Table 3. Preferences of Farmers for the Various Varieties in the Sensory Evaluation Conducted in Korahar, Bihar, India, 1998

Variety	Most liked*		Least liked*	
	Raw	Parboiled	Raw	Parboiled
Brown Gora	0	0	13	5
RR139-1	4	0	2	8
RR151-3	16	0	1	15
RR151-4	8	6	2	2
RR166-645	1	10	10	1
RR203-16	3	9	4	0
RR2-6	1	11	14	0
RR265-1	2	10	3	0
RR347-166	8	2	1	7
RR348-5	7	6	2	3
RR348-7	3	2	15	11
RR352-1	14	0	1	7
RR354-1	14	16	2	1
RR50-5	4	4	4	4
RR51-1	3	3	1	3
Vandana	0	0	1	13

*Farmers were asked to give the codes of the four varieties they liked most and the four varieties they liked lease. However, some of them gave only 1 or 2 scores.

Table 4. Correlations between Farmers' Ranks for Quality Traits of Raw and Parboiled Upland Rice Varieties (Women's and Men's Rankings Pooled Together), Korahar, Bihar, India, 1998

Trait		Milled rice app.	Cooked rice app.	Odor	Color	Texture	Stickiness	Taste
Milled rice app.	Raw Parboiled							
Cooked rice app.	Raw Parboiled	0.59* 0.55*						
Odor	Raw Parboiled	0.72** 0.68**	0.85** 0.88**					
Color	Raw Parboiled	0.60* 0.60*	0.84** 0.87**	0.88** 0.88**				
Texture	Raw Parboiled	0.46 0.50*	0.76** 0.87**	0.80** 0.87**	0.83** 0.85**			
Stickiness	Raw Parboiled	0.18 0.29	0.47 0.62*	0.45 0.66**	0.29 0.48	0.20 0.52*		
Taste	Raw Parboiled	0.58* 0.53*	0.87** 0.83**	0.71** 0.72**	0.72** 0.71**	0.72** 0.74**	0.28 0.39	
Acceptability	Raw Parboiled	0.67* 0.52	0.81** 0.81**	0.82** 0.87**	0.79** 0.75**	0.75** 0.77**	0.23 0.39	0.90** 0.91

Opinions of women and men farmers were similar, with significant to highly significant correlations between their rankings for milled rice appearance, cooked rice appearance, texture, color, and taste (table 5). The only traits for which their agreement was weaker was stickiness and, to lower

Table 5. Correlations between Women and Men Farmers' Mean Ranks for Cooking Characteristics of Raw Rice, Korahar, Bihar, India, 1998

Trait	Spearman rank coefficient of correlation
Milled rice appearance	0.97**
Cooked rice appearance	0.57*
Odor	0.45
Color	0.75**
Texture	0.55*
Stickiness	0.22
Taste/flavor	0.54*
Acceptability	0.83**
Most liked	0.88**
Least liked	0.95**

Note: Sample size was 12 women and 12 men.
* = Significant at 5% level.
** = Significant at 1%.

extent, odor. In terms of overall acceptability, there was no difference in women and men farmers' opinions on the tested varieties nor in their final choices of the varieties they liked most and least.

Laboratory analysis versus sensory evaluation

The ranks given by farmers for the various quality traits were compared with the ranks of the same varieties for the main chemical properties of raw rice measured in the laboratory: alkali value, volume expansion, amylase content, and elongation ratio. Elongation ability was negatively correlated with stickiness $r = -0.55$, significant at the 5% level) but that was the only significant case. In the samples tested, amylase content did not seem to have any link to farmers preferences for texture $r = -0.14$) or stickiness $r = 0.04$).

It is unexpected to see so few relationships between consumer preferences and measurable chemical properties, since these are standard parameters used by all chemistry laboratories. However, for the varieties included in the evaluation, the variability for some traits was limited and therefore consumers had difficulty assessing differences.

Field performance versus grain quality

There was little relationship between farmers' field ranking and grain quality for parboiled rice, as shown by the very low coefficients of correlation for rank and a negative one for the ranking based on yield (table 6). The relationship was stronger and positive for raw rice. There was no particular reason why the rankings should be correlated, but a strong negative correlation would complicate the breeding work. These results confirm that participatory varietal selection should not stop after harvest. Since a compromise might be necessary, at least for parboiled rice, the trade-off between criteria for agronomic performance and cooking quality applied by farmers has to be assessed.

Table 6. Correlation Between Field Ranking and Yield, and Farmers Preferences based on Grain Quality, Korahar, Bihar, India, 1998

Variety	Farmers field ranking	Ranks based on observed yield	Most liked *		Acceptability ***	
	(1)	(2)	Raw	Parboiled	Raw	Parboiled
Brown Gora	15.0	10.5	15.5	14.0	16.0	14.0
RR139-1	12.0	16.0	7.5	14.0	9.0	8.5
RR151-3	4.0	2.0	1.0	14.0	1.0	15.5
RR151-4	2.0	10.5	4.5	6.5	4.0	5.0
RR166-645	6.0	8.0	13.5	3.5	12.5	6.5
RR203-16	10.0	12.0	10.0	5.0	7.0	13.0
RR2-6	8.0	13.5	13.5	2.0	14.0	4.0
RR265-1	13.0	13.5	12.0	3.5	12.5	6.5
RR347-166	3.0	3.0	4.5	10.5	9.0	12.0
RR348-5	11.0	6.5	6.0	6.5	5.0	8.5
RR348-7	16.0	15.0	10.0	10.5	15.0	10.5
RR352-1	7.0	5.0	2.5	14.0	2.5	2.0
RR354-1	5.0	9.0	2.5	1.0	2.5	1.0
RR50-5	9.0	6.5	7.5	8.0	6.0	3.0
RR51-1	14.0	4.0	10.5	9.0	11.0	10.5
Vandana	1.0	1.0	15.5	14.0	9.0	15.5
Rank correlation with (1)			0.35	0.03	0.57*	0.06
Rank correlation with (2)			.027	-.034	0.45	-0.28

* Ranked from 1 (most liked) to 16 (least liked); results of a participatory varietal trial conducted in Korahar in 1998 wet season.
** Ranked from 1 (highest yield) to 16 (lowest yield).
*** Ranked from (most acceptable) to 16 (least acceptable).

Conclusions and recommendations

Grain quality is an important selection criterion (Juliano and Villareal 1993). Sensory evaluation with farmers allows us to assess varietal preferences under conditions of food preparation very close to that of the final consumer. For the set of varieties tested, men and women seemed to share the same opinions. The physico-chemical analysis did not indicate much power to predict the results of farmers' rankings. The methodology was satisfactory although quite costly in terms of organization time. It is important to define which of the two modes of preparation (raw rice or parboiling) is most prevalent in the target area, since they lead to different varietal choices. A simplification of the ranking system by reducing the number of ranked traits is possible.

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Incorporation of Users' and Gender Perspectives in Farmer-Led Participatory Plant Breeding on Maize: Experiences from the Western Hills of Nepal

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Abstract

Maize production is the main source of livelihood for the farmers of the western hills of Nepal. However, farmers have very limited access to improved varieties of maize, suitable to their local requirements. They cultivate a number of maize varieties maintained locally through continuous selection for preferred traits. An initial survey of the two project sites in the Gulmi district of western Nepal suggests that farmers apply a number of criteria to the selection of a particular maize population to suite their production environment and to meet their family requirements for different uses of maize. However, the survey results show that the differences among farmers in the preference for and selection of a particular maize variety are not very strong. The report discusses the ways these differences have been analyzed and incorporated into the design of participatory plant breeding for the improvement of local maize varieties by the farmers.

Introduction

Maize is the first most important food crop in the hills of Nepal in terms of both area and its contribution to household food security. It occupies about 0.8 million hectares (about 35% of the total cultivated area); 78% of this is in terraced hill farming, which produces over 1.3 million tonnes per annum (CBS 1999). The productivity of maize, however, is quite low (1.7 tonnes/hectare) and, as a result, there is high incidence of food-deficit households in the hills of Nepal. One of the major contributing factors to this low yield is the poor performance of farmer-maintained maize varieties. Farmers' access to new seeds and varieties is extremely poor and, at the same time, a majority of farmers tend to keep their own seed without replacing it for years. It is estimated that nearly 90% of the total seed requirements for cereals and other food crops in the country is met by the traditional seed-supply system (Cromwell et al. 1993; Joshi 1995). Since maize is an open-pollinated crop, even new varieties rapidly get contaminated with the undesired traits of local varieties. On the other hand, most of the new varieties developed so far neither fit well with local environments nor meet farmers' diverse needs. Therefore, it is increasingly being realized that breeding must be carried out in the target environment with the full participation of farmers so that the users' perspective is well reflected in the new varieties developed.

The environments where maize is produced in the hills of Nepal are very diverse in terms of topography, soil types, and use of production resources. There are also differences between farmers and farming communities in terms of access to resources (i.e., wealth) and food culture, which is governed largely by ethnicity. These differences exist not only between wider agroecological zones but also between farming families in the same village. For these reasons, farmers require a large number of varietal options to fit into diverse production niches and to meet the varied consumption

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requirements of the farming families. Similarly, because of differences in gender roles and gender needs, there are also requirements for different maize varieties within the same household. Previous studies (Acharya and Bennet 1981; Bajracharya 1994; Shrestha 1998) suggest that women play important roles in agricultural activities and are responsible for major farming decisions. Because of these gender differences, different family members usually have different varietal needs and behave differently toward new crop varieties. The consideration of users' and gender perspectives in the process of variety development, therefore, is vital.

Local Initiatives for Biodiversity Research and Development (LI-BIRD), in collaboration with the Systemwide Program on Participatory Research and Gender Analysis (PRGA), is conducting research on a farmer-led participatory maize-breeding approach that incorporates users' and gender perspectives in developing farmers' preferred maize varieties. The two research sites, namely Darwar Devisthan and Simichaur, are located in the Gulmi district of the western hills of Nepal. This paper draws upon the work and experience of researchers in this collaborative project and discusses the findings regarding the analysis of this research and its subsequent incorporation into the research process.

Methods and sources of information

Various sources of information have been used in the report. These include focus-group discussions (FGDs) conducted during participatory rural appraisals, participatory gender analysis, and household baseline surveys undertaken at the Darwar Devisthan and Simichaur research sites at the inception of the project. Separate FGD sessions were held with different groups of farmers, categorized by gender, wealth, and ethnicity. There were two categories under gender—male and female; three categories under wealth—rich, average, and poor; and three categories under ethnicity—Brahmin/Chhetri/Jogi (BCJ), Gurung/Magar/Newar (GMN), and Kami/Damai/Sarki (KDS). The categorization of farming-household wealth was done by the farmers themselves, using their own perceptions and knowledge of wealth of these households. The ethnic categorization was done by researchers on the basis of sociocultural similarities.

The participatory gender analysis involved the analysis of gender roles and decision-making patterns in the production and utilization system for maize. A sample of 30 selected households was facilitated in doing their own gender analysis by using a pictorial set of a man, woman, and child, and maize grains, to indicate their roles. Similarly, a detailed household baseline survey was conducted to collect detailed and widely representative information, which also served as a major source of information for this report. It involved a questionnaire survey of 100 households (40 at Darwar Devisthan and 60 at Simichaur) selected using a stratified random sampling technique.

Analysis of users' and gender perspectives in maize farming

Users' perspectives in maize production and utilization

The perspective of users in maize production and utilization was analyzed using two socioeconomic variables: ethnicity and the wealth categories derived from participatory wealth ranking. The analysis of gender perspectives, on the other hand, utilized information from male- and female-headed sample households that were included in the household baseline survey. Of the total sample households surveyed, 19% were female headed. These are mostly *de facto* household

heads, i.e., women have taken charge of managing the farm while men work off-farm away from home for several months, mostly in India.

Characteristics of heads of households

The characteristics of the heads of maize-growing households are presented in table 1. The family members who make major farming decisions are mature, with an average age of 50 years. Their literacy rate is much higher (81%) compared to the national literacy rate (39.6%). However, a majority of them (47%) are either barely literate or have a primary-level school education. The family member making the main farming decisions is younger and more illiterate in the average and poor wealth categories, in the KDS and GMN ethnic households, and in female-headed households.

Characteristics of maize-growing households

The characteristics of the maize-growing households are presented in table 1. The maize-farming families are relatively larger than nonfarming families, with an average of seven members per family. The family size is, however, relatively smaller in the average and poor wealth categories and in the KDS and GMN ethnic households than in other households. This implies that the family labor available to these households is less than in other households. Though farming is the major occupation for the households of the two research sites, family members of 72% of the farming households are engaged in off-farm activities to earn additional cash income for the family. The percentage distribution of these households across wealth categories and male- and female-headed households is similar. The percentage of households with family members engaged in off-farm activities, however, is slightly higher in the GMN and KDS households than in the BCJ households.

Maize is the main livelihood crop for the farmers of the research sites. The maize production in the area is subsistence-oriented and production is largely for self-consumption. The self-produced food, however, is not adequate to meet household food requirements. About 86% of the farming household experiences food deficits from less than one to 11 months of the year, and the average length of food self-sufficiency is only about seven months. The degree of food deficiency varies among the different household categories. The average time of food self-sufficiency is lower in average and poor households, in BCJ and KDS ethnic households, and in female-headed households. Only a small proportion of the households (10.4%) sell maize. The proportion of households selling maize is similar across households of different ethnic categories but is lower in the average and poor households and in male-headed households. A high proportion of the households (61%) purchase maize to offset their food-grain deficit. The differences in the proportion of households purchasing maize is highly significant ($p < .0001$) across wealth categories but not significant across ethnic categories and across male- and female-headed households. There is virtually no market influence on farmers' choice of maize varieties.

Access to farm resources

In general, farmers are smallholders with an average maize-growing *bari* land holding of 0.4 hectare, scattered over an average number of 2.3 parcels (table 1). (*Bari* represents rainfed upland where a maize-based cropping system is dominant.) The average holding size and the number of parcels of *bari* land decrease with the wealth of the farming household. The differences in *bari* land holdings are highly significant across wealth categories ($p < .0001$). Similarly, the variation in number of parcels of *bari* land per household is also significant ($p < .05$) across wealth categories. These differences in *bari* land holdings and the number of *bari* parcels per household are not statistically significant across either ethnic categories or male- and female-headed households.

Table 1. Characteristics of Maize Growing Households at Darwar Devisthan and Simichaur in Gulmi District, Nepal

Characteristics	All	Gender categories		Wealth categories			Ethnic categories		
		Male	Female	Rich	Medium	Poor	BCJ	GMN	KDS
Age of household head (years)	50.1±1.1	51.4±1.7	44.4±2.1	52.6±2.4	49.3±2.4	48.1±2.8	49.6±1.6	56.4±5.1	47.6±5.0
Education of household head (%)									
Illiterate	19.0	12.3	47.4	6.0	23.3	29.0	15.0	10.0	60.0
Just literate/primary education	47.0	48.1	42.1	57.1	43.3	40.0	45.0	80.0	30.0
Secondary education	21.0	24.7	5.3	14.3	23.3	26.0	24.0	10.0	10.0
University education	13.0	15.0	5.3	22.2	10.1	6.0	16.3	0.0	0.0
Food self-sufficiency (month)	7.2±0.3	7.3±0.4	6.8±0.6	8.9±0.5	7.6±0.5	5.3±0.4	7.5	9.3	3.3
Wealth class (% household)									
Rich	35.0	26.0	32.0	35.0	0.0	0.0	40.0	30.0	0.0
Medium	30.0	29.6	32.0	0.0	30.0	0.0	31.3	40.0	10.0
Poor	35.0	34.6	37.0	0.0	0.0	35.0	29.0	30.0	90.0
Family size (number)	6.7±0.4	7.2±0.4	4.9±0.5	7.8±0.5	6.1±0.5	6.2±0.7	6.9±0.4	5.4±0.9	6.7±1.0
Resource ownership									
Bari land (ha/household)	0.4±0.04	0.4±0.1	0.3±0	0.6±0.1	0.4±0	0.3±0	0.4±0.1	0.4±0.1	0.2±1
Parcel of bari land (Mean)	2.3±0.1	2.4±0.2	1.9±0.3	2.8±0.3	2.2±0.2	2.0±0.1	2.4±0.1	2.5±0.7	1.6+0.3
Buffalo (number)	2.6±0.1	2.7±0.2	2.05±0.2	3.2±0.2	2.6±0.2	1.2±0.1	2.7±0.2	2.2±0.3	1.6±0.2
Cattle (number)	2.4±0.2	2.4±0.3	1.5±0.5	2.7±0.4	2.1±0.4	2.2±0.4	2.5±0.3	1.8±0.4	2.0±0.0
Goats (number)	2.5±0.2	2.6±0.3	2.2±0.2	2.6±0.4	2.1±0.2	2.7±0.4	2.7±0.2	2.0±0.5	1.2±0.2
Poultry (number)	5.5±0.6	6.0±0.7	2.3±0.6	5.4±1.2	6.5±1.5	5.1±0.9	4.3±0.7	8.1±1.5	6.0±1.6
Livestock unit per household	2.8±0.2	3.0±0.2	1.9±0.2	3.8±0.4	2.7±0.2	1.8	3.0±0.2	2.4±0.4	1.4±0.2
Off-farm labour (%)	72.0	71.6	74.0	71.4	73.3	71.4	70.0	80.0	80.0
Sell maize (%)	10.4	9.1	16.0	20.0	3.4	6.3	12.0	-	11.1
Purchase maize (%)	61.0	60.3	64.3	31.0	74.0	84.0	60.3	44.4	100
Cultivation of improved variety (%)	13.0	8.3	39.0	13.3	12.0	13.3	16.2	0.0	0.0
Changing seeds for the last 5 years (%)	38.6	38.0	42.0	35.0	35.0	44.4	37.3	40.0	44.4
Participated in training (%)	8.2	8.8	6.0	15.2	7.0	3.0	10.4	0.0	0.0
Participated in educational tours (%)	6.0	7.4	0.0	9.0	7.0	3.0	7.5	0.0	0.0
Received information on improved technology for maize production (%)	15.1	16.0	12.0	23.0	21.0	3.0	19.0	0.0	0.0

Note: Ethnicity is represented as BCJ = Brahmin/Chhetri/Jogi; GMN = Gurung/Magar/Newar; KDS = Kami/Damai/Sarki.

Livestock forms an important and integral part of the farming system and, among other things, provides a major source of nutrients (i.e., manure) for plants. Buffalo, cattle, goats, and chickens are the main kinds of livestock in the area, with an average livestock unit of 2.8 per household. The average livestock unit is highest among households in the rich and BCJ categories and lowest in poor and KDS households. This difference is significant across wealth ($p < .0001$) and ethnic ($p < .01$) categories. Similarly, the female-headed households have lower livestock units per household than the male-headed households, but this difference is not statistically significant. The resource analysis thus indicates that BCJ households have the most resources, followed by GMN households, while KDS households have the fewest resources. Similarly, female-headed households have comparatively fewer resources than male-headed households.

Access to information and technology

The access farmers have to improved maize varieties suitable to local environments and their own needs is quite limited (table 1). Only 13% of the farmers reported growing improved varieties of maize; however, they know the value of changing their old seeds. About 39% of the households reported exchanging their seeds during last five years with other farmers. The users' and gender analysis showed that access to new maize seeds is similar across all wealth categories. However, GMN and KDS households have a complete lack of access to new maize seeds, and a lower proportion of male-headed households reported cultivating improved varieties than did female-headed households. The proportion of households changing seeds over the last five years, however, is greater in the poor wealth category, suggesting that farmers in this category change seed more frequently than do the others. Since these households are also highly food deficit, they may be consuming the seed and, therefore, borrowing seeds from other farmers. The proportion of households changing maize seeds is, however, similar across ethnic categories and between male and female-headed households.

Similarly, farmers' access to technical services and information on technology is also poor. Only about 3% of the maize-growing households reported participating in agriculture-related training, and only 6% participated in educational tours. Likewise, about 15% of the households reported receiving information on improved technology for maize production. This reveals that external technical support to farmers in their attempts to develop better maize varieties is quite limited. The proportion of households participating in agricultural training and tours is lower in the average and poor households than in rich households. A chi-square analysis shows significant differences ($p < .05$) in access to information on improved technology for maize production across wealth categories. Similarly, only BCJ households reported having participated in agricultural training and tours or receiving information on improved maize production. The proportion of female-headed households participating in agricultural training and tours and receiving information on improved maize production is lower than male-headed households.

Maize varieties and their uses

Farmers have been found to grow about eight different types of maize varieties, which they broadly categorize into two maize types: one is a large type (*Thulo makai*) with tall plants, big cobs, large grains and long maturity, while the other is a small type (*Sano makai*) with short plants, small cobs and grains, and short maturity. A majority of the farmers grow large-type maize, and it covers about 87.7% of the total maize area. Among the large varieties, *Thulo pyanlo* alone covers about 80% of the area planted to this type, which reflects that, although farmers grow a large number of varieties, a large portion of the maize-growing area is covered by a relatively small number of varieties.

A majority of the households grow one to two varieties of maize (46.5% to 45.5%, respectively) in a season (table 2). Only about 8% of the total maize-growing households grow more than three varieties per season. The varietal diversity maintained at household level, therefore, is low (figure 1). The ANOVA result shows that the difference in the number of maize varieties grown at household level is significant ($p < .05$) across wealth categories but not significant across ethnic categories and between male- and female-headed households. A higher proportion of poor households grows one variety of maize, compared to rich and average households. This is contrary to the currently held view that small farmers maintain significant amounts of crop genetic diversity (Jarvis et al. 1997) and agrees with the findings of other studies (Rana and Kadayat 1999). Similarly, though not significant, a very high proportion of KDS households (90%) grows only one variety of maize.

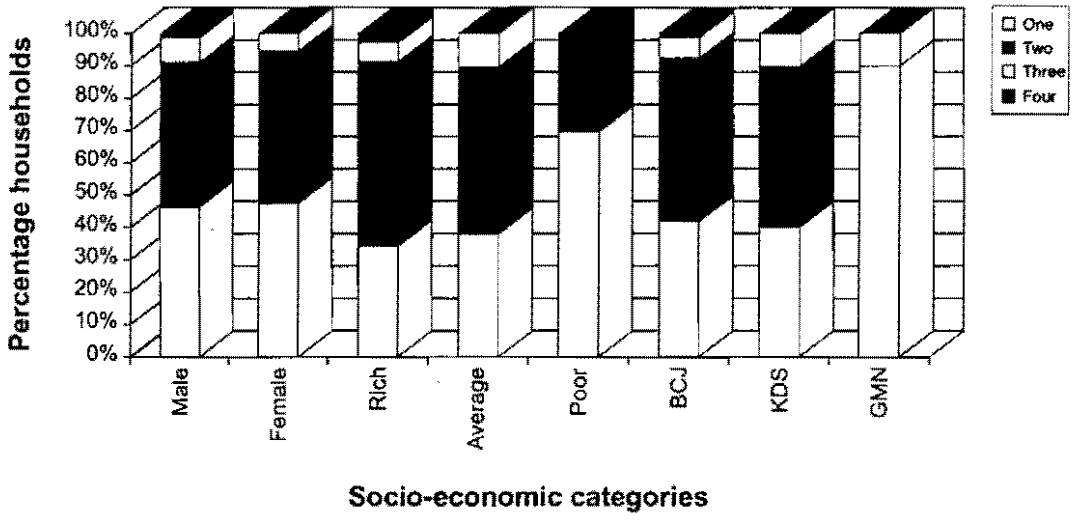

Figure 1. Number of maize varieties per household across gender, wealth and ethnic categories

Farmers who grow more than one variety mentioned various reasons for this (table2): to prepare different food items, to harvest at different times, to suit different land types, to use as animal feed, and to meet fodder requirements. However, a majority of the farmers (67.9%) grow to suit different types of land, and this is true across all wealth and ethnic categories and between male- and female-headed households. The ANOVA result suggests that the number of maize varieties grown at household level is not significantly related to the size of the *bari* land but is highly significantly related to the number of parcels of *bari* land the farmer is planting to maize ($p < .0001$). This indicates that with the increase in the number of parcels of *bari* land, the number of maize varieties grown at household level also increases. This also confirms the PRA finding that farmers in the area grow large-type maize on more fertile land while small-type maize is grown on less fertile soil. The number of *bari* parcels, therefore, appears to be the strongest determining factor in deciding the number of maize varieties to be grown per season. It is, however, true that farmers use multiple criteria to select maize varieties for their household production.

The gender differences in the use of some criteria to choose maize varieties are striking. A large proportion of female-headed households (more than three times the number of male-headed households) mentioned growing more than one variety to meet fodder requirements for their livestock. This is also confirmed by the PRA findings. During the focus-group discussions, women farmers