
	3. > 1 year		0
m.c.	< 6.0%	84.7	98
	> 6.0%	75.3	3

SIGNIFICANT DIFFERENCES
Non-transformed data for germination %

General linear model - Least squares means

Admix - 2	76.7
Admix - 3	85.3
Form - 1	83.7
Form - 2	78.3

KEY		Mean Germ %	n =
VARIETY	1. Improved	85.3	91
	2. Traditional	77.8	6
FORM	1. In pods		0
	2. Shelled	85.0	98
CONTAINER	1. Sack	85.2	87
	2. Traditional store	99.0	1
	3. Other	81.8	10
SELECTION	1. Harvest		0
	2. Pre-planting	85.7	97
	3. Other		0
ADMIXTURE	1. Pesticide	73.0	7
	2. Traditional		0
	3. None	85.9	91
SEED AGE	1. < 6 months	86.3	55
	2. 6-12 months	83.3	43
	3. > 1 year		0
mc	< 9.0%	85.1	96
	> 9.0%	77.5	2

SIGNIFICANT DIFFERENCES

No significant relationships can be detected.

Annex 5a - Tanzania maize (1st survey)

KEY		Mean Germ %	n=
VARIETY	1. Improved	89.1	64
	2. Traditional	91.6	96
FORM	1. On cobs	93.4	68
	2. Shelled	89.6	91
CONTAINER	1. Sacks	89.1	83
	2. Traditional store	93.5	42
	3. Other	90.7	35
SMOKED	1. Yes	89.9	14
	2. No	90.9	143
SELECTION	1. Harvest	91.4	97
	2. Pre-planting	91.2	57
	3. Other	61.5	3
ADMIXTURE	1. Pesticide	88.6	58
	2. Traditional	86.3	4
	3. None	91.9	97
SEED AGE	1. < 6 months	91.9	136
	2. 6-12 months	78.4	17
	3. > 12 months	94.8	2
REGION	1. South	93.6	90
	2. North	86.7	70
m.c.	< 12.0%	86.8	68
	12.0 - 13.1%	93.4	92
	>13.1%		0

SIGNIFICANT DIFFERENCES
Non-transformed data for germination %

General linear model - Least squares means

Age - 1	91.9
Age - 2	87.4
Region - 1	93.9
Region - 2	85.3

	Region	
Age	South	North
< 6 mths	93.6	90.1
6-12 mths	94.3	80.5

Annex 5b - Tanzania beans (1st survey)

KEY		Mean Germ %	n =
VARIETY	1. Improved	66.2	18
	2. Traditional	82.9	142
FORM	1. In pods		0
	2. Threshed	81.1	160
CONTAINER	1. Sacks	80.3	58
	2. Traditional store	82.4	7
	3. Other	81.8	94
SELECTION	1. Harvest	83.0	91
	2. Pre-planting	78.3	65
	3. Other	85.4	3
ADMIXTURE	1. Pesticide	81.3	45
	2. Traditional	78.5	51
	3. None	82.9	64
SEED AGE	1. < 6 months	85.3	87
	2. 6-12 months	75.9	73
	3. > 12 months		0
REGION	1. South	88.7	76
	2. North	74.2	84
m.c.	< 12 1%	81.2	40
	12.1 - 13.0%	82.9	107
	> 13.0%	65.8	13

SIGNIFICANT INTERACTIONS

Non-transformed data for germination % - Least squares means

	Age	
Variety	< 6 mths	6-12 mths
Improved	81.8	51.4
Trad.	81.9	79.5

	Age	
Region	< 6 mths	6-12 mths
South	88.1	67.5
North	75.6	63.5

Annex 5c - Tanzania groundnut

KEY		Mean Germ %	n =
VARIETY	1. Improved	22.5	1
	2. Traditional	56.0	17
FORM	1. In pods	57.6	15
	2. Shelled	36.8	3
CONTAINER	1. Sack	53.0	15
	2. Traditional store		0
	3. Other	60.0	3
SELECTION	1. Harvest	48.8	3
	2. Pre-planting	55.2	15
	3. Other		0
ADMIXTURE	1. Pesticide		0
	2. Traditional		0
	3. None	54.2	18
SEED AGE	1. <6 months	59.7	10
	2. 6-12 months	47.3	8
	3. >1 year		0
REGION	1. South	58.9	13
	2. North	41.9	5
m.c.	< 9.5%		0
	> 9.5%	53.1	16

KEY		Mean Germ %	n =
VARIETY	1. Improved	83.9	92
	2. Traditional	76.3	68
FORM	1. On cobs	81.7	25
	2. Shelled	80.5	135
CONTAINER	1. Sacks	80.3	92
	2. Traditional store	78.5	53
	3. Other	89.5	13
SMOKED	1. Yes	90.4	22
	2. No	79.1	138
SELECTION	1. Harvest	81.7	145
	2. Pre-planting	71.0	13
	3. Other	79.0	1
ADMIXTURE	1. Pesticide	79.9	83
	2. Traditional		0
	3. None	81.5	75
SEED AGE	1. < 6 months	89.6	29
	2. 6-12 months	78.5	129
	3. > 12 months	94.5	1
REGION	1. South	77.8	79
	2. North	83.4	81
m.c.	< 12.0%	80.8	121
	> 12.0%	80.2	39

SIGNIFICANT DIFFERENCES

Non-transformed data for germination %

General linear model - Least squares means

Smoked	89.4
Non-smoked	77.7
Region - 1	78.2
Region - 2	88.9

Annex 6b - Tanzania beans (2nd survey)

KEY		Mean Germ %	n =
VARIETY	1. Improved	51.6	38
	2. Traditional	68.9	122
FORM	1. In pods	97.0	1
	2. Threshed	64.6	159
CONTAINER	1. Sacks	66.5	123
	2. Traditional store	45.8	15
	3. Other	68.3	22
SELECTION	1. Harvest	68.7	130
	2. Pre-planting	47.1	28
	3. Other		0
ADMIXTURE	1. Pesticide	62.8	57
	2. Traditional	69.1	6
	3. None	65.7	97
SEED AGE	1. < 6 months	58.2	44
	2. 6-12 months	67.3	116
	3. > 12 months		0
REGION	1. South	71.1	75
	2. North	59.3	85
m.c.	< 12.0%		0
	12.0 - 13.5%	54.0	50
	> 13.5%	69.7	110

SIGNIFICANT DIFFERENCES
Non-transformed data for germination %

General linear model - Least squares means

Variety - 1	48.6
Variety - 2	62.7
Select - 1	64.3
Select - 2	47.1