# Seed management by small-scale farmers in Ghana. A study of maize and cowpea seed in the Brong-Ahafo and Volta regions (NRI Bulletin 68)

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# SEED MANAGEMENT BY SMALL-SCALE FARMERS IN GHANA

## A Study of Maize and Cowpea Seed in the Brong-Ahafo and Volta Regions

the UNIVERSITY of GREENWICH

DFID

# Seed management by small-scale farmers in Ghana

## A study of maize and cowpea seed in the Brong-Ahafo and Volta Regions

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The survey involved both a questionnaire and the collection of seed samples, often requiring return visits to the farmer. The enumerators carried out these tasks with care and professionalism. The enumerators in Brong-Ahafo were: Rockson M. Akartsu, Tie Gabriel Kpiango, Samuel Sabblah, Alfred Gunu, F. W. Haizel-Cobbina, and George K. Dery. The enumerators in the Volta Region were: Albert Havor, William Ayitevi, Emmanuel Atika, and Emmanuel Segbezi. The survey could not have been undertaken without the full collaboration of the farmers in the villages of Wenchi and Akatsi Districts, and we are grateful to them.

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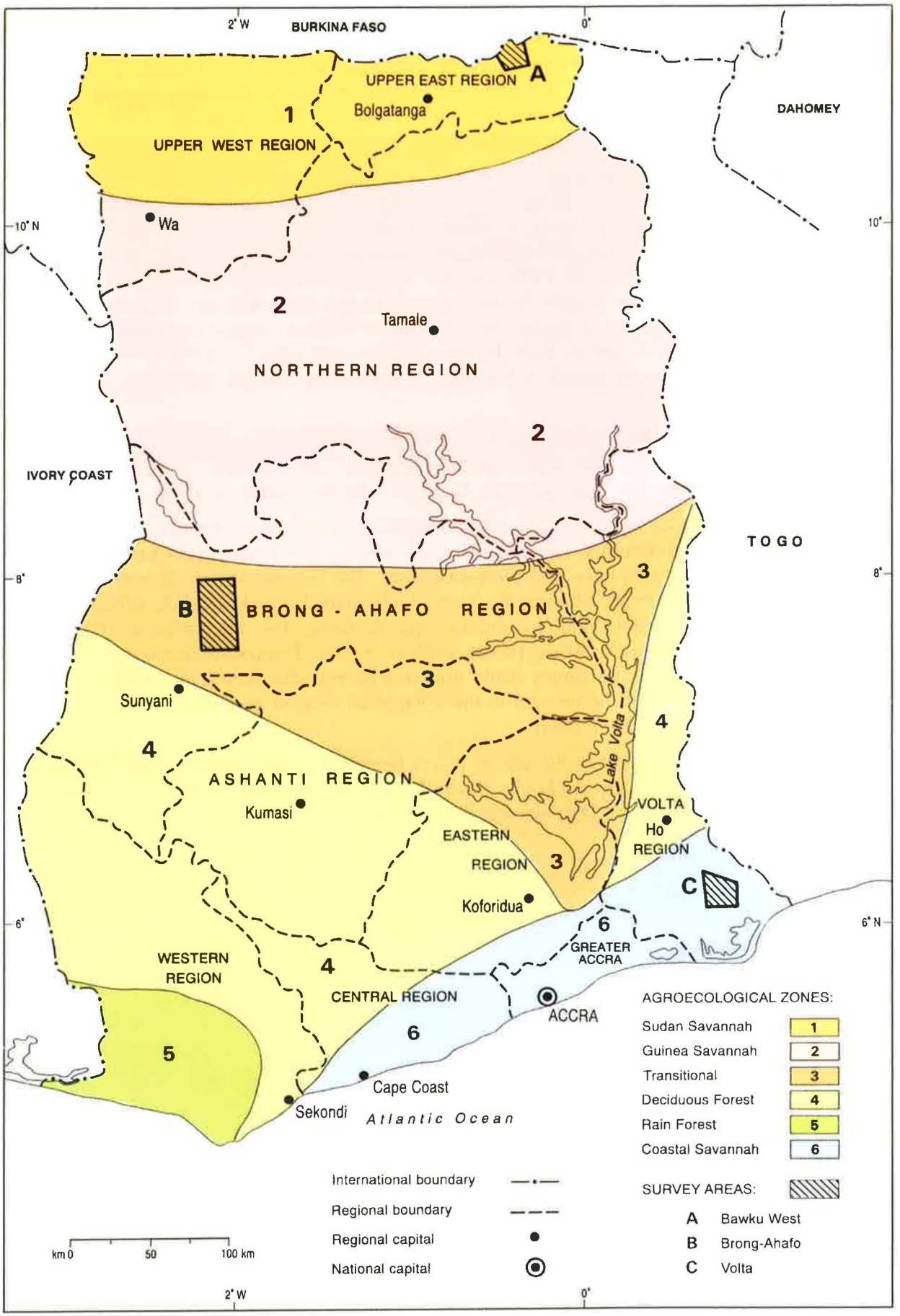


**Figure 1** Seed sampling and survey sites in Ghana

# Summaries


## SUMMARY

Field surveys of on-farm maize and cowpea seed management in two regions of southern Ghana are described. The survey included seed obtained off-farm. Samples of seeds were collected just prior to planting and assessed for germination potential. Conclusions are given on the general status and potential for improving seed quality and on farmer seed management. Notes are included on farmer seed management of millet and sorghum in the Upper East Region.

## RESUME

Des enquêtes de terrain portant sur la gestion des semences de maïs et de niébé dans deux régions du sud du Ghana sont décrites. Elles incluaient les semences mises de côté dans l'exploitation et les sources de semences extérieures. Des échantillons de semences étaient prélevés juste avant le semis et leur potentiel de germination évalué. Des conclusions sur la situation générale, sur le potentiel qui existe pour améliorer la qualité des semences ainsi que sur la gestion des semences par les cultivateurs sont présentées. Des notes sur la gestion des semences de mil et de sorgho par les cultivateurs dans la Upper East Region sont incluses.

## RESUMEN

Se proporciona una descripción de estudios sobre el terreno relativos a la gestión en explotación de semilla de maíz y fríjol de ojo negro en dos regiones de Ghana, habiéndose incluido en los estudios semilla reservada en explotación y semilla procedente de otras fuentes. Se llevó a cabo la recogida de muestras de semilla inmediatamente antes de su plantío y se procedió a evaluar su potencial de germinación. También se proporcionan conclusiones sobre el estado general y potencial para mejorar la calidad de las semillas, así como sobre la gestión de semillas en explotación. Finalmente, se incluyen notas sobre la gestión de semillas de mijo y sorgo por parte de los agricultores de la región oriental superior.

# Seed management by small-scale farmers in Ghana

## A study of maize and cowpea seed in the Brong-Ahafo and Volta Regions

## INTRODUCTION

This study is part of the Natural Resources Institute/Overseas Development Institute (NRI/ODI) implemented project on 'Seed Security for Small-Scale Farmers'. The project objective is to develop materials and methods that can be used by agricultural extension services in Africa to help strengthen on-farm seed management. The aims of the project also include the provision of information and procedures that can be used by national institutions to help strengthen on-farm seed management.

This bulletin describes the results of farm surveys carried out in Ghana that examined the management and quality of maize and cowpea seed used by farmers in two important agricultural areas in the south of the country. Maize is the most widely grown grain in the country and cowpea is the most important grain legume. In addition, some preliminary information from a survey carried out in the north-east of the country on sorghum and millet seed is examined.

In an earlier nation-wide study in Ghana (Wright *et al.*, 1995) a large number of samples of farm-stored seed of maize, cowpea and soybean had been collected and their germination rates analysed. It was felt that the study should be complemented by a more in-depth survey in a few locations that would examine all of the seed, from both on-farm and off-farm sources, that farmers use.

### Study areas

Two study areas were selected for the survey, which was undertaken just prior to planting. These were chosen to provide a contrast between relatively more commercial and more subsistence-oriented agricultural practices for the two target crops. Figure 1 shows the location of the two areas.

One area was selected in the Brong-Ahafo Region, centred on the town of Wenchi. Six villages were chosen for the survey after discussion with local extension officials and staff of the Wenchi Farming Systems Development and Training Project and the Wenchi Farm Institute. Maize was grown in all of the sample villages and cowpea was found in most of the villages. The villages are in the transition zone between the secondary forest of the south and the savannah of the north. The transition zone of Ghana is the single most important area for maize agriculture, particularly for commercial production destined for the towns and cities of the south of the country.

The second survey area was chosen in the south of the Volta Region, near the town of Akatsi. Six villages were chosen for the survey in consultation with local extension staff. These villages all occupy a part of the coastal savannah. Maize and cowpea are both important as subsistence crops in all the villages, and some of the farmers market part of their harvest.

In addition to these two areas, a similar survey was completed in villages in Bawku West District of the Upper East Region (*see* Figure 1). This survey was organized and carried out by staff of ActionAid, using a questionnaire that had been modified for the farming systems of that area. The survey concentrated on millet and sorghum, the most important crops grown in the savannah environment of the extreme north of Ghana. A brief summary of the results of that study is presented in this bulletin.

This publication concentrates on the cowpea and maize surveys in southern Ghana, reported in *Cowpea* (p.4) and *Maize* (p.7). The survey areas will be referred to by the names of the districts (Akatsi and Wenchi). A few key results from the millet and sorghum study are provided in *Millet and Sorghum* (p.10).

## Survey organization

The survey enumerators in Brong-Ahafo were recruited from the Wenchi Farm Institute and from the Department of Agricultural Extension Services. In Volta the enumerators were agricultural extension agents who lived in small towns near the survey villages.

For each village, the enumerators first consulted local leaders to compile a complete list of all maize and cowpea farmers. There was particular emphasis on ensuring that all female farmers were included in the list. Samples were drawn from each village list using a table of random numbers. A list of substitutes was also drawn up. Enumerators were instructed to contact and interview the farmers in the sample. If one of these farmers was not available or was unwilling to participate, another farmer was chosen from the substitute list.

The questionnaires were pre-tested and then thoroughly reviewed with the enumerators, who received several days of practice and instruction before beginning the survey. The enumerators had motorcycles to enable them to travel to the dispersed villages. The surveys were carried out between March and June 1995.

In each of the two areas 60 maize farmers and 60 cowpea farmers were interviewed. If a farmer grew both maize and cowpea, then he or she could participate in the two surveys. The survey questionnaire focused on seed management issues and took about 30 minutes to complete. At the end of the questionnaire, the farmer was asked to provide a small sample (0.5 kg) of seed, for which he or she was compensated by a cash payment equivalent to more than the current local price of seed. If the farmer had not yet selected seed from storage, or if the farmer was going to acquire seed from an off-farm source, the enumerator made arrangements to return to the farm later to collect the seed sample. Considerable effort was devoted to ensuring that the sample represented the actual seed that the farmer was about to plant.

The seed samples were taken to the laboratories of the Ghana Seed Inspection Unit of the Ministry of Food and Agriculture at Pokuasi for testing. For every sample, germination tests were carried out on four subsamples

each of 100 seeds following International Seed Testing Association (ISTA) rules. The germination results are reported as the mean of the four sub-samples.

# COWPEA

## Cowpea in the farming systems of the Wenchi and Akatsi Districts

There is considerable contrast between the two study areas with respect to the cultivation of cowpea. Table 1 summarizes some of the principal characteristics of cowpea cultivation in the two areas. In Wenchi, cowpea is an increasingly important cash crop, grown by about 30% of the farmers. In that District, 45% of the cowpea farmers said it was their first or second most important cash crop. In Akatsi, by contrast, cowpea is more widespread. It is a source of some cash income, but is grown principally as a subsistence crop, making it an important contribution to the local diet.

Cowpea farmers in Wenchi tend to plant larger areas than those in Akatsi, although in neither area is it common to find a farmer with more than a few acres of cowpea. The area figure for Akatsi in Table 1 may be an overestimate, as farmers had difficulty in describing the size of their plots. Most cowpea farmers in Wenchi are able to plant two crops a year, to coincide with the major and minor rains. The cowpea seed that is the subject of this study was planted in March or April. Rainfall is lower and more uncertain in the southern Akatsi region, and most farmers plant cowpea only once, in June or July, often as a relay crop in their maize fields.

There was greater use of purchased inputs, particularly insecticide, for cowpea in Wenchi, partly related to the higher use of modern varieties (MVs). Wenchi cowpea farmers were also more likely to plant cowpea in rows, and less likely to plant it as an intercrop. Table 2 summarizes cowpea planting practices for the two districts.

There is also a sharp contrast between the two areas in use of varieties. Table 3 shows that almost all Wenchi cowpea farmers used MVs developed by the Crops Research Institute (CRI). Asontem, released in 1986, is the most popular. However, it is noticeable that fewer than half of the farmers who used MVs were familiar with the name of the variety they were planting. In Akatsi, most cowpea farmers used local varieties, particularly a mottled cowpea known as Avakli.

## Source of cowpea seed

Table 4 summarizes information on farmers' source of cowpea seed. The survey asked farmers to describe the source of the seed they were going to plant in 1995 as well as to recall sources of seed for the previous three years. The response in Wenchi indicated that about three-quarters of seed used was saved on-farm. The situation is quite different for Akatsi. Only a small minority of seed used in 1995 was farm-saved, and even for the past three years less than half of the cowpea seed planted by Akatsi farmers was farm-saved seed. The very low proportion of own seed for 1995 can be explained by the occurrence of a drought in the 1994 season that seriously affected cowpea production in Akatsi.

When farmers need to acquire cowpea seed off-farm they look to several sources (*see* Table 5). For both study areas, the most common source of cowpea seed is the grain market. Farmers in need of seed will often select seed from the cowpea grain being offered for sale for food in local markets. There are some grain traders who cater specifically for farmers' seed needs by selecting or reserving grain they believe to be appropriate for seed, but often farmers must simply rely on visual inspection of the grain traders' supplies. It is also possible to acquire cowpea seed from another farmer, although this appears to be more common in Wenchi than in Akatsi. In these cases, the farmer may be able to observe the cowpea growing in the neighbour's field and will thus be familiar with the agronomic characteristics of the seed crop.

A growing amount of certified cowpea seed is being produced for sale in Ghana; 30 tons were produced in 1994 for sale in 1995. Only two farmers in the Akatsi sample had purchased certified seed, but the extension service is sometimes a source of seed, particularly during 1995 in Akatsi. Extension agents sometimes sell certified seed, or buy seed from seed growers for resale.

Table 6 details the experiences of those farmers who acquired seed off-farm. In Wenchi, where farmers are familiar with MVs, the most common reason for acquiring seed off-farm is to get a fresh supply of seed of the variety that they planted the previous season. It also appears to be fairly common for farmers in both areas to prefer to acquire another variety. However, this finding is not supported by observations in the field. The most common reason for acquiring seed off-farm in Akatsi is the fact that stocks from the previous harvest had been exhausted, either because the harvest was poor or because what was harvested was sold. It should be emphasized that in Akatsi cowpea farmers generally have only one harvest in a year.

The survey also explored farmers' means of acquiring cowpea seed. Table 7 shows that in most cases, including those in which the seed source is another farmer, seed is acquired in exchange for cash, rather than by barter, gift or loan.

## Cowpea seed management

There are a wide range of methods for storing cowpea seed. Perhaps the most important point is that only a small minority of farmers provide separate storage facilities for cowpea seed; in most cases cowpea is stored as grain and seed is identified and selected close to planting time. Table 8 shows that over 80% of cowpea stored as grain or seed is threshed before storage. The information for Akatsi is deficient because so few farmers were able to store cowpea for the 1995 season. Cowpea threshed and stored in sacks, raised on some type of platform above the floor, is the most common storage method recorded.

The majority of stored cowpea receives some type of storage treatment (*see* Table 9). The insecticide Actellic (the proprietary name for pirimiphos-methyl), recommended by the extension service, is the most common treatment. About one-quarter of the cowpea is stored without any treatment.

Farmers in the survey were asked to describe past instances of damage to stored cowpea seed. Table 10 summarizes their responses, and it can be seen that the major problem they observe is insect damage (probably mostly due to bruchid beetle *Callosobruchus maculatus*). Storage problems caused by moisture and rodents were also reported.

Farmers were also asked to describe problems they had observed in cowpea seed germination in the field. Table 11 presents their responses which indicate a perception that about a quarter of the instances of poor germination were ascribed to seed quality problems. Lack of soil moisture and field pests were also perceived to reduce germination in the field.

Initial conversations with farmers in the two study areas had revealed some knowledge of local tests for seed quality. The survey asked each farmer to describe any experience with such tests. Table 12 shows that only a small minority has such experience. In some cases farmers will take a handful of suspect seed and germinate it in moist soil; in other cases farmers will place seed in a container of water and eliminate any seed that floats.

The survey revealed that very little effort was made to select seed on-farm. Because most cowpea is stored as grain, the majority of the selection for seed takes place just before planting. Table 13 shows that only two farmers in the Wenchi sample made an effort to begin seed selection while the crop was still in the field. A number of farmers reported no special effort at cowpea seed selection, especially in the Akatsi District, although it should be recalled that many farmers in Akatsi have little experience in storing cowpea for seed. As can be seen in Table 14, seed selection mostly involves looking for large, clean grain, free of insect damage.

The survey also explored the division of seed management responsibilities among male and female farmers. In the Wenchi cowpea sample, 88% of the respondents were male, probably reflecting the important cash crop status of cowpea. In the Akatsi sample, 63% of the respondents were male. Table 15 shows how cowpea farmers who are married (both male and female) divide responsibilities with their spouses. In Wenchi, male cowpea farmers generally claim to take responsibility for all seed-related duties. In Akatsi, many male farmers rely on their wives to help manage the cowpea in the field. There is also some reliance on wives for seed management, particularly for seed storage. However, it must be acknowledged that it is difficult to obtain precise information about the complexities of household allocation of responsibility through a formal questionnaire.

## Cowpea seed quality

Table 16 summarizes the results of laboratory germination tests on the cowpea samples. Results are available for all 60 Wenchi farmers and 56 of the Akatsi farmers. The mean germination rate for Wenchi was 65.7% and for Akatsi 70.3%. The Ministry of Food and Agriculture sets an acceptable standard of 75% germination for cowpea. If the seed samples are assessed against this figure then it can be seen that more than half of the samples may be judged inadequate. Of particular concern is the fact that almost one-quarter of the Wenchi sample is below 50% germination rate.

However, it is relatively difficult to find clear correlation with the inadequate seed quality. Table 17 is a summary of an exploration of seed characteristics that might be associated with seed quality. There is no significant difference between the quality of home-saved seed and that acquired off-farm. For the latter, no particular source of seed is distinguished as particularly inadequate, although seed obtained from other farmers has the lowest germination potential. Farmers had been asked to recall the conditions of seed harvest for farm-stored seed, and in Akatsi two instances of damage (from insects) at harvest were associated with low germination rate. No such correlation was found for Wenchi.

In Akatsi, one sample of seed that was stored unthreshed had a particularly low germination rate, but no other relationship was found between either storage method or storage treatment and seed quality. The lack of correlation between the use of storage chemicals and seed quality is not surprising considering the fact that chemicals are often applied only after an infestation problem is detected. No significant relationship was found between the harvest time of home-stored seed and its germination rate.

In Table 18 some characteristics of the cowpea farmers are examined. Male and female cowpea farmers seem to have seed of comparable quality. Farmers who know how to test for seed quality do not have better seed; indeed in the Akatsi District there is a tendency for those farmers to have lower quality seed. Possibly the act of germination testing is an indication that there are doubts concerning seed viability. There is also a tendency for farmers who have lower quality home-stored seed to plant more seed per hill. Whether or not this is a conscious compensation based on farmer observation or suspicion about the quality of their farm-stored seed is not known.

There is no relationship between the area planted to cowpea or the amount of cowpea harvested in 1994 to seed quality, indicating that all economic classes of cowpea farmer are likely to suffer from inadequate seed quality.

# MAIZE

## Maize in the farming systems of the Wenchi and Akatsi Districts

Maize is an important crop in both Wenchi and Akatsi. As Table 19 indicates, it is particularly important as a cash crop in Wenchi, where the local diet is based more on root crops. In Akatsi, in contrast, maize is an important item of local diet. Maize fields in Wenchi are significantly larger than those in Akatsi, and the use of external inputs, particularly chemical fertilizer, is higher, although recent increases in fertilizer price have caused a decline in fertilizer use throughout Ghana. In both areas farmers usually plant two maize crops a year. The major season planting, the subject of this study, was undertaken in March or April in Wenchi and in April in Akatsi.

About half of the maize in Wenchi, and the vast majority in Akatsi, is planted as an intercrop, most commonly with cassava (*see* Table 20). In both study areas, the majority of the maize is planted randomly.

Farmers in Wenchi have long experience with MVs, and Table 21 details the types of maize varieties that they grow. CRI has developed a number of maize MVs that are widely grown throughout Ghana. They are not hybrids, but rather open-pollinated varieties (OPVs); hence farmers can save seed from season to season. The most commonly grown variety in the study villages is Okomasa. Slightly more than half of the maize varieties planted in the Akatsi area in 1995 were MVs, although often very old varieties.

## Source of maize seed

For the 1995 major season, 90% of the Wenchi farmers and 62% of the Akatsi farmers used farm-saved seed (*see* Table 22). In previous years, about three-quarters of maize seed had been farm-saved in both areas. Commercial seed sources are slightly more common than for cowpea (*see* Table 23), but

in contrast to the situation with cowpea the most common off-farm source of maize seed in both areas is another farmer. Grain markets, extension staff and the formal sector are other less frequented sources of supply.

The most common reason for acquiring seed off-farm in Wenchi has been to get another variety (*see* Table 24). Farmers who plant MVs tend to recycle the seed for many seasons. It is unclear how this practice affects the genetic purity of the OPVs. Farmers tend to get fresh seed only when they are looking for a new variety. In Akatsi, on the other hand, the most common reason is that all farm-saved maize has been consumed. In neither area is the replacement of damaged seed a common reason for acquiring seed off-farm.

Although the majority of instances of seed acquisition involve purchase for cash, the prevalence of gifts of maize seed is much higher in both areas than it is for cowpea (*see* Table 25).

## Maize seed management

Approximately 15% of farmers stored or treated seed maize separately from grain maize (*see* Table 26); this is an even smaller proportion than for cowpea. In Wenchi, most maize is stored on the cob in a barn. In Akatsi, the most common methods of storage are as cobs heaped on the floor or as cobs in a barn. In the few instances when maize is selected for seed before storage it is often stored in the same manner as the maize for consumption. In a few instances, seed maize is selected, shelled and stored in bags (Wenchi) or the selected cobs are hung from the ceiling or over the cooking fire.

Only about half of stored maize receives any type of treatment (*see* Table 27). Actellic is the single most common insecticide used in Wenchi, but a number of other insecticides not intended for maize storage are also used. Four farmers in Wenchi used wood ash; one did so in combination with insecticide. In Akatsi several farmers in the sample reported using neem leaves or neem extract for protecting stored maize.

When farmers were asked to recall past instances of damage to maize seed, storage insects (including weevils and termites) were the most common response, particularly in Wenchi (*see* Table 28). The Larger Grain Borer (*Prostephanus truncatus*), a recently introduced serious pest of maize in Ghana, was not mentioned by farmers in either study area. Seed quality was perceived as a problem in establishing adequate plant stands by approximately 10% of respondents, but Table 29 shows that several other factors, namely insects, birds, rodents, millipedes and lack of soil moisture are also perceived as important constraints. Most of the seed analysed was stored over the dry season, so seed with too high a moisture content would not be expected to be a major problem.

Table 30 shows that a few maize farmers in Wenchi have experience with doing a simple germination test, while relatively more farmers in Akatsi (34%) have either done a germination test or examined seed quality by placing seeds in water and eliminating those that float.

When maize seed is selected, farmers have several strategies with respect to which part of the cob is used (*see* Table 31). A number of farmers use all the seed from the cob, while others may use all but the tip of the cob, and a significant number use only the middle portion. Grains at the tip of the cob are often not mature, and are also more likely to carry disease or be damaged by insects.

Most maize seed is selected shortly before planting. Table 32 shows that only two farmers, in Wenchi, report any type of maize seed selection in the field. Some maize is selected before storage, or during storage, but the vast majority is selected from the maize that remains for consumption before planting.

Table 33 shows that cob characteristics rather than grain characteristics are used in selecting seed, and large, weevil-free cobs are chosen for seed maize. This practice certainly contributes to the selection for resistance to storage pests.

Of the maize farmers in the survey, 50% in the Akatsi sample and 22% in the Wenchi sample are female. Table 34 shows how married farmers divide responsibilities for seed management. In Wenchi, about one-third of wives work in their husbands' maize fields, but only a few have any responsibility for variety choice or seed selection. A somewhat higher proportion participate in seed storage, but it should be recalled that in the majority of cases this is synonymous with grain storage. In Akatsi, almost one-half of wives work in their husbands' maize fields. Husbands have predominant responsibility for variety choice, but wives have more participation in seed selection and especially seed storage. It is interesting to note that in Akatsi the husbands seem to play a major role in variety choice for wives' maize fields as well, perhaps because they are responsible for providing seed.

## Maize seed quality

Seed samples from 60 farmers in Wenchi and 59 farmers in Akatsi were tested in the laboratory. The results are summarized in Table 35. The mean germination rate for the Wenchi samples was 95.7%, and only three samples had germination rates of lower than 80%. For Akatsi the mean was 87.0% and six samples had germination rates below 60%. The Ministry of Food and Agriculture sets an acceptable standard of 85% germination for maize. If the samples are assessed against this figure then it can be seen that 5% of the Wenchi samples and 24% of the Akatsi samples fall below this level.

Table 36 relates the characteristics of the sample maize seed to germination rate. For Akatsi, there is a clear difference between farm-stored and off-farm seed, with the latter showing significantly lower germination rates. Seed acquired from other farmers and, perhaps surprisingly, from commercial sources, was of lowest quality. No such distinction between on-farm and off-farm seed sources is evident for Wenchi, although one seed sample acquired by a farmer from an extension agent had unacceptable germination.

Farmers' recollection of seed damage at harvest time did not have any relation to seed quality. An examination of the various storage techniques revealed no significant differences in seed quality among them. In Wenchi, maize seed that was stored with unknown or non-recommended chemicals had lower germination rates, but even here the average was above 90%. Although it is generally considered best not to use grain from the tip of the cob as seed, such seed does not show significantly lower germination rates.

There is a relation between older seed and lower germination rate in Akatsi, due mostly to two seed samples that were saved from the previous major season harvest and which had low germination rates.

In Table 37, maize farmer characteristics in relation to seed quality are examined. There is no significant difference between male and female farmers with respect to their seed quality. Those farmers who know how to test

seed are no more likely to have better seed; the tendency is actually for the opposite to be the case. This possibly indicates that those farmers have farmers have conscious doubts concerning the viability of their seed.

Unlike cowpea, there is no relationship in maize between seed germination rate and the number of seeds per hill that the farmer reports planting. There is a slight tendency in the Akatsi District for farmers with larger maize acreage to have better quality seed, but no other relationships between a farmer's economic status and seed quality were found.

# MILLET AND SORGHUM

## Millet and sorghum in the farming systems of the Upper East Region

Pearl millet and sorghum are the principal grain staples for farmers of the Upper East Region. The crops are planted when the single rainy season begins, usually in April or May. Millet and sorghum are planted on fields close to the homestead (compound farms) as well as on more distant fields. They are often intercropped with cowpea or groundnut.

Both early- and late-maturing types of millet are planted. Virtually all of the millet and sorghum used by farmers are local varieties. The fields may be prepared by ox plough, by hand, or, in a minority of instances, by tractor. Very little chemical fertilizer is used, although the compound farms benefit from the application of farmyard manure. No other chemical inputs are used in millet or sorghum production.

The Upper East Region is a food deficit area, and the millet and sorghum produced here are mostly for home consumption. Few farmers market any appreciable amount of these crops.

A preliminary analysis of the survey is reported. The quantitative figures are only approximate, but provide interesting points of comparison with the results obtained in southern Ghana.

## Source of millet and sorghum seed

Although the majority of farmers used seed of millet and sorghum stored on-farm for the 1995 planting season, a significant number (32% for millet and 44% for sorghum) used off-farm sources. Comparison with responses for the three previous years shows almost exactly the same proportion of farmers relying on external seed sources. When asked why they had to look for seed off-farm, the most common response by farmers was that there was an inadequate harvest the previous year.

Most farmers who obtained seed off-farm in 1995 reported that they used the grain market to obtain seed (56% for millet and 84% for sorghum). The second most common source was other farmers. This degree of dependence on the market (as opposed to neighbouring farmers) is not as high for reports from the previous three years (32% millet and 43% sorghum). Nevertheless, there is a relatively high dependence on the grain market as a source of seed.

## Millet and sorghum seed management

The majority of farmers reported selecting millet and sorghum seed before storage. Many farmers say they do at least some seed selection in the field. This contrasts strongly with the maize and cowpea farmers of the south who do relatively little seed selection before storage. Most of the seed is stored on the head, unthreshed. Many farmers report mixing ash with stored seed.

A variety of methods are used for seed storage. The most common are raised barns, storage on the floor of a compound, and the use of sealed clay pots.

Only a few farmers report any experience with germination tests for their seed. Many wives share field management responsibilities with their husbands, but a smaller proportion of wives are reported to have seed selection or storage responsibilities.

## Millet and sorghum seed quality

In Ghana an acceptable germination rate for both millet and sorghum seed is 70%. Using this standard, most of the seed collected and analysed as part of the survey is acceptable. Nevertheless, 10 (19%) of the millet seed samples examined in the laboratory, and 6 (7%) of the sorghum seed samples were judged to be inadequate. There would thus appear to be relatively more problems with millet than with sorghum. Half of the inadequate millet samples, but none of the sorghum samples, were below 50% germination.

The proportions of seed samples with low germination rates from on and off-farm sources, respectively, are equivalent to the proportion in the entire sample, so it is not possible to identify particular seed sources as being a problem. The preliminary survey analysis shows no obvious correlation between types of seed management and low germination.

# CONCLUSIONS

## The general status of seed quality

The seed quality of two important Ghanaian grain crops was assessed in this study. Most maize is saved by the farmer from one season to the next and the results are quite encouraging. The high germination rates found in the study confirm results from the nation-wide study carried out earlier (Wright *et al.*, 1995). In Wenchi, there were few cases of inadequate maize seed quality. In the majority of cases, maize farmers in southern Ghana plant two crops a year and thus the period of seed storage is relatively short. However, seed acquired off-farm in the Akatsi sample was of a lower standard than farm-saved seed, and 52% of samples in this area did not reach the threshold germination standard. *Inter alia*, this possibly reflects the difference in climate, Akatsi being more humid than Wenchi.

For cowpea, the conclusions are somewhat different. Seed quality is more difficult for farmers to maintain for cowpea than for maize; cowpea is affected by more storage insect damage, and in Akatsi a single planting season means that the seed is stored for about nine months. Most cowpea seed in Wenchi is stored on the farm, in contrast to Akatsi, where fewer than half of the farmers saved seed. The reasons given by Akatsi farmers included problems from poor harvests and difficulties caused by insect infestation.

The mean germination rates found in the two study areas (66% and 70%, respectively) give some concern. These rates are considerably lower than the mean rate of 78% found in the nation-wide study of cowpea seed (Wright *et al.*, 1995). It is not clear why this should be so. The nation-wide study included only farm-saved seed, but in the present study there was no evidence that farm-saved cowpea seed was of better quality than that acquired off-farm. The present study analyses a random sample of the seed that farmers have available at planting time, and may provide a more accurate picture of the status of seed quality.

The majority of cowpea farmers have seed of adequate germination, but a significant number (52% in Akatsi) of farmers are using seed of unacceptable quality and are certainly experiencing some loss of productivity because of this. The most common means of compensating for low germination rates is to plant extra seed which is, within certain limits, a cost-effective strategy. However, if insufficient seeds are planted to obtain the required plant population it will be necessary to replant, assuming more seed is available. If too many viable seeds are planted it might be necessary to thin the stand. Either eventuality would incur additional labour costs. Even if farmers could be guaranteed seed of excellent quality, they might still tend to plant extra seed because of several climatic and biotic factors that affect plant stand establishment in Ghana.

The preliminary results on sorghum and millet show that the majority of seed used by farmers in the Upper East Region has adequate germination rates for those crops.

## Farmer seed management

One of the most striking conclusions to emerge from this study is the lack of attention paid to seed management by the majority of farmers. Although previous studies have reported that at least half of the maize farmers (Ghana Grains Development Project, 1991, Wright *et al.*, 1995) and cowpea farmers (Wright *et al.*, 1995) select seed before storage, the results of this study show such farmers to be a distinct minority. Differences between the results of this study and previous ones need to be examined, but the present survey provided a more in-depth look at seed management practices than did the other studies. The contrast with millet and sorghum seed management in Bawku is evident; farmers there are more likely to devote effort to seed selection before storage.

Selection of maize and cowpea seed in the field was rarely reported in this study, and only limited selection takes place before or during storage. This would have the effect of selecting for good storage characteristics.

Three-quarters of cowpea farmers and nearly half of the maize farmers use recommended storage chemicals, but many use inappropriate products intended for other uses. There is relatively low use of traditional storage substances such as wood ash or neem leaves. A minority of farmers have experience of testing seed quality before planting. The highest incidence was in Akatsi where 20% have tested cowpea seed and 34% have tested maize seed. However, those who have done so do not have seed of better quality.

Most maize and cowpea seed is stored with the rest of the crop and storage techniques and practices vary widely even within a single village. Cowpea is commonly stored threshed in sacks and maize is mostly stored on the cob in barns or stores. Nevertheless, in any farming community there is a

range of seed storage techniques. Seed storage is not a common topic of discussion, and because it takes place within the house there are relatively few opportunities for farmers to learn from the practices of others.

There is not much evidence of careful seed selection to preserve or improve the characteristics of varieties that farmers are growing. For both maize and cowpea the majority of the sample farmers report growing only a single variety, which may be a local variety or an MV. Previous surveys on cowpea practices (Dankyi and Dakurah, 1993) and maize practices (Tripp *et al.*, 1987, Ghana Grain Development Project, 1991) have shown that farmers are able to articulate specific reasons for preferring or rejecting particular varieties. In the current study, farmers were able to list a number of positive and negative characteristics of local maize and cowpea varieties. Nevertheless, almost no seed selection takes place in the field, and seed selection criteria at planting time are mostly confined to the size and freedom from insect damage of the cowpea grain or the maize cob. Additionally, there was no consensus as to which portion of the maize cob provides the best seeds.

## Strategies for improving seed quality

Although the study has demonstrated a fairly wide range of seed quality, and has described a great variety of seed management techniques practised by the farmers, there are few clear relationships that emerge. Although some farmer seed is obviously of inadequate quality, it is difficult to identify causal factors to explain these differences. There are a few statistical relationships between seed or farmer characteristics and seed quality for particular study areas or crops, but there is no overall relationship that is sufficiently consistent or strong to be used as a basis for improving farmer seed quality. However, the frequent use of storage protectants highlights the threat of insect infestation. Although inadequate seed quality is not a pervasive problem for the crops examined in this study, it does represent a risk for loss in farm productivity, and is a problem that farmers have difficulty recognizing. The causes of the inadequate seed quality are not likely to be easy to pinpoint; they may derive from a shifting combination of physical, biotic and climatic factors that affect stored seed in the environment that Ghanaian farmers must confront. However, there are certain basic problems, such as insect damage in cowpea, that deserve particular attention. In addition, extension advice could help farmers appreciate general principles of seed management on the farm.

The national extension service appears to have no effective strategy for improving seed management, nor is there a specific seed storage 'message'. The period after the main harvest is often used by extension agents for leave or for in-service training, further lowering the chances of useful interaction between farmers and extension agents regarding seed management issues.

Extension strategies for improving seed management will have to be addressed to all farmers. The results of the present study revealed that both men and women may be maize or cowpea farmers, and that they may or may not share seed management reponsibilities with their spouses. Variety and seed selection and seed storage are so closely associated with other farm household activities that extension programmes to improve seed management must address all adult household members.

## The broader seed system

In addition to focusing messages on the improvement of seed management at the household, rather than individual farmer level, it is also important to take cognisance of the broader seed system. We cannot assume that all seed is home-stored. In the millet and sorghum study a significant proportion of seed was acquired off-farm. This survey showed that about one-quarter of the maize seed in both areas, one-quarter of the cowpea seed in Wenchi and one-half of the cowpea seed in Akatsi is obtained off-farm. The most common reasons for doing so are to look for a new variety, to get fresh seed of the current variety, and to obtain seed after the home-stored grain supply has been exhausted. The proportions of farmers seeking another variety were higher than expected. In only a minority of the cases do farmers go to commercial sources or to an extension agent for this seed. Even in these instances, the limited evidence from the survey shows that this does not guarantee adequate seed quality.

For cowpea the grain market is a particularly important source of seed, and this is consistent with results from previous surveys (Dankyi and Dakurah, 1993). Any programmes aimed at providing better cowpea varieties and better quality seed to farmers will have to take account of the importance of cowpea grain markets. In contrast, the most common source of maize seed is another farmer, and again this is consistent with other surveys (Ghana Grains Development Project, 1991). The fact that farmers tend to rely on neighbours rather than the formal market for maize seed, and the consequences of farmer maize variety maintenance, both deserve further attention.

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# Appendix

## TABLES

**Table 1** Cowpea cultivation practices

| | Wenchi | Akatsi |
|---|---|---|
| Proportion of farmers who grow the crop (estimated) | 30% | 80% |
| Principal use | cash/subsistence | subsistence/cash |
| Mean area of cowpea cultivation | 1.9 acres | 1.2 acres* |
| Most common varieties | MVs (95%) | local varieties (86%) |
| Use of insecticide in field | 92% | 27% |
| Number of growing seasons per year | 2 | 1 |
| Cowpea as first or second most important cash crop | 45% | 2% |

**Note:** * some farmers had difficulty in describing the sizes of their plots, hence this might be an overestimate

**Table 2** Cowpea plant population management

| | Wenchi | Akatsi |
|---|---|---|
| Farmers who intercrop | 4 (7%) | 26 (44%) |
| Farmers who plant in rows | 58 (97%) | 20 (34%) |
| Median distance between rows | 61 cm | 60 cm |
| Median distance between plants | 25 cm | 20 cm |
| Farmers who plant randomly | 2 (3%) | 39 (66%) |
| Median distance between plants | 81 cm | 67 cm |
| Number of seeds per hill | | |
| 2 | 3 (5%) | 17 (30%) |
| 2-3 | 24 (40%) | 8 (14%) |
| 3 | 20 (33%) | 29 (52%) |
| 3-4 | 11 (18%) | 2 (4%) |
| 4+ | 2 (3%) | 0 (0%) |

**Table 3** Principal varieties of cowpea planted in the 1995 major season

| | Wenchi | Akatsi |
|---|---|---|
| **Modern varieties** | (57) | (8) |
| Bengpla | 0 | 8 |
| Asontem | 28 | 0 |
| 'Agric red'** | 16 | 0 |
| 'Agric white'*** | 4 | 0 |
| 'Agric brown'**** | 3 | 0 |
| 'Agric'* | 6 | 0 |
| **Local varieties** | (3) | (51) |
| Local red | 1 | 0 |
| Local white | 2 | 0 |
| Local black | 0 | 3 |
| Local | 0 | 2 |
| Avakli | 0 | 46 |
| **Total** | (60) | (59) |

**Notes:** * 'Agric' is a general term used by farmers to describe MVs
** 'Agric red' is mostly Asontem
*** 'Agric white' is mostly Bengpla
**** 'Agric brown' is mostly Ayiyi

Figures in parentheses indicate the number of farmer responses.

**Table 4** Source of cowpea seed

| | Wenchi | | Akatsi* | |
|---|---|---|---|---|
| | 1995 | 1992-94 | 1995 | 1992-94 |
| On-farm | 44 (73%) | 214 (76%) | 10 (17%) | 68 (48%) |
| Off-farm | 16 (27%) | 69 (24%) | 49 (83%) | 73 (52%) |
| **Total** | 60 (100%) | 283 (100%) | 59 (100%) | 141 (100%) |

**Note:** * major season only

**Table 5** Source of cowpea seed acquired off-farm

| | Wenchi | | Akatsi* | |
|---|---|---|---|---|
| | 1995 | 1992-94 | 1995 | 1992-94 |
| Packaged, certified seed | 0 (0%) | 0 (0%) | 2 (4%) | 0 (0%) |
| Grain market | 9 (56%) | 39 (57%) | 28 (57%) | 55 (75%) |
| Extension | 3 (19%) | 7 (10%) | 14 (29%) | 12 (16%) |
| Another farmer | 4 (25%) | 23 (33%) | 5 (10%) | 6 (8%) |
| **Total** | 16 (100%) | 69 (100%) | 49 (100%) | 73 (99%) |

**Note:** * major season only

**Table 6** Reasons for acquiring cowpea seed off-farm

| | Wenchi | | Akatsi* | |
|---|---|---|---|---|
| | 1995 | 1992-94 | 1995 | 1992-94 |
| **Seed replacement** | | | | |
| To get new variety | 3 (19%) | 41 (59%) | 13 (27%) | 13 (18%) |
| To get fresh seed | 7 (44%) | 23 (33%) | 12 (24%) | 17 (24%) |
| **Seed shortage** | | | | |
| To replace damaged seed | 0 (0%) | 3 (4%) | 1 (2%) | 2 (3%) |
| Poor previous harvest | 0 (0%) | 0 (0%) | 14 (29%) | 9 (13%) |
| Sold previous harvest | 2 (13%) | 2 (3%) | 9 (18%) | 31 (43%) |
| Consumed previous harvest | 4 (25%) | 0 (0%) | 0 (0%) | 0 (0%) |
| **Total** | 16 (101%) | 69 (99%) | 49 (100%) | 72 (101%) |

**Note:** * major season only

**Table 7** How 1995 cowpea seed was originally acquired

| | Wenchi | Akatsi |
|---|---|---|
| Purchase | 57 (95%) | 48 (81%) |
| Gift | 3 (5%) | 5 (8%) |
| Other | 0 (0%) | 6 (10%) |
| **Total** | 60 (100%) | 59 (99%) |

**Table 8** Cowpea seed storage

| | Wenchi | | Akatsi | |
|---|---|---|---|---|
| Storage method | Seed stored as grain | Seed stored separately | Seed stored as grain | Seed stored separately |
| Threshed, in sack kept above floor | 27 (77%) | 7 (73%) | 3 (43%) | 1 (25%) |
| Threshed, in clay pot | 4 (11%) | 2 (22%) | 0 (0%) | 1 (25%) |
| Threshed, in bottle or jug | 0 (0%) | 0 (0%) | 2 (29%) | 2 (50%) |
| Unthreshed, in sack, kept raised off floor | 3 (9%) | 0 (0%) | 1 (14%) | 0 (0%) |
| Unthreshed, in sack on floor | 1 (3%) | 0 (0%) | 1 (14%) | 0 (0%) |
| **Total** | 35 (100%) | 9 (100%) | 7 (100%) | 4 (100%) |

**Table 9** Cowpea seed treatment

| | Wenchi | | Akatsi | |
|---|---|---|---|---|
| | Seed stored as grain | Seed stored separately | Seed stored as grain | Seed stored separately |
| Actellic* | 18 (51%) | 4 (45%) | 3 (42%) | 1 (25%) |
| Various insecticides, unspecified | 3 (9%) | 1 (11%) | 0 (0%) | 0 (0%) |
| Phostoxin** | 1 (3%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Naphthalene | 0 (0%) | 0 (0%) | 2 (29%) | 2 (50%) |
| Wood ash | 2 (6%) | 3 (33%) | 0 (0%) | 1 (25%) |
| Nothing | 11 (31%) | 1 (11%) | 2 (29%) | 0 (0%) |
| **Total** | 35 (100%) | 9 (100%) | 7 (100%) | 4 (100%) |

**Notes:** * proprietary name for pirimiphos-methyl
** proprietary name for phosphine fumigant

**Table 10** Reports of agents that have previously caused cowpea seed damage

| | Wenchi | Akatsi |
|---|---|---|
| Insects | 17 (28%) | 12 (20%) |
| Rodents | 1 (2%) | 5 (8%) |
| Moisture/mould | 6 (10%) | 1 (2%) |
| No damage | 36 (60%) | 41 (69%) |
| **Total** | 60 | 59 |

**Table 11** Reports of past problems* with cowpea seed germination

| | Wenchi | Akatsi |
|---|---|---|
| Seed quality | 24 (26%) | 14 (25%) |
| Lack of soil moisture | 25 (27%) | 10 (18%) |
| Birds | 12 (13%) | 1 (2%) |
| Termites | 8 (9%) | 14 (25%) |
| Insects | 16 (17%) | 2 (4%) |
| Rodents | 7 (8%) | 9 (16%) |
| Millipedes | 0 | 6 (11%) |
| **Total** | 92 | 56 |

**Note:** * two problems possible

**Table 12** Experience with seed testing for cowpea

| | Wenchi | Akatsi |
|---|---|---|
| No experience | 53 (88%) | 49 (83%) |
| Germinating seeds in soil | 6 (10%) | 5 (8%) |
| Eliminating seeds that float in water | 1 (2%) | 5 (8%) |
| **Total** | 60 (100%) | 59 (99%) |

**Table 13** Times of cowpea seed selection activities

| | Wenchi* (N=60) | Akatsi* (N=59) |
|---|---|---|
| In field | 2 (4%) | 0 (0%) |
| Before storage | 5 (11%) | 8 (14%) |
| During storage | 0 (0%) | 2 (3%) |
| Before planting | 45 (75%) | 16 (27%) |

**Note:** * sum less than 100% because not all farmers report seed selection activities

**Table 14** Criteria used in cowpea seed selection

| | Wenchi | Akatsi |
|---|---|---|
| Large grain | 32 (62%) | 10 (42%) |
| No insect damage | 12 (23%) | 0 (0%) |
| Seed appearance (clean or no cracks or wrinkles) | 7 (13%) | 14 (58%) |
| No mould damage | 1 (2%) | 0 (0%) |
| **Total** | 52 (100%) | 24 (100%) |

**Note:** * not all farmers report seed selection criteria

**Table 15** Cowpea farming responsibilities, by gender (Responses of married farmers only)

| | Wenchi | | | Akatsi | | |
|---|---|---|---|---|---|---|
| Operation | Farmer alone | Spouse alone | Shared | Farmer alone | Spouse alone | Shared |
| **Male farmers** | | | | | | |
| Manage field | 36 | 0 | 5 | 13 | 0 | 21 |
| Variety choice | 40 | 2 | 0 | 26 | 4 | 4 |
| Seed selection | 39 | 3 | 0 | 25 | 4 | 4 |
| Seed storage | 39 | 2 | 1 | 14 | 8 | 6 |
| **Female farmers** | | | | | | |
| Manage field | 5 | 0 | 2 | 13 | 0 | 5 |
| Variety choice | 4 | 2 | 1 | 17 | 1 | 1 |
| Seed selection | 4 | 2 | 1 | 18 | 0 | 1 |
| Seed storage | 4 | 2 | 1 | 16 | 0 | 2 |

**Note:** * not all farmers report responsibilities by gender

**Table 16** Germination rates of cowpea seed samples

| | Wenchi | Akatsi |
|---|---|---|
| 90-99% | 8 | 1 |
| 80-89% | 15 | 15 |
| 70-79% | 8 | 19 |
| 60-69% | 8 | 12 |
| 50-59% | 7 | 5 |
| 40-49% | 2 | 2 |
| 30-39% | 4 | 1 |
| 20-29% | 7 | 0 |
| 10-19% | 1 | 1 |
| **Total** | 60 | 56 |
| **Mean germination rate** | 65.7% | 70.3% |
| Proportion of seed samples below 75% germination | 50% | 54% |

**Note:** * some samples were too badly damaged by moulds to be tested

**Table 17** Cowpea seed characteristics and germination rate

| | Wenchi | | | Akatsi | | |
|---|---|---|---|---|---|---|
| | (N) | Germination (%) | Sig.* | (N) | Germination (%) | Sig.* |
| Source | | | | | | |
| Home | (44) | 65.4 | NS | (9) | 66.0 | NS |
| Off-farm | (16) | 66.4 | | (47) | 71.1 | |
| Source off-farm | | | | | | |
| Formal | (0) | – | NS | (2) | 68.5 | NS |
| Grain market | (9) | 67.3 | | (27) | 73.0 | |
| Extension | (3) | 80.0 | | (13) | 70.5 | |
| Another farmer | (4) | 54.0 | | (5) | 63.2 | |
| Seed damaged at harvest | | | | | | |
| Yes | (8) | 68.2 | NS | (2) | 46.5 | <.01 |
| No | (36) | 62.3 | | (7) | 71.6 | |
| Storage method | | | | | | |
| Unthreshed | (4) | 73.0 | NS | (1) | 36.0 | <.01 |
| Threshed | (40) | 64.7 | | (8) | 64.8 | |
| Storage substance | | | | | | |
| Actellic | (22) | 66.1 | NS | (4) | 74.0 | NS |
| Other substances | (10) | 69.8 | | (4) | 65.5 | |
| Nothing | (12) | 60.5 | | (1) | 70.3 | |
| Age of seed (for home stored) | | | | | | |
| Correlation coefficient | | -.03 | NS | | -.11 | NS |

**Note:** * significance of one-way ANOVA or correlation coefficient

**Table 18** Cowpea farmer characteristics and germination rate

| Characteristic | Wenchi (N) | Wenchi Germination % | Wenchi Sig.* | Akatsi (N) | Akatsi Germination % | Akatsi Sig.* |
|---|---|---|---|---|---|---|
| Farmer gender | | | | | | |
| Male | (53) | 65.3 | NS | (35) | 71.3 | NS |
| Female | (7) | 68.7 | | (21) | 68.5 | |
| Knows how to test seed | | | | | | |
| Yes | (7) | 65.1 | NS | (10) | 63.2 | <.1 |
| No | (53) | 65.7 | | (46) | 71.8 | |
| Seeds per hill (all seed) | | | | | | |
| Correlation coefficient | | −.188 | NS | | −.162 | NS |
| Seeds per hill (home-stored) | | | | | | |
| Correlation coefficient | | −.329 | <.05 | | −.546 | <.15 |
| Area planted to cowpea | | | | | | |
| Correlation coefficient | | −.023 | NS | | +.120 | NS |
| Bags of cowpea harvested in 1994 | | | | | | |
| Correlation coefficient | | −.018 | NS | | −.050 | NS |

**Note:** * significance of one-way ANOVA or correlation coefficient

**Table 19** Maize cultivation practices

| | Wenchi | Akatsi |
|---|---|---|
| Proportion of farmers who grow the crop (estimated) | 90% | 95% |
| Principal use | cash/subsistence | subsistence/cash |
| Mean area of maize cultivation | 6.5 acres | 2.0 acres* |
| Most common varieties | MVs (72%) | MVs (53%) |
| Use of fertilizer | 27% | 7% |
| Number of growing seasons per year | 2 | 2 |
| Maize as first or second most important cash crop | 60% | 12% |

**Note:** * mostly as an intercrop

**Table 20** Maize plant population management

| | Wenchi | Akatsi |
|---|---|---|
| Farmers who intercrop | 31 (52%) | 52 (87%) |
| Farmers who plant in rows | 23 (38%) | 16 (27%) |
| Median distance between rows | 76 cm | 71 cm |
| Median distance between plants | 43 cm | 60 cm |
| Farmers who plant randomly | 37 (62%) | 44 (73%) |
| Median distance between plants | 90 cm | 75 cm |
| Number of seeds per hill | | |
| 2 | 2 (3%) | 0 |
| 2-3 | 13 (22%) | 8 (14%) |
| 3 | 12 (20%) | 36 (61%) |
| 3-4 | 26 (43%) | 6 (10%) |
| 4 | 3 (5%) | 9 (15%) |

**Table 21** Principal varieties of maize planted in the 1995 major season

| | Wenchi | Akatsi |
|---|---|---|
| **MVs (and year of release)** | (43) | (32) |
| Late-maturing (120 days) | | |
| Okomasa (1988) | 24 | 2 |
| La Posta (1970) | 1 | 5 |
| Obatanpa (1992) | 1 | 2 |
| Medium-maturing (105-110 days) | | |
| Ableehi (1990) | 6 | 1 |
| Dobidi (1984) | 2 | 1 |
| Early maturing (95 days) | | |
| Safita (1984) | 0 | 9 |
| Dorke (1990) | 4 | 0 |
| Unidentified | | |
| 'Agric'* | 5 | 8 |
| 'Tuxpeño'* | 0 | 4 |
| **Local varieties** | (16) | (28) |
| Appiah | 13 | 0 |
| Ateaa | 3 | 0 |
| '2 month' | 0 | 13 |
| '3 month' | 0 | 6 |
| Other local | 0 | 9 |
| **Unidentified variety** | 1 | 0 |
| **Total** | 60 | 60 |

**Note:** * names given by farmers to MVs

**Table 22** Source of maize seed

| | Wenchi | | Akatsi | |
|---|---|---|---|---|
| | 1995 | 1992-94 | 1995 | 1992-94 |
| On-farm | 54 (90%) | 255 (78%) | 37 (62%) | 249 (76%) |
| Off-farm | 6 (10%) | 71 (22%) | 23 (38%) | 80 (24%) |
| **Total** | 60 (100%) | 326 (100%) | 60 (100%) | 329 (100%) |

**Table 23** Source of maize seed acquired off-farm

| | Wenchi | | Akatsi | |
|---|---|---|---|---|
| | 1995 | 1992-94 | 1995 | 1992-94 |
| Package, certified seed | 1 (17%) | 11 (15%) | 2 (9%) | 14 (18%) |
| Grain market | 1 (17%) | 1 (1%) | 4 (17%) | 16 (20%) |
| Extension | 1 (17%) | 19 (27%) | 3 (13%) | 1 (1%) |
| Another farmer | 3 (50%) | 40 (56%) | 14 (61%) | 49 (61%) |
| **Total** | 6 (101%) | 71 (99%) | 23 (100%) | 80 (100%) |

**Table 24** Reason for acquiring maize seed off-farm

| | Wenchi | | Akatsi | |
|---|---|---|---|---|
| | 1995 | 1992-94 | 1995 | 1992-94 |
| **Seed replacement** | | | | |
| To get new variety | 1 (17%) | 52 (76%) | 5 (22%) | 11 (14%) |
| To get fresh seed | 1 (17%) | 12 (18%) | 5 (22%) | 19 (24%) |
| **Seed shortage** | | | | |
| To replace damaged seed | 1 (17%) | 3 (4%) | 1 (4%) | 0 (0%) |
| Poor previous harvest | 1 (17%) | 0 (0%) | 3 (13%) | 1 (1%) |
| Sold previous harvest | 2 (33%) | 1 (1%) | 0 (0%) | 0 (0%) |
| Consumed previous harvest | 0 (0%) | 0 (0%) | 9 (39%) | 48 (61%) |
| **Total** | 6 (101%) | 68 (99%) | 23 (100%) | 79 (100%) |

**Table 25** How 1995 maize seed was originally acquired

| | Wenchi | Akatsi |
|---|---|---|
| Purchase | 35 (58%) | 40 (67%) |
| Gift | 22 (37%) | 16 (27%) |
| Other | 3 (5%) | 4 (7%) |
| **Total** | 60 (100%) | 60 (101%) |

**Table 26** Maize seed storage

| | Wenchi | | Akatsi | |
|---|---|---|---|---|
| Storage method | Seed stored as grain | Seed stored separately | Seed stored as grain | Seed stored separately |
| In barn located in field | 23 (51%) | 2 | 2 (6%) | 0 |
| In barn located in compound | 7 (16%) | 0 | 13 (39%) | 0 |
| Heaped as loose cobs, above floor | 5 (11%) | 1 | 2 (6%) | 2 |
| Heaped as loose cobs, on floor | 10 (22%) | 1 | 14 (42%) | 3 |
| Shelled, in sacks | 0 | 3 | 0 | 0 |
| Hung over fire | 0 | 0 | 0 | 1 |
| Hung from ceiling | 0 | 2 | 2 (6%) | 0 |
| **Total** | 45 (100%) | 9 | 33 (99%) | 6 |

**Table 27** Maize seed treatment

| Substance | Wenchi | | Akatsi | |
|---|---|---|---|---|
| | Seed stored as grain | Seed stored separately | Seed stored as grain | Seed stored separately |
| Various insecticides, unspecified | 8* | 0 | 6 | 1 |
| Actellic[1] | 7 | 2 | 0 | 0 |
| Phostoxin[2] | 3 | 0 | 0 | 0 |
| Neem leaves/ extract | 0 | 0 | 11*** | 1 |
| Wood ash | 4** | 0 | 0 | 0 |
| Aldrex 40[3] | 2 | 0 | 0 | 0 |
| Nothing | 21 | 7 | 16 | 4 |
| **Total** | 45 | 9 | 33 | 6 |

**Notes:**
[1] a proprietary name for pirimiphos-methyl
[2] a proprietary name for phosphine fumigant
[3] an insecticide not approved for use on stored food
* one case with two chemicals mixed
** one case where wood ash and Actellic were mixed
*** two cases where neem used in combination with insecticide

**Table 28** Reports of agents that have previously caused maize seed damage

| | Wenchi | Akatsi |
|---|---|---|
| Storage insects | 41 (71%) | 20 (33%) |
| Rodents | 3 (5%) | 0 |
| Moisture/mould | 3 (5%) | 0 |
| No damage | 11 (19%) | 40 (67%) |
| **Total** | 58 | 60 |

**Note:** * not all farmers report causes of damage

**Table 29** Reports of past problems* with maize seed germination

| | Wenchi | Akatsi |
|---|---|---|
| Seed quality | 14 (14%) | 6 (7%) |
| Lack of soil moisture | 18 (18%) | 4 (5%) |
| Birds | 28 (28%) | 3 (3%) |
| Termites | 11 (11%) | 21 (24%) |
| Insects | 4 (4%) | 6 (7%) |
| Rodents | 15 (15%) | 11 (13%) |
| Millipedes | 0 | 33 (38%) |
| None | 10 (10%) | 2 (2%) |
| **Total** | 100 | 86 |

**Note:** * two problems possible

**Table 30** Experience with seed testing for maize

| | Wenchi | Akatsi |
|---|---|---|
| No experience | 55 (92%) | 40 (67%) |
| Germinating seeds in soil | 5 (8%) | 7 (12%) |
| Eliminating seeds that float in water | 0 (0%) | 13 (22%) |
| **Total** | 60 (100%) | 60 (101%) |

**Table 31** Portion of maize cob used for seed

| | Wenchi | Akatsi |
|---|---|---|
| Whole cob | 16 | 25 |
| Middle portion | 25 | 5 |
| All but tip | 17 | 16 |
| No practice reported | 2 | 14 |
| **Total** | 60 | 60 |

**Table 32** Times of maize seed selection activities

| Time | Wenchi* (N=60) | Akatsi** (N=60) |
|---|---|---|
| In field | 2 (3%) | 0 (0%) |
| Before storage | 6 (10%) | 6 (10%) |
| During storage | 3 (5%) | 1 (1%) |
| Before planting | 51 (85%) | 38 (63%) |
| **Total** | 62 | 45 |

**Notes:** * sum greater than 100% because some farmers select at more than one time
** sum less than 100% because not all farmers reported seed selection activities

**Table 33** Criteria used in maize seed selection

| | Wenchi | Akatsi |
|---|---|---|
| Large cobs | 24 (42%) | 27 (61%) |
| Cobs free from weevils | 28 (49%) | 12 (27%) |
| Other | 5 (9%) | 5 (11%) |
| **Total** | 57 (100%) | 44 (99%) |

**Note:** * not all farmers report seed selection criteria

**Table 34** Maize farming responsibilities by gender (Responses of married farmers only)

| Operation | Wenchi | | | Akatsi | | |
|---|---|---|---|---|---|---|
| | Farmer alone | Spouse alone | Shared | Farmer alone | Spouse alone | Shared |
| Male farmers | | (N=39) | | | (N=26) | |
| Manage field | 26 | 0 | 12 | 15 | 0 | 11 |
| Variety choice | 34 | 1 | 3 | 23 | 1 | 2 |
| Seed selection | 35 | 2 | 2 | 15 | 4 | 7 |
| Seed storage | 28 | 3 | 8 | 11 | 1 | 13 |
| Female farmers | | (N=9) | | | (N=29) | |
| Manage field | 7 | 0 | 2 | 20 | 0 | 9 |
| Variety choice | 7 | 0 | 2 | 5 | 10 | 14 |
| Seed selection | 7 | 0 | 2 | 22 | 2 | 5 |
| Seed storage | 7 | 0 | 2 | 20 | 3 | 6 |

**Table 35** Germination rate for maize seed samples

| | Wenchi | Akatsi |
|---|---|---|
| 90-99% | 57 | 40 |
| 80-89% | 0 | 6 |
| 70-79% | 1 | 7 |
| 60-69% | 1 | 0 |
| 50-59% | 1 | 2 |
| 40-49% | 0 | 2 |
| Below 40% | 0 | 2 |
| **Total** | 60 | 59 |
| **Mean germination rate** | 95.7% | 87.0% |
| Proportion of seed samples below 85% germination | 5% | 24% |

**Table 36** Maize seed characteristics and germination rate

| Characteristic | Wenchi | | | Akatsi | | |
|---|---|---|---|---|---|---|
| | (N) | Germination (%) | Sig.* | (N) | Germination (%) | Sig.* |
| Source | | | | | | |
| Home | (54) | 96.1 | NS | (37) | 93.8 | <.001 |
| Off-farm | (6) | 93.0 | | (22) | 75.5 | |
| Source off-farm | | | | | | |
| Formal | (1) | 97.0 | <.001 | (2) | 50.0 | NS |
| Grain market | (1) | 97.0 | | (4) | 89.3 | |
| Extension | (1) | 65.0 | | (3) | 89.0 | |
| Another farmer | (3) | 98.0 | | (13) | 72.1 | |
| Seed damaged at harvest | | | | | | |
| Yes | (18) | 97.3 | NS | (15) | 94.4 | NS |
| No | (36) | 95.5 | | (22) | 93.4 | |
| Storage method | | | | | | |
| On cob with husk cover | (39) | 95.6 | NS | (37) | 93.8 | |
| On cob without husk cover | (12) | 97.4 | | (0) | – | |
| Shelled | (3) | 96.7 | | (0) | – | |
| Storage substance | | | | | | |
| Recognized chemicals | (12) | 97.2 | <.001 | (0) | – | NS |
| Unknown or inappropriate chemicals | (10) | 90.5 | | (7) | 95.0 | |
| Ash or neem | (4) | 96.5 | | (11) | 95.5 | |
| Nothing | (28) | 97.6 | | (19) | 92.4 | |
| Seed selection | | | | | | |
| Whole cob | (14) | 95.4 | NS | (22) | 92.6 | NS |
| Remove tip | (37) | 96.5 | | (15) | 95.5 | |
| Age of seed (for home stored) | | | | | | |
| Correlation coefficient | −.039 | | NS | −.706 | | <.001 |

**Note:** * significance of one-way ANOVA or correlation coefficient

**Table 37** Maize farmer characteristics and germination rate

| Characteristic | Wenchi | | | Akatsi | | |
|---|---|---|---|---|---|---|
| | (N) | Germination % | Sig.* | (N) | Germination % | Sig.* |
| Farmer gender | | | | | | |
| Male | (47) | 95.4 | NS | (29) | 83.3 | NS |
| Female | (13) | 96.7 | | (30) | 90.5 | |
| Knows how to test seed | | | | | | |
| Yes | (5) | 91.4 | NS | 20 | 83.1 | NS |
| No | (55) | 96.1 | | 39 | 88.9 | |
| Seeds per hill | | | | | | |
| Correlation coefficient | −.148 | | NS | +.052 | | NS |
| Area planted to maize | | | | | | |
| Correlation coefficient | +.016 | | NS | +.270 | | <.05 |
| Bags of maize Harvested in 1994 | | | | | | |
| Correlation coefficient | +.049 | | NS | −.03 | | NS |

**Note:** * significance of one-way ANOVA or correlation coefficient

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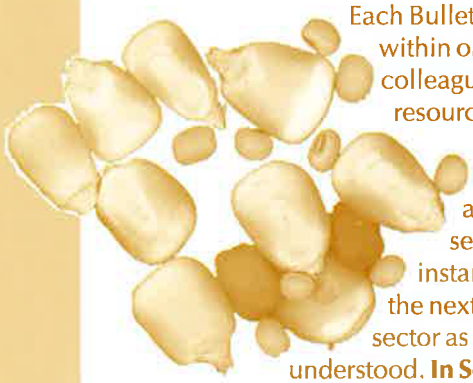

Each Bulletin presents a detailed synthesis of the results and conclusions within one specialized area, and will be of particular relevance to colleagues within that field and others working on sustainable resource management in developing countries.

Seed management by small-scale farmers is an important aspect of national seed security in developing countries. Some seed is obtained off-farm just prior to planting, but in many instances about 80% of seed is saved on-farm from one season to the next. The role of the traditional farmer and the informal seed sector as a whole has not been well supported and is not adequately understood. **In Seed Management by Small-scale Farmers in Ghana—A Study of Maize and Cowpea Seed in the Brong-Ahafo and Volta Regions** the findings of a field survey on small farmers are described. The informal seed sector will continue to be a major consideration in the agriculture of developing countries for the foreseeable future. This bulletin will be of interest to all those concerned with the role of the small-scale farmer to manage his or her seed supply.