REPORT

Karnali zone special project:

Genetic manipulation and marker aided breeding for rice and buckwheat improvement

Project no. 33162002

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Introduction

Karnali zone is food deficit and lest developed region in Nepal. There are many local agrobiodiversity even though food grains have been imported regularly by airbus. Most of the farmers depend on agribusiness. Rice (*Oryza sativa* L.), *tite* (tartary buckwheat) and *mithe* (common buckwheat) buckwheat (*Fagopyrum* spp) are the major crops grown in all districts of Karnali zone. One of the major factors for increasing production is to provide disease resistance and high yielding varieties to the farmers. For managing disease, cultivar mixtures may be the simple technique. The existing variation in rice and buckwheat may be used to develop the varieties suitable to farmers.

Objectives

- To increase productivity and manage diseases problem in rice, tite and mithe buckwheat following cultivars mixture
- To transfer blast resistance gene in Jumli Marshi
- To develop high yielding variety of tite buckwheat (*Fagopyrum tartaricum*)
- To develop high yielding variety of mithe buckwheat (*Fagopyrum esculentum*)
- To contribute in managing agrobiodiversity (rice and buckwheat) of Karnali zone

Karnali zone

Karnali zone lies in high altitude (Table 1, Figure 1). Cultivated land is limited and most of the agricultural lands are sloppy (Table 2). Due to high number of livestock, land is seemed more fertile but this fertility could not be converted fully in consumable goods. Productivity is very low (Table 3). Period for growing crops is very short, therefore, short duration and cold tolerance varieties are suitable for that areas. Snow falls, cold temperature and drought are the major constraints for crop production. Climatic parameters of rice and buckwheat growing seasons are given in Figure 2. Major crops in Karnali zone are maize, buckwheat, *chino* (proso millet), naked barley, finger millet, wheat, barley and *kanguno* (foxtail millet). Most of the VDCs cultivate buckwheat but rice is cultivated in limited VDCs (Annex 1).

Table 1. General information about Karnali zone

District	Headquarter	Total VDC	Area, sqkm	Elevation, m	Climate
Dolpa	Dunai	23	7889	1225-7625	Mild temperate, cool temperate, alpine
Jumla	Khalanga bazaar	30	2531	915-4679	Sub tropical, temperate, alpine
Kalikot	Manma	29	1741	1500-4790	Temperate, cool temperate, alpine
Mugu	Gamgadhi	24	3535	1524-7045	Temperate, cool temperate, alpine
Humla	Simikot	26	5655	1524-7337	Temperate, cool temperate, alpine

Table 2. Agricultural information of Karnali zone

District	Physical condition	Agriculture land, ha		Rice area and production		
		Cultivated	Non cultivated	Year	Area, ha	Production, t
Dolpa	High himalaya	1218	333	97/98	260	490
	High mountain	4790	3000	98/99	260	500
				99/00	260	490
Jumla	High himalaya	12	21	97/98	1450	2475
	High mountain	14731	9293	98/99	1500	1141
				99/00	1835	1835
Kalikot	High himalaya	15828	7920	97/98	1150	2360
	High mountain	0	0	98/99	1150	2500
				99/00	1150	2360
Mugu	High himalaya	17	10	97/98	420	820
	High mountain	11555	7062	98/99	420	820
	Mid mountain	100	49	99/00	420	820
Humla	High himalaya	185	49	97/98	350	553
	High mountain	5881	3182	98/99	390	715
	Mid mountain	0	0	99/00	350	553

Table 3. Status of rice and buckwheat in Karnali zone

District	Crop	Area, ha	Production, t	Productivity, t/ha	Season	
					Seeding	Harvesting
Mugu	Buckwheat	500	982	1.96	Jestha-Ashad	Bhadra-Kartik
	Rice	1850	4550	2.03	Chaitra-Baisakh	Ashwin-Kartik
Humla	Buckwheat	500	500	1	Jestha-Srawan	Ashwin-Kartik
	Rice	200	316	1.58	Baisakh-Srawan	Ashwin-Marga
Dolpa	Buckwheat	290	300	1.42	-	-
	Rice	180	160	0.88	-	-
Kalikot	Buckwheat	102	108.62	1.06	-	-
	Rice	4474	8858.52	1.98	Jestha-Srawan	Ashwin-Kartik
Jumla	Buckwheat	-	-	0.9	Jestha-Ashad	Bhadra-Ashwin
	Rice	1366	2880	2.1	Chaitra-Baisakh	Ashwin-Kartik

Source: Annual report of DADOs.

Focus Group Discussion

One day farmers training workshop on rice genetic resources management and utilization was organized. Main areas of discussion with farmers were listing of available rice landraces with their liked and disliked traits (Table 4), farmers' desired traits, problems and important of Jumli Marshi etc. They prefer Jumli Marshi because, it is tasty, *andilo*, cold tolerance and early maturity. However, Jumli Marshi need more water and fertilizers and it is blast susceptible

Figure 1. Map of Karnali zone

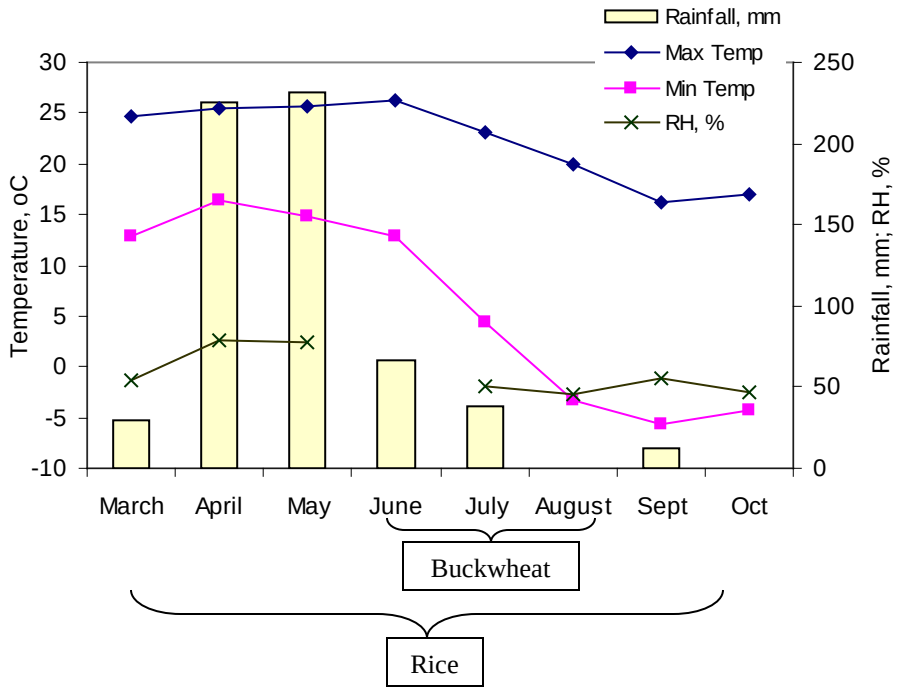

Figure 2. Climatic parameters during rice and buckwheat growing period in Jumla, 2063

Table 4. Rice varieties with prefer and non prefer traits of farmers

SN	Variety	Morphology	Liked traits	Disliked traits
1	Jumli Marshi Rato	Dwarf plant, dense grain in panicle	Tasty, easy to mill	Low straw yield, blast susceptible, need more water
2	Jumli Marshi Seto	Tall plant, red grain after matured	Tasty, fast cooking and need low water for cooking	Low yield, shattering problem
3	Jumli Marshi Kalo	Medium size plant, black and large grain, white seed, reddish plant	Easy milling and threshing, tasty, *andilo*, cold tolerance, rice good for heart patients, good market value, straw good for livestock, low storage pests	Need more water to cultivate, lodging, weed problems, blast susceptible, low grain yield
4	Dadime	Small plant, small size grain, red grain, red seed	High yield, early maturity, wind can't shatter the grains, straw good for livestock	Difficult to thresh, need more water, more storage pests, grain color not good for eating
5	Ghaiya	Low tillering, round and bold grain	Need less water and fertilizer, drought resistance, blast resistance	Not tasty, low yield
6	Chandhannath 1	Short plant, black small grain	High yield, need low water, lodging resistance, hail stone resistance (hail stone can't damage grain), tasty, low disease problems, good straw for livestock	Low straw yield, difficult to thresh, grain color not good for eating
7	Chandhannath 3	Tall plant, long panicle, yellow grain, white seed, long grain	Taste less than Kalo Marshi, high straw yield, easy to harvest, low diseases problems, need low water, cold tolerance	Need more fertilizers, difficult to thresh, late maturity, storage pests problems, difficult to mill, crop can be damaged if there are more water in the field

One day farmers training workshop on buckwheat genetic resources management and utilization was organized. Main focus areas of discussion were listing of *tite* and *mithe* landraces along with important traits (Table 5), problems and important of buckwheat (Box 1), farmers' desired traits in buckwheat varieties etc.

Two days orientation training to staff was organized. P Mahat and CB Rana were fully provided all technical aspects of this project to implement the set activities in Agriculture Research Station, Jumla. Characterization, collections and evaluation methods and use of field books were discussed with the support staff. Rationale and objectives of this project were highlighted in a meeting with DADO, CDO, District administrative officers and others.

Table 5. Landraces of buckwheat with prefer and non prefer traits of farmers

SN	Variety	Morphology	Liked traits	Disliked traits
1	Mithe phapar	Red stem and leaf, white flower, tall plant, shiny black triangular seed, large seed	Tasty, thin husk, lodging resistance, good for *ringata* disease	Low grain yield, straw not good for livestock
2	Barule	Medium size leaf and plant, seed not pointed	High yield, short duration variety, leaf useful for vegetables, more branching, more flour yield, no need of intercultural operations, useful for livestock, good for pregnant livestock especially in case of *Sal najarne* problem	Bitter, flour come out if rainfall occur after maturity, difficult to grind, if eat more, can create swelling and *jamjamaune* problems
3	Chuchche	Long triangular seed, tall plant, triangular leaf, low branching	Low cost of intercultural operations, leaf are useful for fresh and dry vegetables, high yield, early maturity, useful for cough, *jaundice*, diabetes, low weed problems, useful for sick animals and during bleeding,	Bitter, cause headache if eat more, if leaf eat before monsoon cause *jamjamaune*, turn eye yellow and swell body if eat more, no seed set in case of high moisture and fertile soil, lodging problem in fertile soil

Box 1. Problems and importance of buckwheat cultivation

Problems: Bitter taste, lodging in high fertile soil, difficult to dehusk and grind, storage problem for Barule phapar, low grain yield of mithe buckwheat, shattering and marketing problems, rainfall damage crop easily, limited food items made from buckwheat, leaf if eat more can cause joint or leg problems (*Jamjamaune*).

Important traits: No problems of pests, high flour yield, no storage pests, high grain yield, tasty, nutritious and medicinal value.

Seeds collection

Available local diversity of rice, tite and mithe buckwheat in Jumla was collected for characterization, evaluation, isozyme survey and ex situ conservation. Seeds of 6 different landraces of rice were collected consisting of total 37 populations (Table 6). A total of 28 mithe and 21 tite buckwheat lines were collected from different farmers of Jumla, Hill Crops Research Program, Kavre and Agriculture Botany Division, Khumaltar (Table 7). Different landraces of rice and buckwheat are found in five districts of Karnali zone (Table 8), but due to difficult to go to other districts, collections were restricted to only Jumla district. One set of all these collections were kept in Biotechnology Unit for isozyme and molecular works.

Table 6. Rice accessions collected from different farmers of Jumla, 2062

SN	Landrace	Population, n	Sources	Locations
1	Jumli Marshi	5	Ram B. Rawat, Mun B. Edi, Purna B. Bohara, Harikala Rokaya, Naaba R. Kumai	Chumchaur, Patarasi, Dillichaur, Raralihi, Chandhannath
2	Rato Marshi	11	Dal Buda, Man B. Buda, Tanka P Upadhyay, Nanda D. Adhikari, Padam K Dhital, Madi K Chaulagai, Suresh Chaulagai, Naba Sah, Resham Hamal, Dhana K Upadhyay, Pan M Rawat	Malika Bota, Rara Lihi, Thapa, Badki, Narakot, Birat, Tamti, Kanka Sundari, Daku, Lamra
3	Dadime	6	Ram P Upadhyay, Amar R Sahi, Japlal Buda, Hari B Pandey, Krishna B Rawat, Man B Rawat	Mahabai Patar Khola, Kalika Khetu, Kudari, Pandab Gupha, Mallika Danta, Rara Lihi
4	Mehele	5	Kala Sahi, Prithimal Rawat, Gase Roakaya, Hari L Rawat, Jap B Bhandari	Kalika Khetu, Rara Lihi, Ghode Mahadev, Mallika Danta, Hanku
5	Kalo Marshi	9	Nara B Rawat, Hari K Bohara, Datta B Rokaya, Jap P Khatri, Raj B Malla, Bhanu C Neupane, Devi K Upadhyay, Chauro Buda, Gore B Buda	Talium, Dhapa, Depalgau, Mahat, Hanku, Kudari, Patarasi, Chumchaur
6	Seto Marshi	1	Pulti Rawat	Lamra

Table 7. Buckwheat accessions collected from different farmers of Jumla and from Kavre and Khumaltar, 2062

SN	Landrace	Population, n	Sources	Locations
Mithe buckwheat				
1	Mithe phapar	11	Umakali Hamal, Asauji Bista, Hari B Rawat, Mun P Neupane, Kar Buda, Dhana K Upadhyay, Jaya L Buda, Prithisale Rawat, Ram C Basnet, Gase Rokaya, Birsa Nepali	Jumla (Kudari, Lamra, Rara Lihi, Tato Pani, Hanku, Kudari, Mallika Danta, Ghode Mahadev)
2	ACC# 481	1	Hill Crops Research Program	Kavre
3	CBBP-03	1	Hill Crops Research Program	Kavre
4	GF-5099	1	Hill Crops Research Program	Kavre
5	ACC# 6529	1	Hill Crops Research Program	Kavre
6	ACC# 5274	1	Hill Crops Research Program	Kavre
7	GF-5289	1	Hill Crops Research Program	Kavre
8	ACC# 2244	1	Hill Crops Research Program	Kavre
9	GF-5063	1	Hill Crops Research Program	Kavre
10	GF-5283	1	Hill Crops Research Program	Kavre
11	ACC# 2228	1	Agriculture Botany Division	Khumaltar
12	COLL# 7529	1	Agriculture Botany Division	Khumaltar
13	IR-13	1	Agriculture Botany Division	Khumaltar
14	ACC#6575	1	Agriculture Botany Division	Khumaltar
15	AIBL-D	1	Agriculture Botany Division	Khumaltar

SN	Landrace	Population, n	Sources	Locations
16	ACC# 6273	1	Agriculture Botany Division	Khumaltar
17	ACC# 22-7-1	1	Agriculture Botany Division	Khumaltar
18	DHANKUTTA	1	Agriculture Botany Division	Khumaltar
19	ACC# 9251	1	Agriculture Botany Division	Khumaltar
20	MY-10-2	1	Agriculture Botany Division	Khumaltar
21	LOCAL SWEET	2	Agriculture Botany Division	Khumaltar
22	COLL# PL-21	1	Agriculture Botany Division	Khumaltar
23	ACC# 1012	1	Agriculture Botany Division	Khumaltar
24	ACC# LOCAL SWEET	1	Agriculture Botany Division	Khumaltar
25	PL-30	1	Agriculture Botany Division	Khumaltar
26	ACC# 7519	1	Agriculture Botany Division	Khumaltar
27	KHUMAL	1	Agriculture Botany Division	Khumaltar
28	GF-5251	1	Agriculture Botany Division	Khumaltar
Tite buckwheat				
1	Barule	32	Umakali Hamal, Jum Rokaya, Suk L Basnet, Khada N Upadhyay, Mun P Neupane, Lal B Edi, Umse Rokaya, Dhana K Buda, Gore B Buda, Ram M Sahi, Dal Buda, Ram C Basnet, Jau Kali, Laxmi Buda, Munbir Dharala, Siv C Buda, Santa D Dhital, Pulti Rawat, Kar Buda, Karna B Bista, Prithisale Rawat, Gase Rokaya, Bhim B Bista, Bishnu Buda, Dhana B Rawat, Dil B Rokaya, Manbir Dharala	Kudari, Wadki, Ghuthichaur, Patarkhola, Lamra, Chumchaur, Rara Lihi, Hanku, Dhapa, Mallikadhanta, Bumramadichaur, Patmara, Kalikakhetu, Talium, Patrasi, Sanigau, Tatopani, Ghodemahadev, Pandavghupha
2	Chuchche	23	Setu Sahi, Ramgat Gautam, Bharuni Chaulaghai, Prava Rokaya, Dal Buda, Gore B Buda, Chakaya Bohara, Jaukala Buda, Munbir Dharala, Nanda D Adhikari, Laxmi Buda, Prithivi B Sahi, Mun P Neupane, Siva Dhital, Kar Buda, Devi K Upadhyay, Chabilal Neupane, Panna Kali Rawat, Bal B Bhandari, Mansa Kumai, Hari K Bohara, Birsha Nepali, Ause Rokaya	Kalikakhetu, Hanku, Narakot, Rara Lihi, Bumramadichaur, Chumchaur, Birat, Talium, Badki, Patmara, Dhapa, Lamra, Sanigau, Tatopani, Kudari, Kawasowti, Lama, Depalgau, Chandhannath, Malikabota
3	Tite phapar	7	Hari K Bohara, Dhana Edi, Siva C Buda, Punna Upadhyay, Jug Basnet, Dan B Sejuwal	Talium, Patrasi, Tamti, Kankasundari, Mallikadnata, Mahat,
4	MY-2-27-1	1	Hill Crops Research Program	Kavre
5	GF-5283	1	Hill Crops Research Program	Kavre
6	SAMPLE# 6-1	1	Hill Crops Research Program	Kavre

SN	Landrace	Population, n	Sources	Locations
7	SAMPLE# 8	1	Hill Crops Research Program	Kavre
8	ACC# 2223	1	Hill Crops Research Program	Kavre
9	ACC#2227	1	Hill Crops Research Program	Kavre
10	ACC# 7529	1	Agriculture Botany Division	Khumaltar
11	ACC# 2201-2	1	Agriculture Botany Division	Khumaltar
12	BHATE PHAPAR	1	Agriculture Botany Division	Khumaltar
13	ACC# 6485	1	Agriculture Botany Division	Khumaltar
14	MY-2-33-1	1	Agriculture Botany Division	Khumaltar
15	ACC# 2236	1	Agriculture Botany Division	Khumaltar
16	KLE-IR-13-6-106	1	Agriculture Botany Division	Khumaltar
17	LOCAL BITTER	1	Agriculture Botany Division	Khumaltar
18	KAVRE BITTER	1	Agriculture Botany Division	Khumaltar
19	GF-5251	1	Agriculture Botany Division	Khumaltar
20	MY-2-27-1	1	Agriculture Botany Division	Khumaltar
21	ACC# 15170	1	Agriculture Botany Division	Khumaltar
22	S-1	1	Agriculture Botany Division	Khumaltar

Table 8. Rice and buckwheat landraces and varieties being grown in Karnali zone

SN	District	Landraces/ varieties		Main crops
		Rice	Buckwheat	
1	Dolpa	Chommrong, Lumle-1, Jinling, Yunlen, Chandhannath-1, Local	Mithe phapar, Local Chuchche, Local Lekhari, Bhate, ACC# 2223, Dalle, Kalo	Maize, rice, wheat, finger millet, naked barley, barley, buckwheat, chino
2	Jumla	Seto Marshi, Rato Marshi, Kalo Marshi, Jumli Marshi, Jumli Marshi Mehele, Jumli Marshi Dadime, Chandhannath 1, Chandhannath 3, Ghaiya	Mithe phapar, Chuchche, Barule, Takule, Tilkunde, Tote, Ghode, Tite phapar	Rice, barley, wheat, buckwheat, finger millet
3	Humla			Naked barley, wheat, barley, buckwheat, rice, chino
4	Kalikot	Chommrong, Palung, Khumal-4, Khumal-5, Khumal-6, Khumal-7, Khumal-9, Chandhannath-1, Tirthapoke, Tarijiule, Chimathekalo	Tite phapar, Mithe phapar	Naked barley, finger millet, buckwheat
5	Mugu			Wheat, barley, naked barley, chino, kaguno, rice, buckwheat

Characterization and evaluation

All collected rice accessions were characterized and evaluated in Agriculture Research Station, Jumla. Some of these were promising. Traits of some genotypes are given in Table 9. One set of

these collections were tested for reaction to blast in Khumaltar. All collections were susceptible to blast in Khumaltar, however some are resistance to blast in ARS Jumla 2063.

Table 9. Performance of Jumla rice collections, 2063

SN	Landrace*	Maturity day	Plant height	Yield, t/ha	Blast reaction
1	Jumli Marshi Mehele	194	80	3.3	Field resistance
2	Jumli Marshi Darime HBP	159	83	3.5	Field resistance
3	Jumli Marshi Darime KBR	194	86	3.7	Field resistance
4	Kalo Marshi	196	76	3.5	Field resistance
5	Jumli Marshi	194	89	4.2	Field resistance
6	Rato Marshi	196	70	4.5	Field resistance

** Capital letter after landrace name is farmer name in short who provided the seeds.*

Buckwheat is very short duration crop and it can grow in different environments. Both tite and mithe buckwheat were characterized and evaluated in Agriculture Research Station, Jumla. Tite is suitable to high altitude and it can tolerate frost. Due to rainfall during flowering period of mithe buckwheat, most of the genotypes showed poor performance. However some lines did well. Performances of some lines are given in Table 10. Most of the tite buckwheat did well.

Table 10. Performance of Jumla buckwheat collections, 2063

SN	Landrace	Maturity day	Plant height, cm	Yield, kg/ha	Disease
Mithe phapar					Not observed
1	Mithe phapar UKH	66	78	700	Not observed
2	Mithe phapar AB	73	67	300	Not observed
3	Mithe phapar HBR	71	72	601	Not observed
4	Mithe phapar DKU	66	54	863	Not observed
5	Mithe phapar PSR	66	56	495	Not observed
Tite phapar					
1	Barule JR	74	56	696	Not observed
2	Chuchche BC	76	45	600	Not observed
3	Chuchche DB	78	46	537	Not observed
4	Barule KU	106	49	616	Not observed
5	Barule LBA	106	50	700	Not observed
6	Chuchche MBD	96	49	500	Not observed
7	Tite phapar NK	77	42	500	Not observed
8	Barule UR	79	46	500	Not observed
9	Chuchche NDA	66	51	550	Not observed
10	Barule GBB	96	69	500	Not observed
11	Tite phapar PU	96	42	593	Not observed
12	Chuchche SD	76	45	844	Not observed
13	Barule KB	78	63	1430	Not observed

** Capital letter after landrace name is farmer name in short who provided the seeds.*

Isozyme and molecular research

Preliminary study was done for isozyme polymorphism in rice (Jumli Marshi, Fuji 102, Chhommrong, Chandhannath 1, Chandhannath 3) (Figure 3). Bajracharya et al (2001) studied Jumla collections of buckwheat using isozymes and rice using SSR markers. Joshi et al (2007) studied some of Jumla rice collections using RAPD markers (Figure 4). Similarly RAPD markers were used to study variation in wild and tite buckwheat by Bimb et al (2001). These genetic diversity study will be reviewed and further detail study will be done using isozymes and DNA markers in rice, tite and mithe buckwheat. This diversity information will be used for developing varieties.

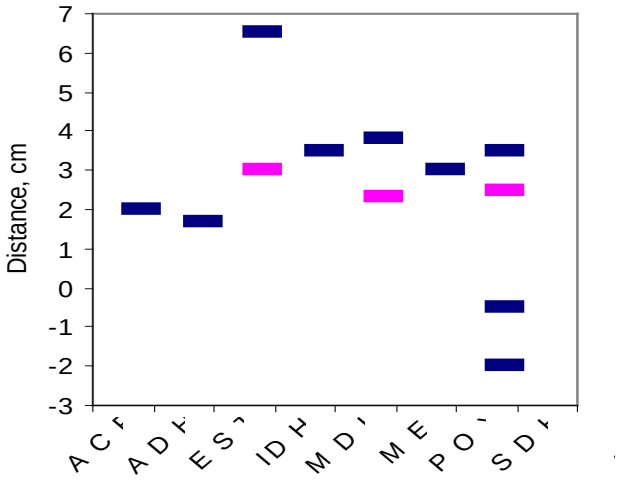

Figure 3. Isozyme profiles of Chhommrong rice cultivar

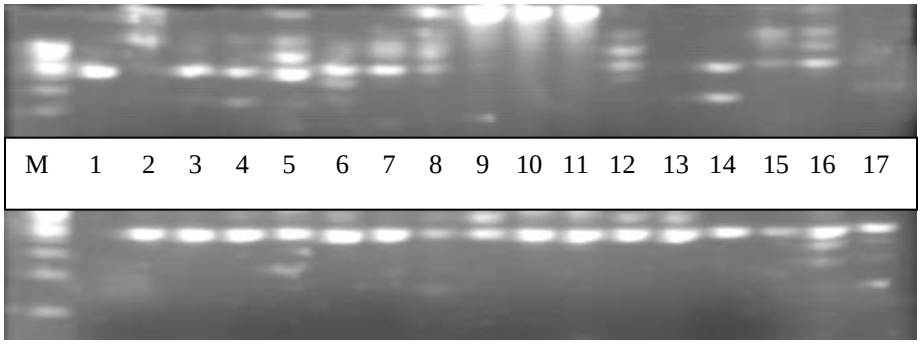

Figure 4. RAPD polymorphism of different rice genotypes with primer 141 (M, marker; **Sample above:** 1, Kali Marshi; 2, Ghaiya dhan; 3, Dhokro dhan; 4, Maine Pokhreli; 5, Lekali dhan; 6, Hanse; 7, Pale dhan; 8, Bageri dhan; 9, Jethobor; 10, Pokhara Masino; 11, Chananchur; 12, Lalshar; 13, NR10315-145-2-3; 14, NR10286-6-3-2-2; 15, Manjushree-2 ; 16, NR10375-20-1-2; 17, Khumal 11. **Sample below**: 1, NR10353-8-2-1; 2, NR28518-3-2-3-1; 3, NR10276-15-2-3-3-2; 4, NR10414-25-2; 5, NR10414-34-2-3; 6, Taichung-176; 7, Jumli White; 8, Chandhannath-1; 9, Chandhannath-3; 10, NR10276-9-3-3-3-2; 11, NR10285-29-3-1; 12, Sabitri; 13, IR-24; 14, A57-115-8; 15, CO 39; 16, Masuli; 17, Check. 3 samples from Jumla, 2 from Humla and 3 from Mugu).

Ex situ conservation

Seeds of some present collections of these rice, tite and mithe buckwheat were kept ex situ for long term conservation in Agriculture Botany Division (ABD), Khumaltar. ABD has 90

accessions of rice consisting of 53 different landraces (Table 11). These were collected by ABD, IBPGR and NRRP in different years. The number of collections was the highest from Humla followed by Mugu (Figure 5). Ten accessions of mithe buckwheat and 17 accessions of tite buckwheat were collected from different districts of Karnali zone by ABD and Japan in different years (Table 12). The highest collections of mithe and tite buckwheat were from Humla and Jumla respectively (Figure 6).

Table 11. Details of collection of different rice landraces from Karnali zone

SN	Landrace	District	Altitude (collection points), m	Accessions, n	Collection year	Collecting institute
1.	Basmati	Humla	1350, 1640, 1665, 1850	4	1985	IBPGR/ABD
2.	Bhertalo dhan	Humla	1850	1	1985	IBPGR/ABD
3.	Bhuwa dhan	Humla	1860, 1970, 2220, 2335	5	1985, 1991	IBPGR/ABD
4.	Dhatulo dhan	Humla	1850	1	1985	IBPGR/ABD
5.	Dogro dhan	Humla	2220, 2400	2	1985, 1991	IBPGR/ABD
6.	Dokor dhan	Humla	2100	2	1985	IBPGR/ABD
7.	Jhuldhan	Humla	1350	1	1985	IBPGR/ABD
8.	Kalo marsi	Humla	2100, 2300, 2350, 2420, 2600	7	1985	IBPGR/ABD
9.	Katikiya dhan	Humla	1350	1	1985	IBPGR/ABD
10.	Khachucha dhan	Humla	2350	1	1985	IBPGR/ABD
11.	Khachya dhokro	Humla	1850	1	1985	IBPGR/ABD
12.	Khetala dhan	Humla	2120, 2220	3	1985	IBPGR/ABD
13.	Lasadro dhan	Humla	1740	3	1985	IBPGR/ABD
14.	Maina pokhari dhan	Humla	1350	1	1985	IBPGR/ABD
15.	Mal marse	Humla	2240	2	1985	IBPGR/ABD
16.	Nakhine dhan	Humla	1350	1	1985	IBPGR/ABD
17.	Nan dhan	Humla	1730	1	1985	IBPGR/ABD
18.	Nauro dhan	Humla	1970	1	1985	IBPGR/ABD
19.	Ratanpur dhan	Humla	1350, 1850	2	1985	IBPGR/ABD
20.	Rato katike dhan	Humla	1360	1	1985	IBPGR/ABD
21.	Rumsero dhan	Humla	1820	1	1985	IBPGR/ABD
22.	Seto dhan	Humla	1360, 1850, 1970	3	1985	IBPGR/ABD
23.	Seto marse	Humla	2100	1	1985	IBPGR/ABD
24.	Thapachine dhan	Humla	1665	1	1985	IBPGR/ABD
25.	Barakoti dhan	Jumla	2530, 2713	2	1991	ABD
26.	Jadan marsi	Jumla	-	1	-	NRRP
27.	Kalo maheli	Jumla	-	1	-	NRRP
28.	Kalo marsi	Jumla	2393, 2603,2713	7	1991	NRRP, ABD
29.	Kalo seto marse	Jumla	2550	1	1991	ABD
30.	Marsi	Jumla	-	1	-	NRRP
31.	Meheli	Jumla	-	1	-	NRRP
32.	Rato marsi	Jumla	-	1	-	NRRP
33.	Seti marsi dhan	Jumla	2390	2	1991	ABD, NRRP
34.	Dadhime dhan	Kalikot	1980	1	1991	ABD
35.	Darma/Chimathe dhan	Kalikot	1792	1	1991	ABD
36.	Ghaiya dhan	Kalikot	1609	1	1991	ABD
37.	Gumki dotelo dhan	Kalikot	1768	1	1991	ABD
38.	Jhose dhan	Kalikot	1609, 1268	2	1991	ABD

SN	Landrace	District	Altitude (collection points), m	Accessions, n	Collection year	Collecting institute
39.	Koglya dhan	Kalikot	1268, 1585	2	1991	ABD
40.	Tirthbhog dhan	Kalikot	1268	1	1991	ABD
41.	Bhuwa dhan	Mugu	2020	1	1985	IBPGR/ABD
42.	Boya dhan	Mugu	2000	1	1985	IBPGR/ABD
43.	Dhan	Mugu	1960, 2035	2	1991	ABD
44.	Dhaudo dhan	Mugu	1780	1	1985	IBPGR/ABD
45.	Dhokro dhan	Mugu	2350	1	1985	IBPGR/ABD
46.	Ghaiya dhan	Mugu	2380	1	1985	IBPGR/ABD
47.	Juga dhan	Mugu	2350	1	1985	IBPGR/ABD
48.	Jumli dhan	Mugu	2020	1	1985	IBPGR/ABD
49.	Kalo marsi	Mugu	2350, 2380, 2600	4	1985	IBPGR/ABD
50.	Lotan sarau	Mugu	2080	2	1985	IBPGR/ABD
51.	Marsi dhan	Mugu	1870	1	1985	IBPGR/ABD
52.	Pakhe ghaiya	Mugu	1960	1	1991	ABD
53.	Seto dhan	Mugu	2030	1	1985	IBPGR/ABD

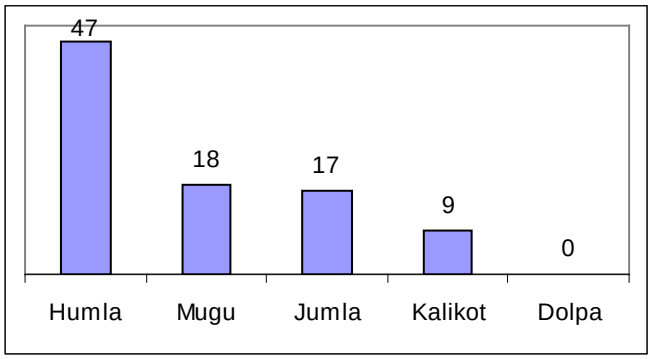

Figure 5. Rice accessions collected from Karnali zone and stored in Gene bank, NARC, Khumaltar

Table 12. Details of collection of different buckwheat landraces from Karnali zone

SN	Local name	District	Altitude, m	Accessions, n	Collected year	Collecting institute
Common buckwheat						
1	Mithe phapar	Dolpa	2520	1	1986	JAPAN/ABD
2	Mithe phapar	Humla	1860, 2230, 2840	4	1985	JAPAN/ABD
3	Guliyo phapar	Humla	2335	1	1991	ABD
4	Bharule phapar	Jumla	2530	2	1991	ABD
5	Mithe phapar	Kalikot	1768	1	1991	ABD
6	Mithe phapar	Mugu	1960	1	1991	ABD
Tartary buckwheat						
1	Goriya tite phapar	Dolpa	3090	1	1989	JAPAN/ABD
2	Tite phapar	Dolpa	2960, 3070	4	1989	JAPAN/ABD
3	Tite phapar	Humla	2335, 2400	3	1987	JAPAN/ABD
4	Tite phapar	Jumla	2390, 2393, 2500, 2603, 2896, 3160	6	1989, 1991	JAPAN/ABD
5	Bharuley phapar	Jumla	2697	1	1991	ABD
6	Tite phapar	Kalikot	1792	1	1991	ABD
7	Tite phapar	Mugu	2652	1	1991	ABD

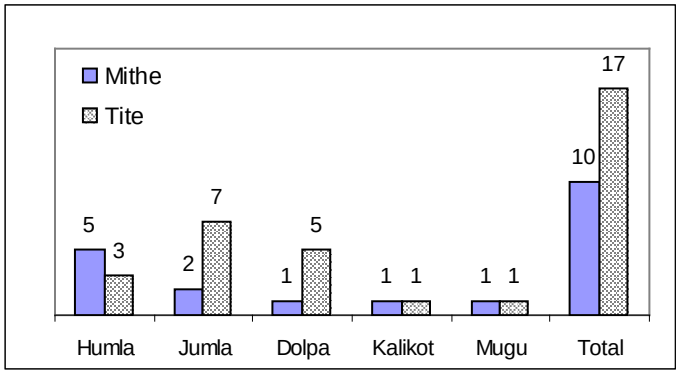

Figure 6. Buckwheat (Mithe and Tite) accessions collected from Karnali zone and stored in Gene bank, NARC, Khumaltar

Agriculture Green Bank

Small area in Agriculture Botany Division, Khumaltar and Agriculture Research Station, Jumla are separated for in situ conservation of agriculture related wild species. This Bank which can provide the valuable gene/s, may be the important areas for conservation of wild species of crops. Seeds and rhizome of *Fagopyrum cymosum* in these areas are planted and conserved. Diversity monitoring and gene flow will be studied in *F cymosum*.

Diallel analysis of cultivar mixtures

The usefulness of mixture whether multilines, isolines or cultivar mixtures for disease management has been well demonstrated in cereals. Cultivars mixtures refer to mixtures of cultivated varieties growing simultaneously on the same parcel of land with no attempt to breed for phenotypic uniformity. With different height and root length of varietal mixtures, this system can utilize soil and aerial space properly. It is considered that this technique is more practical and requires less investment for disease management and for increasing productivity. Based on the performance of rice genotypes, four rice genotypes were selected for cultivar mixtures trial. These will be mixed in all possible combination to estimate the general and specific mixing ability (GMA and SMA). Principal of diallel will be used to estimate the GMA and SMA. Selected genotypes are Jumli Marshi Mehele, Jumli Marshi Dadime, Kalo Marshi and NR-104-82-B-10-3-2-2.

Similarly five genotypes of each tite and mithe buckwheat were selected. GMA and SMA will be estimated in each of these tite and mithe buckwheat trials as described above. Selected genotypes of tite buckwheat are Barule JR, Chuchche BC, Chuchche DB, Barule KU, Barule LBA, Chuchche MBD, Tite phapar NK, Barule UR, Chuchche NDA, Barule GBB, Tite phapar PU, Chuchche SD and Barule KB and that of mithe buckwheat are Mithe phapar UKH, Mithe phapar AB, Mithe phapar HBR, Mithe phapar DKU and Mithe phapar PSR.

Publication

Following papers were prepared using primary and secondary information. These are useful for designing further research in rice and buckwheat for Karnali zone. Particularly breeder can be benefited in selecting suitable genotypes and developing breeding strategy. Three field books for

rice, common and tartary buckwheat were drafted including design detail and description of methods and experiments.

1. BK Joshi. 2006. Genetic contribution of ancestors to Nepalese rice cultivars. IRRN 31 (2):29-31.
2. BK Joshi and BK Baniya. 2006. A diversity in qualitative traits of Nepalese cultivated buckwheat species. Fagopyrum 23:23-27.
3. **BK Joshi. 2005. Correlation, regression and path coefficients analyses for some yield components in common and Tartary buckwheat in Nepal. Fagopyrum 22:77-82.**
4. BK Joshi, HB KC, RK Tiwari, P Shrestha, R Amagain and MP Upadhyay. 2005. Varietal richness of agricultural crop species and farmers' preferred traits over space and time in Nepal. Botanica Oreintalis 5:
5. BK Joshi, ML Vaidya, HK Upreti, DR Sharma, CB Rana, PM Mahat SR Gupta and S Bista. 2007. Rice and buckwheat genetic resources in Karnali zone. Presented in the National Seminar on Sustainable use of Biological Resources *With the special theme* Medicinal and Aromatic Plants, 22-23 April 2007, Pokhara, Nepal. ECOS, Institute of Forestry and PN Campus.
6. **BK Joshi. 2005. Isozyme variation in geo-populations of Nepalese Rice Cultivars. Submitted to IRRN.**
7. BK Joshi. 2006. Crossing Frequency and Ancestors used in Developing Nepalese Mid and High Hill Rice Cultivars. Submitted to Botanica Orientalis
8. BK Joshi. 2006. Diversity based on coefficient of parentage among rice cultivars recommended for mid and high hills of Nepal. Submitted to Afr. Crop Sci. J.
9. BK Joshi and HP Bimb and R Ohsawa. 2006. Multivariate analysis of agromorphological variation in common and tartary buckwheat species. Submitted to Breeding Science, Japan

Issues and recommendation

- Agriculture Research Station, Jumla does not represent the upper part of Karnali zone for evaluating genotypes. Therefore genotypes doing well on station can not perform well in other areas of Karnali zone.
- Rice and buckwheat genetic resources are being lost from Karnali zone and existing landraces are not competitive. Therefore conservation efforts should be initiated making landraces more competitive.
- Farmer's day should be organized to provide an opportunity to select genotypes to the farmers. For that diversity blocks should be maintained
- Activities should be implemented and extended to remote areas of Karnali zone with collaboration of DADO, Jumla
- Farmers have very limited options of rice and buckwheat varieties. Enhancing landraces and introducing new varieties can increase options for selecting varieties to cultivate. Participatory varietal selection may be a good method to increase production and it should be implemented in all five districts of Karnali zone.
- Books and agriculture diary should be provided to the farmers
- Staff of station should be regularly trained

Annex 1. VDCs and rice and buckwheat genetic resources

SN	District	VDC	Rice	Buckwheat		
				Mithe	Tite	Wild
1.	Dolpa	Bhijel	-	-	Y	-
2.		Mukot	-	-	Y	-
3.		Chharka	-	-	Y	-
4.		Dho	-	-	Y	-
5.		Dunai	Y	Y	Y	Y
6.		Jufal	Y	Y	Y	Y
7.		Kaigaun	-	Y	Y	Y
8.		Kalika	Y	Y	Y	Y
9.		Khadang	Y	Y	Y	-
10.		Lawang	Y	Y	Y	Y
11.		Likhu	Y	Y	Y	-
12.		Majhfal	-	Y	Y	Y
13.		Narku	Y	Y	Y	Y
14.		Pahada	Y	Y	Y	Y
15.		Phoksundo	-	Y	Y	Y
16.		Raha	-	Y	Y	Y
17.		Rimi	-	Y	Y	Y
18.		Sahartara	-	Y	Y	Y
19.		Saldang	-	-	Y	-
20.		Sarmi	-	Y	Y	Y
21.		Sunhoo	Y	Y	Y	Y
22.		Tinje	-	-	Y	-
23.		Tripurakot	Y	Y	Y	-
1.	Jumla	Badki	Y	Y	Y	Y
2.		Barat	Y	Y	Y	Y
3.		Buyaramnadi chaur	-	Y	Y	Y
4.		Chandan nath	Y	Y	Y	Y
5.		Chhutnehaur	Y	Y	Y	Y
6.		Depalgaun	Y	Y	Y	Y
7.		Dhapa	Y	Y	Y	Y
8.		Pillichaur	Y	Y	Y	Y
9.		Garjyangkot	Y	Y	Y	Y
10.		Ghode mahadev	Y	Y	Y	Y
11.		gothichaur	-	Y	Y	Y
12.		Haku	Y	Y	Y	Y
13.		Kalikakhetu	Y	Y	Y	Y
14.		Kanakasundari	Y	Y	Y	Y
15.		Kanikswmni	Y	Y	Y	Y
16.		Kudari	Y	Y	Y	Y
17.		Labhara	Y	Y	Y	Y
18.		Lihi	Y	Y	Y	Y
19.		Mababepattharkhol	Y	Y	Y	Y
20.		Mahatgaun	Y	Y	Y	Y
21.		Maligathata	Y	Y	Y	Y
22.		Malika bota	Y	Y	Y	Y

SN	District	VDC	Rice	Buckwheat		
				Mithe	Tite	Wild
23.		Narakot	Y	Y	Y	Y
24.		Pandawagufa	Y	Y	Y	Y
25.		Patarasi	Y	Y	Y	Y
26.		Patmara	Y	Y	Y	Y
27.		Sanigaun	Y	Y	Y	Y
28.		Talijun	Y	Y	Y	Y
29.		Tamti	-	Y	Y	Y
30.		Tatopani	Y	Y	Y	Y
1	Kalikot	Badikot	Y	-	-	-
2		Chhapre	Y	-	-	-
3		Chikhava	Y	-	Y	-
4		Dahapafatgaun	Y	-	-	-
5		Dholagohe	-	Y	Y	-
6		Gela	Y	-	-	-
7		Jubika	Y	-	-	-
8		Kheen	-	Y	Y	-
9		Kothaba	-	-	-	-
10		Kumalgaun	Y	-	-	-
11		Lalutantikot	Y	-	-	-
12		manma	Y	-	-	-
13		Marta	Y	-	-	-
14		Mehamudi	Y	-	-	-
15		Mugraha	Y	-	-	-
16		mumrakot	-	-	-	-
17		Nanikot	Y	-	-	-
18		Odanku	Y	-	-	-
19		Pakhu	Y	-	-	-
20		Pohi mahadev	Y	Y	Y	-
21		Phukot	Y	-	-	-
22		Raku	Y	-	-	-
23		Ramanakot	-	Y	Y	-
24		Ramchuli	Y	Y	Y	-
25		Rupsa	-	-	-	-
26		Sipkhana	Y	-	-	-
27		Siuna	Y	-	-	-
28		Suktiva	Y	-	-	-
29		Thirpu	Y	-	-	-
1	Mugu	Dolphu				
2		Ghainakot				
3		Gumtha				
4		Hyanglung				
5		Juma				
6		Karkihada				
7		Kumari				
8		Kot Danda				

SN	District	VDC	Rice	Buckwheat		
				Mithe	Tite	Wild
9		Mangri				
10		Mihi				
11		Mugu				
12		Natharpu				
13		Photu				
14		Pipa				
15		Puht				
16		ram Kale				
17		Rara (Gilae)				
18		Rowa				
19		Ruga				
20		Rumale				
21		Seri				
22		Shree Kot				
23		Shree Nagar				
24		Sukhandhik				
1	Humla	Bargaun				
2		Chhipra				
3		Dami				
4		Dandafava				
5		Gothi				
6		Hepka				
7		Jaur				
8		Kermi				
9		Khagalgaun				
10		Kharpunath				
11		Lali				
12		Lauthi				
13		Limi				
14		Maila				
15		Melchham				
16		Mimi				
17		Muchu				
18		Raya				
19		Ripa				
20		Rodikot				
21		Sava (Sama)				
22		ShreeNagar				
23		Simikot				
24		Syada				
25		Thechava				
26		Yangchu				

Annex 2. List of farmers participated in focus group discussion in ARS, Jumla, 2062

SN	Farmer	Address	Remarks
Rice			
1			
2			
3			
4			
5			
6			
7			
8			
Buckwheat			
1			
2			
3			
4			
5			
6			
7			

Annex 2. Traits to be measured from buckwheat diversity block (characterization, observation and selection) ARS, Jumla 2006

A. Vegetative part

1. Weight of seeded seed (Weigh before seeding, g)
2. Seeding date
3. Date of emergence (50%) (Plot basis)
4. Cotyledon/ seedling leaf color (Plot basis)
5. Growth and branch shoot habit
6. Degree of determination
7. Plant height
8. Number of internodes (On main stem)
9. Length of internodes (middle 3 internodes of main stem)
10. Number of primary branches (at physiological maturity)
11. Number of secondary branches (at physiological maturity)
12. Stem color
13. Petiole color
14. Leaf color
15. Leaf margin color
16. Leaf vein color
17. Leaf blade color (as leaf margin color)
18. Leaf number
19. Leaf blade length (3 leaves of each plant)
20. Leaf blade width (3 leaves of each plant)
21. Leaf blade shape
22. Lodging susceptibility (Plot basis)

B. Reproductive part

1. Date of first flowering
2. Date to flowering (Plot basis) (50%)
3. Type of inflorescence (raceme or cyme)
4. Compactness of inflorescence
5. Color of inflorescence stalk
6. Length of cyme/ raceme (3 cyme from each plant)
7. Number of flowers clusters per cyme (From 3 cyme of each plant)
8. Number of flower/cluster (From 5 clusters)
9. Number of flower/ cyme (From 3 cymes)
10. Total number of cluster/ plant
11. Total number of flower/ plant
12. Number of cymes per plant
13. Total number of seed/ plant
14. Number of seed/ cyme (From 3 cymes, consider 7 point)
15. Number of seed/cluster (From 5 clusters, consider 8 point)
16. Flower color
17. Flower morphology (If 3 types are observed in same plant count all types)
18. Flower abortion
19. Date of first maturity (consider point 1)
20. Date to maturity (Plot basis) (75%)

C. Seed and yield

1. Seed color
2. Immature seed edge color

3. Immature seed surface color
4. Pericarp color
5. Seed shape
6. Seed surface
7. Number of ridge (Observe 5 seeds)
8. Seed length (From 5 seeds)
9. Seed width (From 5 seeds at widest portion)
10. 1000-seed weight (sun dried seed)
11. Threshability (Plot basis)
12. Number of plant per plot (Plot basis)
13. Grain yield per plant
14. Grain yield per plot (Plot basis)
15. Straw yield per plant
16. Straw yield per plot (Plot basis)
17. 1000-dehulled seed weight

D. Biotic and abiotic stress

1. Insect name and damage intensity (%) (Plot basis)
2. Disease name and damage intensity (%)(Plot basis)
3. Weeds

E. Post harvest traits

F. Metrological data (weekly)

G. Notes

- Study carefully buckwheat descriptors and guidelines
- Record data sincerely, data must be complete and accurate
- You can also measure other traits
- Record data at right stage of crop
- Tag individual plant to measure
- Measure base on either individual, 3-5 parts of plant or plot basis
- Seed, grain and straw weight after sun dried. You can measure two times one just after harvest and other after sun dried)
- Do not average.

Annex 3. Traits to be measured from rice diversity block (characterization, observation and selection) ARS, Jumla 2006

A. Vegetative part

1. Seeding date
2. Transplanting date
3. Number of internode (Main tiller)- after flowering
4. Length of internode (3 middle internodes of main tiller)- after flowering
5. Leaf blade length (below the flag leaf on the main tiller)- late vegetative stage
6. Leaf blade width (widest portion), below flag leaf on the main stem- late vegetative stage
7. Leaf angle (below the flag leaf) (Erect, horizontal and drooping)- prior to heading
8. Leaf blade color (below the flag leaf), pale green, green, dark green, purple tips, purple margins, purple blotch and purple
9. Leaf sheath color (below the flag leaf) green, purple lines, light purples, purple
10. Flag leaf length of blade
11. Flag leaf width of blade
12. Flag leaf angle (erect, intermediate, horizontal and descending)- after heading
13. Plant height
14. Hill number/ plot (plot basis)
15. Fertile tiller number/ hill
16. Sterile tiller number/ hill
17. Strength (lodging resistance) (plot basis) (strong, moderately strong, intermediate, weak and very weak)- maturity
18. Phenotypic acceptance (plot basis), excellent, good, fair and poor

B. Reproductive part

1. Date of first flowering
2. Date of flowering (50%) (plot basis)
3. Date to first maturity
4. Date to maturity (plot basis, 75%)
5. Panicle length
6. Exerted length of panicle
7. Number of primary branching in panicle
8. Number of secondary branching in panicle
9. Panicle type (compact, intermediate and open)
10. Fertile spikelet number/panicle
11. Sterile spikelet number / panicle
12. Threshability (plot basis), difficult, intermediate and easy)

C. Seed and yield

1. Shattering (plot basis), very low, low, moderate, moderately high and high
2. Awn (absent, short and partly awned, short and fully awned, long and partly awned, long and fully awned)
3. Awn color (straw, gold, brown, red, purple, balck)

4. Lemma and palea color (straw, gold and /or gold furrows on straw background, brown spots on straw, brown furrows on straw, brown, reddish to light purple, purple spots on straw, purple furrows on straw, purple, black, white)
5. Grain length (observe 5 grains)
6. Grain width (observe 5 grains at widest portion)
7. Grain yield/hill
8. Straw yield/ hill
9. Grain yield/plot (plot basis)
10. Straw yield per plot (plot basis)
11. 1000-grain weight
12. 1000-dehusked grain yield

D. Biotic and abiotic stress

4. Insect name and damage intensity (%) (Plot basis)
5. Disease name and damage intensity (%)(Plot basis)
6. Weeds

E. Post harvest traits

F. Metrological data (weekly)

G. Notes

- Study carefully rice descriptors and guidelines
- Record data sincerely, data must be complete and accurate
- You can also measure other traits
- Record data at right stage of crop
- Tag individual plant to measure
- Measure base on either individual or hill or parts of plant or plot basis
- Seed, grain and straw weight after sun dried. You can measure two times one just after harvest and other after sun dried)
- Do not average