Farmer and Researcher Contributions to the Selection of Landraces of *Ghaiya* (Upland Rice) for *Tar* areas of Nepal

by

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with R.B. Rana and A. Subedi

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Abbreviations

FGD	focus-group discussion
FW	farm walk
FYM	farmyard manure
IDRC	International Development Research Centre
IRD	informal research and development
KRIBHCO	Krishak Bharati Cooperatives
LI-BIRD	Local Initiative for Biodiversity, Research and Development
NAA	Nepal Agricultural Association
PLS	participatory landrace selection
PRA	participatory rural appraisal
PVS	participatory varietal selection
SAARC	South Asian Association for Regional Cooperation
SANFEC	South Asian Network for Food, Ecology and Culture
SRISTI	Society for Research and Initiatives for Sustainable Technologies and Institutions
UD	Using Agricultural Diversity Research Award
VDC	Village Development Committee

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Glossary of Nepali words

Bari	unbunded and unirrigated terraces for upland crops
Ghaiya	direct-seeded, broadcast rice grown in *tars*, sloping hillside terraces or hill slopes on newly cleared land
Kalo	black
Kalo mato	black soil
Phusro	ash colored
Phusro mato	ash-colored soil
Rato	red
Rato mato	red soil
Mato	soil
Subne	grows well, gets adopted
Soharne	removal of weeds and basal dried leaves from the *ghaiya* plants during the booting stage
Tar	unirrigated, ancient alluvial river fans
Terai	southernmost fertile plains of Nepal stretching east to west with an altitude ranging from < 100 m to 200 m
Rato raja kalo kaji phursro paji	red soil is like a king, black is as a prime minister and ash-colored soil is useless

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1. Introduction

Nepal is a landlocked country lying between latitudes 26°22" and 30°27" north, and between longitude 80°45" and 88°12" east, with a land area of 147,141 km^2. Nepal is divided into five physiographic regions: *Terai, Siwalik*, Middle Mountain, High Mountain, and Himalayas. The *Terai* area occupies the southern flatland of the country, stretching east to west across Nepal at altitudes from less than 100 m to 200 m. The climate of the *Terai* is tropical to subtropical. The *Siwalik* area ranges in altitude from 300m to 1500m above sea level and has a subtropical climate. There are longitudinal tectonic valleys between the *Siwalik* and Middle Mountain areas and in the Middle Mountain region. The Middle Mountain area is a hilly region with an altitude between 1500m to 2500m. It has a favourable climate and produces a wide range of cereals and horticultural crops. The High Mountain region is rugged and steep; its lower slopes are terraced, and the upper slopes are covered by forests. The High Himalayan region is steep, rugged, and rocky and is covered with snow most of the time.

There are also a wide variety of socio-economic conditions in Nepal. The *Terai*, inner *Terai,* and low hill regions of the country are inhabited predominantly by Indo-Aryans, whereas the mid- and high hills are mainly inhabited by people of Tibeto-Burmese origin. These groups differ not only in their economic, social, and cultural characteristics but also in their food habits and preferences for crop species.

Nepal is rich in biodiversity because of the diversity of agro-ecological and cultural conditions. Nepal covers about 0.1% of the world's land area but houses over 2% of the world's flowering plants and 4% of the vertebrate species (Shrestha 1996). This diversity is quite significant for a small land area. More than 7000 species of flowering plants are estimated to be growing in the country, about 80% of which have been collected, identified, and preserved in the National Herbarium and Plant Laboratories in Godawari (NAA 1995).

Nepal is an agricultural country with a rich diversity of crops—cereals, vegetables, fruit, and medicinal and ornamental plants. It has an enormous diversity of both cultivated and wild relatives of rice, estimated at about 2000 different landraces (Gupta et al. 1996). These diverse landraces—grown in both irrigated and rain-fed environments—have contributed substantially to the food security of the country. Rain-fed or upland rice, known as *ghaiya dhan,* is mainly grown on *tars*[1], and also in, marginal hillside terraces or hillsides newly cleared of

1 *Tars* are actually ancient alluvial river fans now formed into flat basins with agricultural importance.

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forest cover. This crop is broadcast sown and grown under rain-fed conditions where there is no standing water at any time during rice growing season.

At least 9% (constituting a total of about 126,000 ha) of the total rice area in the country is planted to *ghaiya* (Sthapit 1992). This crop plays a significant role in the household food security of subsistence farmers where the possibility of irrigation facilities or of a more profitable alternative crop is unlikely in the foreseeable future. It is a crop of socially and economically disadvantaged ethnic communities like the Derai, Kumal, and Bote, but also to the Brahmin, Chhetri, and the occupational castes living in areas dominated by *tars*. *Ghaiya* is preferred to maize because of the value of its grain for human food and its straw for animal feed. The crop is also suited to marginal growing conditions, such as under shade, where maize cannot be grown because the land is unsuitable, or in areas where maize cultivation is problematic because it is harvested by monkeys.

Despite its importance to specific farming communities and conditions in Nepal, very few studies have been done on the indigenous knowledge, status and potential of *ghaiya* genetic resources. This study seeks to partly address this gap by documenting farmers' knowledge of the genetic diversity of *ghaiya* at the village and household levels and by involving farmers in the identification of landraces potentially useful in *tar* areas of Nepal.

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2. Farmer's Knowledge of the Genetic Diversity of *Ghaiya*

The study was undertaken in the *tar* areas of the Lamjung, Gorkha, and Tanahun districts situated in the low hill region of Nepal (below 1000 m). Appropriate communities were identified by visiting and discussing the study with farming communities, building on the prior experience in the area of the researchers and the non-governmental organization LI-BIRD (Local Initiative for Biodiversity, Research and Development). Five villages were selected and studied by a team consisting of a plant breeder and four agricultural technicians. These were Dhamilikuwa, Garambesi and Mangaltar in the Dhamilikuwa Village Development Committee (VDC) of the Lamjung District, Thantipokhari in the Palungtar VDC of Gorkha District and Duipiple in the the Bhorletar VDC of Tanahun District.

Once the villages were selected, the next task was to engage the community in the study by developing social and resource maps through transect walks with farmers and direct observation of the area. The maps were used to delineate the *ghaiya*-growing areas in each village and assess the relative importance of *ghaiya* in each farming system. Subsequently, the researchers undertook semi-structured interviews with key informants on ethno-history and related issues; organized focus-group discussions to rank and collect preferred landraces and collected farmer's preferred varieties.

2.1 Cropping Patterns

Farmers in the study area distinguish three major land types – *tar, bari*,[2] and *khet*[3] – with the cultivation of *ghaiya* done on *tar* and other sloping hillsides. The *tar* production system is diverse and accommodates a number of cropping patterns, fodder, and fruit trees as well as supporting a wide range of farm animals. The commonly found cropping patterns are as follows:

- *Ghaiya* – black gram
- *Ghaiya* + maize – black gram
- *Ghaiya* – finger millet
- *Ghaiya* – niger/black gram
- *Ghaiya* – soybean

2 *Bari* is unbunded un-irrigated land where mainly upland crops are grown.
3 *Khet* is bunded and irrigated land where transplanted rice is grown.

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Ghaiya is the major staple crop in most of the study area. In some sites, as much as 90% of the *tar* and *bari* are planted to *ghaiya*. Traditionally, *tars* are associated with the *ghaiya* crop and *ghaiya bhat* (steamed rice) and sesame cake curry are said to be common foods of *tar* areas. Farmers believe that a mixed crop of *ghaiya* and maize is advantageous because it gives a higher combined yield. A few rows of maize in the flat *tar*s also facilitate broadcasting the *ghaiya* more uniformly and green cobs of maize supply a delicious and nutritious breakfast food.

The farmers' decision to plant a succeeding crop in the *tar* after *ghaiya* depends on the moisture condition in the field. The common strategy is to grow both niger and black gram in almost equal proportions. Manipulating the population of the two component crops depends on the rainfall. When there are good moisture conditions, more of the niger plants are thinned out, retaining more black gram; in poor moisture conditions, more of niger plants are retained.

Apart from the major cropping patterns described above, crops such as groundnut (*Arachis hypogaea*), taro (*Colocasia* spp.), sesame (*Sesamum indicum),* sweet potato (*Ipomoea gatatus*), and tapioca (*Manihot esculenta*) are grown along with a number of seasonal vegetables. The important fruit crops in the area include mango (*Mangifera indica*), litchi (*Litchi chinensis*), jack fruit (*Artocarpus heterophyllus*), banana (*Musa paradisiaca*), and pineapple (*Ananas comosus*).

2.2 Diversity of *Ghaiya* Landraces at Village and Household Levels

The study documented landrace diversity at the village and household levels. This also included the study of threatened landraces or those that had disappeared from the study villages.

Discussions and field visits with farmers revealed that varietal diversity still exists for *ghaiya*, both within and across sites (Table 1). While we found that the same *ghaiya* landraces are known by different names in different areas, cross checking in the field and with knowledgeable farmers in different villages revealed a total of 18 distinct landraces still grown in the five villages. The Sunakhari, Chobo, and Parampyuri landraces were reported in three villages while the Thantar, Karlunge, Kanaki, Khoplange, and Tauli landraces were found in at least two villages. The rest of the landraces were reported in just one village each.

All farmers interviewed on the ethno-history of the landraces were of the opinion that the landraces had been grown there from time immemorial.

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Nevertheless, the exchange of landraces between locations through farmer-to-farmer networks was reported. For example, Khoplange was introduced to parts of Lamjung from the Khoplang Village of the Gorkha District.

In one village (Thantipokhari) diversity was particularly high (9 landraces) and the proportion of known varieties no longer grown was low (1). In the other villages, the diversity was somewhat lower and the proportion of known varieties no longer grown was much higher (Figure 1). In total, 19 different landraces were reported to have disappeared from the study villages. However, when all the villages are taken together some of the landraces reported as having disappeared in one village were grown in at least one other village. For example, Tauli was reported to have disappeared from three locations but was still grown by the farmers of Diupiple. Thantar was reported to have disappeared at Dhamilikuwa but was grown at two of the other villages studied (Table 1). Chiuri (which is also known as Panthe and more recently as Sunakhari) is grown in at least three of the villages studied. This suggests that the number of *ghaiya* landraces actually lost from the entire *ghaiya* growing system may be less than it seems at the individual village level. This conclusion must be tempered, however, by our partial knowledge of the characteristics of landraces that are no longer grown, and the possibility that some of these are the same landraces named differently.

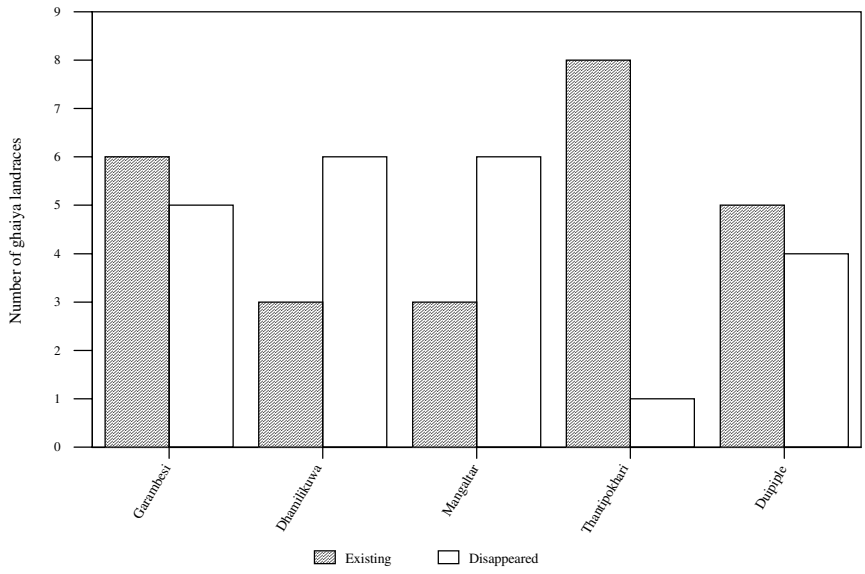

Figure 1: Situation of *ghaiya* landraces in the study area of Gorkha, Tanahun and Lamjung districts, 1997

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Table 1: Status of *ghaiya* genetic resources at study sites in Lamjung, Gorkha, and Tanahun districts, Nepal

Existing landraces	Landraces reported to have disappeared	Reasons for disappearance
Garambesi		
1. Sunakhari	1. Seto Tauli	• low yielding
2. Gegari Seto	2. Korsali	• declining soil fertility
3. Kalnathre	3. Choto	• requires high fertility
4. Chobo	4. Pakhesali	• improvement in irrigation facilities
5. Thantar	5. Charinagre (Khoplange)	
6. Karlunge		
Mangaltar		
1. Parampyuri	1. Dalle Sete	• low yielding
2. Sunakhari	2. Tauli	• declining soil fertility
3. Kanaki	3. Phalame	• requires high fertility
	4. Korsali	• improvement in irrigation facilities
	5. Banspate	
	6. Sadani	
Dhamilikuwa		
1. Sunakhari	1. Tauli	• low yielding
2. Kanaki	2. Kalonathre	• requires high fertility
3. Khoplange	3. Chobo	
4. Gegari rato	4. Dalle Sete	
5. Karlunge	5. Thantar	
6. Parampyuri		
Thantipokhari		
1. Thantar	1. Asmati	• low yielding
2. Panthe		
3. Chobo		
4. Tauli		
5. Subi		
6. Parampyuri		
7. Pakhesali		
8. Khoplange		
9. Masino Thantar		
Duipiple		
1. Chobo	1. Chiuri	• low yielding
2. Rato *ghaiya*	2. Pahenlo	• decline in soil fertility
3. Tauli	3. Kalodanthe	
4. Masino	4. Ratodanthe	

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The number of *ghaiya* landraces at the household level was studied in detail the following year in two of the study villages (Dhamilikuwa and Thantipokhari). We found that a total of 15 different *ghaiya* landraces were maintained by households in these two villages (Table 2). However, a large number of households grew a few landraces, while other landraces were maintained by only one or two households in the village. Of 52 households surveyed, about 35% were maintaining a single landrace, 46% were maintaining two landraces, and only 19% were maintaining three or more landraces. In general, farmers with very small holdings maintained a single landrace, mostly choosing a stable variety such as Sunakhari, Panthe, Chobo, or Masino thantar. As land holdings increased, more *ghaiya* landraces were maintained at the household level. This finding suggests that many landraces are vulnerable to the changing fortunes and priorities of a few households. One implication is that the landraces that are less commonly grown and therefore more vulnerable to disappearance should be targeted for collection and conservation.

Table 2: Diversity and relative popularity of different *ghaiya* landraces at household level, 1998

S No	***Ghaiya* landrace**	**Number of households growing**
1	Panthe	24
2	Chobo	20
3	Sunakhari	14
4	Kanaki	7
5	Thantar	6
6	Tauli	5
7	*Kalnathre*	4
8	Gegari	4
9	Marange	3
10	Parampyuri	2
11	Chiure	2
12	Subi	2
13	Dalle	1
14	Sete	1
15	Pakhesali	1
	Total households	**52**

2.3 Varietal Preference and Traits

The inventories of *ghaiya* diversity undertaken in 1997 and 1998 were followed by preference ranking and direct matrix ranking in the same five study villages.

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Preference ranking sought to evaluate the overall worth of a landrace, while direct matrix ranking sought to identify and rank individual traits.

Table 3 summarises the ranking of farmers' preferences for different *ghaiya* landraces. Sunakhari, Chobo and Thantar were ranked in the top three landraces in three or more locations while Kanaki was highly ranked in two locations. The reasons for these preferences were identified through the direct matrix ranking in each village (Figure 2 to 6). All of the data from the direct matrix ranking is shown because it reveals the range of specific traits valued in each location. Overall, the high ranking of Sunakhari was due to its high yield potential, high milling recovery and long grains as well as the moderate fertility requirements and drought tolerance. Chobo was ranked highly because of its drought tolerance, better adaptation to low fertility conditions, high yield potential, good straw quality, earlier maturity and resistance to diseases. It was even considered suitable for late planting conditions.

Table 3: Summary of farmers' preference rankings of *ghaiya* landraces in different study sites

Ghaiya **landraces**	**Occurrence in No. of location**	**Farmers' preference ranking**				
		Garam-besi	**Mangal-tar**	**Dhamili-kuwa**	**Thanti-pokhari**	**Duipiple**
1. Sunakhari	3	I	I	II		
2. Gegari rato	1	II				
3. Kalnathre	1	IV		IV	VI	
4. Chobo	3	II		VI	I	I
5. Thantar	2	III		III	II	
6. Karlunge	2	III				
7. Parampyuri	3		III		IV	
8. Kanaki	2		II	I		
9. Khoplange (Charinagre)	2			V	VII	
10. Panthe	1				III	
11. Tauli	2			VII	IV	IV
12. Dalle seti	1			VIII		
13. Subi	1				V	
14. Pakhesali	1				VI	
15. Rato *ghaiya*	1					III
16. Masino thantar	1					
17. Mansino	1					II

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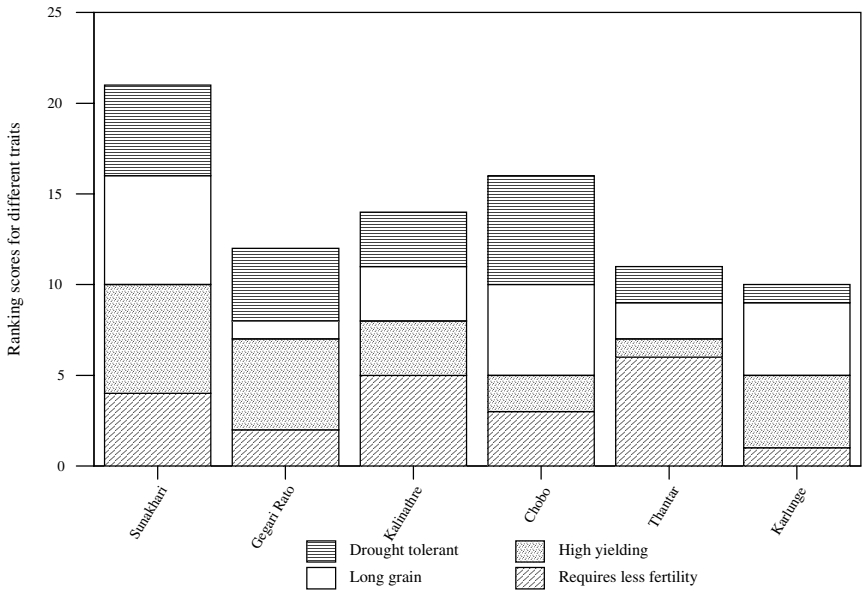

Figure 2: Direct matrix ranking of *ghaiya* landraces by farmers at Garambesi, Nepal

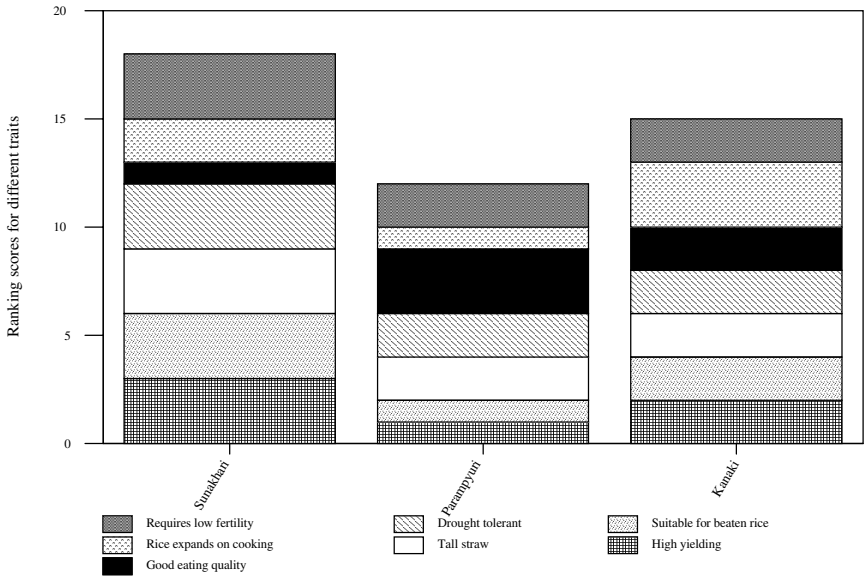

Figure 3: Direct matrix ranking of *ghaiya* landraces by farmers at Mangaltar, Nepal

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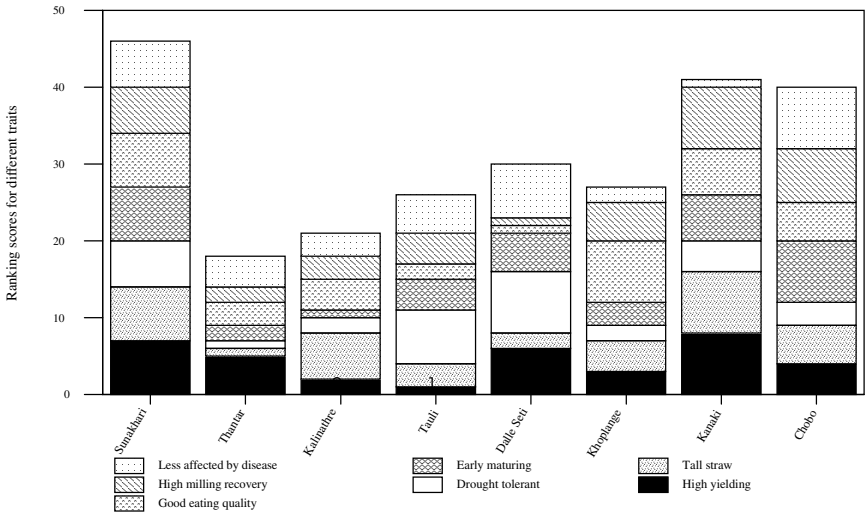

Figure 4: Direct matrix ranking of *ghaiya* landraces by farmers at Dhamilikuwa

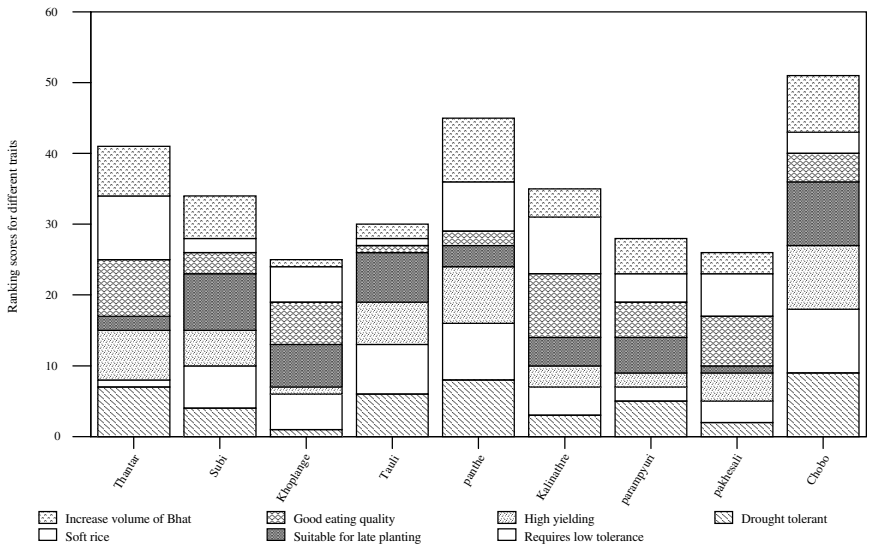

Figure 5: Direct matrix ranking of *ghaiya* landraces by farmers at Thantipokhari, Nepal

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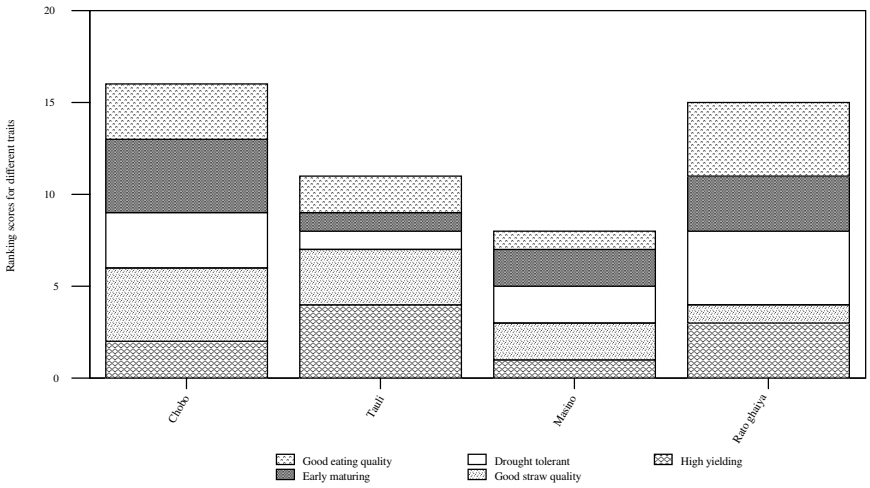

Figure 6: Direct matrix ranking of *ghaiya* landraces by farmers at Duipiple, Tanahun District, Nepal

2.4 Farmer Naming System for *Ghaiya* Landraces

The farmer assessment of genetic diversity presented above helps us to understand the local naming system, information useful for enhancing crop production and benefits to farmers (Table 4). Three factors seem to stand out: use, morphology and name of originating village.

Farmers' use classification reflects grain and cooking qualities. For example, a landrace gets the name 'Parampyuri' for its soft cooking and excellent eating qualities. Similarly, 'Pakhesali' is another variety whose name is associated with grain quality. Rice varieties suitable for making *chiura*[4] are called 'Chiuri'. *Ghaiya* varieties known by two different names (e.g. Panthe and Sunakhari) may share a third name (Chiuri) because they are both considered good varieties for making *chiura*.

4 *Chiura* is a kind of snack made by flattening roasted rice grains. For making *chiura*, farmers prefer relatively sticky rice with round, short grains rather than longer and more slender grains.

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Table 4: Farmers' basis for naming *ghaiya* varieties at Thantipokhari, Gorkha, Nepal

S. No.	Name of variety	Basis for naming
1	Thantar	Difficult for threshing and milling (pounding)
2	Panthe	Very old variety; basis not exactly known; also known as Chiuri as the variety is suitable for making *chiura* (beaten rice)
3	Tauli	For dense grain setting like *taulia* (towel)
4	Subi	Subne = suited; variety is suitable for all types of soils
5	Kalnathre	*Kalo* = black, *nathre* = spicules/awns: spicules are black and basal leaf sheaths are purple
6	Khoplange	Introduced from a place called Khoplang, Gorkha
7	Parampyuri	*Param* = extreme, *pyuri* = soft: quality of cooked rice is extremely soft
8	Pakhesali	Pakhe = upland, Sali = transplanted rice; because of eating properties similar to those of transplanted rice; Yield is also comparable to transplanted rice
9	Sunakhari	Very old variety; basis not known; recently also known as Chiuri as it is very suitable for making *chiura* (beaten rice)
10	Kanaki	*Kanika* = broken rice: because of its fine grain, as small as broken rice
11	Bans pate	*Bans* = bamboo, *pate* = leaf: very long, broad leaves like those of bamboo; plants droop like bamboo at maturity
13	Chobo	*Chobilo* = vigorous: the variety remains vigorous even under low fertility
14	Gegari rato	*Rato* = red; grain colour is brick red
15	Karlunge	Not known
16	Dalle seto	Grain is very short and husk colour is white

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Colour, pigmentation, size, and shape of different parts (morphology) are also traits used by farmers to name the *ghaiya* varieties. Other morphological traits used for classification are colour basal leaf sheath. For example, it was revealed in discussion that *ghaiya* varieties that have pigmented culm or basal leaf sheaths, such as Kalnathre, have been maintained to control volunteer plants in the field.

Some landraces seem to be named after the village from which the variety was introduced. As noted above, Khoplange was introduced to parts of Lamjung from the Khoplang Village of the Gorkha District.

2.5 Farmer Perceptions of *ghaiya* Drought Tolerance

Drought is a particularly important constraint in *tar* areas, and was singled out for detailed study. Critical stages of *ghaiya* for moisture stress were identified through discussions with participating farmers: planting time, gap filling or transplanting and booting stage.

Farmer experience indicated that the booting stage is the most critical because a prolonged drought during booting affects yield of *ghaiya* severely. However, prolonged drought during booting is unlikely in *tar* areas as the stage coincides with the monsoon (July through August). They are more concerned about the gap filling stage between May and early June because it is the driest period in the *ghaiya* crop cycle. While they note that land preparations and inter cultural operations are best done during the dry period because weeds are easily controlled, some rain (one or two showers) following transplanting and gap filling is highly desirable.

According to the farmers of Thantipokhari, cycles of long dry spells repeat once every three to four years and can cause up to 50% yield loss. Farmers in this community use the Chobo landrace of *ghaiya* because it suffers a lower loss even during extreme drought. Farmers believe that Chobo has longer roots, compared to other varieties, and it may be that they penetrate deeper and are able to extract more moisture to keep the plants alive.

The experience of farmers in Mangaltar is different. They observe that prolonged dry cycles repeat more frequently, once every two to three years, but cause lower losses (up to 25%). They have not identified a particular *ghaiya* landrace with relative advantages for drought tolerance.

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2.6 Farmer Soil Management Practices for *ghaiya*

Ghaiya-growing farmers possess a wealth of soil management knowledge to ensure production. In the study area, three soil types are dominant, although farmers also mentioned other types of soils. The major soil types reported by the farmers are *kalo mato* (black soil), *rato mato* (red soil), and *phruso mato* (ash-coloured soil). Farmers described the relative importance of these soils (Table 5) in the following way: "*Rato raja* (red is king)." "*Kalo kaji* (black is prime minister)." "*Phurso paji* (ash-coloured soil is useless)." It was learnt that the darker the colour of a soil, the more fertile it is considered to be. Although *rato mato* is rated as king of the soils, *kalo mato* is considered the best soil for crops because it performs well even with little added manure. *Rato mato* is second to *kalo mato* in preference for crop production. Farmers also reported that *rato mato* requires more water, is less fertile, requires more manuring, and is difficult to work. *Phurso* soils are the least fertile, with poor soil structure.

Table 5: Summary of farmers' preferences on the suitability of soil types for growing *ghaiya* landraces, Nepal

Name of site	Farmer's preferences of soil types					
	Kalo mato	Rato mato	Phusro mato	Pango mato	Kamero mato	Chimtyailo mato
Mangaltar	1	2	3	–	–	–
Dhamilikuwa	1	2	–	3	4	–
Thantipokhari	–	1	2	3	–	–
Duipiple	1	2	–	–	–	3

Farmyard manure is the major source of nutrients for *ghaiya*. Analysis of household survey data (N = 52) found no significant difference in the level of application of farmyard manure across soil types or in the level of farmyard manure application across farmer soil fertility assessments (high to low). Farmers consider cattle manure the most fertile, followed by goat manure; buffalo manure is considered an inferior source of nutrients. A few farmers reported top-dressing their fields with urea at the rate of approximately 20 kg/ha.

Farmers recognise that *ghaiya* varieties differ in their fertility requirements, yield potential, and stability. They use this knowledge to select landraces appropriate

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to the soil fertility status of the particular field or part of field. The general tendency of the farmers is to replace *ghaiya* varieties that require considerable nutrient inputs with those that do well in conditions of low or moderate fertility and that are stable. Some farmers also mentioned the practice of changing *ghaiya* varieties periodically on the same piece of land to realise a better yield. It is common practice to grow maize and *ghaiya* alternately on the same piece of land in order to take full advantage of soil fertility. This rotation practice was also used to control volunteer plants.

2.7 Gender roles in the *ghaiya* crop

Gender is a significant source of differentiation in agricultural systems. Consequently, the impacts of interventions on gender roles need to be carefully assessed. In our study of the *ghaiya* system we examined with farmers the gender roles related to overall management of the *ghaiya* system, and especially the labour contributions of female and male farmers. The management of the *ghaiya* system was divided into four main operations for the study: land preparation, crop management, seed selection and maintenance, crop harvest and post-harvest food processing.

2.7.1 Land preparation

The distinct operations involved in land preparation are:

- Ploughing
- Digging the unploughed portion of the land
- Breaking clods
- Removing weeds or stubble following land preparation
- Carrying and spreading farmyard manure onto the main field

Ploughing is the domain of male farmers. But the labour contributed by female farmers was dominant in the rest of the land-preparation activities, such as clod breaking (69%), removing weeds (75%), carrying FYM (92.5%), and spreading FYM (85.7%). Digging the unploughed portion of land is the only activity that was reported to have equal contributions (50% each) from female and male farmers.

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2.7.2 Crop management

Crop management includes all the operations that are done from sowing the seed to harvesting the crop, including:

- Seed sowing
- Inspection of seedling emergence
- Thinning
- Raking
- First hoeing
- Second hoeing
- Insect management
- Disease management
- Clearing the field at the booting stage

The findings reveal that crop management is more of a joint operation done by both sexes. The contribution of females dominates in thinning (68%), first hoeing (62%), second hoeing (55%), and clearing the field at the booting stage (90%), known as *soharne* in the vernacular. Male farmers contribute more in activities such as raking – an operation done with the help of a bullock-drawn implement (98%) – disease management (55%), and insect management (55%). On average, 52% of the labour for managing the *ghaiya* crop is contributed by female farmers, while male farmers contribute the rest.

2.7.3 Seed selection and maintenance

Seed selection and maintenance includes the following activities:

- Rouging of off types
- Panicle selection (panicle harvesting)
- Drying
- Seed treatment and storage
- Periodic seed inspection

Seed selection and maintenance is a distinctly female domain. The findings reveal that the contribution of male farmers to seed selection and maintenance ranges from 3% to 10% across all activities. Overall, female farmers contribute some 94% of the total labour required for seed selection and maintenance.

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2.7.4 Harvesting the crop and post-harvest food processing

Activities included under harvesting and post-harvest processing include:

- Crop harvesting
- Making bundles
- Preparing the threshing floor
- Carrying the bundles
- Piling the bundles
- Threshing
- Winnowing
- Drying
- Storage
- Rice pounding

The labour contributed to harvesting the *ghaiya* crop and its post-harvest processing for food is again dominated by female farmers. The contribution of female farmers to threshing, winnowing, drying, storing, and rice pounding ranges between 73% and 100%. No activity in this area of crop management is mainly undertaken by male farmers. On average, 68% of the total labour requirement for harvesting the crop and post-harvest food processing is done by female farmers.

Analysis of the different operations involved in *ghaiya* system indicates that overall female farmers contribute 69% of the labor inputs, including major responsibility for rouging of off types, panicle selection, seed drying and storage, seed inspection, threshing, winnowing, and food processing critical to the conservation and management of plant genetic resources. This finding is significant as it clearly shows that the conservation and enhancement of the knowledge and skills of women farmers is critical to the effective management of agricultural biodiversity.

In summation, farmers use different *ghaiya* landraces as part of their livelihood strategy, not for the sake of conservation per se. They tend to grow at least one stable variety to ensure food security. Landrace diversity is also maintained to take advantage of different types of soils and different soil fertility regimes, as well as to meet different household needs such as *chiura* making, straw yield for fodder, eating quality, and controlling volunteer plants. Other preferred characteristics include early maturity and easy threshing, and varieties that allow labour to be spread over the season and that minimise risks from biotic

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and abiotic stresses. This information is useful in planning plant breeding strategies that seek to enhance *ghaiya* landraces. These participatory strategies should give particular attention to the knowledge and skills of women as they are the main managers of seed.

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3. Participatory Landrace Selection

While undertaking the study of farmer knowledge, practices and preferences for particular landraces reported above we simultaneously undertook a farmer-managed trail with introduced landraces, a process we call participatory landrace selection (PLS). The steps in the process of PLS are identical to those used in participatory varietal selection (PVS) processes, except that landraces from the region are used instead of modern varieties. Our method was adapted from the PVS method first applied by the Krishak Bharati Coperatives (KRIBHCO) Indo-British Rainfed Farming Project in India (Witcombe et al. 1996; Joshi and Witcombe 1996).

3.1 The Study Methodology

The study was undertaken in Garambesi and Mangaltar in the Lamjung District and in Thantipokhari in the Gorkha District, three of the five communities included in the farmer knowledge study. These villages were selected because of their apparent landrace diversity, interest in the study on the part of the farming communities and the considerable importance of the *ghaiya* crop in the local farming system.

Based on initial assessments of *ghaiya* diversity in the study villages, we undertook a search for landraces closely matching farmers' own landraces but potentially superior in some aspects. Initially, we introduced farmers to five *ghaiya* landraces previously collected and evaluated by the Lumle Agricultural Research Centre. These were 'Jire chobo', 'Jhyale bicharo', 'Phalame chobo', 'Tauli' and 'Rato *ghaiya*'. The evaluation had suggested that some were drought tolerant while others had traits important to farmers (yield potential on poor soils, grain quality, etc.). While we wanted to include a larger number of landraces in the study to ensure greater choice for the community, this was not possible due to the lack of sufficient seed of potential landraces.

One of these landraces (Tauli) was already grown in one of the study villages (Thantipokhari) and was substituted by farmers after the first year with Linde basaha. Another landrace (Rato *ghaiya*) was grown in a village (Duipiple) included in the farmer knowledge study but not in the PLS process. These five landraces were assessed by farmers in the three villages.

For two years (1997 and 1998), individual farmers were given 2 kg of seed of one introduced landrace, randomly selecting the landrace given to each farmer. In 1997, seeds were distributed to 50 farmers, but five farmers did not actually

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plant the seeds. In 1998, 54 farmers participated in the three study villages. Some 50 sets of 1 kg seed packets were also given to farmers in distant villages, to serve as an additional point of comparison.

In each year, the introduced *ghaiya* landraces were planted alongside farmers' existing landraces. The selection of testing sites, input levels and other agronomic decisions were made entirely by the participating farmers. Our analysis of their decisions revealed that about half of the farmers placed the trial toward the edge of their farmland (a more marginal area) while the other half used a central portion of their land. The majority of farmers (62%) tested new *ghaiya* landraces under moderate fertility levels (based on farmer self-assessment of soil fertility levels) while in about 29% of the new *ghaiya* landraces were planted on better lands. The crop was planted in early April, after the onset of pre-monsoon showers; the normal *ghaiya* planting time in the area. Our main advice to farmers was to avoid mixing the new landraces with the existing landraces from seed sowing through post-harvest assessment.

Farmer assessments of the *ghaiya* landraces were documented both individually through a questionnaire and collectively during farm walks and focus-group discussions, undertaken at different stages in the crop cycle and post-harvest period. The perceptions documented during the farm walk and focus-group discussions were based on group consensus. The perceptions of individual farmers were recorded through a separate questionnaire designed to compare the performance of introduced *ghaiya* landraces in their fields with existing landraces.

3.2 Individual farmer evaluations

Participating farmers were interviewed in 1997 and 1998, to compare the new *ghaiya* landraces with their own landraces using subjective scales: better, same, or worse relative to their own landraces.

3.2.1 Germination and tillering ability

In virtually all cases, the trial was planted at the optimum time in April with adequate soil moisture for the emergence of the *ghaiya* seeds. In 1997, only one *ghaiya* landrace – Jire chobo – was rated better at germination than the existing landraces, with most of the others perceived as the same as the existing ones. This pattern held in 1998 when all the new landraces were rated as very similar to the existing landraces for germination, except for Linde basaha and Jhyale bicharo, which had a high number of farmer responses indicating poor

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germination (27% and 42% of respondents, respectively). In both years the majority of farmers also rated the new *ghaiya* lines as similar to or better than existing landraces for tillering (Figure 13).

3.2.2 Plant height

Plant height is an important and tricky trait in *ghaiya*. Landraces with short stature are not suitable for growing under upland conditions because their performance could be adversely affected by heavy weed infestations after the monsoon rain. Similarly, excessively tall landraces may be prone to lodging and are likely to incur yield losses. Thus, farmers make trade-offs between weed and lodging problems. During the first year's evaluation, farmers rated Jhyale bicharo and Phalame chobo as taller landraces compared to their own, while the others were consistently rated as 'the same.' Farmers' perceptions were consistent the following year, although they rated the new landrace Linde basaha as taller than their own.

3.2.3 Lodging problems

Indigenous *ghaiya* landraces are generally tall with weak stems, and most of them lodge under high fertility or in the event of heavy winds or rains during the reproductive phase. It could therefore be expected that farmers would be sensitive to this criteria. In the first year, most farmers rated the new landraces as the same as their own for lodging. However, Rato *ghaiya* and Phalame chobo were rated as better than their own by 50% and 40%, respectively, of the farmers testing them. In the second year, the pattern was less promising: the majority (73%) indicated that the new landraces were the same as existing landraces for lodging.

3.2.4 Crop maturity

There were mixed reports from farmers about this trait. Most farmers reporting on Jire chobo, Jhyale bicharo, and Phalame chobo in the first year indicated that they matured earlier than the existing landraces. In the second year most farmers indicated that they were the same as their own, with only a few farmers still reporting that they matured earlier.

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3.2.5 Insect pests and disease problems

In terms of insect pests and disease problems, the general perception in both years was that the introduced landraces were better or the same as the existing ones. The most vulnerable introduced landraces were Tauli (1997), Rato *ghaiya* and Jhyale bicharo, with a number of the respondents indicating that it had more insect and disease problems than their own landrace. Overall, this finding suggests that several of the introduced landraces (Phalame chobo and Jire chobo) may have an advantage over local landraces for these traits (Tables 6 and 7).

Table 6: Farmers' perceptions of relative disease incidence in new *ghaiya* landraces, Nepal, 1998

Name of landrace	Disease problem			Total respondents
	More	Same	Less	
Phalame chobo	–	4	6	10
Jire chobo	–	1	6	7
Linde basaha	–	5	3	8
Jhyale bicharo	1	4	4	9
Rato *ghaiya*	2	1	1	4
Total	**3**	**15**	**20**	**38**

Table 7: Farmers' perceptions of relative insect pest incidence in new *ghaiya* landraces, 1998

Name of landrace	Insect problem			Total respondents
	More	Same	Less	
Phalame chobo	–	4	7	11
Jire chobo	1	1	6	8
Linde basaha	–	5	3	8
Jhyale bicharo	2	4	3	9
Rato *ghaiya*	–	2	2	4
Total	**3**	**16**	**21**	**40**

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3.2.6 Fertility requirements

Our experience with farmer evaluations suggests that the general tendency of farmers is to rate new landraces as more demanding for soils, perhaps because of their experience with high yielding modern varieties. However, in both years the majority of respondents were of the opinion that the fertility requirements of the introduced landraces were similar to those of the existing landraces. The exceptions were for Tauli and Rato *ghaiya*: 30% of the respondents in the first year reported that they require more fertile land compared to their own landrace.

3.2.7 Moisture requirements and drought tolerance

The majority of the farmers (87%) felt that the new landraces were no different than existing ones in terms of moisture requirements and drought tolerance. However, a few respondents rated Jhyale bicharo and Tauli better than their own for drought tolerance.

3.2.8 Panicle length and grain setting

All the new *ghaiya* landraces except Tauli were perceived to have longer panicles compared to existing landraces. Responses on grain setting showed a similar pattern: all except Tauli were reported to have dense grain setting, compared to their own landrace.

3.2.9 Grain yield

Farmer consistently rated Linde basaha, Jhyale bicharo and Rato *ghaiya* as higher yielding than their own, while rates for Phalame Chobo and Jire Chobo were mixed (Figure 7). The performance of the introduced landraces for grain yield in 1998 assessed by the researchers was consistent with farmer evaluations, with two having a clear and statistically significant advantage over the existing landrace (Table 8).

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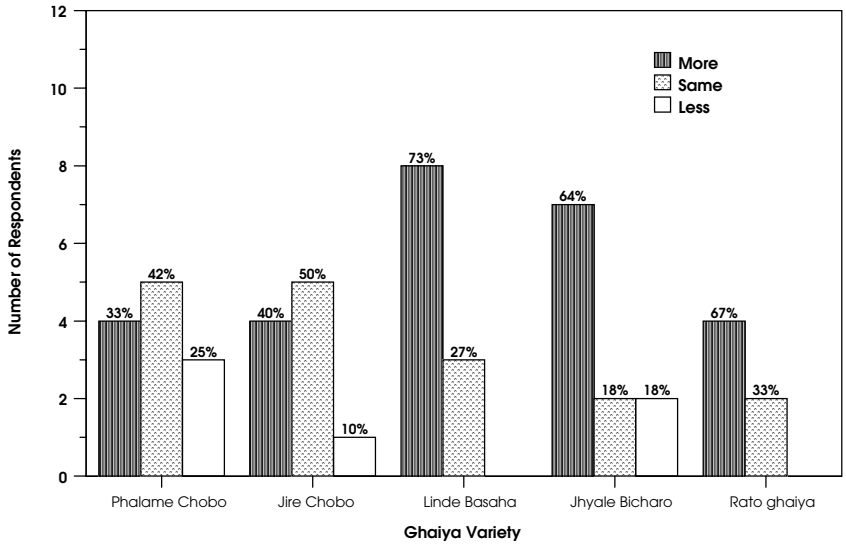

Figure 7: Farmers' perceptions of new *ghaiya* landraces for grain yield, Nepal, 1998

Table 8: Grain yield of new *ghaiya* landraces during 1998, Nepal

***Ghaiya* landraces**	**N**	**Mean grain yield (t/ha)**	**Significance**
Phalame chobo	10	2.02	ns
Existing landraces	10	2.12	
Jire chobo	10	2.73	ns
Existing landraces	10	2.20	
Linde Basaha	9	3.31	**
Existing landraces	9	1.89	
Jhyale bicharo	10	3.11	**
Existing landraces	10	2.03	
Rato ghaiya	6	3.99	ns
Existing landraces	6	2.66	

** = P < 0.01, ns = non-significant

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3.2.10 Straw yield and palatability

The straw yield of the introduced landraces was rated the same as that of the existing landraces during both years, despite the perception that several of the tested landraces were slightly taller. The palatability of the straw was perceived as exactly the same as that of existing landraces by 100% of the respondents.

3.2.11 Milling recovery, cooking and eating quality

Quality traits such as milling recovery, cooking quality, taste of *bhat* and appetite-delaying ability were only assessed the first year by a few farmers due to the lack of sufficient grain for the tests. In the second year, the milling recovery and the volume of *bhat* of the introduced landraces was typically rated the same or better (Table 9). The taste of the *bhat* was considered better by most farmers for all but one of the introduced landraces (Linde basaha). Most respondents did not perceive any difference, better or worse, in the ability of the landrace to satisfy their appetite and delay hunger.

Table 9: Farmers' perceptions of milling recovery, increase in volume of *bhat*, taste of *bhat,* and content feeling for new *ghaiya* landraces, Nepal, 1998

Ghaiya landraces	Farmers' responses (%)										
	Milling recovery			Increase in volume of *bhat*			Taste of *bhat*			Content feeling	
	More	Same	Less	Increase	Same	No increase	Better	Same	Worse	Better	Same
Phalame chobo	10	90.0		30	70		60.0	40		10.0	90.0
Jire chobo	25	63.0	12.0	50	50		62.5	25	12.5	25.0	75.0
Linde basaha	33	67.0		33	67		43.0	57		28.5	71.5
Jhyale bicharo	50	37.5	12.5	22	67	11	67.0	22	11.0	11.1	88.9
Rato *ghaiya*	20	80.0		40	60		60.0	40		40.0	60.0

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3.3 Focus-group evaluation

The farm walk and focus-group discussion was an integral component of our method during the first year. It was not repeated during the second year, due to time constraints. In the farm walk, a group of farmers from each community visited trial plots with researchers when the crops were mature for on-the-spot, direct observation. The visits were immediately followed by a focus-group discussion, during which assessments were noted once the group had reached consensus on a varietal characteristic. Three Participatory Rural Appraisal (PRA) techniques were used:

- Narrative summary about landraces, describing salient features
- Matrix ranking
- Preference ranking

In both villages, women participated in both the field walk and focus-group discussion, and made clear and substantial contributions to the evaluation process.

Table 10: Narrative summary of *ghaiya* landraces at standing condition in PLS compared to existing landraces, as perceived by participating farmers at Mangaltar, Nepal

SN	Landraces	Positive Traits	Negative Traits
1	Jire chobo	Medium plant height, fine grain, long panicle, non-lodging, synchronised maturity, good phenotypic acceptance	—
2	Jhyale bicharo	Medium plant height, medium-coarse grain, good tillering, long panicle, less sterility, non-lodging, synchronised maturity, phenotypic acceptance	—
3	Phalame chobo	Withstands heavy manure application, early maturing, dense grain setting	Thick husk, coarse grain
4	Tauli	Tall plant; long, drooping panicles	Does not withstand heavy manure, coarse grain, sparse grain setting
5	Rato *ghaiya*	Medium plant height, requires less manure, does well under shade, good milling recovery, good beaten rice	Late maturity, sparse grain setting, sterility, short panicle

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From the discussions it was evident that farmers in both Mangaltar and Thantipokhari had clearly favourable perceptions of the Jhyale bicharo and Jire chobo landraces (Tables 10 and 11). Phalame chobo had a more mixed rating in both villages, while Rato *ghaiya* did not attract farmers' interest in either of the locations. Tauli was liked very much in Thantipokhari but disliked at Mangaltar.

Table 11: Narrative summary of *ghaiya* landraces at standing condition in PLS compared to existing landraces, as perceived by participating farmers at Thantipokhari, Nepal

SN	Landraces	Positive Traits	Negative Traits
1	Jire chobo	Early maturing, thin husk (high milling recovery), less lodging like Thantar, long panicles	Sparse grain setting
2	Jhyale bicharo	Long panicles, dense grain setting, thin husk, less lodging, performs well in shady areas, matures about five days earlier than existing landraces	—
3	Phalame chobo	Non-lodging under normal conditions, long panicles	Requires high fertility, sparse grain setting, lodges under shade
4	Tauli	Tall plant height, long panicles, dense grain setting	Lodges under high fertility, does not grow well in shady areas
5	Rato *ghaiya*	Straw similar to existing landraces	Late maturing, high sterility, short panicles

The reasons for these perceptions became more apparent in a matrix ranking exercise in which farmers were asked to identify the major criteria for comparing the new landraces with the farmer's local landraces and to rank them on a three-point scale: better, same, or worse (Tables 12 and 13). Six major pre-harvest criteria for evaluating newly introduced landraces were used by farmers in Mangaltar while only three were considered important to farmers in Thantipokhari.

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Table 12: Comparative assessment of *ghaiya* landraces in PLS against major traits in existing landraces at Mangaltar

S. No.	Traits (Characteristics)	Landraces	Same as Local	Better than local	Worse than local
1	Tillering ability	Jire chobo	–	✓	–
		Jhyale bicharo	–	✓	–
		Phalame chobo	–	–	✓
		Tauli	–	–	✓
		Rato *ghaiya*	–	–	–
2	Maturity time	Jire chobo	✓	–	–
		Jhyale bicharo	✓	–	–
		Phalame chobo	✓	–	–
		Tauli	✓	–	–
		Rato *ghaiya*	–	–	✓
3	Fertility requirement	Jire chobo	✓	–	–
		Jhyale bicharo	–	✓	–
		Phalame chobo	✓	–	–
		Tauli	✓	–	–
		Rato *ghaiya*	✓	–	–
4	Panicle quality	Jire chobo	–	✓	–
		Jhyale bicharo	–	✓	–
		Phalame chobo	–	–	✓
		Tauli	–	✓	–
		Rato *ghaiya*	–	–	✓
5	Grain quality	Jire chobo	Very Fine	–	–
		Jhyale bicharo	Fine	–	–
		Phalame chobo	Coarse	–	–
		Tauli	Coarse	–	–
		Rato *ghaiya*	Medium	–	–
6	Yield potential	Jire chobo	–	✓	–
		Jhyale bicharo	✓	–	–
		Phalame chobo	–	–	✓
		Tauli	✓	–	–
		Rato *ghaiya*	–	–	✓

✓ Indicates trait of an individual landrace relative to existing landraces.

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Table 13: Comparative assessment of *ghaiya* landraces in PLS against major traits in existing leading landraces at Thantipokhari, Gorkha, Nepal

Trait	PLS Landraces	Same as existing	Better than existing	Worse than existing
Panicle quality	Jire chobo	–	✓	–
	Jhyale bicharo	–	✓	–
	Phalame chobo	–	–	✓
	Tauli	–	✓	–
	Rato *ghaiya*	–	–	✓
Rice quality	Jire chobo	–	✓	–
	Jhyale bicharo	–	✓	–
	Phalame chobo	✓	–	–
	Tauli	–	–	✓
	Rato *ghaiya*	–	✓	–
Fertility requirement	Jire chobo	✓	–	–
	Jhyale bicharo	–	✓	–
	Phalame chobo	✓	–	–
	Tauli	✓	–	–
	Rato *ghaiya*	✓	–	–

✓ Indicates trait of an individual landrace relative to existing landraces.

Finally, farmers were asked to rank the landraces, based on their overall preference (Figure 8). Farmers in both locations ranked Jhyale bicharo as the best entry and Rato *ghaiya* as the worst entry. Tauli was ranked poorly in Manglatar (4th) but highly in Thantipokhari (2nd). Jire chobo and Phalame chobo were ranked in the middle by both communities of farmers (this exercise was only done in 1997, so Linde basaha was not rated).

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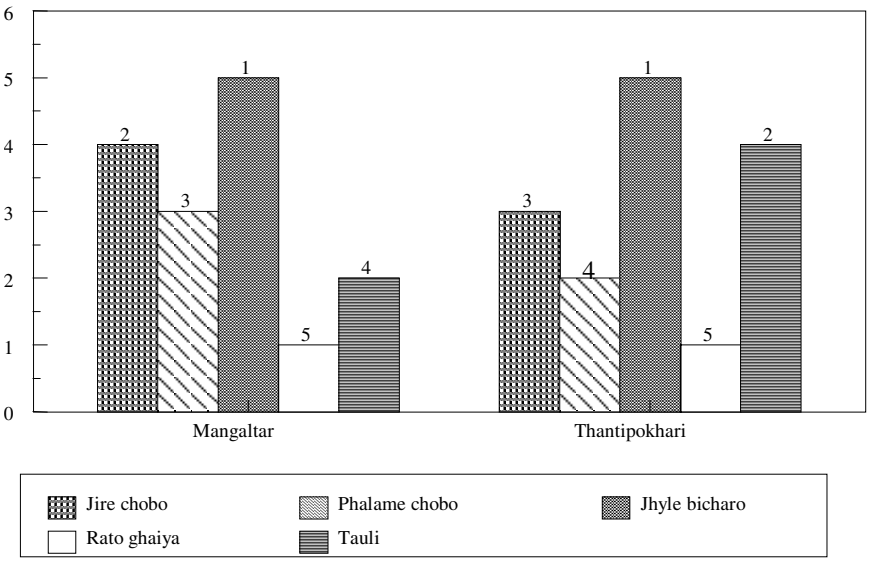

Figure 8: Preference ranking of *ghaiya* landraces under PLS at Mangaltar and Thantipokhari, Nepal

In summation, all of the introduced landraces were rated at least the same as the existing landraces for many traits, suggesting that the pool of landraces suitable for *ghaiya* on *tars* is greater than is currently being used. Linde basaha and Jhyale bicharo consistently ranked as better than the existing landraces over the two year period, taking into account a wide range of traits including yield and rice quality. Jire chobo and Phalame chobo were rated positively for tolerance to insect damage (mainly from stem borers), compared to existing landraces while Jhyale bicharo and Tauli were rated as having better drought tolerance than existing landraces.

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4 Adoption patterns, quantity of seed saved, and potential area coverage

Seed saving by farmers for the next year's planting is one of the most reliable indicators of probable adoption. The study of the amount of seed saved for the next year's planting and the potential area coverage was encouraging. During the spring of 1998, a total of 108 kg of seeds for the different *ghaiya* landraces was distributed to 54 farmers. Thirty-two farmers—impressed with the performance of the new *ghaiya* lines—saved a total of 444 kg of seeds, which could potentially cover more than 4 ha of land in the coming season. Table 14 presents the relative popularity of individual *ghaiya* landraces.

Table 14: Quantity of seed saved for the next year's planting and potential area coverage in 1999, Nepal

***Ghaiya* landraces**	**Quantity of seed saved (kg)**	**Potential area coverage (ha)**
Phalame chobo	49.0	0.50
Jire chobo	82.5	0.80
Linde basaha	175.0	1.70
Jhyale bicharo	100.0	1.00
Rato *ghaiya*	37.5	0.40
Total	**444.0**	**4.40**

In the year following the process of PLS, farmers were visited again and their on-going use of the landraces assessed (Table 15). We found that the number of households growing Jhyale bicharo, Jire chobo and Linde basaha had increased, indicating that there is good scope for introducing at least these three landraces in *tar* areas. The number of households adopting Phalame chobo and Tauli had decreased in 1999, and Rato *ghaiya* had been totally abandoned.

By 1999, farmers had come to the general conclusion that all of the varieties required good to moderate soils and were most suitable on black soils (*kalo mato*). Only a few farmers thought that any of the introduced landraces were suitable for the relatively poor ash-coloured soils (*phusro mato*). It is interesting to note that the individual rankings of Tauli and Rato *ghaiya* in 1998 had

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indicated that these landraces required highly fertile soils, one possible reason for their declining use.

Table 15: Adoption of introduced *ghaiya* landraces after PLS, Nepal, 1999

S. No.	Name of landrace	Number of participating households in PLS			Adopters in 1999		Preference rank
		1997	1998		Continuing adopters	New households	
			Continuing adopters	New households			
1	Jhyale bicharo	7	7	12	14	8	II
2	Jire chobo	8	4	12	16	3	I
3	Phalame chobo	10	3	12	3	0	
4	Rato *ghaiya*	10	0	0	0	0	
5	Tauli	10	1	6	4	0	
6	Linde Basaha	–	0	12	10	4	III
	Total	**45**	**15**	**54**	**47**	**15**	

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5. Conclusions

Farmer and researcher collaboration in the study and selection of *ghaiya* landraces for *tar* areas in the Gorkha, Lamjung, and Tanahun districts in Nepal proved fruitful. We learned that the total number of landraces identified by farmers was considerable, both across and within communities. Landraces that had disappeared in some communities were still grown in others, suggesting that the system as a whole was still maintaining diversity even as it declined in specific communities. However, only four or five landraces occupied most of the study area, with the rest used by only a few households each. Generally, well-to-do farmers maintained more landraces, while small farmers maintained a single landrace: the most stable. This has important implications insofar as on-farm *in situ* conservation is concerned: the less commonly grown landraces should be targeted for conservation because changes in the circumstances of a few farmers can put them at risk.

Farmer knowledge of the characteristics of the landraces and the conditions under which they are grown (rainfall patterns, soil types, etc.) is used by farmers to select the most stable landrace for their particular circumstance and livelihood strategy. Women's role in this decision is particularly critical as they contribute the greatest portion of labor to *ghaiya* (69%), including virtually complete control over the steps critical to maintaining diversity such as seed selection and storage.

Participatory landrace selection proved to be an effective means of broadening the range of suitable *ghaiya* landraces available to farmers at little risk to the participating farmers and at a relatively low cost to the researchers. Farmers were provided with the opportunity to evaluate new options under their own conditions, and came to observable conclusions in a relatively short time (two seasons). All of the introduced landraces were rated at least the same as known landraces for most traits, and a few offered advantages of longer term interest to farmers. The net effect was an increase in the number of landraces in all the study villages and ongoing use of several new landraces with productivity advantages.

While development and testing of the PLS approach required intensive input from the researchers, now that the approach has been proven effective the principle of regular searches for and introduction of landraces can be implemented over a larger area with less effort per community. This can be expected to increase the number of suitable and potentially better landraces available to particular communities. Given that there is currently very little institutional support for this crop, the following activities would help to enhance the

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conservation of genetic resources of the *ghaiya* landraces and speed up the process of farmer selection of better landraces:

- Ongoing documentation of the genetic diversity of *ghaiya* landraces, based on farmer naming conventions and scientific review of the minimum identifying traits of each *ghaiya* landrace;

- Establishment of seed diversity fairs at the community level to create greater awareness about existing landraces within and across communities and facilitate farmer-to-farmer exchange of the genetic materials and knowledge;

- Distribution to farmers of the seed of promising landraces identified through the documentation process and at seed diversity fairs, combined with farmer-based assessment of their qualities and periodic monitoring of their use.

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