

# Farmers' appraisal of pearl millet varieties in Eritrea

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## Glossary

Danda	a storage rack for grain panicles usually one metre above the ground and made of wood and leaves
Ga'at	a stiff porridge
Gussia	a second ploughing usually carried out in the second month after planting to improve water retention, reduce weeds, and encourage tillering
Injera	a fermented pancake
Kawo	a Kunama practice that calls upon the whole community to work on particularly laborious tasks
Kitcha	a flat unleavened bread
Koffo	a traditional clay grain storage pot about 1.5 metres tall
Subko	a liquid porridge
Tutuko	boiled whole grain

## List of abbreviations

AEAS	Association of Eritreans in Agricultural Sciences
CDE	Centre for Development and Environment
DLGP	Dependable Length of Growing Period
ESAPP	Eastern and Southern Africa Partnership Programme
FAO	Food and Agriculture Organisation
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
MLGP	Median Length of Growing Period
MoA	Ministry of Agriculture
NARI	National Agricultural Research Institute
PET	Potential Evapotranspiration
PIA	Participatory Impact Appraisal
PRA	Participatory Rural Appraisal
SFSA	Syngenta Foundation for Sustainable Agriculture
SLM	Sustainable Land Management (SLM) Programme – Eritrea
UoA	University of Asmara
WRD	Water Resource Department





## Summary

### Pearl millet – general characteristics

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is grown mainly for grain in the tropical and sub-tropical areas of Africa and the Indian sub-continent. It is an indispensable food for millions inhabiting the semi-arid and arid tropics and is more important in the diet of the poor. Pearl millet grain is among the most nutritious of the major cereals. Its protein content is not only high, but of exceptionally good quality, being seriously deficient only in lysine. It also has good levels of phosphorus and iron, and reasonable quantities of thiamine, riboflavin, and nicotinic acid. The major types of foods produced from pearl millet grain are (a) porridges, either thick or thin, which are common in west Africa and (b) flat bread, either unfermented (mostly Asia) or fermented (Eritrea and Sudan). Downy mildew caused by *Sclerospora graminicola* (Sacc.) J. Schröt is the most widespread and destructive disease of pearl millet causing severe economic losses. Other major diseases affecting pearl millet are smut (*Moesziomyces penicillariae* (Bref.) Vanky), ergot (*Claviceps fusiformis* Loveless) and rust (*Puccinia substriata* Ellis & Brath.).

### Pearl millet in Eritrea

Pearl millet is the second most important cereal crop in Eritrea, grown mainly by small farmers in low lands and mid lands. It is predominantly grown in less favourable environments where rainfall is variable and low (250–300 mm). Landraces currently grown contain the traits that farmers have selected over the past generations, and thus represent a very valuable resource. However, because of the cross-pollinated nature of the crop, desirable traits may not exist in a high frequency in landrace populations and may be accompanied by various undesirable traits, such as susceptibility to downy mildew.

The pearl millet breeding programme was begun in 2000 by National Agricultural Research Institute (NARI) based upon the improvement of local landraces by crossing these with introduced varieties/ populations with disease resistance, early maturity, and improved plant or panicle type. The process has resulted in the introduction of an ICRISAT variety (ICMV 221) (*Kona*), and the release of new cross-bred variety (*Hagaz*), which is a cross between *Kona* and a local Eritrean landrace (*Tokrora*), and by a range of other new varieties in on-station and on-farm trials, involving a number of different Eritrean landraces. All of these are superior in disease (downy mildew) resistance and grain yield to the parent landraces, yet retain many of the desirable characteristics of those races. Most importantly, the approach has produced a range of improved experimental varieties in a very short time, allowing Eritrean farmers access to new varieties within a few years of the beginning of the breeding programme. The two newly released varieties – *Kona* and *Hagaz* – have shown increased demand by farmers due to their higher yields, early maturity, and resistance to the primary pearl millet disease, downy mildew. They represent an important part of the governments' food security efforts, addressing the immediate needs of the farmers with relatively quick impact.

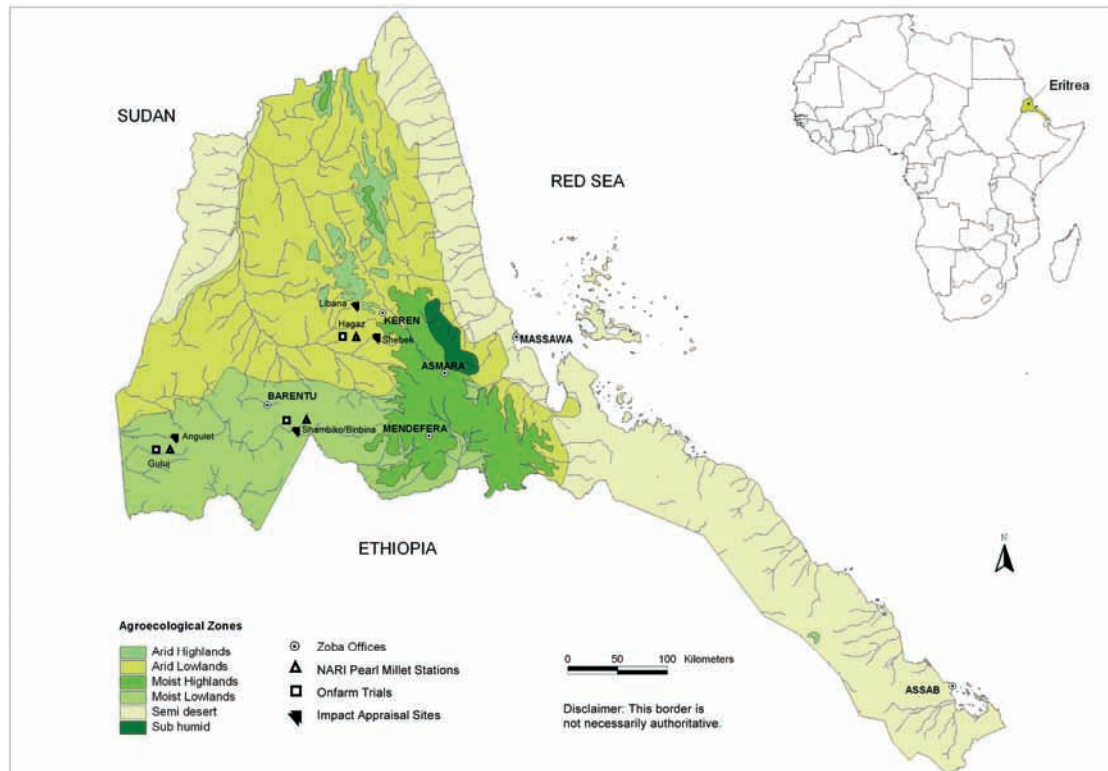


Figure 1 Pearl millet growing areas and study sites in Eritrea

The map above shows the location of the three villages selected for the present study.

# Introduction

## Pearl millet in Eritrea

Pearl millet is the second most important cereal crop in Eritrea. It is predominantly grown in less favourable environments where rainfall is variable and low (250–300 mm); and the grain is for human food whilst the straw is used as feed for livestock. The Pearl Millet Improvement Program at the National Agricultural Research Institute (NARI), through conventional plant breeding, has identified, in collaboration with ICRISAT, two higher yielding pearl millet varieties, *Kona and Hagaz*, which are adapted to Eritrea's marginal environments. On-station trials showed that the yield of these varieties was up to 30% higher than those of traditional landraces. These positive results encouraged the Program to start on-farm trials in selected areas, and to assess the farmers' response to the newly released varieties, as a feedback on past breeding activities, and a guideline for future efforts in millet breeding.

## Aims of this study

This study assesses farmers' perceptions, both men and women, of new pearl millet varieties (*Kona and Hagaz*<sup>1</sup>) developed and released by the Ministry of Agriculture through the National Agricultural Research Institute (NARI). The study attempts to determine the adoption rates of these new varieties as an indicator of improved livelihoods, and whether farmers are interested in planting them again. To this end, it compares the newly released varieties with local landraces, by using farmers' criteria, both those of women and of men. A team comprising a socio-economist, a pearl millet breeder, an animal scientist, a plant scientist and Zoba extension workers were responsible for the appraisal. The study was carried out at three different sites, of which two are located in Zoba Anseba (Libana, Shebek) and one in Zoba Gash Barka (Binbina). These sites represent three different agro-ecological zones (Table 1) as well as different ethnic groups. Their location is indicated on the map on page 8 in this report.

The *Kona* variety was first released in 2000 and the *Hagaz* variety in 2004. When the first appraisal was conducted in 2004, farmers had little experience as yet with these varieties, especially compared to their traditional landraces. This second appraisal, in two of the same locations, and two years after the first appraisal now provides a deeper assessment of the participants' views.

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<sup>1</sup> Descriptions available in the Annex



## Methodology

Participatory methods were used throughout this survey with the aim to share our knowledge, to obtain information from the local land users on indigenous knowledge, their total costs and benefits, and to help plan for the future relating to breeding and release of new millet varieties. Moreover, it was our intention that participation would engender ownership of the research findings and so increase the likelihood that this impact appraisal will itself have an impact.

Specifically, the survey was conducted using group discussions and Participatory Impact Appraisal (PIA) methods. In two of the study sites separate groups of approximately 10 to 20 men and 5 to 10 women participated. In Binbina, only one group comprising 80% women participated. One day was allocated for each community.

### Discussions and Questionnaire

General background information was collected on community livelihood strategies, the natural resource base, crop production activities, post harvest activities, and marketing. Other data gathered was on trends in crop and pearl millet land coverage from 2001 to 2006.

### Pair-wise ranking matrix

The purpose here was to gather information and to make comparisons between men and women's priority attributes of pearl millet *in general*, i.e. without making any specific reference to any particular variety.



Photo 1 Participatory exercise in Binbina

## Matrix ranking

After the participants had identified the priority attributes of pearl millet, we compared them firstly to the specific pearl millet varieties that have been developed and released by the NARI – Ministry of Agriculture, and secondly to the local landraces. Matrix ranking in this case was useful in providing a comparative understanding of various pearl millet varieties according to the list of attributes that were already identified in the pair-wise ranking. The results are presented for each village separately in the analysis and discussion chapter of the present report.

## Crop coverage

In order to provide information on adoption rates and the importance placed by farmers on the new pearl millet varieties compared to local landraces and other crops grown, farmers were asked to provide an approximation of area coverage, for 2006, planned for 2007, and for the year before the new varieties were first introduced. Farmers present were given ten seeds each representing the total of their individual cropland holdings. In the first exercise they divided the seeds' to show the proportion of their different crop types. In the second exercise they divided the seeds to show the proportion of different pearl millet varieties grown.

Table 1 Study sites

Study site, village	Libana	Shebek	Binbina
Sub Zoba/Zoba	Hamelmallo/Anseba	Hagaz/Anseba	Shambuko/Gash Barka
Ethnic group	Bilen	Tigrigna	Kunama
Distance from main town	40 min drive from Keren	120 min drive from Keren	60 min drive from Barentu
Altitude (m.a.s.l)	1,391m	956m	approx 800m
Agro-ecological zone	arid highlands zone	arid lowlands zone	moist lowlands zone
Rainfall (mm) per year	200–500	200–500	500–800
Temperature (°C)	15–21	21–29	21–28
PET (mm) per year	1,600–1,800	1,800–2,000	1,800–2,000
DLGP (days)	0–30	0–30	50–90
MLGP (days)	30–60	30–60	60–120

Source: FAO 1997. Agro ecological zones map of Eritrea. Department of Environment, Ministry of Land Water and Environment. Project FAO/TCP/ERI/4554 (A) field document 2, 67 pp.

Explanations:

PET – Potential Evapotranspiration

DLGP – Dependable Length of Growing Period

MLGP – Median Length of Growing Period

# Analysis and Discussion

## Libana Village

Crop production in Libana is dominated by pearl millet and groundnut. A minor crop is sorghum. Local millet landraces used for comparison with the introduced new varieties were *Tokroray* and *Zibedi*.

### Community background

Libana Village is located in Subzoba Hamelmalo, Zoba Anseba. It is a village with a mixed ethnic grouping; Bilen and Tigre. The community is largely involved in subsistence farming, with 5% relying on livestock rearing and 1% on trading and daily labor as their primary livelihood.

### Crop types

The main crops grown are pearl millet, groundnut, sorghum, and cowpea. A clear indication of the importance of pearl millet to the communities' farming livelihood is shown in Figure 2; where 42% of total crop area is grown under pearl millet whilst the second most important grain crop, sorghum, occupies 18%. Of the area grown under pearl millet the introduced varieties occupy 34% and 27% respectively for *Kona* and *Hagaz*. The local varieties, *Zibedi* and *Tokroray*, cover 18% and 21% respectively. Both the sorghum and groundnut varieties are local.

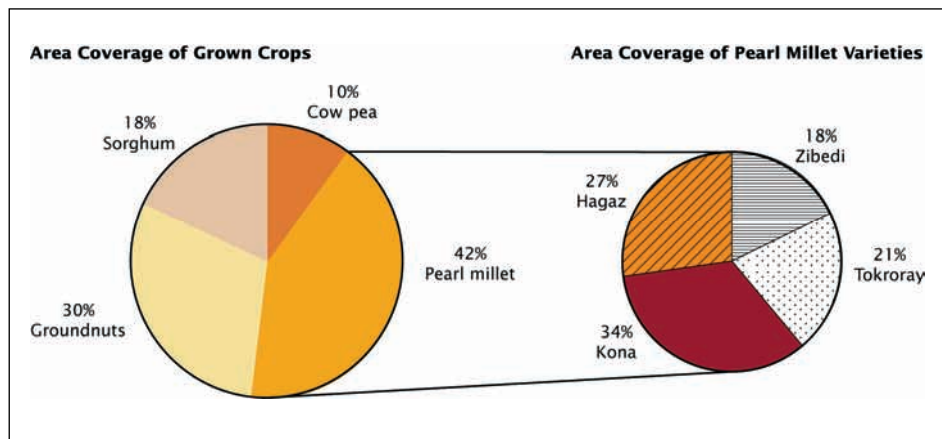


Figure 2 Libana. Crop type and pearl millet variety coverage as a percentage of cultivated land

Some of the major benefits identified for growing pearl millet, in comparison to sorghum are: a better quality of *Ga'at* and *Kitcha* can be made (*Ga'at* being their main food type); striga resistance; early maturity; durability and higher water-repelling capacity of the stalk for thatch; higher market price for grain; higher food protein content both for fodder and human consumption; more dough and hence food per unit of flour; and longer grain storability.



The following graphs (Figures 3 and 4) show the overall priorities that both men and women identified for pearl millet. They are the responses to the question: 'What are the attributes that you look for and value in pearl millet?' The figures also show the rankings that the participants gave for each pearl millet variety grown in Libana village.

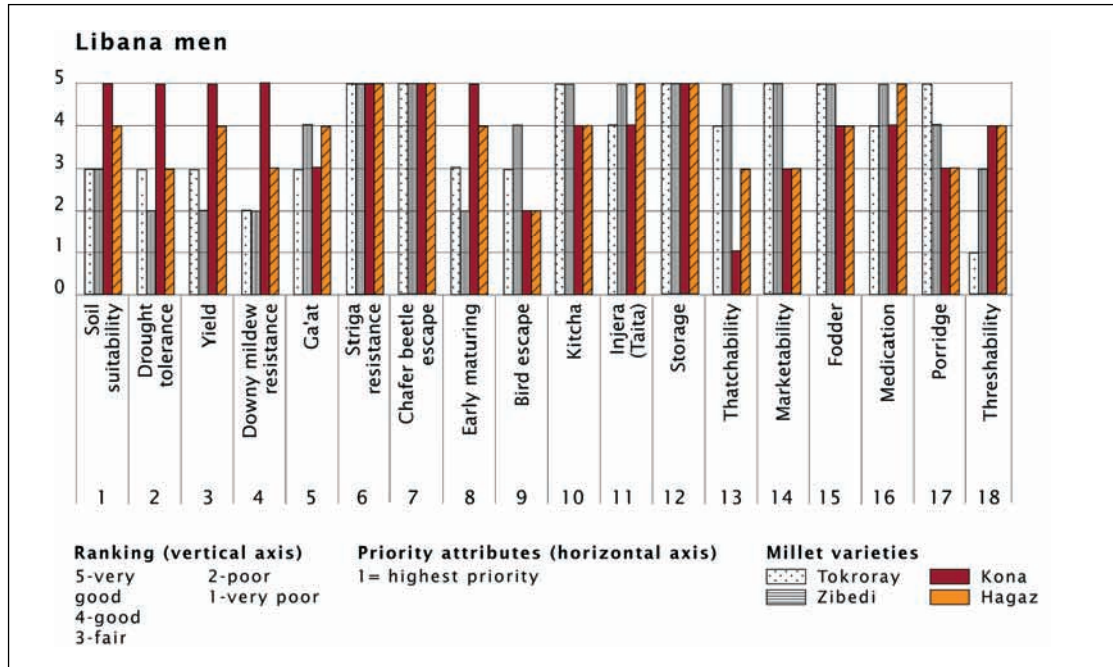


Figure 3 Libana. Men's ranking of millet varieties

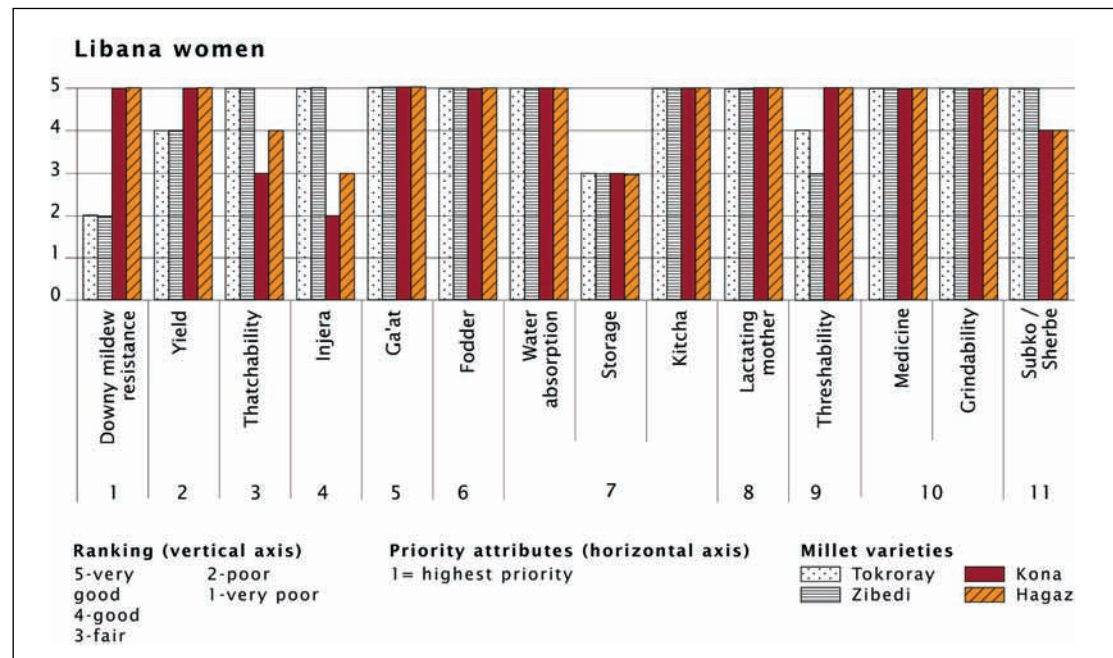


Figure 4 Libana. Women's ranking of millet varieties

## Yield

Under current conditions farmers are unable to meet their annual subsistence food requirements through farming. Yield was thus the second and third most important attribute for women and men respectively. Grain yield is a function of the following traits: drought tolerance, early maturity (hence reduced risk from a failure in rains) and disease resistance (downy mildew). These key traits are present primarily in *Kona*, which was ranked as the highest yielding, followed by *Hagaz*, *Tokroray* and *Zibedi*.

Farmers averaged the sum of their yields (kg/ha), for poor and good soils, starting from the year when they first planted the introduced varieties. The results are shown in Figure 5. The higher ends of the bars represent their highest average yields, the lower ends show the lowest average yields.

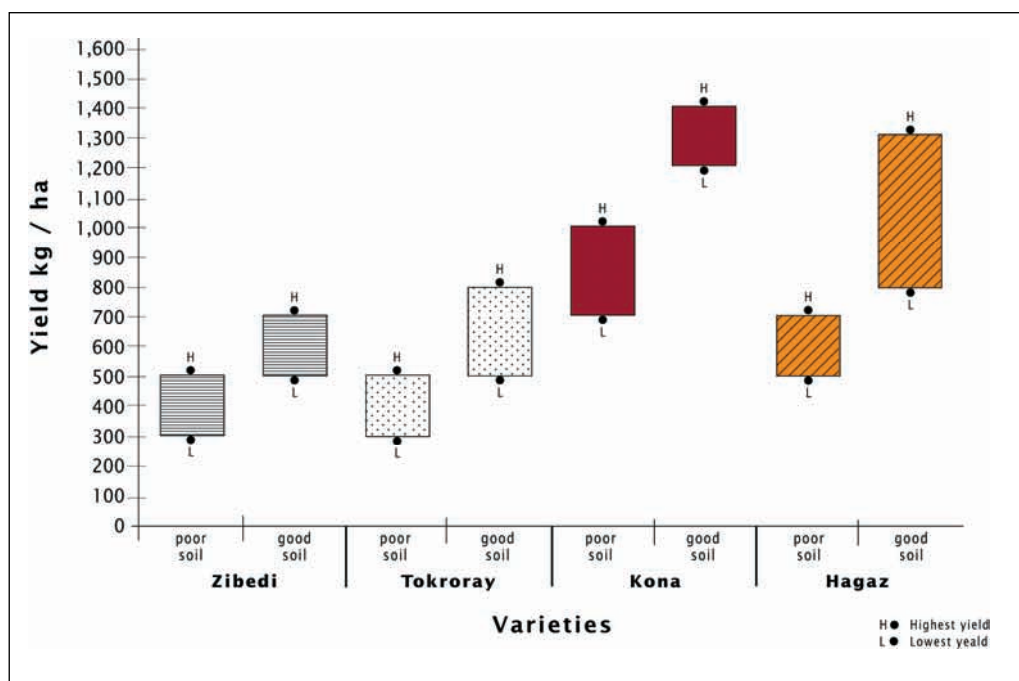


Figure 5 Libana. Yields of different pearl millet varieties in good and poor soils, and in good and bad years, according to farmers' assessment

A simple analysis of Figure 5 above shows that the introduced varieties are 30% to 100% higher yielding than the local varieties. *Kona* maintains the highest yields in both the good and poor soil. In contrast to the yields from *Zibedi*, *Tokroray*, and *Hagaz*, *Kona* maintains relatively consistent yields in the good as well as in the poor soils. It also shows that the lowest yields from *Kona* in the poorest soils are equal to the highest yields from the local varieties grown in the best soils. This gives farmers more choices as to where and by what land proportion they can grow the different pearl millet varieties.

## Soils

The main soil types comprise of, largely, coarse sand (*Tebatay hutsa*), followed by sandy loam (white soil – *Tsada hamed*) and laterite (red soils – *Keyih hamed*). According to farmers, the most fertile soil is sandy loam, then coarse sand and red soil. The sandy loam soil also has a better water holding capacity.

Soil suitability was considered to be the most important attribute for the men in 2006 (Figure 3). With the aim of, first, ensuring a yield, and, secondly, maximizing that yield, farmers consider climatic conditions, relate this to their various soils, and select which crops are likely to grow relatively successfully. Compared to other regions of the country soils here are relatively poor in terms of fertility and water holding capacity. Consequently, pearl millet and groundnut are widely grown and on the best soils. Sorghum, which is likely to perform poorly even in the best soils, is grown on the poor lateritic soil.

Farmers further consider the different attributes of pearl millet varieties in deciding in which soil types to plant. Generally, the local varieties and the *Hagaz* variety are planted in the best soils and *Kona* in relatively poorer soils. This is in recognition of the fact that *Kona* is relatively early maturing and tolerant to drought, and that although planted in the poorer soils it still stands a higher chance of producing a yield. However, *Kona* is also grown in all the other soil types. Farmers said that *Zibedi* performs poorly as it has a higher water demand.

## Climate

Drought is clearly a serious problem in this area. It scored second in the priority rankings. Ten year average rainfall data shows an average of 360 mm per annum. *Kona*, followed by *Hagaz*, were considered to be the most drought tolerant due in part to their earlier maturity trait. *Kona* also has a well expressed stay green character trait. This allows it to survive dry spells longer than the local varieties.

Days to maturity was recognized as the eighth most important attribute. Libana is located in an agro-ecological zone with relatively higher rainfall, more abundant natural resources (fauna), plus, owing to their close proximity to the town of Keren, the population has access to alternative sources of income through trade and other employment opportunities, especially in the horticultural farms.

## Disease, pests and weeds

Downy mildew was recognized as a serious problem affecting yields and scored as first with women and fourth by men (Figures 3 and 4). Farmers approximated that the local varieties were up to 50% affected by this disease. *Kona* was the most resistant to downy mildew, followed by *Hagaz*, and the local varieties were scored as poor. Farmers in this area have called the disease 'AIDS'; an indication as to the seriousness with which they consider it.

Striga resistance is an important attribute. It primarily affects sorghum crops therefore encouraging farmers to grow striga resistant pearl millet. Crop rotation with pearl millet and sorghum is practiced in order to reduce striga infestation. Pearl millet is grown in a

striga-infested field for two to three years, after which farmers will then plant sorghum again. Other weeds identified are: *Cynodon dactylon* (*Romadi*), *eshokmerghem*, *segherdid*, *aret*, and *Amaranths spp.* (*Hamliadghi*).

Chafer beetles are generally a problem, however in 2006, pest incidence was low, and farmers scored all the pearl millet varieties as very good. Other insect pests identified were Angoumois grain moths (*Sitotroga cerealella*). These affect stored grain.

Bird damage is a well recognized problem in Libana. The days to maturity of the different varieties, the surrounding maturity of wild grasses (main source of food), the population of birds, the availability of labour to scare away birds, the boldness, compactness, size of grain, and extent of hectareage grown under pearl millet all affect the severity of bird damage. Owing to their earliness *Kona* and *Hagaz* were relatively more susceptible to bird damage. Nevertheless, the actual yields for the improved varieties remained higher than the local.

### Processing and utilization

Once the grain and stalk are dry the crop is harvested manually using a knife or sickle. The harvested panicles are then stored on a wooden rack (*Danda*) before they are threshed. Threshing is carried out primarily by men, who use a long wooden pole to beat the grain out of the panicles. Those that can afford it use a mechanized thresher. It is a laborious task. Due to grain boldness the improved varieties scored as the easiest to thresh, whilst the local varieties and especially, *Zibedi* scored as poor.

Farmers are very aware of the need to maintain good seed for the next season. They select panicles from the best plants which display the following characteristics: vigorousness; healthiness; bigger panicles; bold and large seed size. In some cases some farmers select panicles after harvest. This is a poor practice as they are unable to identify the best performing plants. In addition to selecting seeds they also exchange seed and/or purchase from the market. Once the seed is collected it is mixed with ash, stored in small sacks and shelved within the roof beams of their homes. The high, dry and smoky environment helps to protect the seed from pests and disease such as rodents, moths, and fungus.

Grain is stored in a traditional short-term store called *Gufet* which has a size of 0.3 to 0.4 tons. A study of on-farm storage of sorghum showed that losses in this agro-climatic zone can amount to up to 10% if left untreated; treatment with ash reduces this loss to 3% (Adugna, 2006). No comparison was made between sorghum and pearl millet in the study by Adugna. Our study team is unable to comment on pearl millets storability in quantitative terms. However, the men ranked pearl millet as having very good storability for all the varieties grown, whilst the women ranked all the varieties as fair.



Photo 2 Fodder storage in Hamelmalo, Zoba Anseba

Currently farmers use a traditional method of seed treatment whereby seed is soaked in cattle urine for 24 hours, and then dried before sowing. This helps to reduce pest and disease infestation in the soil.

The harvested stalk is stored as a fodder for times when there is a lack of range feed. It is stored above the reach of livestock and termites: high in the branches of trees; on wooden makeshift tall racks (*Danda*); and/or raised above the ground on stones and then surrounded by a thorny fence.

Farmers were concerned with the availability of animal feed, both range and hay. This situation is worse from April to June (the dry season). We looked at the various benefits of the different pearl millet varieties with regards to quality and quantity of fodder. Farmers recognize that pearl millet stover has a higher protein (they expressed this as higher energy) content than sorghum, and that the same quantity of feed results in increased milk production and body mass. However, they also said that pearl millet stover is less palatable than that of sorghum. They would continue to grow sorghum, even if they are

not secure in receiving a grain yield, because it is the preferred animal feed. Of the different pearl millet varieties *Kona* stover is the most palatable as it is 'soft' and has a longer stay green character. However it has less biomass and hence scored lower than the *Hagaz* and the local varieties.

Women are responsible for the duties carried out within the home. This includes the cleaning and grinding of the grain, and the preparation of food. Women ranked all the varieties as very good for all their food types during the matrix ranking. However, following further discussions and a comparison with the men's results we learnt that the preferred diet is *Ga'at* which is eaten with yogurt and butter during the rainy season and the period just after harvest; as milk and butter are relatively in abundance at this time. *Zibedi* was the preferred variety, all the other varieties scored as average for this food type. *Kitcha* and *Injera* are eaten during the dry season. The local varieties scored as very good for *Kitcha*, whilst *Kona* and *Hagaz* were scored as fair to good. All the varieties scored as good for making *Injera*. Women mentioned 'water absorption' as a desirable trait. This refers to the flours' capacity to absorb water and is beneficial in the preparation of all the food types. A high absorption water level means that for a smaller proportion of flour one is able to produce a satisfying meal. This is contrary to food made from sorghum. In addition, sorghum is not suitable to make either *Kitcha* or *Ga'at*.

Interestingly, in contrast to the results of the appraisal carried out in 2004, women ranked all the varieties as equally good for making all their food types! Conversely, the men's responses in 2006 were more subtle. They scored the local varieties more highly for the preparation of all food types.

Other notable observations are thatchability; owing to their height, *Zibedi* and *Tokrora*, were ranked higher, *Kona* and *Hagaz* scored poorly. Farmers also said that pearl millet has a better thatch as compared to that of sorghum which spoils within one year.

## Marketing

As pearl millet is the preferred food for the majority of the population in the surroundings its prices are generally higher than that of sorghum in the Keren market. Grain prices at the market during the harvest period are shown in Table 2. *Kona* has a lower price; this is a reflection of its distinct appearance, which differs from the local varieties, as well as from a lack of awareness of its culinary suitability. Keren market traders informed us that consumers preferred the taste of the local varieties over that of the introduced ones. *Hagaz* fetches a higher price. It is more accepted as it retains some of the culinary characteristics of its local parent line, *Tokrora*.

Farmers informed us that they largely sell the local varieties as these have a higher market price whilst the introduced varieties are used for subsistence needs. Overall, farmers sell up to 10% of their grain harvest to the local market. Women said that they also sell grain, without the knowledge of their husbands. We were unable to get an estimate as to the quantity of this.

Table 2 Market prices for pearl millet, market in Keren

Pearl millet varieties	Market price in Nakfa per Kilo <sup>2</sup>		
	Dry season (December to June)	Rainy season (June to July)	At harvest (September to November)
<i>Tokroray</i> and <i>Zibedi</i>	12.5	14	10
<i>Hagaz</i>	-	-	10
<i>Kona</i>	-	-	7.50

### Seed

Since 2001 some farmers involved in Ministry of Agriculture (MoA) improved seed multiplication programmes sell their product directly to the Ministry at 25% above the existing market price for grain. Surrounding villages that are not recipients of MoA *Kona* seed also buy their seed from the Libana community at a higher price than that of grain.

### Trend of adoption

Prior to 2001 farmers were growing only local landraces: *Zibedi* and *Tokroray*. These landraces are susceptible to downy mildew (30 to 70% susceptible, NARI survey, 2000) and as late maturing types they are more prone to the prevailing unreliable climatic conditions, resulting in increased chances of lower grain yields or a risk of complete yield failure. As a response to these limiting factors, the MoA released *Kona* in 2001 and *Hagaz* in 2004.

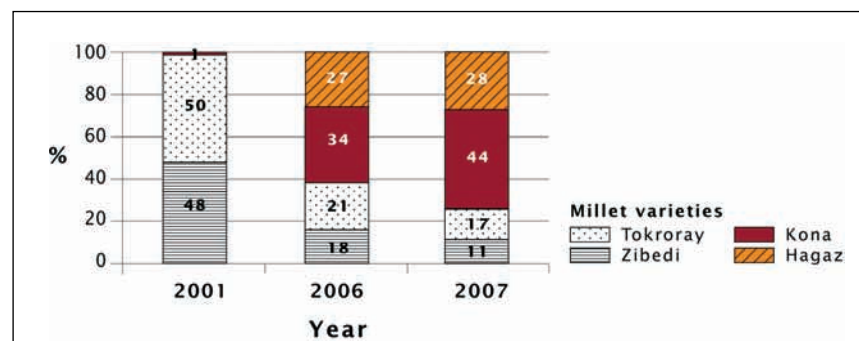


Figure 6 Libana. Trends in pearl millet variety coverage

We ended the appraisal exercise with a question that ultimately shows to what extent the released varieties have been adopted. Figure 6 clearly shows that adoption rates of the newly released improved varieties have increased over the past five years, and farmers intend to further increase this proportion in the 2007 season. Participants stated that this is because *Kona* and *Hagaz* varieties provide an earlier harvest and higher yield. For instance, in 2006, the average overall yield from local landraces was two to three quintals per hectare while that of the improved variety, *Kona*, was six quintals per hectare.

Despite lower agronomic performances farmers decided that they will still maintain growing their local races, but at a much lower proportion. The key reason for this being taste and culinary preferences for *Zibedi* and *Tokroray*, at home and in the market.

<sup>2</sup> 1 USD=15 Nakfa

## Shebek Village

Crop production in Shebek is dominated by pearl millet and groundnut. A minor crop is sorghum. The local millet landrace used for comparison with the introduced new varieties was *Bultuq*.

### Community background

Shebek is located in Sub Zoba *Hagaz*, Zoba Anseba. It is a village with a largely Christian Tigrigna ethnic group. The main source of livelihood is agriculture and livestock rearing. To a small extent some inhabitants are involved in petty trading and the selling of wood. Daily waged labour is not a source of income owing to the great distance to the nearest urban settlement.

### Crop types

The main crops grown are pearl millet, groundnuts, sorghum, and to a small extent chickpea. Ground nut is grown as a cash crop. As indicated in Figure 7 pearl millet is the predominant crop. Of the three varieties of pearl millet *Kona* is the most widely grown and occupies 67% of the total area allocated to pearl millet in 2006, *Hagaz* occupies 20%, and the local variety, *Bultuq*, only 13%.

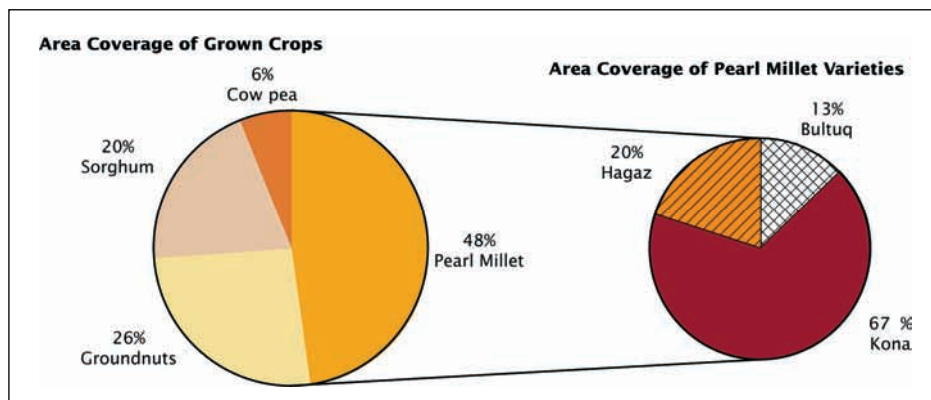


Figure 7 Shebek: Crop type coverage and pearl millet variety coverage as a percentage of cultivated land

Farmers identified several benefits of growing pearl millet and these included their knowledge on pearl millet which has been passed down to them from their forefathers; the particular suitability of the land and climate; and the vulnerability of sorghum, a longer duration crop, to chafer beetle infestations.

The following graphs (Figures 8 and 9) show the overall priorities that both men and women identified for pearl millet. They are the responses to the question: 'What are the attributes that you look for and value in pearl millet?' The figures also show the rankings that the participants gave for each pearl millet variety grown in Shebek village.



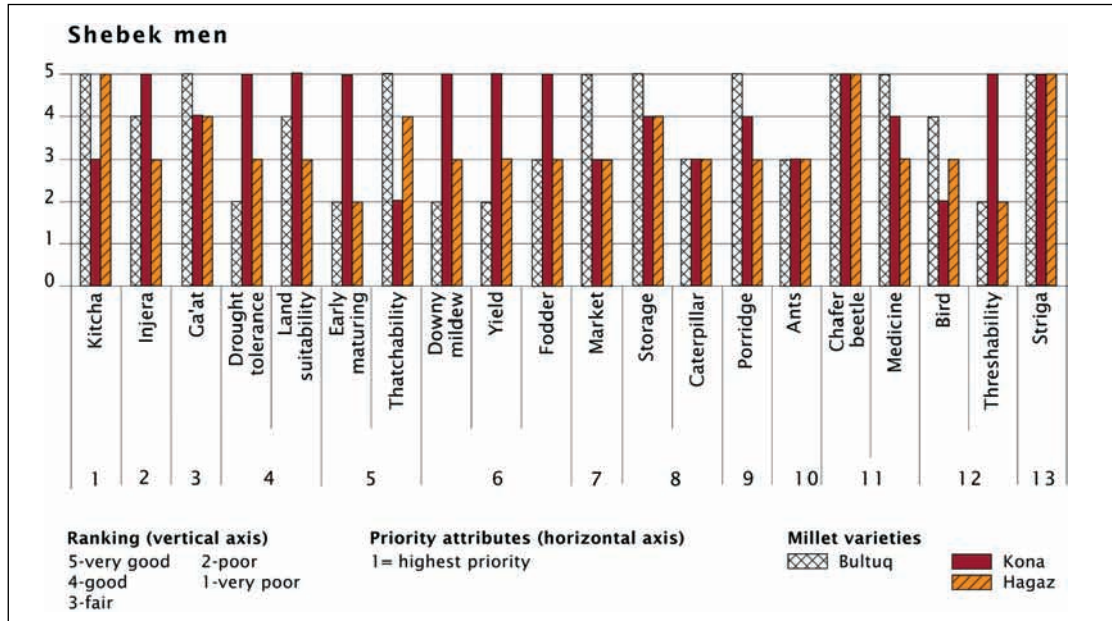


Figure 8 Shebek, men's ranking of millet varieties

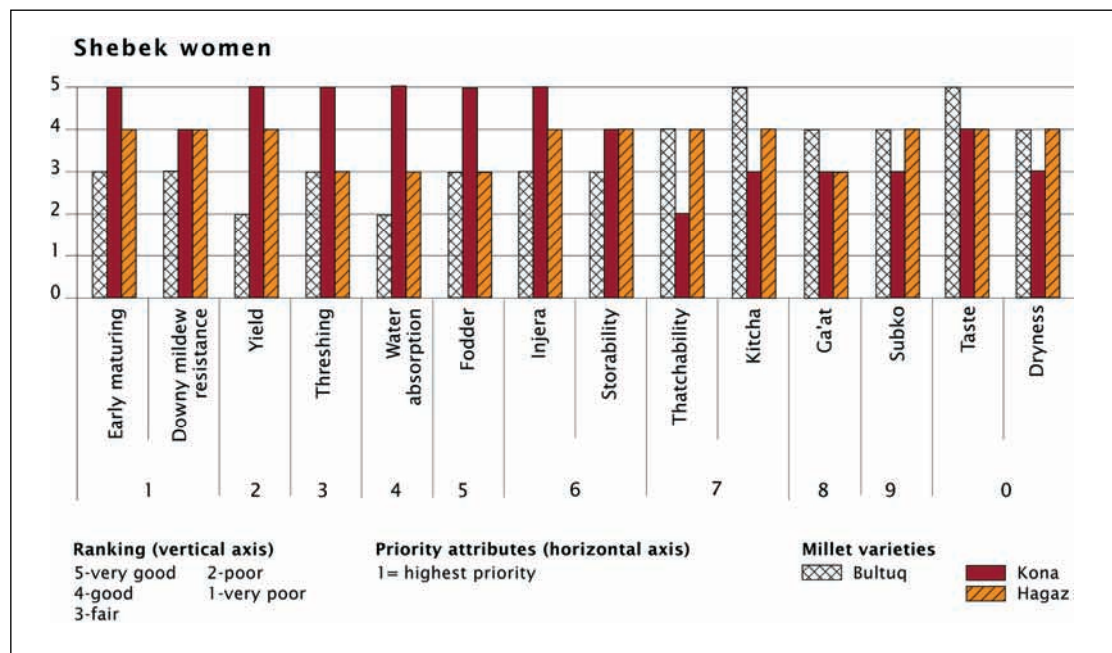


Figure 9 Shebek, women's ranking of millet varieties

Reference should be made in the following text to the priority attributes identified by both men and women as shown in the figures above.

### Yield

*Hagaz* produces up to two and a half times more grain than the local variety, and will still yield 500 kg per hectare when there is a complete failure of the local variety. Men ranked yield mid way down their priority ranking whilst women ranked it amongst the top three.

Farmers averaged the sum of their yields (kg/ha) starting from the year when they first planted the introduced varieties. The results are shown in Figure 10. The higher ends of

the bars represent their highest average yields, the lower ends show the lowest average yields. *Kona* has yields that are up to 5 times more than the best yields received from the local variety.

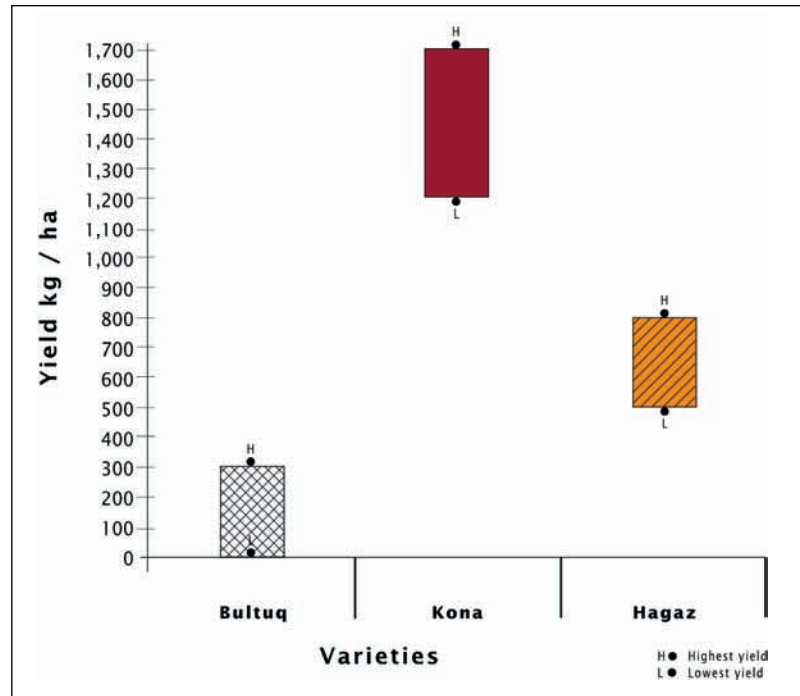


Figure 10 Shebek. Yields of different pearl millet varieties according to farmers' assessment in good and bad years

## Soils

Farmers in Shebek identified two main soil types; sandy loam (*Arib*) and a loamy soil (*Keyih duka or Rogid*). The sandy loam is cultivated with pearl millet and groundnuts as these prefer well drained loose soils. Sorghum and cowpea prefer soils with a higher water retention capacity and are therefore planted in the loamy soils.

Men ranked soil (land suitability) as their fourth most important (or first equal agronomical) priority attribute. This differs from their 2004 ranking when it was their second most important. The improved varieties were recently released – *Kona* in 2002/2003 and *Hagaz* in 2004. Farmers' priority at the time was to ensure that the varieties were suited to their soils. Farmers agreed that they were now satisfied with their grain yields from the newly released varieties. Their priorities have shifted to the culinary aspects as they were interested in obtaining a higher market price than what they currently get for *Kona* and *Hagaz*. Differences in ranking existed between the different varieties, *Kona* was judged the most suited, followed by *Bultuq* as good and *Hagaz* as poor.

## Climate

Shebek lies in the agro-ecological zone where the 10 year rainfall average is 255mm per annum. This is towards the lower range of 200 mm that pearl millet needs to grow. Drought tolerance, land suitability, and early maturity were all attributes that farmers prioritized. These all underscore the central importance of rainfall for millet growing in Shebek.

Early crop maturity was ranked as the first priority by women and the sixth by men (or second most important by men when we first look at the non food attributes). An early yield is highly desirable as it helps bridge the hunger gap. *Kona* matures in 75 days, *Hagaz* in 85 day, and *Bultuq* in 90 to 110 days. For a community with no other source of livelihood than farming and livestock rearing this one month difference in maturity is important. Participants ranked *Kona* as very good for this attribute, *Hagaz* as fair to good, and *Bultuq* as poor to fair.

Farmers were further impressed with the drought tolerance of *Kona*. They concluded that *Kona* has the capacity to withstand a dry spell in all stages of its growth when compared to the other varieties. Its seed germination viability remains good even when planted much earlier in anticipation of the first rains. This was also an overall attribute given for all pearl millet varieties when compared to sorghum.

## Disease, pests and weeds

Downy mildew is considered a serious problem affecting yields. It scored as the third most important non-food attribute amongst the male participants, and second most important with the women (Figures 8 and 9). The local variety is very susceptible to this disease and scored as poor, *Kona* as very good against the disease, and *Hagaz* as fair.

Insect pests that were ranked include caterpillar which attack at the seedling stage, chafer beetles (though not a problem in 2006), and ant infestations when the crop is on the storage rack.

Farmers agreed that all pearl millet varieties were heavily affected by weeds in their early growth stage. The weeds mentioned are *Hintut* (*Convolvulus sagittatus*), *Hamliadghi* (*Amaranthus spp.*), *Abertata* (*Setaria homonyma*), *Degela* (*Dactyloctenium aegyptium*), *Kak-wito*, *Tekan* (*Setaria pumila*). Striga was identified as a priority because of the damage that it does to sorghum and the high resistance of pearl millet to it.

Other pests/diseases that were not mentioned in the priority ranking but were in the general discussions are stem borer and smut.

Bird damage was not excessive in 2006. Farmers ranked it as 12th priority. There is an intensive two week period before harvest when bird scaring is carried out. According to the local extension worker the farmers put a lot of time and effort into scaring birds away, a necessity as bird numbers were large in 2006.

## Processing and utilization

Threshing and winnowing is carried out primarily by women, but men also assist in these tasks (Photo 3). It is a laborious and time consuming chore that women ranked as their fourth most important priority. They found that due to its boldness *Kona* was the easiest to thresh and scored it as very good. *Hagaz* and *Bultuq* scored equally as fair. Men also gave similar inter-variety ratings.



Photo 3 Threshing and winnowing in Shebek

Seeds are stored in an indoor rack suspended beneath the roof beams where it is well ventilated and safe from rodents. Before storage, effort is taken to ensure that seeds are clean and free from detritus, and powdered with ash. Farmers said that because of the high temperatures there are high pest infestations of seed if care is not taken to ensure safe storage. Applying ash helps to limit insect infestation and damage to the seed. The seeds are checked frequently to make certain that they are okay. Farmers access their seed from the MoA, from selected panicles in the field, and through an informal seed exchange system with their neighbours.

In the recent past, grain was stored in a *Koffo*; this is a traditional clay pot approximately 1.5 m tall. Storage methods have now changed as many are now abandoning the traditional houses in preference for cement block walls and tin roofed houses. Separate rooms are constructed for grain; which are now stored in sacks and piled one upon the other. According to the farmers grain storability is improved if the crop is machine threshed. Manual threshing damages the grain and makes it more susceptible to damage from pest infestations. Both men and women felt that storage was an important attribute. They, however, gave different rankings as to which variety stored best. Men agreed that it was *Bultuq* and women *Kona*. Both groups scored *Kona* and *Hagaz* as good. In separate discussions on grindability participants said that *Kona* was the hardest to grind due to its tougher grain cover. The research team postulate that this characteristic is a plus for storability as pests would find it more difficult to bore into the grain.

In contrast to the last appraisal carried out in this village in 2004 men ranked food and food types as their most important attributes, whilst the women relegated these attributes in the middle ranges. We are unable to determine what the participants' reason is for this change of valuation. It may be that because they are now more food self-sufficient, they have more liberty to express their taste preferences.

Food preparation is done by women, from threshing to grinding and cooking. The research team managed to partly unravel a complicated selection process that the community uses in determining which varieties are preferred for a particular food type. The main factors influencing the scores were water absorption capacity, bitterness (taste) and dryness of foodstuff; all ranked by women as important attributes. The higher the absorption capacity the more suited the grain is to preparing their food. It also means that for a smaller proportion of flour a larger on-the-table meal can be served.

A point to keep in mind is that in the women's results, the taste and dryness traits were identified as attributes, yet did not score a place on the priority list of attributes. This effectively relegates these traits so that now a preference in yield and quantity of food (water absorption) is stressed. These downgraded attributes, however, are important as determining factors influencing inter-varietal scores.

*Injera* is overall the most preferred food, followed by *Kitcha*, *Ga'at*, and finally *Subko*. The seasons influence what food is eaten. *Injera* is consumed mostly in the dry season. *Ga'at* in the period close to the end of the rainy season; when there is plenty of milk for butter and yoghurt which is a complement to this dish. *Kitcha* is the favorite in the rainy season as at that time vegetables such as *Amaranthus* spp. (*Hamli adghi*) are available to go with it.

*Kona* scored highest and very good for making *Injera*, because it is not bitter and can be prepared in one day in contrast to the three to four day fermentation process needed to reduce the bitterness of the local variety. However, participants said that the grey colour of *Kona* was not visually attractive. *Hagaz* and *Bultuq* scored comparably as fair for making *Injera*.

*Bultuq* scored as good to very good for making *Ga'at*, *Kona* and *Hagaz* as fair to good. The more bitter taste of the local variety was preferred for this food-type. Participants agreed that *Ga'at* made from *Kona* dries out too quickly.

For their third most important food type, *Kitcha*, farmers preferred *Bultuq*. Its yellow colour is more visually attractive; it has a more bitter flavour and does not dry out. *Bultuq* scored as good to very good.

Livestock is an important part of farmers' livelihood strategies. It allows them to exploit the surrounding natural vegetation and acts as a food (milk and meat) and money bank. Livestock are generally kept in the vicinity of the village except from April to June when they are forced to migrate in search of grazing. Fodder is the third most important non-culinary attribute identified by men; it was ranked as sixth by women. Both groups ranked *Kona* as very good, and *Hagaz* and the local variety as fair. These scores were influenced by palatability; *Kona* being the most palatable. It is important to note that fodder is also a source of income and may be sold in the village and as far away as *Hagaz*.

Generally, however, there is a preference for sorghum stover as it is more palatable. As it is in shorter supply animals are inclined to feed on pearl millet. Because of its higher energy content pearl millet stover raises animal temperatures and makes them thirstier. This places additional demands on the limited drinking water in the area. The only potable water available for people is shared with livestock. Camels, donkeys, sheep and goats are fed with groundnut stover. Cattle are not fed on this because of its limited supply.

Thatchability for housing and storage facilities is a very important attribute in Shebek as there are no suitable alternatives in this dry and largely vegetation-free environment. Both *Hagaz* and the local variety are preferred for thatch as they have long and strong stems. *Kona* scored poor because of its shorter height and thinner stem.



Photo 4 Drying racks for sorghum and pearl millet in Shambuko

## Marketing

Marketability is considered to be the fourth most important non-food attribute by men, but was not mentioned by women. *Bultuq* scored highest as very good, whilst *Kona* and *Hagaz* scored as fair. Depending on the availability of grain and their groundnut harvest, up to approximately 25% of the grain is sold in the market. However, farmers are generally unwilling to sell their grain as this is mainly for subsistence needs, and prefer selling only groundnuts, especially so when the rains and hence the groundnut harvest were good.

As part of the agreement for the provision of *Kona* and *Hagaz* seed, farmers are required to sell a proportion of their harvest to the MoA. Even though the Ministry offers a generous 25% markup on the prevailing market rate farmers are unwilling to sell, preferring to keep the grain in their food reserves.

The main market centre is at Hagaz; the Sub zoba capital on the Keren-Akordat tarmac road, roughly 8 hours walk from Shebek. Grain is taken there by camel. Pearl millet grain prices for all varieties are highest between May and September (Nakfa 12.5/kg) and low-

est just after the harvest period in October / November (Nakfa 7.5/kg). Both men and women said that they would normally sell in August. This possibly indicates that they are food self-sufficient for most of the year.

## Seed

Farmers originally sourced their *Kona* and *Hagaz* seed from the MoA and now are more inclined towards saving their own seed and to rely on the Ministry when they need seeds. Shebek farmers also sell or exchange *Kona* and *Hagaz* seed to the surrounding villages. They informed us that there was a large demand from the other villages which are not served by the MoA.

## Trends of adoption

In 2001 Shebek farmers were only growing one local landrace, *Bultuq*. From that year onwards, the MoA introduced *Kona* and *Hagaz* as potential alternatives. Only one farmer took up the offer and in the same year (2001) he harvested much more than his neighbours. The following year most farmers turned to the released varieties on a share of their land. In 2006, 67% of their land was under *Kona*, 20% under *Hagaz*, and 13% under *Bultuq*. Their 2007 plans are similar to that of 2006, except with a slight increase in *Hagaz*.

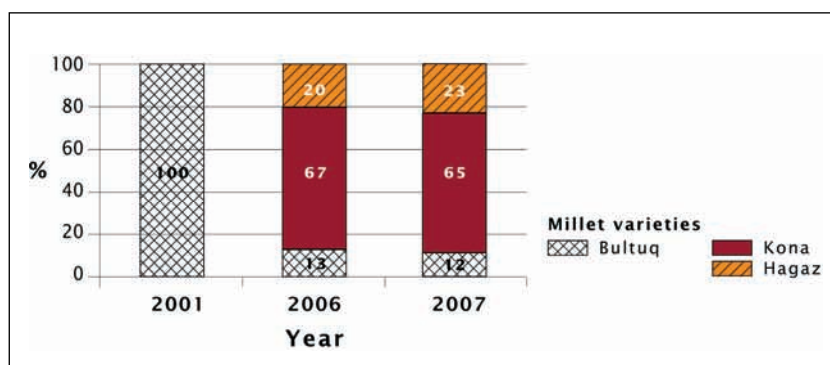


Figure 11 Shebek. Trends in pearl millet variety coverage

Our closing question was to ask what seeds the farmers required from the MoA in the future. They indicated that to date they were happy with the results that they obtain from the new pearl millet varieties. However, they would like to have the same results with their sorghum crop. The MoA in return promised that they would follow-up with this if they received farmer support in the free trials of sorghum. In addition the MoA has plans to trial groundnuts.

## Binbina Village

### Community background

Binbina is located in Sub Zoba Shambuko, Zoba Gash Barka. It is a village which largely comprises the Kunama ethnic group, with a small Tigrigna population. They mainly practise sedentary agro-pastoralism. Livestock plays an important part in their livelihood strategy, and they also engage in some trading of grain, local brew, handicrafts, fuel wood, wild fruits and medicines, and ghee (unrefined butter).

The Kunama society is matriarchal and women here have a larger freedom of action than in other ethnic communities in the country. Women play an important role in decision making within the family and the community at large. Pearl millet is culturally important and is considered to be the affair of women. They can grow, store and sell it as they see fit. During weddings it is also symbolically given as a bride gift by the bride's grandmother. All the other crops are grown primarily by men. Compared to the other ethnic groups in the country, Kunama women play a more direct and significant role in contributing to household food security.

The participants at the appraisal were largely women as they are the pearl millet farmers.

### Crop types

The main crops grown are sorghum, pearl millet, sesame, and maize. The grain crops are largely grown for subsistence needs, and sesame as a cash crop.

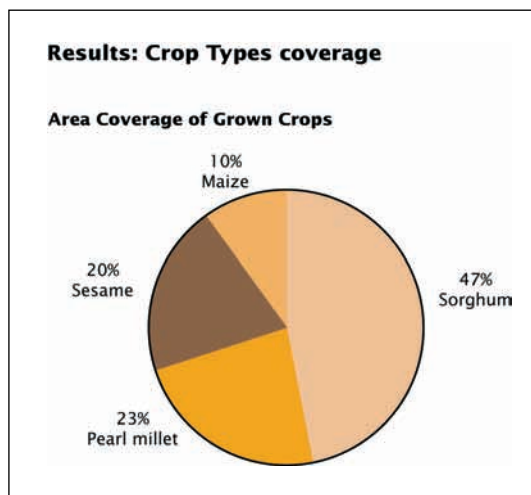


Figure 12 Binbina. Crop type coverage



Farmers cultivate sorghum as their main crop because it is less affected by bird pests compared to pearl millet. In addition, it can be used for brewing alcohol and for the preparation of *Tutuko* (plain boiled sorghum). Like pearl millet it can be made into *Injera*. Two varieties of pearl millet were grown in 2006: *Deda*; their local landrace, and *Kona*. *Hagaz* was grown in 2005, but due to a lack of seed, none of the farmers grew it in 2006. *Hagaz* would be a viable alternative as it is suited to this agro-climatic zone and soils. Other landraces grown in Binbina two generations back but abandoned now, are *Tosho*, *Alowa*, *Shera Berta*, and *Merda Berta* (see Annex 2).

The advantages of pearl millet over sorghum, in the eyes of the farmers, are that it can be mixed into sorghum to make *Injera* because it absorbs more water and therefore makes more *Injera*, it has a good taste, is drought tolerant, earlier maturing, gives more energy, stores longer, and its porridge is good for lactating mothers and children. Millet is also good as a rotation crop used to reduce the incidence of striga infestation, it has stover with higher protein content and its thatch is more durable.

The following graph (Figure 13) shows the overall priorities identified for pearl millet. It is the response to the question: 'What are the attributes that you look for in pearl millet?' The figures also show the rankings that the participants gave for each pearl millet variety grown in Binbina village. As the rankings between *Deda* and *Kona* are so close to each other the research team decided only to aggregate and average, but not roundup, the scores. 11 participants, with 5 seeds each, took part in the ranking.

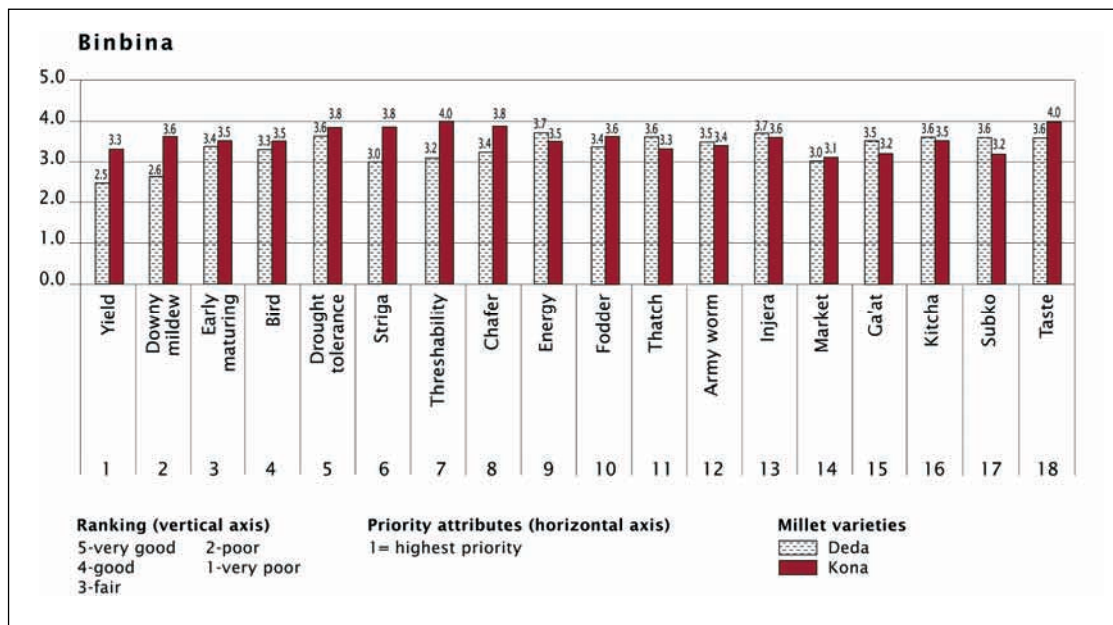


Figure 13 Binbina. Ranking of millet varieties

Looking across all attributes it is difficult to see which variety, *Kona* or *Deda*, scored better overall. However, a summation of all the scores shows that *Kona* scored as fair to good and *Deda* as fair. We shall not attempt to analyze each attribute as done for Shebek and Libana, but shall only look at the attributes where there is a significant difference between the two varieties.

## Yield

According to the pair-wise ranking yield was the most important attribute and *Kona* scored marginally better than *Deda*. Additional data gathered from the farmers with regards to the average maximum and minimum yields experienced over the past years, show that *Kona* yields one third more under best conditions and more than twice during poor rainfall conditions (Figure 14).

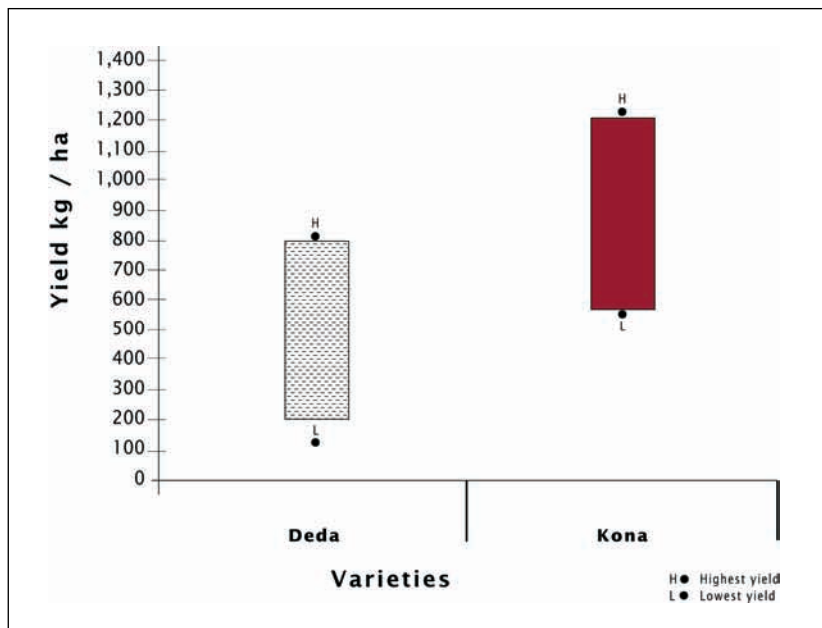


Figure 14 Binbina. Pearl millet yields in good and bad years

## Soils

In contrast to the other two villages, soil was not considered as a priority attribute here. Soils are primarily clayey (*Baduma* / *Walaka*) with a high water holding capacity and are therefore used to grow sorghum, with some pearl millet and sesame. Farmers also identify a stony soil which is primarily used for growing sorghum and sesame. This soil is to some extent protected from evaporation losses due to its stone cover on the surface (stone mulching effect). The third soil is sandy with a poorer water holding capacity. It is used to grow maize and sesame. The fourth and least fertile soil is lateritic, locally called *Lagabiba* (red soil), and is used for growing pearl millet; the only crop that gives a yield in this soil. Both pearl millet varieties are grown in this soil. It is interesting to note that pearl millet is grown in the poorest soils. By implication these are soils that are allocated to the women.



Photo 5 Camel drawn plough in Binbina, Shambuko. Ploughing millet fields here is done by women

## Climate

Binbina lies within the moist lowlands agro-ecological zone that ranges in altitude from 500 to 1,600m. 10 year average rainfall data in Shambuko where the nearest rain gauge is located is 381mm. A good year in the past decade received 569 mm<sup>3</sup>.

Early crop maturity was ranked as the third most important priority input. Both *Kona* and *Deda* scored as fair to good. Note that the farmers grow pearl millet in the least fertile and less water retentive soils in their remit. This means that the crop does not perform as well as its potential would allow.

Despite the relatively higher rainfall in this agro-ecological zone drought tolerance is still considered an important attribute. This also reflects the fact that pearl millet is grown in the worst soils. These soils have a low water holding capacity. Both varieties scored as good.

## Disease, pests and weeds

Downy mildew is the second most important attribute identified. *Kona* scored as fair to good and *Deda* as fair. The research team agrees that an on-the-field identification of the incidence of downy mildew needs to be carried out during the next growing season to determine why such a low score was given to *Kona*.

Common weeds include *Abebela* (*Corchorus olitorius*), *Elawa* (*Coleome gynandra*), *Dodota* (*Cassia obtusifolia*), *Alama* (*Convolvulus sagittatus*), *Afenfena* (*Setaria pumila*), *Weynaka* (*Striga hermontica*), *Arkubeshukufa* (*Amaranthus sp.*) and *Legogata* (*Tribulus terrestris*). These are removed manually using a hoe and by camel drawn ploughs in a process called *Gussia*, which is carried out in the second month after planting for the additional purpose of improving soil water retention and increased tillering. In the third month after planting an additional weeding is carried out by hand. This is performed through a traditional

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<sup>3</sup> Baseline Study on Livelihood Systems in Eritrea. National Food Information System of Eritrea (NFIS). 2005

community effort called *Kawo* where friends and family join efforts to undertake particularly demanding tasks.

Striga was ranked as an important weed that affects their sorghum crops. Resistance to it was ranked sixth in their priority list. *Kona* and *Deda* scored as fair to good. The research team questions this result as pearl millet in Eritrea is not known to be affected by striga. Again, we recommend a field investigation in Binbina during the 2007 growing season.

Chafer beetle ranked as the 8th most important attribute and army worm came 12th. Both *Kona* and *Deda* were ranked as fair to good against these pests.

*Kona* and *Deda* scored as fair to good for bird escape; this was the fourth most important attribute identified. Farmers said that pearl millet was most affected by birds as it is earlier maturing than sorghum. Their method of scaring birds is to tie strips of plastic sheeting on poles spread randomly in their field, which when blown by the wind act to scare the birds.

### Processing and utilization

Seed combinations are determined by women. They identify the best panicles in the field based on panicle size, disease resistance, and tillering capacity. After selection the seed is dried thoroughly and treated with ash and then stored in large clay pots within the living quarters. Properly dried seed can be stored for years, un-dried seed spoils after the first year.

Farmers did not rank storage as an attribute, however, discussions revealed that *Kona* stores well but not as well as the local variety; the reason being that the local one has a smaller seed size that dries out more quickly and evenly.

Grain is traditionally stored in large cylindrical clay pots almost 1.7 metres tall, which are kept within a special separate grain store. Many farmers also store grain in sacks within the grain store. The relative coolness within this thatched and mud-walled building helps preserve the quality of grain and reduces the incidence of storage pests and fungus.

Thatchability is an important attribute. *Deda* is their main choice as it has a tougher and longer stalk.

Food types (*Injera*, *Ga'at*, *Kitcha*, *Subko*) and properties (energy and taste) were identified amongst the priority attributes. They all ranked between fair to good for both *Kona* and *Deda*. Energy was identified as the most important food attribute of pearl millet. Their preferred food type is *Injera*. *Kitcha* and *Ga'at* are eaten usually in the morning. However, from September to October, they eat mostly *Ga'at* and *Kitcha* as they are eager to sample their new harvest. At this time they perform a two day cultural ceremony whereby only *Ga'at* is eaten for two days. *Subko* is fed to children and to the sick.



Photo 6 Hand grinding of pearl millet in Shambuko

Livestock plays an important role in their livelihood strategy as a source of food (milk and butter) and as a bank for lean times due to, for example, crop failures. It is not surprising, therefore, that fodder scored as an important attribute. Sorghum, maize and pearl millet were recognized as a main source of energy for livestock and are fed at critical times, such as during lactation, illness, and for weight gain. Farmers felt that grass is more useful to fill the animals' stomachs and would therefore come before crop stover as a feed. Sorghum and maize were considered more palatable than pearl millet. Farmers preferred *Deda* over *Kona* because it has more biomass.

### Marketability

Marketability is ranked as an important attribute. Both varieties scored as fair. In discussion we learnt that *Deda* has a higher market price than *Kona* on local markets (Table 3).

Table 3 Market prices for millet, Shambuko

Variety	Market price	
	Low price (Nkf/kg)	Highest price (Nkf/kg)
<i>Deda</i>	6	13
<i>Kona</i>	7	11

## Adoption trends

Due to limited time during the appraisal, we were unable to ask farmers about their plans relating to the area they would devote to millet production, and to the two varieties grown. However, they stated that they would continue to grow both *Kona* and *Deda*, and in addition requested for *Hagaz* seed for the coming season.

## Seasonal calendar

A seasonal calendar was drawn with this community to explore changes taking place over the period of one year. It provides information on how much work people have at different times of year, on how resource availability changes in different periods, and on other important aspects of livelihoods such as food and water availability.

Table 4 Pearl millet seasonal calendar Binbina

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Rainfall intensity			2	3	4	6	8	9	5			
Clearing												
Ploughing and planting												
Weeding												
<i>Gussia</i>												
Harvesting												Sorghum
Threshing												
Birdscaring												
Chafer												
Termites												
Labour intensity				1	2	2	3	4	4	8	8	5
Food availability	3	3	3	2	2	2	2	2	3	5	5	5
Livestock feed availability	4	3	3	2	1	1	2	3	4	4	5	5

Participants were given 37 seeds to distribute across the months of the seasonal calendar along predefined aspects, these were: rainfall intensity, labour intensity, food availability, and livestock feed availability. By limiting the number of seeds we aimed to obtain information that reflects the finite character of these resources. Table 4 presents the result. Higher numbers in the different squares indicate higher importance, need, or intensity for the period indicated by the square.



## Conclusions

The three villages presented in this study had been selected by the National Agricultural Research Institute (NARI) as release sites for the newly developed millet varieties (*Kona* and *Hagaz*) based on the compatibility of these varieties with the agro-ecological conditions found in these locations. The different agro-ecological and cultural background of these locations reflects the great diversity found in the millet growing areas of Eritrea.

Figures 15 to 17 illustrate the main priority attributes of both men and women as separate groups. The priority ranking scores for each attribute for Libana and Shebek were tallied and then averaged to provide a general overview of the priority attributes. The Kunama village of Binbina is illustrated separately as women are responsible for both cultivating and preparing food.

The attributes are separated according to the following groupings; 'Primary' for the top three attributes, 'Secondary' for the second set of three attributes, and 'Other' for the remaining attributes. In addition the attributes are grouped according to 'production' and 'use', the latter are illustrated in the top half of the diagrams.

**Pearl millet is a key part of local livelihoods and culture in the study areas.** In the perception of farmers, millet has **many different functions**. Safe food supply for the household is the growers' main concern, but there are many other qualities or attributes of millet that are important in their eyes. The different functions that millet fulfils in local livelihoods and their relative importance are illustrated by Figures 15 to 17.

As these figures show, **farmers** in all three villages rated drought tolerance, disease (downy mildew) resistance, early maturity and land suitability, as their most important production priority attributes for pearl millet. These qualities all relate to increased food security with a primary focus on dependability of a grain harvest rather than on its quantity. The introduced millet varieties scored higher than the local landraces for all of these attributes.

The women (Libana and Shebek) also ranked production attributes, such as downy mildew resistance and early maturity, as their most important overall. However, all the other attributes identified were 'use' attributes.



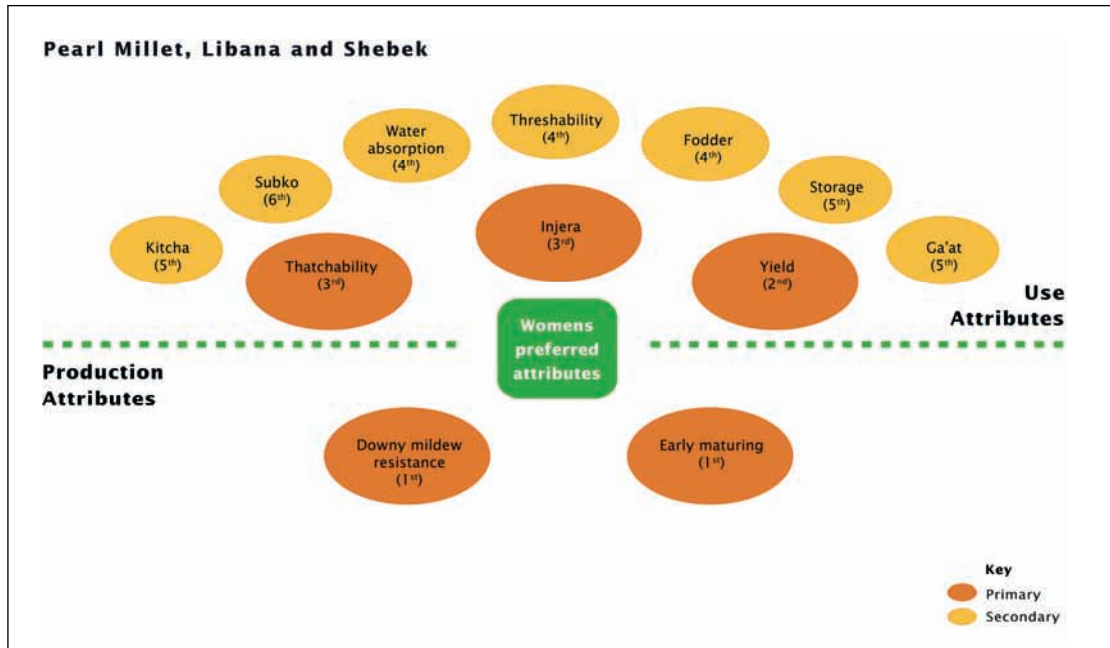


Figure 15 Women's priority attributes for pearl millet, Libana and Shebek

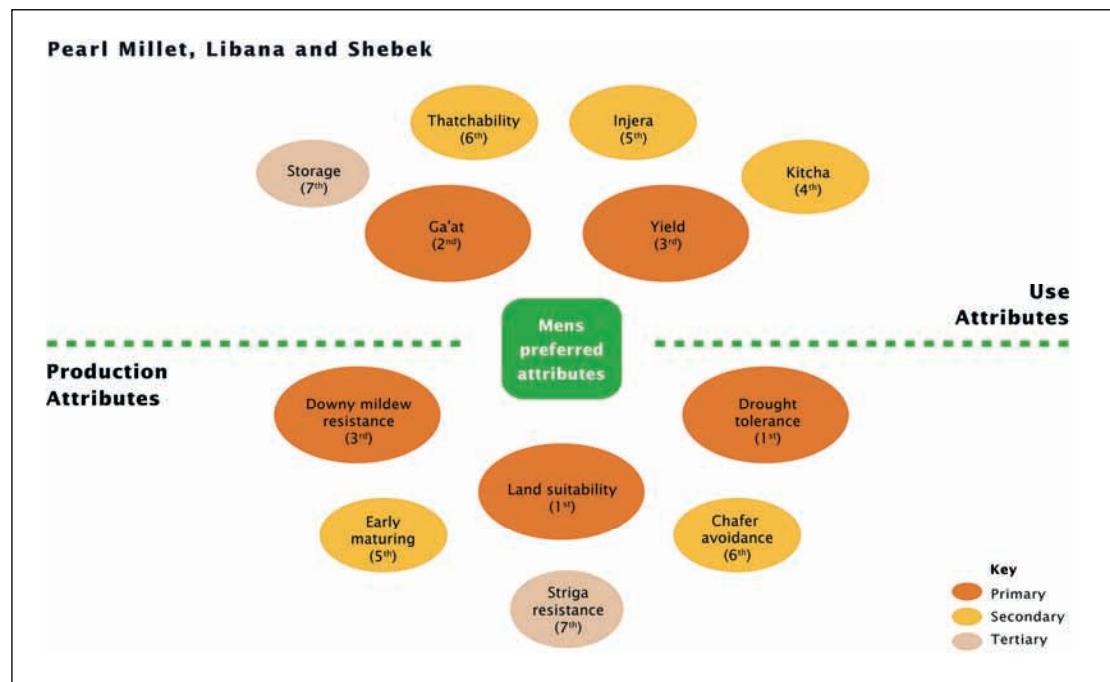


Figure 16 Men's priority attributes for pearl millet, Libana and Shebek

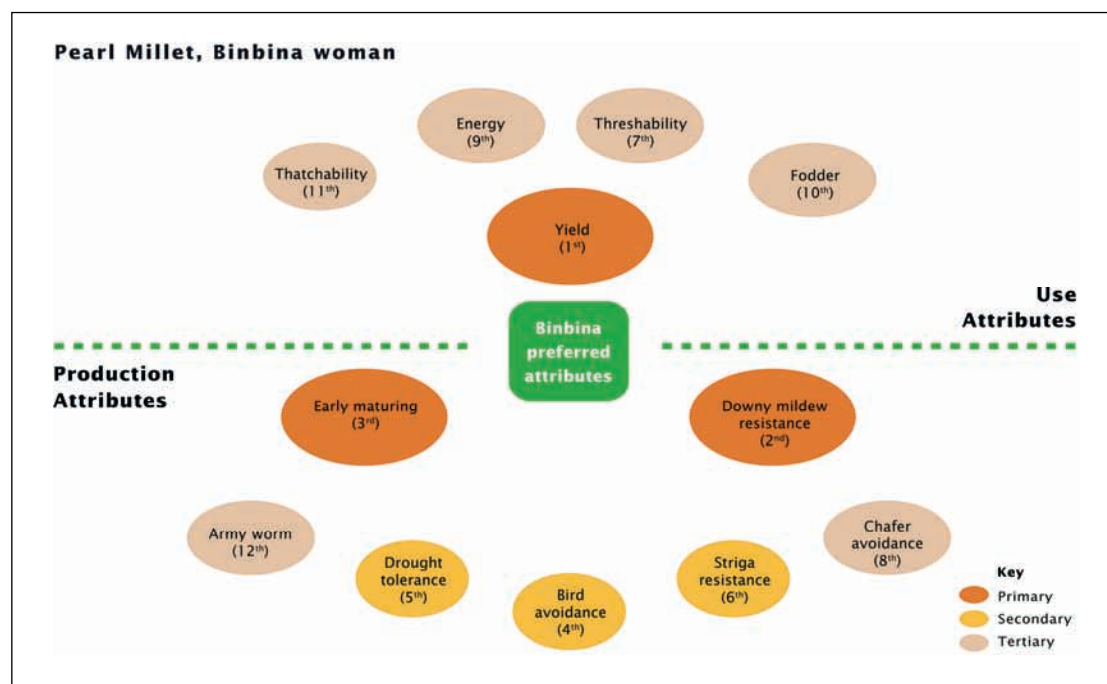


Figure 17 Binbina women priority attributes

The first appraisal was carried out in 2004 and two of the communities – Libana and Shebek – participated again in 2006. For the example of these two communities, the 2006 appraisal thus provided some insights into **farmers' changes in perception and adoption relating to the different pearl millet varieties**. The results from the appraisal in 2004 showed that women were more concerned with processing and consumption aspects, whilst men were concentrated with agronomic and production factors. In the current appraisal (2006), there was a change in the ranking of both men and women as compared to 2004. The men were now more specific in identifying food qualities for the different varieties. By contrast, the women gave less priority to culinary characteristics as compared to 2004, and their focus was now more on food security aspects such as downy mildew resistance, yield, early maturity, but also retained processing and consumption qualities (water absorption, threshability). Women have been able to adapt their cooking requirements to the new varieties. For consumption qualities, 'water absorption' or 'water solubility', was the most important culinary aspect. It refers to the flours' capacity to absorb water and is helpful in the preparation of all the food types. As some women mentioned, a high water absorption level means that with a smaller proportion of flour one is still able to produce a satisfying meal in terms of quantity. It can be deduced that due to this high water solubility the grain's vital substances can, like liquid nutrients, be absorbed quickly by the body. *Kona* scored highest for this attribute.

Farmers perceptions are influenced by the interlinkage of several factors that are crucial for pearl millet production; including socio-economic and agro-ecological factors. At the biophysical level these are annual variations in growth and yield defining factors (varieties, climate), growth and yield limiting factors (water and nutrients), and growth and yield reducing factors (pests and disease). (InterAcademy Council. 2004). For example; the effects of downy mildew are increased with increased levels of humidity; the incidence of chafer beetle is determined by the patterns of rain; poor early rains increase the incidence of striga and weaken the sorghum plant thereby increasing the negative effects of

the weed. A poor sorghum crop affected by striga will influence farmer's attitudes towards the benefits of growing striga resistant pearl millet.

The **adoption rate** of the new varieties has been dramatic and has led to a reduction in the area cropped under local varieties. The research team recognizes that the current dual programme of introducing new varieties on the one hand, as well as conserving local landraces ex-situ on the other hand should be continued. The MoA currently maintains some local landraces off-farm in refrigerated sites and periodically plants out the seed to ensure their long term viability. However, a comprehensive collection and study of all landraces is needed to make sure that current Eritrean genetic diversity is preserved and can be enhanced for future generations. In addition, a programme for on-farm improvement or maintenance of landraces should be promoted to ensure that the cultural knowledge associated with these local land races is retained.

A wider uptake of the improved varieties has been hampered by the current **low availability and accessibility of improved seed**. One way to meet this demand sustainably and step up supplies would be the production of good quality seed placed largely in the hands of the farmers themselves. In 2006, this approach was explored by the MoA through a series of workshops and the development of a proposal for the establishment of a pilot **Village Based Seed Enterprise** in Shebek, one of the test villages for this present study.

Even though farmers aim to ensure household food supplies first before they sell grain, experience has shown that they do have to sell at regular intervals as the need arises. Investigations made by the team of this present study at the farmer level and at the main regional **markets** revealed that the introduced varieties still receive a lower market price than the local varieties. In order to increase the potential of the new varieties for improving cash returns for those who have to sell grain at a given time, a programme of popularisation of the new varieties should be considered.

Dramatically increased yields in areas with inherently low soil fertility are unsustainable. A holistic **natural resource management package** is being prepared by NARI for development with farmers in Shebek to ensure that they are able to maintain their yields sustainably. Measures planned are the introduction of tied-ridges, intercropping with cowpea, and rotation with groundnuts. Biomass is in low supply so efforts should be made to meet the high demand for livestock fodder. An integrated approach, such as this, looking at the farming system within a livelihoods framework may be the appropriate approach to help determine possible remedies for a return of some of that biomass to the soil.

We also learnt that farmers maintained a comparison to **sorghum** when they made their rankings for the pearl millet varieties. Generally, it was found that sorghum was a preferred crop and that they would increase its hectareage if they had more suitable soils, striga resistant varieties and adequate rainfall. The preference of sorghum relative to pearl millet is influenced by; its higher grain yield, more palatable and higher fodder biomass, and it is easier to thresh than pearl millet. This information is important for the MoA in guiding it in its efforts to develop new pearl millet *and* sorghum varieties that meet farmers demands.

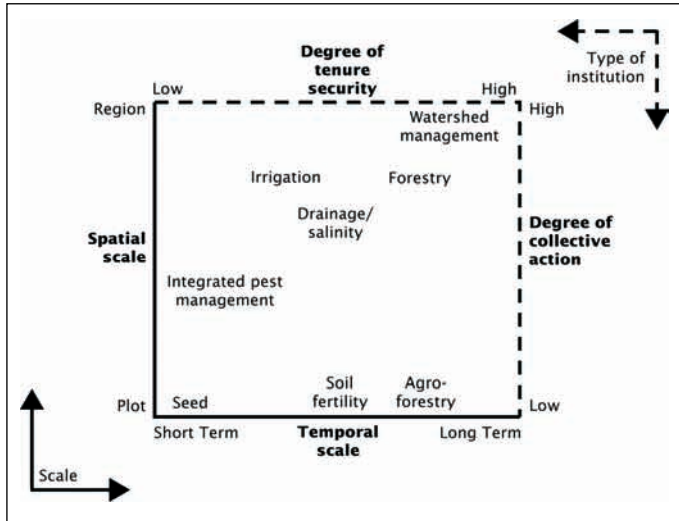


Figure 18 Property rights, collective action, and sustainable agricultural and natural resource management. (adapted from Knox et al., 2005)

The importance of improved varieties in increasing production and productivity has been clearly demonstrated. When compared to other technology solutions developed to improve farmers’ livelihoods, quality seed including provision of seed from improved varieties has the capacity to make a relatively quick impact with a minimum amount of supplementary input at the farmer level (Figure 18). The adoption of seed is largely based on an individual farmers choice and is not hindered by the need for wider community based decisions or land tenure issues. Impacts can be seen within one growing season, allowing vulnerable groups to quickly develop their capital base and reduce their vulnerability to shocks or seasonality. As a comparison, watershed management efforts would require a longer term horizon, higher land tenure security, and a large degree of community participation to ensure success at both farmer and watershed level. Results from watershed management interventions are prone to more risks, especially as people are inherently individualistic, and so a change in one farmer’s efforts, without community involvement, is unlikely to make a difference.

Table 5 *Summary of conclusions*

1. Pearl millet is an intrinsic part of **local livelihoods** and **cultures**.
2. Overall, farmers seek to meet their **immediate household food security** needs. When compared to other technology solutions, such as soil and water conservation, quality seed has the capacity to make a quick impact, with a minimum amount of supplementary input at the farmer level. The impact can be seen within one season and hence allows vulnerable groups to quickly develop their capital base.
3. **Gender** differences are reflected in the priority attributes identified. Men are more concerned with production, and women with use and consumption aspects.
4. **Perceptions** are influenced by different gender objectives and by annual variations in yield defining factors (varieties, climate), yield limiting factors (water and nutrients), and yield reducing factors (pests and disease).
5. **Adoption rates** have increased rapidly since the introduction of the new varieties in 2001. The new varieties are now the most widely grown types in the study areas, and cover 60 to 80% of land allocated to pearl millet.
6. The increase in area coverage of new varieties at the expense of local varieties suggests that there is a risk of loss in **indigenous genetic variety**. A comprehensive collection of local materials and knowledge associated with these varieties is to be advised.
7. A wider uptake of the new technology has been hampered by the currently low availability and accessibility of improved seed. Potential exists to supply this extra **demand for seed** through the establishment of local and decentralized '**Village Based Seed Enterprises**'.
8. The new varieties fetch a lower **market price** compared to local varieties. In order to increase cash returns from the released varieties, a programme for their popularization should be considered.
9. The higher yields obtained from the new varieties will lead to increased demands on the fragile soils found in the study areas. In order to ensure sustainable yields and to maintain soil quality a joint farmer–research solution is being developed to incorporate **improved soil management techniques**.
10. Farmers maintained a comparison between pearl millet and **sorghum**. Market demand, grain yield, palatability and yield of fodder for livestock, and ease of threshing, are the winning attributes of sorghum. This information is important in developing traits that farmers demand; and is applicable to both pearl millet and sorghum breeding.

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# ANNEX 1

## Selected key information on the improved pearl millet varieties

### **KONA variety (ICMV 221)**

- Potential grain yield - 20 - 28 qt/ha
- Downy mildew resistance - less than 1% infestation
- Drought tolerance
- Early maturing - 70 - 75 days
- Medium plant height - 160 - 200 cm
- Bold, attractive panicles
- Tillering - 2-5
- Sowing time- Early July -Mid July
- Method of sowing - row planting/broad casting
- Seed rate - Broad casting - 5-8 kg/ha, row planting - 3 kg/ha
- Fertilizer rate - DAP 100 kg/ha, Urea 50-100 kg/ha
- Time of fertilizer application - DAP at time of sowing basal application, Urea 3 weeks after planting as top-dressing
- Weed control - once, after two weeks from planting

**Recommended regions for planting:** In the drier areas of Zoba Anseba, Gash Barka or when rainfall starts late July

### **HAGAZ variety (ICMV 221 x Tokroray)**

- Potential grain yield - 22.0 - 30 qt/ha
- Downy mildew resistance - less than 5% infestation
- Drought tolerance
- Early maturing - 75 - 85 days
- Medium - tall plant height - 200 - 230 cm
- Bold, attractive panicles
- Tillering - 2-5
- Sowing time- Late June - early July
- Method of sowing - row planting/broad casting
- Seed rate - Broad casting - 5-8 kg/ha, row planting - 3 kg/ha
- Fertilizer rate - DAP 100 kg/ha, Urea 50-100 kg/ha
- Time of fertilizer application - DAP at time of sowing basal application, Urea 3 weeks after planting as top-dressing
- Weed control - once, after two weeks from planting

**Recommended Zobas for planting:** In the wetter areas of Zoba Anseba, Gash Barka or when rainfall starts late June





## Annex 2

### Selected key information on local pearl millet landraces

S. No	Name	Area where found	Agronomic characters
1	<i>Bariyay</i>	Anseba and Gash Barka	Short plant height, early maturing (60–75 days) with good tillering capacity, tolerant to drought and susceptible to downy mildew
2	<i>Tokroray</i>	Anseba and Gash Barka	Medium to tall plant height, late maturing (90 days) good tillering capacity, susceptible to downy mildew and has bristled panicle
3.	<i>Zibedi</i>	Anseba and Northern Red Sea	Tall plant height, good tillering capacity, late maturing (nearly 120 days), susceptible to downy mildew and gives high grain yield with high rain-fall
4	<i>Shera Berta</i>	Gash Barka (around Bar-entu)	Short plant height, less tillering capacity, early maturing (nearly 90 days), susceptible to downy mildew, drought tolerant and bristle in nature
5.	<i>Tika Berta</i>	Gash Barka (around Bar-entu)	Tall plant height, good tillering capacity, medium maturing (nearly 100 days), moderately resistance to downy mildew , drought tolerant and Bristle nature
6	<i>Merda Berta</i>	Gash Barka (around Bar-entu)	Short plant height, early maturing (nearly 90 days), good tillering capacity, susceptible to downy mildew
7.	<i>Kunama</i>	Gash Barka (around Sham-biko mainly)	Short to medium plant height, early maturing (nearly 90 days), good tillering capacity, susceptible to downy mildew, not drought tolerant
8	<i>Tosho</i>	Gash Barka (around Sham-biko)	Medium to tall plant height, good tillering capacity, early maturing (nearly 90 days), some resistance to downy mildew disease , bristle nature and susceptible to lodging
9	<i>Deda</i>	Gash Barka (around Sham-buko mainly)	Short plant height, good tillering capacity, early maturing (nearly 90 days), susceptible to downy mildew
10	<i>Gudmay</i>	Gash Barka (around Aw-garo and Gogne )	Medium to tall plant height, good tillering capacity, early maturing (nearly 90 days), susceptible to downy mildew and smut, bristle nature
11	<i>Bultuq</i> (Keren/ Mebred)	Anseba	Tall plant height, good tillering capacity, medium to late maturing (nearly 90–110 days), susceptible to downy mildew and smut disease and requires more rainfall
12	<i>Sheleti</i>	Anseba	Medium plant height, less tillering capacity, early maturing (nearly 90 days), susceptible downy mildew and drought tolerant

Highlighted: landraces referred to in this study

### **Previous SLM Reports**

- Report 1 A Baseline Survey for Sustainable Development of the Deki Lefay Community, Eritrea (1998)
- Report 2 Tradition in Transition – Aspects of Rural Livelihoods in the Eritrean Highlands. A survey for sustainable development of the Adi Behnuna community, Eritrea (2001)
- Report 3 Long-term Monitoring of Soil Erosion and Soil and Water Conservation in Afdeyu, Eritrea 1984–1998 (2002)
- Report 4 Small-scale Micro Irrigation in Eritrea. A feasibility study of affordable micro irrigation technology in Eritrea (2003). Available as a CD Rom.
- Report 5 Amadir. Livelihood and Resource Management in an Eritrean Highland Community. A development baseline (2005)
- Report 6 Land Management in the Central Highlands of Eritrea. A participatory appraisal of conservation measures and soils (2006)
- Report 7 Farmers' appraisal of pearl millet varieties in Eritrea (2006)

### **Other reports related to SLM**

Soil and Water Conservation and Management in Eritrea. Current Status and Trends. Published by AEAS (Association of Eritreans in Agricultural Sciences) jointly with SLM (1999)

Irrigation Development in Eritrea: Potentials and Constraints. Proceedings of the Workshop of the Association of Eritreans in Agricultural Sciences (AEAS) and the Eastern and Southern Africa Partnership Programme (ESAPP) (2005)

Innovative Agricultural Approaches of Promoting Food Security in Eritrea: Trends, Challenges and Opportunities for Growth. Proceedings of the Workshop of the Association of Eritreans in Agricultural Sciences (AEAS), 2–3 March 2006, Asmara, Eritrea. (2007)



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