Project no. **032055**

Project acronym: **FOSRIN**

Project title: **Food security through ricebean research in India and Nepal**

Instrument: STREP

Thematic Priority: 10.3.1.A.3.2: biodiverse, biosafe and value added crops: research to increase the sustainable use and productivity of annual and perennial under-utilised tropical and sub-tropical crops and species important for the livelihoods of local populations.

Title of report: Third periodic activity report, April 2008 – March 2009

Period covered: from April 1, 2008 to March 31, 2009 Date of preparation: May 30, 2009

Start date of project: April 1, 2006 Duration: 4 years

Project coordinator name: Dr PA Hollington
Project coordinator organisation name: CAZS Natural Resources, Bangor University

Revision: Draft

Abstract

The project Food Security through Ricebean Research in India and Nepal (FOSRIN) is a 4-year STRP funded by the 6th Framework Programme of DG Research of the European Commission under the International Cooperation (INCO) Programme. This document summarises the activities that took place within FOSRIN in the period 1 April 2008 – 31 March 2009. Achievements and work progress are described for all relevant workpackages, and additional information provided on project management, coordination activities, and dissemination and exploitation of results. The document contains a 4-page *Publishable Executive Summary*, and as an annexe the current version of the *Plan for Using and Disseminating the Knowledge*.

Ricebean is an underutilised grain legume, grown by hill farmers on marginal land particularly in Nepal and northern India. The project aims to promote the crop and widen its use through a number of activities. Activities include assessment of the supply chain to see where value may be lost; the assessment of genetic diversity and indigenous knowledge of the crop, and the assessment of the potential impact of enhanced pulse availability on local human nutrition. We aim to develop a Market-based Legumes Traits Value-Index (MLTVI) that allows breeders to assess legumes in terms of their monetary value to consumers, and innovative and efficient marketing methods for high quality, protein-rich products. Finally, we will develop policies to support and promote equitable access to such protein-rich foods and so build sustainable medium and long term food security.

The report details project activities in Year 3. Traits were assessed and analysed, and an initial version of Deliverable 1.1 – the hedonic price function – calculated and presented at a conference. From this, the Legumes Trait Value Index can be calculated. A variety that matches the needs of both consumers and farmers will need large seeds, high crude fibre content, and low ash content, with high yield, drought tolerance and pest resistance.

Further samples of germplasm and local knowledge were collected, along with GPS coordinates from locations in Nepal. Observation nurseries were grown for ricebean evaluation. and high-yielding lines identified. It had become apparent that outcrossing in ricebean is greater that had been expected, which could have significant implications, but also present opportunities, for breeding new varieties. Deliverable 2.2, on Indigenous Technical Knowledge, was completed.

A set of 35 adzuki bean SSR markers were found to amplify DNA of ricebean accessions and exhibited polymorphism in a stratified sample of ricebean. A set of 91 accessions based to analysis of agro-morphological diversity were identified and the 13 most polymorphic SSR primers distributed across the genome tested with adzuki bean (red bean) as a check sample.

Over 200 germplasm lines were evaluated for quantitative characters to isolate promising lines. Mother and baby trials were conducted on a large scale and farmer preferences assessed through matrix ranking. Farmers preferred high yielding, short duration and bold seeded varieties rather than the long duration landraces they usually grew. They also preferred varieties with bold (large) seed and early maturity.

Dietary surveys showed that most frequently consumed pulse in the region was lentil. Ricebean was the fifth most frequently consumed pulse. The Deliverable on ricebean nutrient content (Deliverable 5.2) was completed. To popularize ricebean cultivation, publications in local languages were produced, and small-scale demonstrations laid out on farmer's fields. A page on hill farming in NE India was added to the website, and a Wikipaedia page produced.

Annexes with detailed information on experimental protocols, germplasm characterisation, and SSR primers screened, are provided, and conference presentations and deliverables are attached to the report.

Correct citation: Hollington, P.A., Andersen, P., Bajracharya, J., Gautam, R, Joshi, K.D., Khanal, A., Kumar, N., Mueller, R.A.E., Neog, S.B., Yadavendra, J.P. (2009) Food Security through Ricebean Research in India and Nepal (FOSRIN). Third Annual Report. Bangor, UK: CAZS Natural Resources. 109 pp

Executive summary

Introduction. This document describes the third year's work of the FOSRIN (**Fo**od **S**ecurity through **R**icebean Research in **I**ndia and **N**epal) project. FOSRIN is a consortium of eight partners, universities, NGOs and government research organisations in Europe and South Asia, working to popularise the underutilised grain legume crop ricebean (*Vigna umbellata*) and promote its cultivation over a wider area of the environments to which it is suited than is currently the case. The work involves research on the supply chain and marketing of the crop, the diversity and adaptation of germplasm, farmers' preferred traits and indigenous knowledge of the crop, and its health and nutritional aspects. The project, funded by DG Research of the European Commission under the 6th Framework Programme (FP6) began in April 2006, and continues until March 2010. The work of the project is showcased on the website of The Ricebean Network (www.ricebean.org).

Background. Cereal production in S Asia has far outstripped the production of legumes, with serious consequences for the food security and nutritional well-being of poor farmers in marginal areas. Ricebean is a grain legume grown in Western, Northern and Eastern India and Nepal. It is widely grown as an intercrop, particularly of maize, and was widely grown in the past on residual water after rice. There is little or no choice of improved varieties as there has been almost no modern plant breeding, landraces predominate and seed supply is limited or non-existent. Consequently, it is not grown widely despite its suitability for marginal agricultural areas where many poor people live. Ricebean grows well on a range of soils. It has rapid establishment, is pest resistant, and has the potential to produce large amounts of nutritious animal fodder and high quality grain, and there is great scope for genetic improvement in this neglected crop.

Objectives. The overall objective is to make ricebean more than locally popular by identifying and measuring the diversity within the range of germplasm available in India and Nepal and characterising it for suitability to the cropping systems of the region. We will match farmer-preferred varieties to diverse seasons, environments and markets, using a combination of genetic, agronomic, and socio-economic approaches and using client-orientated principles to identify genotypes and parents for breeding programmes suitable for integrating ricebean into rice- and maize-based cropping systems in WNE India and Nepal. Our specific scientific objectives are:

1. To analyze the legumes supply-chain for stages and linkages where product value of improved ricebean is potentially lost or where information on product quality may be compromised or lost
2. To assess genetic diversity and indigenous knowledge on ricebean in Nepal and India
   2.1. To assess genetic diversity and uses of ricebean using indigenous knowledge of the crop
   2.2. To characterise the germplasm diversity using molecular marker techniques
   2.3. To characterise the germplasm for phenological traits and suitability for a range of diverse environments and cropping systems using participatory approaches
3. To assess the potential impact of enhanced pulse availability on local human nutrition
4. To develop a Market-based Legumes Traits Value-Index (MLTVI) that allows breeders to assess *ex ante* the value of new legumes in terms of their monetary value to consumers
5. To develop innovative and efficient marketing methods for high quality, protein-rich products from the crops to increase market accessibility, product value and promote export value
6. To develop policies to support and promote equitable access to such protein-rich foods, building sustainable medium and long term food security

In addition, we have 3 management objectives to ensure the smooth running of the project: these are detailed in the full report.

Contractors involved and coordinator contact details

Contractors	**Senior staff involved**
Coordinator: Dr Philip Hollington, CAZS Natural Resources, Bangor University, UK (CAZS-NR) email: p.a.hollington@bangor.ac.uk; Phone: +44 1248 382285; Fax +44 1248 370594 ; Web: http://www.ricebean.org	Prof John Witcombe, Dr David Harris, Dr KD Joshi (Kathmandu office)
Dept. of Agricultural Economics, Christian Albrechts University of Kiel, Germany (CAU):	Prof Dr Rolf Mueller, Prof Dr M von Oppen; Ms Doreen Buergelt
Department of Geography, University of Bergen, Norway (UB)	Dr Peter Andersen
Crop Research Component, Gramin Vikas Trust, Dahod, Gujarat, India (GVT)	Dr JP Yadavendra
Ch. Sarwan Kumar Krishi Vishwa Vidyalaya**,** Palampur, Himachal Pradesh, India (CSKHPKV)	Dr Naveen Kumar, Dr JC Bhandari, Dr RK Chahota, Dr DK Banyal, Dr Harbans Lal, Dr Rajan Katocht
Assam Agricultural University, Jorhat, Assam, India (AAU)	Dr Mrs SB Neog
Nepal Agricultural Research Council, Kathmandu, Nepal (NARC)	Dr Mrs Jwala Bajracharya, Mr Man B Shrestha
Local Initiatives for Biodiversity, Research and Development, Kaski, Nepal (LI-BIRD)	Dr Pratap K Shrestha, Mr Kamal Khadka

Work performed and results achieved

To meet the scientific objectives, we developed five workpackages. The first was concerned with the marketing and supply chain of the crop. A comprehensive literature review has been carried out to form part of a PhD thesis, although the review process is naturally on-going. A working paper on approaches to supply network analysis of the flow of pulses is approaching completion. Ricebean physical and quality traits were assessed and analysed, and an initial version of Deliverable 1.1 – the hedonic price function – calculated. This was presented to the International Conference on Grain Legumes held in Kanpur, India in February 2009. From this, the Legumes Trait Value Index can be calculated. It was concluded that a ricebean variety that matches the needs of both consumers and farmers needed to be have large seeds, high crude fibre content, and low ash content, with high yield, drought tolerance and pest resistance. A further period of field work was carried out in India and Nepal in winter 2009, in order to sample traders and farmers who had been missed the first time round in Uttrakhand, and to sample a new area of Nepal.

The second workpackage on assessing genetic diversity and indigenous knowledge is coordinated by the Nepal NGO LI-BIRD. A further fifty samples of ricebean germplasm were collected in various parts of India. Representative samples of ricebean along with associated local knowledge were collected from different parts of Nepal. GPS coordinates were obtained when collecting these, and also to go with the distribution data collected earlier, and this work is now being written up as an academic paper.

A large number of observation nurseries were sown for the evaluation of genotypes. In the first and second year of the project germplasm evaluation was carried out in Gulmi district in Nepal. Two sets of observation nurseries were conducted by LI-BIRD this year with 21 accessions in each set of trials and a number of high-yielding lines were identified. In India, a large number of genotypes were evaluated by the three partners, each at several sites, and a number of promising lines identified. In trials at NARC ranging from lowland through mid- to high-hill environments (Khumaltar, Dolakha and Rampur), a number of high yielding lines were identified for promotion to yield trials in the next season. In a nursery for the evaluation of off-types it became apparent that, contrary to accepted belief, there is substantial out-crossing in ricebean. This could have

significant implications, but also present opportunities, for breeding new varieties. Deliverable 2.2, on Indigenous Technical Knowledge, has been completed and submitted with this report.

Indeterminate ricebean at Kumaltar, Nepal (Dr J Bajracharya, NARC)

In WP3, work on molecular diversity was continued by NARC. A series of field and laboratory experiments on genetic diversity of landraces were carried out in different agro-ecosystems, combining work in WP2, WP3 and WP4. A set of 35 adzuki bean SSR markers were found to amplify DNA of ricebean accessions and exhibited polymorphism in a stratified sample of ricebean. A set of 91 accessions based to analysis of agro-morphological diversity were identified and the 13 most polymorphic adzuki bean SSR primers distributed across the genome were tested along with adzuki bean (red bean) as check sample. This activity is on-going.

WP4, on germplasm characterisation, is led by GVT, with inputs from the other Asian partners. This year a total of 249 germplasm lines were evaluated for quantitative characters in *Kharif* 2008 (rainy season) by the Indian partners at various locations. Lines were evaluated and characterized in farmer's fields in order to isolate promising lines for cultivation in the region.

Mother and baby trials were conducted on a large scale in the project area. Farmer preferences were assessed through matrix ranking. Most farmers preferred high yielding, short duration and bold seeded varieties rather than the long duration landraces they usually grew. They also preferred varieties with bold (large) seed and early maturity. In Nepal, the twelve best performing accessions from 2007 were evaluated in mother trials at two areas of Gulmi district; two of Tanahun district one in Sindhuli district. Again, several high yielding genotypes were identified: these differed between locations. Baby trials revealed a clear preference for bold seeded varieties with determinate growth, early to medium maturity, drought tolerance and low shattering, giving a plant type suited for growing as an inter or mixed crop with maize, sorghum or on terrace risers.

Trials were also conducted to test winter (*rabi*) season cropping, a new possibility for farmers. In Nepal, seed set was very poor compared to the normal monsoon season crop. However, in India one of the trials gave exciting results. The crop developed flowers and seeds, and has reached maturity. Seed production was undertaken, but little seed was produced due to poor growing conditions. To popularize ricebean cultivation, a folder on ricebean in Hindi (*Mungi ki Kheti*) and various other publications in local languages were produced, and a number of small-scale demonstrations laid out on farmer's fields.

UB were responsible for WP5, on health and nutritional aspects of the crop. Results from the literature survey show ricebean to have a very favourable amino acid content for human consumption, a high content of B vitamins and of some minerals, and to be free from toxic and allergenic substances. The latter point is of particular importance, as many other pulses contain such compounds and need special preparation before consumption, or require additional breeding efforts to remove the problem

Mori dhal – a typical ricebean preparation (Dr Naveen Kumar, CSKHPKV)

characters. Data have been entered into the WorldFood2 program, and analysed.

Dietary surveys showed the most frequently consumed pulse in the region to be lentil. Ricebean was the fifth most frequently consumed pulse. There were considerable differences recorded in terms of the main grain staples. In Assam and Nepal most people ate rice as their main cereal, although in Nepal maize and wheat were also eaten. In HP, both rice and wheat were eaten.

Expected end results

We anticipate that by the end of the project we will have developed a hedonic demand function for legumes and completed and quantified the MLTVI, and designed a strategy to introduce ricebean into the legumes supply-chain in India and Nepal. We will have an understanding of ricebean's distribution in India and Nepal, of its diversity in terms of farmers' names, of phenology and morphology, and on a molecular basis, and of the indigenous technical knowledge on the crop's production and use. We will also have a workable set of polymorphic markers for the crop which may also be of use to workers on other *Vigna* species. We will know the traits that farmers regard as being important, and have identified particular varieties that meet those requirements. Finally, we will understand the potential impact upon human health and nutrition that the introduction of ricebean into the diets of a larger proportion of the population could have.

Intentions for use and impact

Our results of the project will interest many audiences, such as scientists working in project-related areas, including on other grain legumes, and farmers and farmers' organisations in the region, market traders, intermediaries and their organisations, urban and rural consumers, and policy makers.

We aim for farmers in the region to adopt the new technologies and germplasm developed by the project. From, previous experience, we expect this to be as much by informal farmer-to-farmer dissemination as by the extension activities of the project partners. This will have direct impact in terms of improving livelihoods and food security through increased use of legumes with inherent abiotic stress resistance, high biomass production and good nutritional quality that would obtain a good market price. Improved fodder production will improve livestock health and production, and greater use of legumes in the farming system will reduce erosion, fix N, and increase soil organic matter. By illustrating the value of research into underutilised crops we will impact on policy, and we will improve equity by targeting the results at resource-poor farmers. In the longer term the knowledge generated by FOSRIN will greatly assist the breeding of improved and well-adapted varieties of ricebean. The MLTVI will provide an exceptionally useful tool for plant breeders, not only of ricebean but also of similar grain legumes in S Asia, by enabling them to allocate a monetary market value to the traits they are breeding or selecting for.

Main elements of the publishable results of the plan for using and disseminating the knowledge

As noted in the year 2 report, a comprehensive ricebean bibliography is available on the project website at http://www.ricebean.org/references1.htm. Four major deliverables have been produced: distribution of ricebean in India and Nepal (D2.1); indigenous knowledge of ricebean in Nepal (D2.2); identification of polymorphic markers (D3.1); and nutrient contents of ricebean (D.2). D2.2 and D5.2 are annexed to the report. D5.1 (Diet and food preparation) is currently undergoing final edits (D2.1 and D3.1 were submitted earlier. The first two deliverables from WP1 (D1.1 the Hedonic Price Function and D1.2 the Market Legumes Trait Value Index) are simple formulae and are already available in draft form. A number of farmer leaflets and posters have been produced, and a page on ricebean has been added to Wikipaedia.

Section 1 – Project objectives and major achievements during the reporting period

1.1 Overview of general project objectives and current relation to the state-of-the-art

Introduction. Cereal production in S. Asia has far outstripped that of legumes, with serious consequences for the food security and nutritional well-being of poor farmers in marginal areas. Ricebean (*Vigna umbellata*) is a legume grown in Western, Northern and Eastern (WNE) India and Nepal. It is widely grown as an intercrop, particularly of maize[1], and was often grown in the past on residual water after rice. There is little or no choice of improved varieties as there has been almost no modern plant breeding. Landraces predominate and seed supply is limited or non-existent. Consequently, it is not grown widely despite its suitability for marginal agricultural areas where many poor people live. Moreover, well-functioning marketing channels for the crop do not exist. Ricebean grows well on a range of soils. It has rapid establishment, is pest resistant, and has the potential to produce large amounts of nutritious animal fodder and high quality grain, and there is great scope for genetic improvement in this neglected crop.

Objectives. The overall objective is to make ricebean more than locally popular by identifying and measuring the diversity within the germplasm available in India and Nepal and characterising it for suitability to the cropping systems of the region, matching farmer-preferred varieties to diverse seasons, environments and markets, using a combination of genetic, agronomic, and socio-economic approaches firmly based on client-orientated principles to identify genotypes and parents for breeding programmes suitable for integrating ricebean into rice- and maize-based cropping systems as well as into the diets of consumers in WNE India and Nepal.

The scientific objectives of the project are as follows:

1. To analyze the supply-chain for stages and linkages where product value of improved ricebean is potentially lost or where information on product quality may be compromised or lost
2. To assess genetic diversity and indigenous knowledge on ricebean in Nepal and India
   - 2.1. To assess genetic diversity and uses of ricebean using indigenous knowledge of the crop
   - 2.2. To characterise the germplasm diversity using molecular marker techniques
   - 2.3. To characterise the germplasm for phenological traits and suitability for a range of diverse environments and cropping systems using participatory approaches
3. To assess the potential impact of enhanced pulse availability on local human nutrition
4. To develop a Market-based Legumes Traits Value-Index (MLTVI) that allows breeders to assess *ex ante* the value of new legumes in terms of their monetary value to consumers
5. To develop innovative and efficient marketing methods for high quality, protein-rich products from the crops to increase market accessibility, product value and promote export value
6. To develop policies to support and promote equitable access to such protein-rich foods, building sustainable medium and long term food security

In addition, we also aim:

7. To ensure effective integration of results, hypotheses and germplasm, and their wide dissemination to stakeholders and other interested parties
8. To ensure dialogue between participating institutions, research teams, other projects, participating communities and governments
9. To strengthen sustainably the research capability of the Asia Partner Country institutes involved in the project

[1] Lawn, RJ (1995)

Current relation to state-of-the-art

The sustainability of continuous cereal systems is in doubt unless broken by a legume. However, in Northern and Eastern hill areas of India and in Nepal, farmers have only a limited choice, usually greengram (*Vigna radiata*) or blackgram (*V. mungo*). Neither is ideal due to their high water use and long duration. Farmers' preliminary consultations suggest that they need a short duration legume, with few disease and pest problems. Ricebean has all the required traits except grain quality and photoperiod-insensitivity. It grows well on a wide range of soils, and has good pest resistance. Some genotypes are drought tolerant, and the twining habit of some genotypes makes it suitable to intercrop with maize, although difficult to harvest mechanically. With its quick growth and good biomass production it can be used as animal feed during the fodder-scarce summer, and as a green manure.

Germplasm and indigenous technical knowledge. There has been no systematic attempt to collect Nepalese ricebean germplasm, very few studies on its diversity, and no systematic documentation of indigenous technical knowledge on the crop, and little in India since the 1960s, although indigenous and exotic collections evaluated in the 1970s[2] showed a wide range of genetic variation for morpho-agronomic attributes. Existing indigenous knowledge on ricebean in both countries needs documenting and collating. We have previously developed participatory methods to systematically collect germplasm and relate it to various socio-economic questions, so germplasm evaluation will not rely on field evaluation or molecular marker diversity alone, but be supported by these other approaches to allow a better understanding of genetic diversity.

Farmers' knowledge has been most commonly and widely discussed using the term *indigenous knowledge*,[3] a label that some major institutions working on the subject have adopted. However, the great diversity of disciplines in both the natural and the social sciences that have been involved in this, as well as the value judgements of individual investigators, has led to the concept been described and discussed using a large number of terms: these are detailed in Deliverable 2.2[4].

While these definitions may in many contexts be useful, they serve to seriously constrain how local knowledge can be gathered and used. Although the way in which local knowledge is acquired and transformed into decisions depends on the cultural context, knowledge is distinguishable from other aspects of a person's, or a community's culture. A 'utilitarian' approach to the definition and use of local knowledge in research and development defines knowledge as 'the outcome, independently of the interpreter, of the interpretation of data, that can be articulated and communicated', and local knowledge as 'locally derived understanding which is based on experiences and real world observation.[5]'

The central tenet of Participatory Technology Development (PTD) is to facilitate and support farmer experimentation by combining farmers' local knowledge and methods with advances in scientific knowledge and methods. Despite a growing interest and emphasis on local knowledge, its use in research and development has been constrained by a lack of appropriate methods for storage, analysis, synthesis and interpretation of the qualitative knowledge held by farmers[5].

---

[2] Chandel, KPS *et al* (1988). Ricebean - a potential grain legume. NBPGR Sci. Monogr. No. 12. NBPGR, New Delhi

[3] Thapa, B *et al* (1995). Incorporation of indigenous knowledge and perspectives in agroforesty development. II: Case study on the impact of explicit representation of farmers' knowledge. *Agfor Sys* **30**:249-261

[4] Khanal, AR & Poudel, I (2008) Farmers' local knowledge associated with production, utilization and diversity of ricebean (*Vigna umbellata*) in ricebean growing areas of Nepal. Deliverable 3.1, FOSRIN Project. Pokhara, Nepal: LI-BIRD.

[5] Sinclair, FL & Walker, DH, (1999). A utilitarian approach to the incorporation of local knowledge in agroforesty research and extension. In: Shrestha PK (2003) *Incorporating local knowledge in participatory development of soil and water management interventions in the Middle Hills of Nepal*, PhD thesis, Univ. Wales, Bangor, UK.

Farmers' decisions whether to select, reject or maintain a particular landrace at any given time are influenced by many environmental, biological, cultural and socio-economic factors[6]. Understanding farmers' practices, and the underlying local knowledge regarding them, is useful to guide the conservation and promotion strategy for any indigenous crop. As farmers have been cultivating ricebean for many generations, they have unique practical knowledge of the crop, and an assessment of this is an essential prelude to the promotion of this underutilized crop.

The use of farmers' local knowledge in research and development requires a methodological framework that allows it to be effectively and systematically stored, accessed, analyzed, and synthesized, so making it available for future use[7]. Knowledge-based systems (KBS) developed originally for agroforestry research and extension have been successfully used in Nepal, especially in the collection and analysis of farmers' ecological knowledge about tree fodders[8]. Such systems are increasingly being used in a number of countries worldwide in a variety of disciplines.

Farmers' perceptions and knowledge of diversity. Farmers grow landraces to meet their agronomic and cultural needs, and have a well-developed indigenous knowledge of their crops and varieties. Farmers' diversity management consist of seed flows, variety selection and adaptation, and seed selection and storage[9], all influenced by agro-ecological, socio-economic and cultural conditions, many of which affect the management of landrace diversity, so farmers' indigenous knowledge is linked to the maintenance and management of genetic diversity[10,11]. Landrace choice is primarily determined by adaptation to the agro-ecological domain and farm management practices, followed by selection for phenotypic features that best meet farmers' preferences.

Analysis of genetic diversity using morphological and molecular data. Traditionally, legume variability is largely described by their morphology, agronomic behaviour, and on biochemical traits. It is generally associated with a low level of diversity[12,13]. However, variability in Asian *Vigna* has more recently been studied using a variety of molecular techniques as well as traditional agro-morphological characterisation. Restriction fragment length polymorphism (RFLP), amplified fragment length polymorphism (AFLP), random amplified polymorphic DNAs (RAPDs), inter simple sequence repeats (ISSRs), and microsatellites or simple sequence repeats (SSRs) are molecular marker techniques that have been extensively used in genome analysis of the Asian *Vigna,* especially Adzuki bean (*V. angularis*). Using recombinant DNA technology, variation in DNA sequences can be examined directly, avoiding environmental effects which could confound morphological evaluation, and possibly biased allozyme estimates.

[6] Bajracharya, J *et al* (1999). Farmers selection of germplasm using agromorphological and isozyme characteristics. A scientific basis of *in-situ* conservation of agro-biodiversity on-farm: Nepal's contribution to the Global Project .NP Working Paper No.1/99. NARC/LI-BIRD, Nepal/IPGRI, Rome, Italy

[7] Sinclair, FL & Walker, DH (1998). Qualitative knowledge about complex agroecosystems. Part 1: a natural language approach to representation. *Agric Sys* **56**:341-363

[8] Thapa, B *et al* (1997) Indigenous knowledge of the feeding value of tree fodder. *Anim Feed Sci Tech*. **67**:97-114

[9] Bellon, MR *et al* (1997) Genetic conservation: a role for rice farmers. In Maxted BV *et al* (eds) Plant genetic conservation: an *in-situ* approach. London, Chapman Hall

[10] Eyzaguirre, P & Iwanga, M (1995) Farmers contribution to maintaining genetic diversity in crops, nd its role within the total genetic resources systems. P 9 – 18 in Proc Workshop on Participatory Plant Breeding, July 1995, Wageningen. IPGRI, Rome

[11] Jarvis, DI *et al* (2000) A training guide for *in situ* conservation on farm. Version 1. IPGRI, Rome

[12] Yamaguchi H (1992). Wild and weed adzuki beans in Japan. *Econ. Bot*. **46**: 384-394

[13] Lumpkin TA & McClary DC (1994). *Adzuki bean: Botany, production and uses*. CAB International, Wallingford, UK.

Recent work has assessed between-farm diversity in cowpea (*V. unguiculata*) landraces using AFLP and SAMPL markers to determine the distribution of genetic variation[14], genetic diversity in blackgram has been studied using RAPD and ISSR markers[15], and in greengram using AFLPs[16]. Molecular markers have been used to study genetic diversity in rice landraces in Nepal[17]. Twelve *Vigna* microsatellites were identified earlier[18], and an integrated consensus map developed for cowpea, containing over 400 markers[19].

Linkage maps have been developed for three of the Asian *Vigna* species: mung bean (*V. radiata*), adzuki bean and black gram[20,21] and a large number of SSR markers have been developed for adzuki bean[22,23]. These have been used in comparative linkage maps in other related legumes and have provided information on genetic relationships among the related species. However, no molecular information is yet available for ricebean.

Germplasm characterisation – participatory methods. Germplasm characterisation using agromorphological and molecular data is valuable for breeding programmes, but as well as testing across environments complete evaluation additionally requires measures of farmers' preferences for varieties and traits. Well established participatory methods for variety evaluation in farmers' fields often use single replicate, multi-entry trials (mother trials) and single intervention trials of a new entry versus a local check (baby trials)[24]. Mother trials sample more environments than replicated on-station trials[25], and baby trials allow the cost-effective use of many replicates[26], contributing major improvements over more conventional varietal testing:

(1) Participatory trials allocate more resources to more advanced lines than many conventional breeding programmes[27].

---

[14] Tosti, N & Negri, V (2005) On-going on-farm microevolutionary processes in neighbouring cowpea landraces revealed by molecular markers. *Theor Appl Genet* **110**: 1275-1283

[15] Souframanien, J & Gopalakrishna, T (2004) A comparative analysis of genetic diversity in blackgram genotypes using RAPD and ISSR markers. *Theor Appl Genet* **19**: 1687-1693

[16] Bhat, KV *et al* (2005) Amplified fragment length polymorphism (AFLP) analysis of genetic diversity in Indian mungbean [*Vigna radiata* (L) Wilczek] cultivars. *Ind J Biotech* **4**: 56-64

[17] Bajracharya, J (2003) Genetic diversity study in landraces of rice (*Oryza sativa* L) by agromorphological characters and microsatellite DNA markers. PhD Thesis, Univ. Wales, Bangor, UK

[18] YuKang Fu *et al* (1999) Abundance and variation of microsatellite DNA sequences in beans (*Phaseolus* and *Vigna*). *Genome* **42**: 27-34

[19] Kelly, JD *et al* (2003) Tagging and mapping of genes and QTL and molecular marker-assisted selection for traits of economic importance in bean and cowpea. Fld Crops Res **82**: 135-154

[20] Kaga A *et al* (2005). Molecular markers in *Vigna* improvement: understanding and using gene pools. In Lotz H, Wenzel G (eds) *Biotechnology in agriculture and forestry,* vol 55. Molecular marker systems . Springer, Berlin, Heidelberg New York, pp 171-187.

[21] Chaitieng B *et a*l (2006). Development of black gram [*Vigna mungo* (**L**.) Hepper] linkage map and its comparison with an adzuki bean [*Vigna angularis* (Willd.) Ohwi and Ohashi] linkage map. *Theor Appl Genet* **113**: 1261-1269.

[22] Wang XW *et al* (2004). The development of SSR markers by a new method in plants and their application to gene flow studies in adzuki bean [*Vigna angularis* (Willd.) Ohwi and Ohashi] *Theor Appl Genet* **109**: 352-360.

[23] Han OK *et al* (2005). A genetic linkage map for adzuki bean [*Vigna angularis* (Willd.) Ohwi and Ohashi] *Theor Appl Genet* **111**: 1278-1287.

[24] Snapp, S, 1999. Mother and baby trials: a novel trial design being tried out in Malawi. In: TARGET. *Newsl. of the Soil Fert. Res. Net. for Maize-Based Cropping Systems in Malawi and Zimbabwe*. Jan. 1999. CIMMYT, Zimbabwe

[25] Johnson, JJ *et al* (1992). Replacement of replications with additional locations for grain sorghum cultivar evaluation. *Crop Sci* 32:43-46

[26] Witcombe, JR *et al* (2005) Participatory plant breeding is better described as highly client-oriented plant breeding. I. Four indicators of client-orientation in plant breeding. *Expl Agric* **41**: 299 - 319

[27] Witcombe, JR *et al* (1998). The extent and rate of adoption of modern cultivars in India. In *Seeds of choice: Making the most of new varieties for small farmer* 53-58 (Eds JR Witcombe et al). New Delhi: Oxford IBH, and London: Intermediate Technology Publications

(2) Farmers can evaluate varieties for all traits and make trade-offs of, e.g., grain yield against fodder yield, maturity, and grain quality.

(3) Varieties are tested under realistic management, across more physical niches as trials are replicated in more locations, and also across social niches where food preferences might vary.

Although these, or similar, approaches have been applied to several crops, no work has been done on ricebean.

Market requirements. Crop breeding adds economic value in two ways, by lowering the costs of produce, and by adding value through improved cooking and keeping qualities. Conventional breeding focuses on crop traits that reduce production costs or storage losses, or both, but traits that add value or reduce costs at the household level are usually ignored for lack of information. Current economic demand theory and econometric methodology added to experience from applied studies allows us to develop an index to guide breeders towards adding value by satisfying consumer wants[28]. Ricebean is mostly produced for subsistence and it is not well introduced into supply-chains, but without market sales the benefits of improved varieties would not reach urban consumers. Developing markets for improved ricebean will be based on an analysis of existing legumes markets, and will require mechanisms that assure both the flow of the material product and of product information from producers to consumers. The information flow requires research, as some quality characteristics valued by consumers are likely to be invisible and will not be automatically passed on along the supply-chain, so must be communicated by other means. Whenever information about quality characteristics is separate from the good that has the characteristics this information may be lost, misrepresented, or otherwise become corrupted, so that buyers' valuation of improved ricebean products will be reduced. Also, if ricebean's true quality is misrepresented consumers' willingness to pay for improved varieties will be reduced.

Health and nutrition. Average legume consumption in Nepal is below suggested FAO levels[29], and in India only just reaches them[30]. Pulses are expensive for poor people, and farmers' yields are low. As pulses have only been replaced to a small extent by animal source foods, there has been a strong decrease in micronutrient density in the diet, and a steady rise in the proportion of people suffering from anaemia and other deficiencies[31], with around 95% of the population of S. Asia at risk of zinc deficiency[32]. Food-based strategies are of specific interest in poor populations, especially allied to increasing production, profitability and sustainability of smallholder agriculture. Fortifying food products with protein-rich ricebean flour can improve diets, so expanded ricebean consumption in marginal areas could increase access to food with high protein and essential mineral content, but its reputation as a food for the poor may hinder to its spread. One factor limiting the spread of the positive effects of the Green Revolution among many of the

[28] Jeminez-Portugal, LA (2004) Relevant quality attributes of edible dry beans – An application of the hedonic price analysis. Osnabrück, Germany: Der Andere Verlag

[29] Lekhak, HD (2003) "Nepal". Chapter 10 in Processing and Utilization of Legumes. Asian Productivity Organization, Tokio, Japan ISBN 92-833-7012-0

[30] Govindan, A 2001: India Grain and Feed. Shopping for Pulses. GAIN Report # IN 1065. GAIN/USDA Foreign Agricultural Service

[31] Kennedy, G *et al* 2003: The scourge of 'hidden hunger': global dimensions of micronutrient deficiencies. *Food, Nutr Agric* **32**: 8-16

[32] Brown, KH & Wuehler, SE 2000: *Zinc and human health*. The Micronutrient Initiative, Ottawa

world's poorest rural communities is lack of recognition of inter-farm heterogeneity[33], which requires similar heterogeneity in the innovations provided.

1.2 Summarise the objectives for the reporting period, work performed, contractors involved and the main achievements in the period

Table 1.1: Workpackages and WP leaders

WP No.	WP Title	WP Leader	Objective
Scientific			
1	Supply chain, demand and marketing	CAU	1, 4, 5, 6, 9
2	Genetic diversity and indigenous knowledge	LI-BIRD	2, 9
3	Molecular markers	NARC	2, 9
4	Germplasm characterisation and adaptation	GVT	2, 9
5	Nutrition and health	UB	3, 5, 6, 9
Management			
6	Coordination and management	CAZS-NR	7, 8, 9
7	Dissemination	CAZS-NR	7, 9
8	Review	CAZS-NR	

To meet the project objectives, we are carrying out 5 scientific and 3 management workpackages, as noted in Table 1.1. Work was carried out in all of these to meet the specific objectives for the third reporting period, April 1, 2008 – March 31, 2009, which were as noted in Table 1.2. The timing of these milestones was altered substantially from that foreseen in Annexe 1 due to delays in signing the contract with the consequent effect on the relationship of the project to the crop calendar, although some work was able to take place before the contract was signed. Further slight alterations were made at the 2nd and 3rd Annual Meetings as a result of experimental problems, as well as problems resulting from political difficulties in Nepal. An updated, frontlined barchart is appended in Section 3.

Table 1.2: Objectives for the third reporting period

Objective	WP	Partner	Month*
Organise the analysis of collected (07 January– 25 March 2008) ricebean samples in laboratories, plus analysis of the data obtained	1	CAU	30 (24)
Plan and carry out a second field work period in India (Uttarakhand) and Nepal (western part) to survey supply chain agents	1	CAU	33 (18)
Present results of the hedonic price analysis to other researchers specializing in pulses	1	CAU	34 (27)
Complete collection of a representative sample of ricebean germplasm together with associated socio-economic data	2	LI-BIRD	36 (24)
Understand the socio-economic and bio-physical factors controlling ricebean diversity and its utilization	2	LI-BIRD	36 (24)
To complete the laboratory analyses of nutrient content	5	UB	30 (28)
Hold the 3rd Annual Meeting	6	CAZS-NR	30 (30)
Analyse molecular diversity	3	NARC	30 (30)
Complete field evaluations of germplasm	2	LI-BIRD	30 (30)
To complete the second year of mother and baby trials	4	GVT	33 (24)
To report on ricebean nutrient content	5	UB	30 (11)

*Revised. Initial month foreseen in parentheses.

[33] Zilberman, D & Sunding, D (2001) The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector. Chapter 4 in BL Gardner & GC Rauuser (eds.) *Handbook of Agricultural Economics* Vol 1A, Elsevier, Amsterdam ISBN 0-4448-2588-6

Work in WP 1

This work is led by CAU Kiel, with assistance from the Asian partners. A comprehensive literature review has been carried out, which will form part of a PhD thesis, although the review process is naturally on-going. A working paper on approaches to supply network analysis of the flow of pulses from producer to consumer is approaching completion. Ricebean physical and quality traits were assessed and analysed, and an initial version of Deliverable 1.1 – the hedonic price function – calculated. This was presented to the International Conference on Grain Legumes held in Kanpur, India in February 2009 (attached). From this, the Legumes Trait Value Index can be calculated. It was concluded that a ricebean variety that matches the needs of both consumers and farmers needed to be have large seeds, high crude fibre content, and low ash content, with high yield, drought tolerance and pest resistance. A further period of field work was carried out in India and Nepal in winter 2009, in order to sample traders and farmers who had been missed the first time round in Uttrakhand, and to sample a new area of Nepal.

Work in WP2

Further samples of ricebean germplasm were collected in various parts of India. Representative samples of ricebean along with associated local knowledge were collected from different parts of Nepal.

A large number of observation nurseries were sown for the evaluation of genotypes. In the first and second year of the project germplasm evaluation was carried out in Gulmi district in Nepal. Two sets of observation nurseries were conducted by LI-BIRD this year with 21 accessions in each set of trials. LRGR 44 (2333 kg/ha) exhibited highest yield followed by LRGR 135 (2190 kg/ha) and LRGR 129 (1956 kg/ha) in the first set and LRGR 139 (1953 kg/ha), NPGR 05422 (1722 kg/ha), NPGR 05372 (1696 kg/ha), LRGR 87 (1672 kg/ha), and NPGR 05383 (1622 kg/ha) were best among the 21 accessions in the second set of observation nursery.

In trials at NARC ranging from lowland through mid- to high-hill environments (Khumaltar, Dolakha and Rampur), a number of high yielding lines were identified for promotion to yield trials in the next season. In a nursery for the evaluation of offtypes it became apparent that, contrary to accepted belief, there is substantial out-crossing in ricebean. This could have significant implications, but also present opportunities, for breeding new varieties.

In India, a large number of genotypes were evaluated by the three partners, each at several sites, and a number of promising lines identified.

GPS coordinates were obtained to go with the distribution data collected earlier, and this work is now being written up as an academic paper. Deliverable 2.2, on Indigenous Technical Knowledge, has been completed and submitted with this report.

Work in WP3

This work is carried out by NARC, with back-up and assistance from CAZS-NR. A series of field and laboratory experiments on genetic diversity of ricebean were carried out in different agro-ecosystems of the country, combining work in WP2, WP3 and WP4.

A set of 35 adzuki bean SSR markers were found to amplify DNA of ricebean accessions and exhibited polymorphism in a stratified sample of ricebean. For the molecular diversity, a set of 91 accessions based on analysis of agro-morphological diversity were identified and the 13 most polymorphic adzuki bean SSR primers distributed across the genome were tested along with adzuki bean (red bean) as check sample. This work is on-going.

Work in WP4

This WP is led by GVT, with inputs from the other Asian partners. This year a total of 249 germplasm lines were evaluated in *Kharif (Summer)* -2008 (rainy season) for their quantitative characters by all the Indian partners at their respective locations. The germplasm lines were evaluated and characterized under farmer's field situation for isolation of the promising lines suitable for cultivation in the region. 54 more lines have been collected from different areas of the country during winter season of 2008 from different locations of Northern India from farmers' households.

Mother and baby trials were conducted on a large scale in the project area. The data on yield and yield attributes in mother and baby trials were recorded and statistically analyzed. Matrix ranking was done in mother trials on the basis of farmer's preference simultaneously in baby trials farmer's preference was recorded. Most farmers preferred high yielding, short duration and bold seeded varieties of ricebean because land races are of long duration type. They had given the maximum numbers in matrix ranking to those varieties having the bold seed and early in maturity.

In Nepal, the twelve best performing accessions from 2007 were evaluated in mother trials at Darbar Devisthan and Simichaur VDCs of Gulmi district; Purkot and Dulegauda VDCs of Tanahun district and Ratanchura VDC of Sindhuli district. NPGR 0076 (1555 kg/ha) and NPGR 05364 (1328 kg/ha) followed by LRGR 103 (1146 kg/ha), LRGR 111 (1116 kg/ha) and LRGR 117 (1091 kg/ha) gave the highest grain yield in Tanahun district. In Simichaur VDC grain yield of NPGR 00015 (986 kg/ha), NPGR 00076 (857 kg/ha), LRGR 111 (815 kg/ha), NPGR 00008 (800 kg/ha), NPGR 05364 (786 kg/ha) and LRGR 117 (772 kg/ha) was impressive. NPGR 06756 (1494 kg/ha) and NPGR 05364 (1140 kg/ha) performed best in terms of yield in Darbar Devisthan VDC.

The farmers preference in baby trials revealed that farmers have clear preference for bold seeded varieties with determinate growth, early to medium maturity, tolerant to drought and low shattering giving more grain yield and a plant type which is suited for growing as an inter or mixed crop with maize, sorghum or on terrace risers.

Following discussion in the second annual meeting, ricebean was planted in the *rabi* season in Assam where 38 entries were tested. The seed set was observed but was very poor as compared to monsoon season normal crop. The winter adaptation trials in Jhapa, India, have given exciting results. Ricebean planted in winter developed flowers, fruits and now plants are in maturity stage. The winter adaptation trials in Dang failed completely although seeds germinated partially. An experiment on seed priming of Ricebean was also conducted at CSKHPAU Palampur.

Seed production was undertaken, but little seed was produced due to poor growing conditions.

To popularize ricebean cultivation among farmers, a folder on ricebean in Hindi named as (*Mungi ki Kheti*) was brought out by GVT. Two pamphlets by CSKHPAU and some publications in local languages by Assam were also prepared which contains the package and practices of ricebean. These will be useful to disseminate the project activities and enhancing the knowledge of farmers. In addition to this, 62 small- scale demonstrations of ricebean were laid out on farmer's fields in Himachal Pradesh and two in Madhya Pradesh.

Work in WP5

Partner 5 (BU) has continued the work on establishing the current knowledge on the nutritive value of ricebean, and its present and potential role in human nutrition and food security at local level. The values on nutritive values found in the literature are generally from a small number of samples and varieties, and it is likely that there will be substantial variations between different

varieties, and between crops grown under various conditions, but there appears to quite consistent trends in the results presented by various authors and analyses.

Some important general observations appears to be

- a very favourable amino acid composition for human consumption
- a substantial content of B vitamins and some minerals
- the absence of toxic and allergenic substances

This last point is of importance since many other pulses may have a substantial content of for instance cyanides, allergenic compounds or enzyme inhibitors that need special concern in breeding work and nutritional extension work. Ricebean is not completely free such compounds, but the evidence suggests that there are no specific risk problems with ricebean as a source of food for humans. The content of flatulence producing factors in ricebean is similar to that in similar pulses. However, mild gastritis is noted in connection with consumption of ricebean. The effects of these factors are affected by cooking methods, and the use of overnight soaking before boiling as a *dal* should be encouraged in extension work, also since soaking increases the bioavailability of several nutrients.

The report on nutrient content (Deliverable 5.2) has been finalised and submitted, and work is ongoing on Deliverable 5.1.

Further work links nutrient content to the actual nutritional status of various groups in the project areas. Two surveys were carried out in each of India and Nepal. Each survey team collected dietary recalls three times from 200 individuals (adult women), a total of 20,000 records. This was processed using the WorldFood2 package, using the Indian food tables for calculating the contribution of each record for 47 nutrient variables, with statistical analysis using STATA and SPSS.

The dietary surveys gave a rich source of information concerning differences in diets between the sites. Lentil is the most common pulse consumed overall, followed by field bean. Chickpea is very commonly consumed in the predominantly vegetarian Himachal Pradesh where it serves as a second pulse per day. Ricebean was the fifth most important pulse item, most commonly consumed in Himachal Pradesh.

A major difference between sites was the composition of staple grains. In Assam, rice was the main staple. In Nepal, rice was also a main staple, but maize and wheat are taken as alternative grain staples. In Himachal Pradesh, women take rice as well as wheat in most days.

Pulses are in general an important source of protein, and ricebean has a particularly good composition of essential amino acids. However, while the pulses made a considerable contribution to protein supply, protein and essential amino acids were not a nutritional risk factor in the populations, due to relatively varied other sources of protein, either in terms of milk products (Himalayan sites) or fish and pork (Assam). As a source of vitamins, the pulses are primarily important with respect to B vitamins, and especially B1 and B9 (folic acid).

The calculated values showed mainly low intakes of vitamins A, B9, B12, C, D, E, and of calcium and potassium. The most critical contributions of ricebean and other pulses compared to the recorded levels of inadequate nutrient supplies were vitamin B9, calcium and potassium.

The study contains a number of findings expected to have broader interest, and it will be published as a journal article. A paper on challenges in research, development and promotion of under-utilized crops, using ricebean as a case example was presented at the annual meeting of the American Association of Geographers in Las Vegas in March 2009, and has been invited to peer reviewed publication.

Management activities

Routine management activities were carried out according to the workplan. The third annual workshop was held at Ullensvang, near Bergen in Norway, in October 2008. The event was organised by Dr Andersen of Universitat Bergen. The meeting updated project participants on the progress of the year 2 activities, and allowed adjustment to the plans for year 3 where necessary. Experimental protocols and workplans were further elaborated during a technical meeting and a field evaluation visit in Nepal, and a meeting for the Indian partners in Bhopal in April 2008.

A number of relevant networks have been joined additional to those noted in year 2, and email discussions contributed to.

The project website (www.ricebean.org) was developed by CAZS-NR, and went on-line in December 2006. It is subject to continual updating. An important feature is the extensive bibliography on ricebean and related species, which includes links to the abstracts or to the papers themselves where copyright permits. This list is continually updated. The dissemination strategy was developed during the proposal stage, and has been further refined since then. End users and intermediate users have been identified. A substantial addition was made to the ricebean page on Wikipaedia, and will be updated as the project continues.

The GVT calendar 2008, with a distribution of 1000 copies, was largely devoted to ricebean and activities under FOSRIN. Nutritional awareness campaigns were organized in Darbar Devisthan and Simichaur VDC of Gulmi district, Nepal. Knowledge dissemination through radio broadcast has been initiated. Information on ricebean was published in 'The Kantipur Daily', the highest selling national daily newspaper in Nepal. Booklets, poster and documentary on ricebean have been developed and will be used to share information on ricebean in the coming year, and ricebean information was included in the LI-BIRD calendar. To promote ricebean further, a number of value addition activities in ricebean have also been initiated, including the development of new recipes and their demonstration at farmers' fairs.

1.3 If applicable, comment on the most important problems during the period including the corrective actions undertaken

There were again no major problems during the period, although some of the activities were still delayed as knock-on effect of the delays in year 1. Data collection in Nepal has again been affected by a number of strikes and blockades. Although not affecting project staff directly, they have made it impossible to move in some of the rural areas where data was to have been collected. There have been some similar problems in Assam state in India. However, none of these problems has had a major effect this year.

Germplasm exchange.

So far as germplasm exchange was concerned, it was anticipated that accession to the International Treaty on Plant Genetic Resources for Food and Agriculture would have made germplasm exchange simpler, but this was not to be the case. Project staff from India and Nepal had held meetings with officials in Delhi to develop a way to send seed of Indian genotypes to Nepal, but this has not yet been possible, although there is no problem in sending seed from Nepal into India. The problem appears to be with the Biodiversity Authority of India, who must give permission for germplasm exchange, and a new approach made last winter may yet bear fruit. In the meantime, Dr Yadavendra is going ahead with the Indian crosses, which will provide material for any future work.

Prof Yadavendra had met the DDG Crops and other senior officials including the Director of the NBPGR (National Bureau of Plant Genetic Resources) at the ICAR meeting for the AICRPUC. In discussions on germplasm export to Nepal, it was clear that the Crop Director of NARC (Nepal

Agriculture Research Council) needed to write officially to NBPGR to request the activity officially. What seems to have happened is that, although an agreement is there on paper nothing is happening in practice. There is an on-going process at Ministerial level, but we intend to draft a letter for submission at the DG level to encourage matters. This will say simply that NARC want some ricebean lines, and will not mention the project. The focus should be on germplasm exchange.

Hard-seededness.

Hard-seededness seems to be a particular problem in ricebean, and affects both farmers and consumers. The need to screen our germplasm collection using a relatively simple procedure was stressed at both annual meetings, and is already done at Palampur, with the results noted in WP4. It will be done at all study sites in Nepal on the core collection over the next season 2009. There are obviously solutions to using hard beans, but it is important to know if the problem is particularly high in certain varieties, and upscaling from the project will be for varieties with less of a problem.

Outcrossing

Most of the ricebean literature suggests a low rate of outcrossing, as for other legumes, and this has been assumed in the project, but detailed information is not available and there are some reports of very high outcrossing rates (for example Yadav quoted Das & Zana with rates of 27 – 81% in 86 – 100 lines in W Bengal), and some experimental work in FOSRIN has suggested rates as high as 28%. However, if there really was a lot of outcrossing, then we would expect more variation than we have. This is clearly an area that needs further investigation, as it could have serious implications for the breeding work.

Section 2 – Workpackage progress of the period

2.1 Workpackage 1: Supply chain, demand and marketing

2.1.1 Objectives

The objective of this WP, which is being conducted by CAU Kiel in conjunction with the Indian and Nepalese partners, is to derive from an empirically estimated hedonic demand function a "legumes trait value index" for guiding ricebean breeding, and to design a strategy for introducing ricebean into the legumes supply-chains of India and Nepal.

WP1 objectives/ research plan for the period

1. Review the scientific literature and available data about the pulse sector in India and Nepal;
2. organise the analysis of collected (07 January– 25 March 2008) ricebean samples in laboratories;
3. evaluation and statistical analysis of the data obtained from laboratories;
4. plan a second field work period in India (Uttarakhand) and Nepal (western part);
5. carry out second field work period in India and Nepal in order to survey agents of the ricebean supply chain;
6. present results of the hedonic price analysis to other researchers specializing in pulses.

2.1.2 Summary of work in years 1 and 2

In WP1 the literature on the estimation of the hedonic demand functions and on supply chain analysis was surveyed by CAU Kiel, and digital biographies assembled. A robust set of laboratory analyses for measuring ricebean and other pulse characteristics were designed and pre-tested, and a number of samples collected for analysis. This will eventually enable the development of the Market-price based Legumes Trait Value Index – a tool to allot a monetary value to particular traits of a variety which can be used to guide plant breeders when selecting traits to breed for. Methods for the field work were developed and presented in a conference, and linkages were established to enable the main field work to begin in 2007, in consultation with the Asian partners.

In Year 2, after the literature review, a working paper on approaches to supply chain analysis for pulses in India and Nepal was drafted. Intensive surveying of ricebean markets, and sampling, was carried out in India and Nepal at different stages of the supply chain. To develop the MLTVI, a set of laboratory tests was devised after consultation with experts, and used to measure a number of traits in ricebean and other pulses. We analysed these samples to assess their differences, in particular to compare ricebean to chickpea, the most common pulse in the region. The analysis included both physical and nutritional parameters. Of the pulses analysed, ricebean had the lowest water uptake capacity (and highest moisture content), the highest ash and protein contents, and the lowest fat.

2.1.3 Progress towards objectives in year 3:

(1) Review the scientific literature and available data about the pulse sector in India and Nepal;

- the relevant literature has been reviewed;

- a working paper on the approaches to supply network analysis of the flow of pulses from producer to consumer in India and Nepal is approaching completion.

(2) Organise the analysis of collected (07.01.08 – 25.03.08) ricebean samples in laboratories;
During the second reporting period (April 07- March 08) elaborate laboratory analyses were conducted by two laboratories (determined traits are shown in Table 2.1.1). The quality and physical parameters of ricebean were determined by the laboratory of LI-BIRD, Pokhara, Nepal, and by Anand Agricultural University, Anand, India.

Table 2.1.1: Trait analyses of ricebean

Ricebean characteristic	
1. Fat	8. Swelling capacity
2. Protein	9. Water up-take capacity
3. Moisture	10. L/B ratio
4. Ash	11. Colour
5. Carbohydrates	12. Share foreign matter
6. Crude fibre	13. Colour diversity index
7. 100-seed weight	

(3) Evaluation and statistical analysis of the data obtained from laboratories;
In the current period, the data were statistically analysed using SPPS (statistics software). The results were presented at the FOSRIN meeting held from 12 to 16 October 2008 at Bergen, Norway and as an oral presentation "Quality parameters in relation to consumer's preference in rice bean" at the International Conference on Grain Legumes : Quality Improvement, Value Addition and Trade held at IIPR, Kanpur, India, February 14-16, 2009 (see: http://www.agric-econ.uni-kiel.de/Abteilungen/II/PDFs/Kanpur_Buergelt_final-version.pdf and http://www.agric-econ.uni-kiel.de/Abteilungen/II/PDFs/Kanpur_Buergelt-V02.pdf). The presentation is attached as Annexe 13.

Results
The quality of a good is defined by product traits (characteristics) and their quantity or concentration. The aim of this part of the work is to link ricebean prices to the selected traits in the crop, and we can achieve the Hedonic Price Function by using multiple linear regression. A commodity's price does not depend upon the good itself, but upon its characteristics, and this was the focus of the work.

$P_i = b_i + a_{i1} * q_{i1} + a_{i2} * q_{i2} + \ldots + a_{in} * q_{in} + e_i$

where

P_i = Price for one unit of a bean sample i

b_i = Constant

a_{ij} = Coefficient for the characteristic j in the sample i

q_{ij} = Amount of characteristic j in sample i

e_i = Random error

Descriptive statistics for the Nepal samples are shown in Table 2.1.4, and for India in Table 2.1.5, while the regressions individually for each country are shown in Tables 2.1.6 and 2.1.7 for Nepal and India respectively.

Table 2.1.4: Descriptive statistics for the Nepal samples

Characteristic	Unit	Mean	Minimum	Maximum
Weight	g/100 seeds	10.16	5.78	19.42
Water uptake	Ratio of weight increase	1.96	1.69	2.20
Swelling capacity	Ratio of Volume increase	1.12	1.02	1.19
L/B ratio	Ratio length to breadth	1.65	1.36	2.10
Foreign material	%	8.06	2.25	19.31
Moisture	%	10.46	8.23	15.51
Ash	%	4.19	3.45	9.54
Fat	%	0.29	0.12	0.49
Protein	%	24.64	18.83	32.16
Carbohydrates	%	66.47	58.15	71.99
Crude fibre	%	4.40	3.55	5.47

Table 2.1.5: Descriptive statistics for the Indian samples

Characteristic	Unit	Mean	Minimum	Maximum
Weight	g/100 seeds	6.94	4.07	15.13
Water uptake	Ratio of weight increase	2.11	1.98	2.24
Swelling capacity	Ratio of volume increase	1.77	1.62	1.96
L/B ratio	Ratio length to breadth	1.66	1.31	1.93
Foreign material	%	4.03	1.10	7.40
Moisture	%	9.84	8.10	12.82
Ash	%	3.76	2.44	5.10
Fat	%	0.59	0.42	0.75
Protein	%	17.87	14.53	21.55
Carbohydrates	%	62.05	58.27	65.96
Crude fibre	%	5.34	4.05	6.98

Table 2.1.6: Regression results from Nepal

Variables	Coefficient		St. Error	T-value	Significance
Constant	4.865	**	0.78	6.26	0.000
Ramechhap	-0.441	**	0.03	-16.72	0.000
Dhading	0.214	**	0.03	6.51	0.000
Chitwan	-0.111	**	0.03	-4.26	0.000
Syanja	0.203	**	0.04	5.05	0.000
Nawalparasi	0.094	**	0.05	1.93	0.057
Moisture	-0.130	*	0.08	-1.55	0.124
CrudeFibre	0.087		0.10	0.89	0.378
Carbohydrates	-0.249		0.17	-1.46	0.146
Ash	-0.154	**	0.08	-1.93	0.057
Seedweight	0.212	**	0.04	4.77	0.000
Foreignmatter	-0.025		0.02	-1.37	0.174
LBRatio	-0.112		0.09	-1.19	0.235
Wateruptake	-0.084		0.09	-0.98	0.329
Black_group	0.007	*	0.00	1.83	0.070
Olive_group	0.000		0.00	-1.08	0.284
Red_group	0.002		0.00	0.89	0.377
Yellow_group	0.005	*	0.00	1.50	0.137
N = 114	adj. R^2: 0.90				

* significant at α: 0.1, ** α: 0.05

In Nepal the slope of the regression was affected by the location (Table 2.1.6), while in India (Table 2.1.7) dummy variables included (for location) affected the constant of the equation, but not the slope – they also affected the r^2. The data were normally distributed.

Table 2.1.7: Regression results from India

Variable	Coefficient		St. Error	T-value	Significance
Constant	-6.57	**	2.50	-2.63	0.012
Protein	0.89	**	0.40	2.22	0.032
CrudeFibre	0.48	**	0.23	2.10	0.043
Seedweight	0.36		0.28	1.29	0.205
Wateruptake	2.90		2.55	1.13	0.263
SwellingCap	5.45	**	1.76	3.09	0.004
Black group	0.05	**	0.01	4.12	0.000
N = 47	adj. R^2: 0.4				

* significant at α: 0.1, ** α: 0.05

The combined regression which forms the Hedonic Price Index is shown in Table 2.1.8. This shows that, overall, positive traits in terms of price are crude fibre, seed weight, colour diversity, black colour and high fat content. Negative traits (which should be avoided by plant breeders, are high contents of foreign matter in the sample, an olive colour, high ash content, and a grey colour. There is no information on ash content of ricebean available anywhere, so dry matter (DM) could be used as an approximation.

Table 2.1.8: Hedonic Price Index for India and Nepal

Variables	Coefficient		T-value	Significance
Constant	1.936	**	3.24	0.00
Country	0.915	**	8.45	0.00
Orissa	0.078		0.99	0.32
Uttarakhand	0.197	**	2.52	0.01
Ramechhap	-0.403	**	-8.38	0.00
Dhading	0.238	**	3.77	0.00
Chitwan	-0.155	**	-3.18	0.00
Syanja	0.226	**	2.86	0.00
Nawalparasi	0.107		1.16	0.25
Moisture	-0.107		-0.82	0.42
Protein	0.166		1.42	0.16
Fat	0.095	*	1.75	0.08
CrudeFibre	0.346	**	2.84	0.01
Ash	-0.192	*	-1.85	0.07
Seedweight	0.250	**	4.06	0.00
Foreignmatter	-0.076	**	-2.36	0.02
LBRatio	0.157		0.94	0.35
Black	0.024	**	3.95	0.00
Gray	-0.009	*	-1.81	0.07
Olive	-0.012	**	-3.13	0.00
Red	-0.005		-1.13	0.26
Colour diversity	-0.121	**	-2.18	0.03
N = 167	adj. R^2: 0.84			

* significant at α: 0.1, ** α: 0.05

The effect of the traits upon prices is shown in Table 2.1.9 for the two countries combined. Crude fibre content had a significant positive effect upon price, as did seed weight, whereas ash content and foreign matter decreased it. From this, we can conclude that to provide (breed) a ricebean variety which matches consumers and farmers needs breeders to address:

- In terms of quality, seed size, crude fibre (and also colour diversity), with low ash content
- To produce more beans to sell, high yield, pest resistance and drought tolerance.

When the enhanced quality is put together with an increase in the number of beans to sell, then not only will there be improved ricebean for consumers, but there will also be more income for farmers.

Table 2.1.9: Hedonic Price Analysis - Influence on price in India and Nepal (combined data)

Characteristic	Mean	Minimum	Maximum	Difference	%	Coefficient	Price effect %
Crude Fibre	4.70	3.55	6.98	2.28	48	0.35	17
Ash	4.05	2.44	9.54	1.61	40	-0.192	-8
Foreign matter	6.78	1.10	19.31	5.68	84	-0.08	-7
Seed weight	9.14	4.07	19.42	10.29	113	0.250	28

(4) Carry out the field work in Uttarakhand, India and West-Nepal, 10 January – 20 February 2009

This was carried out to survey agents of the ricebean supply chain, and interviewing farmers and traders in India and Nepal (retailers, wholesalers, commission agents. A total of 57 traders and 41 farmers were interviewed for India and Nepal (Table 2.1.10).

Table 2.1.10: Locations visited and number of interviews conducted, 29 Jan – 4 Feb 2009

	India	No. of interviews			Nepal	No. of interviews	
Period	Location	Trader	Farmer	Period	Location	Trader	Farmer
13 Jan	Dehradun	5	0	29 Jan	Baitadi	3	1
14 Jan	Sahaspen	3	0	30 Jan	Dadeldhura	5	0
14 Jan	Vikasnagar	2	0	30 Jan	Koteuda	0	2
15/16 Jan	Rishikesh	6	0	31 Jan	Safebagar	1	0
17 Jan	Chamba	8	0	2 Feb	Bagaichula	0	1
17 Jan	Gajna	0	7	2 Feb	Faltude	1	0
17 Jan	Baluwala	0	2	2 Feb	Ampaani	0	1
17 Jan	Pirthipur Kheda	0	1	3 Feb	Dhangadi	7	0
18 Jan	Koth	0	2	4 Feb	Attariya	1	0
18 Jan	Bergani	0	1		**Total**	**18**	**5**
18 Jan	Khandikhal	1	3				
19 Jan	Arakot	0	5				
19 Jan	Chopadial	0	1				
19 Jan	Majado	0	1				
20 Jan	Srinagar	2	0				
21 Jan	Hindolakhal	0	2				
21 Jan	Sodh/Chodh	0	2				
21 Jan	Kandi	0	1				
21 Jan	Sirmoli	0	1				
21 Jan	Gram Chaund	0	2				
23 Jan	Nainital	8	2				
24 Jan	Nainital	1	0				
24 Jan	Garampani	1	0				
25 Jan	Chafoad	0	1				
25 Jan	Danikot	0	1				
25 Jan	Manartha	0	1				
27 Jan	Almora	2	0				
	Total	**39**	**36**				

(5) Present results of the hedonic price analysis to other researchers specialized in pulses;

The results were presented to a scientific audience at the International Conference on Grain Legumes : Quality Improvement, Value Addition and Trade held at IIPR (International Institute for Pulse Research), Kanpur, India, February 14-16, 2009. The oral presentation was entitled

"Quality parameters in relation to consumer's preference in rice bean", and will be published in the proceedings (see: http://www.agric-econ.uni-kiel.de/Abteilungen/II/PDFs/Kanpur_Buergelt_final-version.pdf and http://www.agric-econ.uni-kiel.de/Abteilungen/II/PDFs/Kanpur_Buergelt-V02.pdf) as well as on the FOSRIN website www.ricebean.org, and is attached to this report as Annexe 13. In addition, we are preparing a paper and a poster for the 27th Conference of the International Association of Agricultural Economists (IAAE), Beijing, China, August 16-22, 2009.

Table 2.4.16. Ash and CP content in some promising entries of ricebean at CSK HPAU during *Kharif* 2008

Entry	Ash content (%)	CP %
BRS-1	4.4	22.16
BRS-2	4.1	21.09
Nainy	4.4	21.80
RBHP- 38	5.2	19.32
RBHP-35	4.7	22.46
RBHP-38	5.1	21.32
RBHP-41	5.4	20.43
RBHP-43	5.2	20.86
RBHP-44B	5.1	21.21
RBHP-44C	5.6	19.49
RBHP-53	5.4	19.62
RBHP-60	5.5	22.12
RBHP-61	5.5	21.12
RBHP-97	5.0	21.20

Partner 5 have analysed a few promising lines of ricebean for ash and CP content. However, this data has not yet been analysed statistically.

2.2 Workpackage 2: Genetic diversity and indigenous knowledge

2.2.1 Objectives

WP2, led by LI-BIRD (Partner 8), with additional inputs from the other Asian partners NARC, GVT, CSKHPKV and AAU, involves the assessment of genetic diversity and indigenous knowledge on ricebean. It has the following four objectives:

- To describe the extent of ricebean diversity and its geographical distribution
- To collect a representative sample of ricebean germplasm together with associated socio-economic data
- To evaluate the collections in the field for phenotypic diversity analysis and,
- To understand the socio-economic and bio-physical factors controlling ricebean diversity and its utilization

Table 2.2.1 summarises the objectives, the respective work performed and major deliverables during this period.

Table 2.2.1. Summary of objectives and work performed during reporting period

Objectives	Worked performed	Deliverables
2.1 To describe the extent of ricebean diversity and its geographical distribution	Assessment of potential ricebean growing districts in Nepal. Area under ricebean in each district assessed and districts categorized on the basis of area coverage GPS coordinates collected from 12 potential ricebean growing districts Work begun on writing a journal paper (D1.3)	Report of distribution of ricebean in India and Nepal (D 2.1) prepared and submitted in May 2007
2.2 To collect a representative sample of ricebean germplasm together with associated socio-economic data	Along with 156 accessions of ricebean landraces in 2006, additional accessions from Kaski and Ramechhap collected in 2007. 33 ricebean accessions from home gardens of Chitwan valley also collected in 2007/08	Data from three years trials and seed samples available for evaluation Agro morphological data of accessions from Chitwan valley, and seed samples, available
2.3 To evaluate the collections in the field for phenotypic diversity analysis	50 core accessions and 66 non-core accessions evaluated on-farm under intercropping system and sole cropping system respectively in Gulmi. 12 best performing accessions evaluated in 12 mother trials in 2008 42 accessions evaluated in two sets of observation nurseries each set comprising 21 accession in 2008	Promising landraces identified for further evaluation and promotion
2.4 To understand the socio-economic and bio-physical factors controlling ricebean diversity and its utilization	Farmers' local knowledge associated with production, diversity and utilization of ricebean from potential ricebean areas documented and analysed. Reconnaissance survey conducted in Chitwan	Deliverable on farmers' indigenous knowledge (D 2.2) produced in March 2008 and submitted May 2009

valley to assess the traits of ricebean grown in home gardens and preferred by farmers

Various approaches for dissemination of knowledge on ricebean implemented (radio programme, publications, documentary etc)

2.2.2 Summary of work in years 1 and 2

An initial assessment of potential ricebean-growing districts was carried out in Nepal. In addition, over 150 ricebean accessions were collected from 16 districts in Nepal, together with over 100 from the historical collection at NARC and almost 90 from 16 districts in India. Local knowledge on the crop was also collected in both countries. The collected accessions from Nepal were evaluated for agro-morphological traits and phenotypic diversity on-farm at Gulmi in the middle hills by LI-BIRD, and at NARC headquarters. The data collected showed that ricebean could be grown in a range of climatic conditions, but in Nepal was mostly found in drought-prone sloping areas as well as on unirrigated flat river fans between 700 and 1300 m. It is also grown in home gardens from 200 m in Chitwan up to 2000 m in Ilam district. Passport data was recorded using standard procedures developed by the project partners.

The germplasm evaluation was carried out under normal farmers' conditions without chemical fertiliser, although spraying was carried out against pests – standard protocols were developed and used to record the data. The on-farm evaluation showed considerable variation between accessions in time to maturity, seed size and colour, time to maturity and yield. The NARC evaluation also showed differences in growth habit. Principal Components Analysis showed that a cluster of genotypes from the mid to high hills in W Nepal were similar. The degree of diversity shown suggested considerable possibility for plant breeding to improve the crop.

Assessment of diversity as seen by farmers identified four main types of ricebean in each of Gulmi and Ilam districts in Nepal, and seven in India (although in Himachal Pradesh only a mixture of landraces was grown). The main criteria used by farmers were grain size and colour, maturity, and growth habit. In both countries, ricebean was grown mainly as an intercrop or a mixed crop with maize, as well as on its own as a sole crop, although in some areas it was mixed with cowpea or sorghum. Most of the crop was planted in June before the onset of the monsoon. Farmers identified a number of production constraints including low yield potential, availability of other legumes in the market, unavailability of improved material, and low interest by research and extension services. They were aware of a number of medicinal and nutritional benefits, and noted that ricebean had cultural significance in a number of areas. However, they were also aware of its flatulence-causing properties. There were no established markets for ricebean – it was not grown for commercial purposes and was usually exchanged between farmers or sold in local markets.

In 2008, germplasm collection continued in 2007 as an adjunct to other activities – in future we will record GPS coordinates of collection sites where possible. In 2007 evaluation trials were conducted at two field sites in Nepal by LI-BIRD, in Darbar Devisthan and Simichaur VDC, Gulmi district, Western Nepal. These had an average altitude of 1350 m asl, and were dominated by sloping *Bari* land.

The core collection of 50 accessions, with 2 replications, was grown as an intercrop with maize at Gulmi, while 66 non-core accessions were grown as a sole crop also at Gulmi. Principal components analysis was used to group the material. In India, germplasm evaluation was carried out at one location in Assam, one in Himachal Pradesh, and two in Madhya Pradesh (MP). A total of 23, 66 and 15 genotypes respectively were evaluated.

We designed, reviewed and refined the documentation for the indigenous technical knowledge (ITK) work, and developed and refined a checklist. The first round of documentation has been completed in Gulmi, and activities initiated in Ramechhap. In Gulmi, 15 interviews have been carried out, stratified by gender, ethnicity and altitude. In India, documentation of ITK has been carried out in Palampur, with the emphasis on recipes and culinary uses. Photographs of ricebean preparations in the area are available on the website.

2.2.3. Activities of workpackage 2

Germplasm collection

In India, exploratory visits were made during 2007 in ricebean growing areas of Chhattisgarh, Madhya Pradesh, Assam, Meghalaya, Himachal Pradesh and Uttarakhand for the collection of germplasm (Table 2.2.2). This was accomplished by visiting individual households and seed from their stores was obtained as the crop was not in the field during exploration time.

Table 2.2.2: Area surveyed and germplasm collected during 2008-09, additional to 2007

Name of place	No. of accessions	Name of partner
Chhattisgarh, Madhya Pradesh, Uttarakhand	44	GVT
Himachal Pradesh (Kangra, Chamba, Mandi) ; Uttaraknahd	22+34 *	CSKHPAU
Barapani (Meghalaya), Karbi Anglong (Assam), Darjeeling (West Bengal)	44	AAU

*Collected during March 2008 and will be evaluated during 2009

Germplasm evaluation

On-farm trials of ricebean conducted by LI-BIRD in Nepal in 2008 consist of observation nurseries and a nursery for off-type evaluation. These were conducted in the main (summer) season. Trials were conducted on farmers' fields using farmers level of inputs and agronomic practices. The fertility status of soil in different trials is shown in Table 2.2.3.

Table 2.2.3. Result of soil analysis, 2008

Sample details	pH 1:2.5	OM (%)	% N	Available P ppm	Available K ppm	Sand %	Silt %	Clay %	Soil type
Rikha B Karki	6.50	3.23	0.17	123.5	83.70	38.0	35.0	27.0	CL
Dornacharya Panthi	6.55	3.15	0.17	22.70	303.4	53.0	25.0	22.0	SCL
Chetman Karki	6.52	3.42	0.18	11.30	159.9	48.0	30.0	22.0	L
Sita Aryal	6.42	4.04	0.21	209.0	170.9	48.0	25.0	27.0	SCL
Ramhari Tiwari	6.50	3.95	0.20	37.15	306.9	63.0	20.0	17.0	SL
Kalpana Pandey	6.60	5.62	0.28	45.00	335.0	53.0	15.0	32.0	SCL
Ghanasyam Subedi	6.45	3.31	0.17	182.0	538.0	68.0	15.0	17.0	SL
Gunaraj Thapaliya	5.90	2.65	0.14	23.50	239.8	38.0	30.0	32.0	CL

Observation nurseries were conducted by LI-BIRD in Gulmi and Tanahun districts in 2008. The 21 best performing accessions were selected for the observation nursery from non-core collection at Rampur, Kavre and Gulmi. Similarly, the 21 accessions performing best in Gulmi were selected for next set of observation nursery. Two sets with twenty one entries in each set were grown as sole crops, with additional stakes provided. Three observation nurseries were in Gulmi district and one in Tanahun district. The trials were planted in 2 rows of 3 meter length with a spacing of 75cm x 50cm (Annexe 2). Twelve plants were maintained per plot per accession in each trial. At NARC, the observation nursery comprised the 21 best performed accessions in agro-morphological characterisation of ricebean from the non-core collection in 2007 (Table

2.2.4). Three sets with 21 entries in each set were conducted in 2008 under sole cropping on-stations in Rampur, Khumaltar and Kabre. Land preparation, manure and fertilizer application and other intercultural operations were as per farmers' practice (Annexe 2).

Table 2.2.4: Ricebean genotype details in observation nursery, 2008

Accession No	Districts	Best performed in respective study sites
NPGR 00005	Nuwakot	Kabre
NPGR 00184	Kavre	Kabre and Khumaltar
NPGR 00191	Dang	Kabre and Khumaltar
NPGR 05422	Dhankuta	Kabre
NPGR 05424	Dhankuta	Kabre
NPGR 05383	Tanahu	Rampur
NPGR 05381	Lamjung	Rampur
NPGR 05425	Dhankuta	Rampur
NPGR 05367	Bhojpur	Rampur
NPGR 08381	Myagdi	Rampur
NPGR 05374	Goukha	Khumaltar
NPGR 05372	Gorkha	Khumaltar
NPGR 00189	Kabre	Khumaltar
LRGR 143	Kaski	Khumaltar
LRGR 153	Kavre	Khumaltar
NPGR 05410	Dhankuta	Khumaltar
LRGR 87	Dang	Khumaltar
LRGR 113	Gulmi	Khumaltar
LRGR 123	Palpa	Khumaltar
LRGR 139	Kaski	Khumaltar
LRGR 133	Palpa	Khumaltar

Evaluation of germplasm lines in India was during *Kharif* 2008 (rainy season) in farmers' fields in Bhagore village by GVT, and on university experimental farms by CSKHPAU and Assam. Each germplasm line was grown in plot size of 2.40m x 1.80m with row to row spacing of 60 cm and plant to plant spacing of 40 cm. The different phenological characters and yield data were recorded (Annexe 10) to assess variation.

Nursery for evaluation of off types

A total of 16 off-type seeds each from 13 accessions in core collection of 2007 season were selected for separate study. These off-type seeds were grown in non-replicated observation nursery in Darbar Devisthan VDC of Gulmi district. The trial was conducted in sole cropping system with 4 rows of 2-meter length maintaining the spacing of 75 cm x 50 cm (Annexe 3). The main objective of this evaluation trial was to observe if there is any out cross in ricebean. All the plots were harvested in a bulk.

Result and discussions

Observation nurseries

Table 2.2.5 shows the mean results from the two sets of observation nurseries at Dulegauda VDC, Tanahun district and Darbar Devisthan VDC, Gulmi district. There were significant differences for days to emergence, 50% flowering, plant height, grain yield and pods per plant. LRGR 132 (107.5 days) flowered later then other genotypes, and LRGR 138 (91 days) was earliest. LRGR 138 (72.6 cm) was shortest, and LRGR 135 (232 cm) tallest. LRGR 44 (2333 kg/ha) had the highest yield. The highest number of pods per plant was in LRGR 129 (146). There were no significant differences for pod length, days to maturity hundred grain weights and seeds/pod.

Table 2.2.5. Mean results of agronomic traits in observation nurseries at Dulegauda VDC, Tanahun district and Darbar Devisthan VDC, Gulmi, 2008

Genotype	50% flowering(days)	Height (cm)	Pod length (cm)	Days to maturity	100 grain weight (g)	Grain yield (kg/ha)	Pods	Seeds
LRGR 43	102.5	199.0	10.0	163.0	10.5	1074	72.0	8.70
LRGR 44	101.5	202.5	13.3	156.0	10.0	2333	109.0	8.90
LRGR 73	105.5	211.0	10.3	158.0	9.0	1111	108.0	8.50
LRGR 97	102.5	196.5	63.3	158.0	9.5	711	86.5	8.70
LRGR 107	104.0	184.0	10.2	159.5	10.5	389	55.0	8.30
LRGR 116	103.0	174.5	10.1	157.5	12.5	778	96.0	8.70
LRGR 124	101.5	190.5	9.5	140.0	12.5	1407	107.5	7.65
LRGR 126	103.5	215.5	9.3	159.5	9.5	1778	70.0	7.65
LRGR 129	106.5	208.0	10.5	160.0	11.5	1956	146.0	9.20
LRGR 130	104.0	182.0	9.8	163.0	11.0	1000	133.5	9.10
LRGR 132	107.5	185.5	11.8	157.0	10.5	667	106.5	9.40
LFGR 135	104.0	232.0	9.4	150.0	9.50	2190	109.5	9.10
LRGR 138	91.0	72.6	10.1	155.5	12.0	904	111.0	8.90
LRGR 148	102.5	186.0	9.9	159.5	12.0	889	86.0	7.90
LRGR 160	107.0	144.0	10.7	156.0	9.5	111	141.0	7.40
NPGR 00007	105.0	210.0	11.0	167.0	10.0	1422	41.0	8.20
NPGR 01975	96.0	108.0	8.8	157.0	9.5	556	104.0	9.40
NPGR 05382	105.0	124.0	11.8	156.0	12.0	1000	86.0	8.20
NPGR 06591	100.0	200.0	10.9	163.0	11.0	1444	116.0	8.80
NPGR 07583	105.0	138.0	10.0	163.0	11.0	824	65.0	10.00
NPGR 08380	106.0	162.0	9.0	163.5	11.0	1000	66.0	9.25
Mean	**103.0**	**177.4**	**12.8**	**158.2**	**10.7**	**1121**	**96.0**	**8.66**
Probability	**	*	ns	ns	ns	*	**	ns
LSD	5.47	74.7	-	-	-	1105	40.5	-
CV	2.5	20.2	-	-	-	47.2	20.2	-

†DE=days to emergence, 50% FL=days to 50% flowering, PH=plant height, PL=pod length, DM=days to maturity, Pods/P=pods per plant, Seed/P=seeds per pod, HGW=hundred grain weight, Y=yield

The second set of the observation nursery was in Darbar Devisthan VDC Gulmi (Table 2.2.6). Genotypes varied appreciably for days to emergence and days to maturity. LRGR 113 (9 days) was earliest to emergence, and LRGR 143 and NPGR 00189 (both 11 days) late. NPGR 00184 (144 days) was earliest to maturity, and LRGR 143 (169.5 days) was latest. Genotypes did not display any significant difference for days to 50% flowering, height, pod length, hundred grain weight and grain yield.

In the trials at NARC, the coefficient of variation (CV) ranged from 0.05 for days to maturity to 0.23.for the grain and biomass yield[1] plant, with average of 0.15 (Table 2.2.7). The grain and biomass yield were highest in NPGR 05374 (252 g/plant), with lowest grain yield in NPGR 05383 (106 g) and low biomass in NPGR 05383, NPGR 05422 and LRGR 113 (600-800 g/plant). Hundred grains weight ranged from 5.1g to 12.4g. Overall, NPGR 00005, NPGR 00184, NPGR 05374, LRGR 113, LRGR 133 and LRGR 139 were promising in Khumaltar and could be promoted for similar environments.

At HCRP Dolakha, a number of genotypes produced more than one ton of grain per ha, although others gave little over 200 kg (Table 2.2.8). NPGR 05372 was earliest to mature (138 days) and had the highest biomass (6.96t/ha), and could therefore be good for fodder. There was about 2 weeks difference in time to maturity between early and late genotypes. Most genotypes were resistant to rust, and might also be useful in breeding programme. NPGR 05422, which had the most pods per plant, was resistant to rust and free from powdery mildew, although it had watery pod formation which resulted low in grain yield.

Table 2.2.6. Mean results of agronomic traits in observation nursery, Darbar Devisthan VDC, Gulmi, 2008

Genotype	50% flowering(days)	Height (cm)	Pod length (cm)	Days to maturity	100 grain weight (g)	Grain yield (kg/ha)
NPGR 0005	112.5	175	8.87	149.5	6.70	1225
NPGR 00184	107.0	149	8.56	144.0	7.60	1062
NPGR 00191	111.0	143	8.87	154.5	8.20	895
NPGR 05422	109.5	208.	9.42	151.5	10.25	1722
NPGR 05424	113.5	166	9.20	153.0	10.35	943
NPGR 05383	113.5	166	8.10	154.5	6.55	1622
NPGR 05381	113.5	91	8.77	160.5	6.85	1272
NPGR 05425	115.0	151	8.65	164.0	7.05	1243
NPGR 05367	111.0	150	8.82	161.5	9.95	1571
NPGR 08381	108.5	157	9.42	154.0	9.55	1456
NPGR 05374	112.0	111	8.62	165.0	8.35	1358
NPGR 05372	111.5	132	8.20	159.0	9.15	1696
NPGR 00189	112.5	200	8.35	149.0	8.30	1304
LRGR 143	117.5	109	9.38	169.5	9.80	1581
LRGR 153	114.0	116	9.27	159.0	6.10	1076
NPGR 05410	109.5	111	9.73	157.0	10.80	1472
LRGR 87	108.5	119	9.00	154.5	6.90	1672
LRGR 113	116.0	125	8.45	161.0	7.20	1402
LRGR 123	116.5	161	8.70	162.5	9.10	1451
LRGR 139	115.5	166	10.36	163.0	10.95	1953
LRGR 133	116.0	98	9.71	163.0	10.80	1157
GM	112.6	143	8.97	157.6	8.60	1387
F test	ns	ns	ns	*	ns	ns
LSD	-	-	-	11.98	-	-
CV	-	-	-	3.6	-	-

†DE=days to emergence, 50% FL=days to 50% flowering, PH=plant height, PL=pod length, DM=days to maturity, HGW=hundred grain weight, Y=yield

Table 2.2.7: Performance of ricebean genotypes in the observation nursery at Khumaltar (2008)

Genotypes	Days to flowering	Days to maturity	Height (cm)	Pod length (cm)	Pods	Seeds	Grn yld / plant (g)	100 seed weight (g)	Biomass / plant (g)
NPGR 00005	85	129	89.6	9.2	177	8.3	169	6.7	1400
NPGR 00184	91	129	140.6	11.2	155	8.0	176	5.1	1200
NPGR 00191	82	149	153.6	9.6	164	7.4	139	7.4	1300
NPGR 05422	92	149	102.8	9.4	135	6.4	119	8.5	600
NPGR 05424	85	149	123.4	9.6	143	8.3	124	7.9	1000
NPGR 05383	83	149	110.8	9.4	144	7.5	106	6.6	700

NPGR 05381	89	129	105.6	7.6	163	8.2	146	7.1	1050
NPGR 05425	95	149	134.4	7.4	157	8.5	143	7.8	1000
NPGR 05307	100	151	146.4	7.6	172	8.0	151	7.8	1100
NPGR 08381	102	139	114.0	8.8	149	8.5	125	8.7	1150
NPGR 05374	105	151	102.0	8.0	276	5.7	252	6.9	1500
NPGR 05372	88	157	124.8	7.8	197	6.3	178	8.7	1450
NPGR 00189	92	141	78.2	8.0	156	6.4	138	6.6	1000
LRGR 143	89	144	110.2	10.2	143	7.6	125	8.2	1000
LRGR 153	85	151	89.8	7.8	157	7.7	131	9.0	1124
NPGR 05410	105	140	134.6	7.4	171	7.0	148	9.2	1300
LRGR 87	92	141	115.2	10.2	193	6.7	169	5.1	1000
LRGR 113	89	151	118.6	9.0	211	7.7	186	7.6	800
LRGR 123	97	141	107.4	9.0	131	7.8	109	8.5	1200
LRGR 139	92	151	93.6	9.0	198	8.2	179	12.4	1700
LRGR 133	95	141	125.8	9.6	188	7.3	168	8.9	1200
CV	**0.07**	**0.05**	**0.17**	**0.12**	**0.20**	**0.10**	**0.23**	**0.20**	**0.23**

Table 2.2.8: Performance of ricebean genotypes in the observation nursery at HCRP Dolakha (2008)

Genotypes	Days to flowering	Days to maturity	Height (cm)	Pods per plant	Seeds per plant	HSW(g)	Grn yield (kg/ha)	Biomass (kg/ha)
NPGR00005	96	150	110	125	7	5.0	1056	3278
NPGR00184	83	153	71	165	9	6.0	791	3458
NPGR00191	92	146	86	110	8	7.0	756	3867
NPGR05422	108	153	79	210	11	8.0	202	4646
NPGR05424	107	153	81	190	6	7.0	1498	4609
NPGR05383	105	150	95	140	10	5.0	202	1313
NPGR065381	101	146	55	90	9	6.0	758	4314
NPGR05425	107	150	50	80	9	6.0	589	4589
NPGR05367	94	146	59	75	8	6.0	504	4060
NPGR08381	109	146	54	105	6	8.0	1144	6255
NPGR05374	96	142	93	110	11	6.0	524	3191
NPGR05372	90	138	65	65	9	7.0	1182	6960
NPGR00189	90	140	44	40	8	6.0	324	2102
LRGR 143	115	153	59	80	10	9.0	313	3869
LRGR 153	101	150	88	85	8	8.0	647	4647
NPGR 05410	107	140	60	105	7	10.0	702	3146
LRGR 87	105	140	62	90	9	8.0	607	4829
LRGR 113	109	142	65	110	8	8.0	238	2460
LRGR 123	101	155	84	120	7	9.0	307	2307
LRGR 139	107	153	80	110	7	12.0	1138	6027
LRGR 133	108	152	65	125	10	8.0	1060	5282
CV	**0.08**	**0.04**	**0.26**	**0.37**	**0.18**	**0.25**	**0.58**	**0.35**

In Rampur, the observation trial was not successful due to heavy and continuous rainfall during the crop season. Both vegetative and reproductive growth of plant of all genotypes was poor, and yields were only 3 and 43 g/m^2.

In India, 83 genotypes were evaluated in Assam, 66 in GVT and 100 in CSKHPAU, along with checks in an augmented design. Observations were recorded for days to 50% flowering, flowering period, days to first mature pod, plant height, number of pods per plant, pod length, 100 seed weigh and seed yield per plant (Annexe 10). Data (Annexure 1) showed significant differences between genotypes for different traits under study. In Madhya Pradesh, out of the 44 new germplasm lines, 24 lines did not flower at all hence their seed could not be obtained. Table 2.2.9 shows the most promising lines.

Table 2.2.9: Promising lines for different characters among germplasm lines of ricebean in comparison to the best check (CSK HPAU)

Characters	Best check	Promising lines
Days to 50% flowering	NAINY	RBHP – 67,RBHP – 81, RBHP – 88, RBHP – 87, RBHP – 86, RBHP – 82
Flowering period	BRS I	RBHP – 73, RBHP – 97, RBHP - 44 (A), RBHP – 55, RBHP – 52, RBHP – 60, RBHP – 71, RBHP - 44(B), RBHP - 18
Days to first mature pod	BRS I	RBHP – 88, RBHP – 18, RBHP – 96, RBHP – 4, RBHP – 67, RBHP – 30, RBHP – 58
Terminal leaflet blade length (cm)	BRS I	RBHP – 41, RBHP – 48, RBHP – 61, RBHP – 89, RBHP – 31, RBHP - 44 (C), RBHP - 64
Terminal leaflet blade width (cm)	BRS I	RBHP – 41, RBHP – 61, RBHP - 44 (C), RBHP – 48, RBHP - 54
Plant height (cm)	NAINY	RBHP – 60, RBHP – 73, RBHP - 44(B), RBHP - 26
Pods / plant	NAINY	RBHP – 33, RBHP – 14, RBHP – 34, RBHP – 39, RBHP - 53
Pod length (cm)	BRS I	RBHP – 48, RBHP – 41, RBHP – 50, RBHP - 44 (C), RBHP – 45, RBHP - 31
100-Seed weight (g)	BRS II	RBHP – 62 (B), RBHP – 67, RBHP – 64, RBHP – 50, RBHP – 52, RBHP - 43
Dry biomass / plant (g)	BRS II	RBHP – 95, RBHP – 34, RBHP – 46, RBHP – 58, RBHP – 100, RBHP - 93
Seed yield / plant (t/ha.)	Nainy	RBHP-41,RBBP-14, RBBP-61, RBBP-43, RBBP-38

Nursery for evaluation of off types from core trials

The details of this study are presented in Table 2.2.13. Agro-morphological data were not taken in this evaluation nursery, as the objective was to observe if there is any outcrossing in ricebean, only the harvested seed lot was observed. Due to heavy rain during harvesting period, seed was damaged significantly. However, collected seed was observed to find out something that would guide for further research. The result clearly indicated that there is significant degree of outcrossing in ricebean.

Table 2.2.13: Evaluation of off types seeds selected from 13 accessions from core trials in 2008

Accession	Original colour	Colour of the off type	No of seed selected	Size of off type	Basis of selection	Colour of seeds harvested in bulk
NPGR 00012	Yellow	Mottled	16	Large	Colour	Mottled>Yellow
NPGR 05364	Yellow	Brown	16	Medium	Colour	Brown> red> Yellow
NPGR 05373	Brown	Black	16	Medium	Colour	Black> Brown >Yellow
NPGR 05386	Red	Mottled	16	Medium	Colour	Mottled>Yellow>Marooned>Black
NPGR 05396	Yellow	Mottled	16	Medium	Colour	Mottled>Yellow>Black
NPGR 05420	Yellow	Black	16	Medium	Colour	Black>Yellow>Red>Mottled
NPGR 05423	Yellow	Yellow-late maturity but bold grain	16	Large	Selected due to size	Mottled>Yellow (both bold)
NPGR 06657	Yellow	Yellowish brown	16	Large	Colour	All bold and yellowish brown
NPGR 08382	Yellow	Mottled	16	Medium	Colour	Yellow>Mottled >red
LRGR 43	Yellow	Mottled	16	Medium	Colour	Mottled>Marooned
LRGR 107	Mottled	Light mottled	16	Medium	Colour	Whole plot damaged
LRGR 129	Yellow	Mottled	16	Medium	Colour	Whole plot damaged

LRGR 101	Mottled	yellow	16	Large	Bold grain type	Whole plot damaged

GPS Coordinates

The report on distribution of ricebean in Nepal and India was submitted to Brussels earlier. However, for publication in an academic journal further work including collection of GPS coordinates will be essential. As a result, the GPS coordinates from twelve districts viz. Gulmi, Palpa, Kaski, Nuwakot, Kavre, Darchula, Dadeldhura, Doti, Achham, Bajura and Bajhang have been collected (Annexe 6). Work has begun on writing this deliverable up as a paper for publication.

2.3 Workpackage 3: Molecular markers

2.3.1 Objectives

WP3 addresses the characterization of ricebean diversity using molecular markers, and is led by NARC, with assistance from CAZS-NR. A series of field (as part of WP 2 and WP4) and laboratory based studies on genetic diversity of ricebean germplasm of Nepal was carried out on-farms and stations in different agro-environments of the country: the field studies are reworted under WP2 and WP4 as appropriate. The SSR molecular marker diversity study was also carried out on a stratified test sample of landraces with a consideration of geographical and phenotypic diversity to determine the extent and amount of diversity in ricebean germplasm of Nepal. The relationships and diversity between the genotypes will be determined and these estimates will be used in identification of the genotypes for improvement. This work will draw to a considerable extent upon the outputs from WP2 and 3. Table 2.3.1 summarises the activities undertaken by NARC to achieve the respective deliverables in connection to objectives of WP3 and related activities to other WPs.

Table 2.3.1: Summary of activities, objectives and deliverables in WP3 (2008)

Objectives	Activities performed	Deliverables
3.2: Analysis of molecular marker diversity	91 accessions from 35 districts based on agro-morphological diversity selected for molecular marker diversity assay	The studied germplasm was found to be diverse, but study is on-going with additional polymorphic loci.
	Bulk DNA (15 individuals) for each stratified sample isolated	
	13 out of 35 polymorphic loci have been tested	

2.3.2 Progress/Achievement

Variability in legumes is largely based on their morphology, agronomic behaviour, and biochemical traits. There is limitation on this traditional agro-morphological characteristic and it is associated with a low level of polymorphism in legumes[12,13]. Asian *Vigna* has largely been studied for their molecular marker diversity including the traditional agro-morphological diversity. Restriction fragment length polymorphism (RFLP), amplified fragment length polymorphism (AFLP), random amplified polymorphic DNAs (RAPDs), inter simple sequence repeats (ISSRs), and simple sequence repeats (SSRs) are certain molecular marker techniques that have been extensively used in genome analysis of Asian *Vigna* specially of Adzuki bean (*V. angularis* (willd.). Linkage maps have been developed for three of the Asian *Vigna* species: mung bean (*Vigna radiata*), adzuki bean (*V. angularis*) and black gram (*V. mungo*)[20, 21] and a large number of SSR markers have been developed for adzuki bean[22, 23]. These SSR markers have been used in comparative linkage maps in other related legumes and have provided information on genetic relationships among the related species. Ricebean, a legume domesticated as for cultigen is very closely related to Adzuki bean[34, 35]. In WP3, the evaluation of best performing ricebean genotypes and SSR molecular diversity were carried out in field and laboratory in NARC in 2008

[34] Kaga A (1996). Construction and application of linkage maps for azuki bean (*Vigna angularis*). Doctoral dissertation, Kobe University, Japan.

[35] Tomooka N, Kaga A, Vaughan DA and Jayasuriya AHM (2003). Advances in understanding the genus *Vigna* subgenus *Ceratotropis*. Pp 25-35. In AHM Jayasuriya and DA Vaughn (eds) Conservation and use of crop wild relatives. Proceedings of the joint Department of agriculture, sri Lanka and National Institute of Agrobiolocal Sciences, Japan workshop. Plant Genetic Resources Centre, department of Agriculture, Sri Lanka.

with the objective to determine the best genotypes for further scaling up and to analyze the molecular marker data investigating genetic diversity in local ricebean germplasm.

Materials and methods

Analysis of molecular marker diversity

35 polymorphic SSR markers were used to elucidate genetic distinctness and detect the marker diversity in ricebean germplasm (Annex III). This number of markers was identified as polymorphic loci on a stratified set of 27 diverse ricebean germplasm in 2007. The molecular marker diversity study comprises 91 test samples of ricebean germplasm and two controls: adzuki bean and ricebean bold (Table 2.3.2). These samples were selected from core and non-core collection field evaluation of agro-morphological characteristics carried out in 4 different agro-environments in 2007. The set is therefore hoped to be diverse enough to capture the total ricebean germplasm diversity in Nepal.

Bulk DNAs of 15 seeds of each accession (genotype) were isolated using the Phytopure Genomic DNA extraction kit (Tepnel Sciences PLC, Manchester, UK). The DNA isolates were checked for concentration on 0.8% agarose mini-gel in 1xTBE buffer (0.09 M Tris-borate and 0.5 M EDTA) at 80 volts for 90 min with ethidium bromide staining. The thermal cycling of PCRs (polymerase chain reaction) carried in MJ Research PTC– 100™ Programmable Thermal Controller (MJ Research, INC, Waltham, MA, USA), amplified PCR products separation and diversity analysis of generated marker data for test samples were carried following the protocol described in Annex III[36] (Wang *et al.*, 2004).

Table 2.3.2: Details of ricebean genotypes studied for molecular marker diversity

Accession	Collection districts	Source	Remarks
NPGR-00007	Nuwakot	Core collection	
NPGR-00008	Nuwakot	Core collection	Included in mother trial in 2008
NPGR-00010	Lalitpur	Core collection	
NPGR-00012	Nuwakot	Core collection	
NPGR-00015	Bhaktapur	Core collection	Included in mother trial in 2008
NPGR-00073	Gulmi	Core collection	
NPGR-00076	Arghakhanchi	Core collection	Included in mother trial in 2008
NPGR-00087	Pyuthan	Core collection	
NPGR-00090	Dang	Core collection	
NPGR-00194	Kabre	Core collection	Included in mother trial in 2008
NPGR-01975	Baitadi	Core collection	
NPGR-05364	Bhojpur	Core collection	Included in mother trial in 2008
NPGR-05368	Bhojpur	Core collection	
NPGR-05370	Terhathum	Core collection	
NPGR-05373	Gorkha	Core collection	
NPGR-05377	Lamjung	Core collection	
NPGR-05382	Tanahu	Core collection	
NPGR-05384	Mugu	Core collection	
NPGR-05386	Humla	Core collection	
NPGR-05391	Bajura	Core collection	
NPGR-05396	Illam	Core collection	
NPGR-05420	Dhankuta	Core collection	Included in mother trial in 2008
NPGR-05423	Dhankuta	Core collection	
NPGR-05432	Baitadi	Core collection	

[36] Somta P, Kaga A, Tomooka N, Kashiwara K, Isemura T, Chaitieng B, Srinives P and Vaughan DA (2006). Development of an interspecific Vigna linkage map between *Vigna umbellata* (Thunb.) Ohwi and Ohashi and *V. nakashimae*) Ohwi) Ohwi and Ohashi and its use in analysis of bruchid resistance and comparative genomics. Plant breeding 125:77-84.

Accession	Collection districts	Source	Remarks
NPGR-05565	Okhaldhunga	Core collection	
NPGR-06591	Mugu	Core collection	
NPGR-06657	Kalikot	Core collection	
NPGR-06756	Humla	Core collection	Included in mother trial in 2008
NPGR-07583	Jhapa	Core collection	
NPGR-07882	Bajhang	Core collection	
NPGR-08380	Myagdi	Core collection	
NPGR-08382	Banglung	Core collection	
NPGR-09391	Syangja	Core collection	
NPGR-09461	Panchthar	Core collection	
NPGR-09464	Taplejung	Core collection	
LRGR-42	Surkhet	Core collection	
LRGR-43	Surkhet	Core collection	
LRGR-44	Surkhet	Core collection	
LRGR-75	Pyuthan	Core collection	
LRGR-91	Dang	Core collection	Included in mother trial in 2008
LRGR-99	Palpa	Core collection	Included in mother trial in 2008
LRGR-101	Palpa	Core collection	
LRGR-102	Palpa	Core collection	
LRGR-103	Palpa	Core collection	Included in mother trial in 2008
LRGR-107	Palpa	Core collection	
LRGR-111	Gulmi	Core collection	Included in mother trial in 2008
LRGR-117	Gulmi	Core collection	Included in mother trial in 2008
LRGR-129	Palpa	Core collection	
LRGR-137	Kaski	Core collection	
LRGR-152	Kavre	Core collection	
NPGR-05435		Non-core collection	
LRGR-7	Dadeldhura	Non-core collection	
NPGR-06725	Humla	Non-core collection	
LRGR-55	Baitadi	Non-core collection	
LRGR-30	Bajura		
LRGR-8	Dadeldhura	Non-core collection	
LRGR-3	Dadeldhura	Non-core collection	
LRGR-79	Dang	Non-core collection	
NPGR-00014	Nuwakot	Non-core collection	
FOSRIN-06	Kathmandu	Non-core collection	
NPGR-00183	Kavre	Non-core collection	
FOSRIN-02	Dailekh	Non-core collection	
LRGR-90	Dang	Non-core collection	
LRGR-132	Gulmi	Non-core collection	
NPGR-00091	Dang	Non-core collection	
NPGR-00088	Pyuthan	Non-core collection	
NPGR-00188	Kavre	Non-core collection	
NPGR-05395		Non-core collection	
NPGR-05367	Bhojpur	Non-core collection	Included in OBN in 2008
NPGR-05424	Dhankuta	Non-core collection	Included in OBN in 2008
LRGR-133	Palpa	Non-core collection	Included in OBN in 2008
NPGR-00199	Kabhre	Non-core collection	
LRGR-148	Kavre	Non-core collection	
NPGR-05404	Illam	Non-core collection	
NPGR-00074	Arghakhanchi	Non-core collection	
LRGR-151	Kavre	Non-core collection	
LRGR-123	Palpa	Non-core collection	Included in OBN in 2008
NPGR-05380	Lamjung	Non-core collection	
LRGR-118	Gulmi	Non-core collection	
NPGR-05383	Tanahun	Non-core collection	
NPGR-05398	Illam	Non-core collection	
NPGR-05372	Gorkha	Non-core collection	Included in OBN in 2008
NPGR-05399	Illam	Non-core collection	
LRGR-146	Kaski	Non-core collection	

Accession	Collection districts	Source	Remarks
NPGR-05409	Illam	Non-core collection	
NPGR-05401	Illam	Non-core collection	
LRGR-73	Pyuthan	Non-core collection	
LRGR-145	Kaski	Non-core collection	
NPGR-05410	Dhankuta	Non-core collection	
LRGR-159	Kaski	Non-core collection	
LRGR-135	Palpa	Non-core collection	
Adzuki bean	Bangor	Optimization/polymorphic marker analysis	Dr P A Hollington provided
Ricebean bold seeded	Illam	Optimization/polymorphic marker analysis	Dr P Anderson collected

Results

Analysis of molecular marker diversity in ricebean accessions

Thirteen SSR primers out of 35 screened and found to have a high polymorphic index were tested on 91 test samples of ricebean measuring the extent of genetic diversity (Table 2.3.2). The diversity indices calculated based on the allelic data showed a range of genetic variation among the samples and they are summarized in Tables 2.3.3 and 2.3.4. A total of 30 alleles (bands) were revealed for 13 primers and all except CEDG134 (92 % PPL) were polymorphic with an average of 2.4 bands per polymorphic locus. CEDG195 exhibited the highest 4 alleles per polymorphic locus, while the rest showed 2 to 3 alleles (Table 2.3.4). Similarly, the average number of alleles per locus was 2.3 for test samples and 1.4 for the check samples in the study. The percentage of polymorphism as PIC ranged from 7 % (CEDG294) to a maximum of 63 % (CEDG073 and CEDG044), with an average of 33%. Likewise the Shannon diversity index value was highest (1.24) in CEDG073 and least (0.15) in CEDG253, with an average of 0.61 for the test samples (Table 2.3.4).

All these polymorphic loci contained the AG repeats except the CEDAAG002 with AAG repeats and CEDG044 with GT(AT)AG repeats. These polymorphic primers belonged to the linkage groups of 1, 2, 3, 6, 8, 10 and 11 of the ricebean genome. These primers thus explained the variation at DNA level among tested ricebean genotypes and also between adzuki bean and ricebean. This analysis is on-going for diversity assay with the rest of polymorphic primers detected.

Table 2.3.3: Summary of SSR Diversity values calculated for ricebean accessions and all samples

Diversity parameters	Ricebeans	Checks
Number of accessions consisted	91	3
Number of SSR primers screened	13	13
Number of primers amplified	13	13
Number of monomorphic primers	1	3
Number of polymorphic primers	12	10
Percent of polymorphic primers	92	78
Total number of alleles (bands) observed	30	18
Number of alleles /primer	2.3	1.4
Total number of polymorphic alleles (bands)	29	15
Number of alleles/polymorphic primer	2.4	1.5
Percent of polymorphic alleles (bands)	97	83
Polymorphic information content (PIC)	0.33	0.15
Shannon index (SW)	0.61	0.29

Table 2.3.4: PIC and Shannon indices of 13 polymorphic adzuki bean SSR primers calculated for 91 ricebean samples

Primers	Linkage	Alleles (bands)	PIC values	Shannon index
CEDAAG002		2	0.36	0.63
CEDG015	1	2	0.30	0.56
CEDG073	8	3	0.62	1.24
CEDG286	2	2	0.15	0.28
CEDG294	3	2	0.07	0.16
CEDG232	9	2	0.47	0.66
CEDG253	8	2	0.07	0.15
CEDG044	11	3	0.63	1.15
CEDG178	1	2	0.54	0.88
CEDG037	6	3	0.28	0.56
CEDG195	6	4	0.59	1.00
CEDG134	10	1	0.00	0.00
CEDG050	2	2	0.18	0.33

2.4 Workpackage 4: Germplasm characterization and adaptation

2.4.1 Project objectives and major achievements during the reporting period

Gramin Vikas Trust (GVT, Partner 4) leads WP4: **To characterise the germplasm for phenological traits and suitability for a range of diverse environments and cropping systems**. Assam Agricultural University (AAU, Partner 6) and Chaudhary Sarwan Kumar Krishi Vishwavidyalaya**,** Palampur, Himachal Pradesh (CSKHPAU, Partner 5) are the other two participants in WP 4 in India, with NARC (Part 7) and Local Initiatives for Biodiversity, Research and Development (LI-BIRD, Partner 8) in Nepal. The work package has the following objectives:

- To characterise ricebean germplasm using participatory approaches and identify that best meet farmers' needs in terms of morphology, flowering time and grain quality traits in Nepal and India.
- To analyse and understand farmers preferred traits for ricebean in India and Nepal
- To test selected accessions in Mother and Baby trials.

Various activities conducted in this work package have been summarized in Table 2.4.1.

Table 2.4.1. Summary of objectives and work performed during reporting period

Objectives	Worked performed	Deliverables
4.1 Identify a set of accessions that best meet farmers' needs in terms of morphology, flowering time and grain quality traits.	Accessions from different agro-ecological places in India by partners were collected and evaluated during *Kharif (summer)* 2008 (rainy season).	Sufficient seed samples of lines which have set seeds are available for further germplasm evaluation.
4.2 Test selected accessions in Mother and Baby trials.	Promising landraces have been identified and evaluated in *Kharif* 2008 at farmer's field through mother and baby trials and phenology. Yield and yield components related data was collected.	Mother and baby trials have been conducted as per protocol developed for mother and baby trials. Seeds of all the promising entries are available for mother and baby trials for the next year.
4.4 Analyze data across locations years.	Data of mother and baby trials have been recorded location wise and have been sent for analysis to CAZS-NR as per statistical methodology applicable.	Quantitative and qualitative data of mother and baby trials are being analysed.

2.4.2. Summary of work in years 1 and 2

In the first year, farmer-preferred trait analysis was carried out in both India and Nepal, in the same districts as the germplasm collection in WP2 and using focus-group discussions with mixed groups of between 10 and 20 male and female farmers. Standard protocols developed by the project partners were used to collect the data, and included the assessment of organoleptic traits such as taste and cooking quality. Attempts have been made to exchange germplasm between the two countries, but this has so far not proved possible. Of the collected and evaluated germplasm in WP2, the most promising accessions that meet farmers' requirements have been identified for sowing in mother and baby trials in 2007.

Ricebean did not compare well with other locally-grown legumes: out of eight crops, farmers in both Nepal and India preferred black gram (*Vigna mungo*) and kidney bean (*Phaseolus vulgaris*), with ricebean placed seventh, ahead of only lentil (*Lens culinaris*).

All parts of the crop were used, for a range of purposes including *dal* (soup), as a fresh vegetable and snack, as a livestock forage and as a green manure. Food was the most important use, followed by fodder production and green manuring. Positive and negative traits were identified for the various uses in both countries. Large-seeded determinate and synchronous varieties were preferred for food production, and late-maturing indeterminate types with soft palatable herbage for fodder and green manure. Early maturing varieties were not favoured as their maturity coincided with the peak rainy season, and they also had low yields and small grains. Pest and disease resistance, and suitability for intercropping or mixed cropping were regarded as less important, as was tolerance to high rainfall during flowering.

Overall, in Nepal preference was given to the landrace *Seto Thulo* (white bold [large]) while in India the three preferred types were all bold-seeded. It was felt important for any breeding work to include organoleptic traits.

In 2008, the 103 germplasm lines collected in 2006 were evaluated in *Kharif* 2007 (rainy season) for their quantitative characters by all the Indian partners at their respective locations. The germplasm lines were evaluated and characterized under farmer's field situation for isolation of the promising lines suitable for cultivation in the region. 54 more lines were collected from different areas of the country during *rabi* (winter) season of 2007/08 from the stores of farmers in their households.

Mother and baby trials were conducted on a large scale in the project area. The data on yield and yield attributes were recorded and analysed. Matrix ranking was done in mother trials on the basis of farmers' preferences, while in the baby trials farmers' preference were also recorded. Most farmers preferred short duration and bold seeded varieties of ricebean. The baby trials revealed that farmers have a clear preference for bold seeded varieties with determinate growth, early to medium maturity, tolerant to drought and low shattering giving more grain yield and a plant type suited for growing as an inter or mixed crop with maize, sorghum or on terrace risers. However, getting some of the organoleptic traits of the most preferred existing landraces will probably help strengthen the role of ricebean in the farming systems.

An attempt was made to assess the performance of ricebean planted during winter season in the hilly tract of Jhabua region as well as in eastern Gujarat. The germination and plant population was good at all the locations but due to low temperature only vegetative growth was seen, no fruit set was observed. An experiment on seed priming of ricebean was also conducted at CSKHPAU Palampur.

2.4.3 Workpackage progress of the period

Mother trials

As per protocol, mother trials were conducted on a large scale by all the partners in their respective project areas. Each trial contained six entries, as detailed in Table 2.4.2.

Table 2.4.2: Experimental material used in the mother trials in India

Genotype	Source of seed	Locations included in mother trials
PRR-1	Uttarakhand	MP, Assam, HP
PRR-2	Uttarakhand	MP, Assam, HP
RBL-6	Punjab	MP, Assam, HP
JR-1	GVT	MP, Assam

JCR-08-49	Assam	MP, Assam
JCR-08-50	Assam	MP, Assam
RBHP- 6	Himachal Pradesh	HP
RBHP- 38	Himachal Pradesh	HP
RBHP- 42	Himachal Pradesh	HP

In western Madhya Pradesh (MP), 22 mother trials were conducted during *Kharif* (rainy season) by GVT in Jhabua, Alirazpur, Barwani and Dahod. In Assam, eighteen mother trials were conducted at Danichapori and Rongkangthir. In Himachal Pradesh, 15 mother trials were conducted in Trilokpur, Ladruhin, and Ghar. The trials were sown in plots of 2.7m x 4 m, with 4 meter row length and row spacing of 45 cm. Each farmer was treated as one replication. The trials successfully harvested are shown in Table 2.4.3. One mother trial of grain and one of fodder with three replications was also conducted on the experimental farm of CSK HPAU.

Table 2.4.3: Details of successful mother trials in India

	Farmers' name	Village	Location	Date of Sowing
GVT				
1	Pema Habsingh	Kallipura	Jhabua	12 July
2	Mansingh Chiniya	Bhagor	Jhabua	18 July
3	Madiya Roopsingh	Bhagor	Jhabua	10 July
4	Ramesh Bhuriya	Chichlana	Alirajpuir	21 July
5	Gyansingh	Chichlana	Alirajpuir	21 July
6	Roomsingh/ Najru	Chichlana	Alirajpuir	22 July
7	Sridhar /Pratap	Chichlana	Alirajpur	23 July
8	Kalu /Bhura Goyal	Chichlana	Alirajpuir	29 July
9	Pratap Badiya	Shegaon	Barwani	25 July
10	Mehatab Singh	Shegaon	Barwani	25 July
11	Omkar Ratan	Sakad	Barwani	23 July
12	Mohan Loniya	Chapari	Barwani	24 July
13	Ponam Chandra Patel	Badgawan	Barwani	22 July
14	Kashiram Mangilal	Vedpuri	Barwani	06 July
15	Ter singh/ Naika Tomar	Javania	Katthiwada	03 July
16	Hatiya/ Bhukaniya	Javania	Katthiwada	03 July
17	Jamsingh /Chagan singh	Javania	Katthiwada	04 July
18	Harlia / Vesta	Javania	Katthiwada	04 July
19	Kalu / Somji	Sarmaria	Limdi	12 July
20	Galia / Manna	Sarmaria	Limdi	12 July
21	Babu / Jaitha	Sarmaria	Limdi	08 July
22	Subhash / Ramesh	Karambha	Limdi	14 July
Assam				
1	Naren Tide	Danichapori	Dergaon	23 July
2	Bilawar Tide	Danichapori	Dergaon	23 July
3	Bhugeswar Pegu	Danichapori	Dergaon	23 July
4	Bubu Chaliha	Kasari Gaon	Dergaon	23 July
5	Bulbul Modoi	Kasari Gaon	Dergaon	23 July
6	Baneswar Pegu	Danichapori	Dergaon	23 July
7	Pulin Chaliha	Kasari Gaon	Dergaon	23 July
8	Ranjan Pegu	Danichapori	Dergaon	26 July
9	Chandra Kanta Pegu	Danichapori	Dergaon	26 July
10	Rupsing Teron	Rongkangthir	Diphu	25 July
11	Samson Rongpi	Rongkangthir	Diphu	25 July
12	Khoya Teron	Rongkangthir	Diphu	25 July
13	Horen Engtti	Rongkangthir	Diphu	25 July
14	Bikram Teron	Rongkangthir	Diphu	25 July
15	Junaki Teronpi	Rongkangthir	Diphu	25 July
16	Monglan Sing Teron	Rongkangthir	Diphu	27 July
17	Manoj Teron	Rongkangthir	Diphu	27 July
18	LorenTeron	Rongkangthir	Diphu	27 July
Palampur				

	Farmers' name	Village	Location	Date of Sowing
1	Sh Jagroop Singh Sepahiya	Trilokpur	Trilokpur	24 June
2	Sh Dharam Singh Sepahiya	Trilokpur	Trilokpur	24 June
3	Sh Rajeev Singh	Trilokpur	Trilokpur	24 June
4	Sh Daljeet Singh	Trilokpur	Trilokpur	24 June
5	Sh Sita Ram Sharma	Trilokpur	Trilokpur	24 June
6	Sh. Kalyan Chand	Ladruhin	Jogindernagar	09 June
7	Sh. Birwal Rana	Ladruhin	Jogindernagar	10 June
8	Sh. Charanji Ram	Ladruhin	Jogindernagar	10 June
9	Smt. Kamla Devi	Ladruhin	Jogindernagar	10 June
10	Sh. Sher Singh	Ladruhin	Jogindernagar	10 June
11	Smt. Anjana Rana	Ladruhin	Jogindernagar	10 June
12	Smt. Anita	Ladruhin	Jogindernagar	10 June
13	Sh. Joginder Singh	Ladruhin	Jogindernagar	09 June
14	Sh. Bikram Dass	Ghar	Panchrukhi	29 June
15	Sh. Bisho Ram	Ghar	Panchrukhi	29June

In Nepal, a total of 12 mother trials were conducted in Gulmi, Tanahun and Sindhuli districts (Table 2.4.4). The twelve best performing ricebean accessions were selected for these, but due to the lack of seed of 2 (NPGR 00048 and NPGR 06756), 2 other accessions (LRGR 42 and LRGR 75) were used in Tanahun and Sindhuli.

Table 2.4.4. Ricebean mother trials conducted by NARC in Nepal in 2008

District	Address	Number of trials
Gulmi	Darbar Devisthan VDC	3
Gulmi	Simichaur VDC	3
Tanahun	Dulegauda VDC	1
Tanahun	Purkot VDC	2
Sindhuli	Ratanchura VDC	3
Total		**12**

Intercropping with maize was followed in trials, which were of 4 2-metre rows with spacing of 75 cm x 50 cm for both maize and ricebean (Appendix 1). Sixteen plants per plot per accession were maintained in each trial, and evaluated for height, pods, pod length, days to maturity, grain yield, seeds per pod, 100 seed weight etc.

At NARC, the 10-12 best performing genotypes from the agro-morphological characterisation of the core collections across sites in 2007 (Table 2.4.5) were evaluated. Five sets were sown in field plots intercropped with maize (on-farms/stations) in different environments from lowland to mid-hills. The details of field plots, methodology and observations undertaken and the sites of experiment are given in Annex I. The plots were managed according to customary farmers' practices, and therefore neither fertilizer nor irrigation was applied.

Table 2.4.5: Details of accessions in mother trials with NARC, 2008

Accession No	Districts	Best performed in respective study sites
NPGR 00008	Nuwakot	Rampur and Kabre stations
NPGR 00015	Bhaktapur	Rampur and Khumaltar stations
NPGR 00076	Arghakhanchi	Kabre and Khumaltar stations
NPGR 00194	Dolakha	Kabre and Khumaltar stations
NPGR 05364	Bhojpur	Rampur station
NPGR 05420	Dhankuta	Khumaltar station
NPGR 06756	Humla	Poor in yield but included for determinate type
LRGR 91	Dang	Kabre station
LRGR 99	Palpa	Rampur and Khumaltar stations
LRGR 111	Gulmi	Kabre station

LRGR 103	Palpa
LRGR 117	Gulmi

Preliminary crossing work

Two determinate (NPGR 07882 and NPGR 09391) and two indeterminate accessions (LRGR 91 and LRGR 111) were selected by NARC on the basis of last year's field performances with the objective to develop the genotype with determinate, busy plant type with synchronous maturing and high yield. This was carried out in Rampur and Khumaltar and reciprocal crossing among these accessions were performed. The plants were planted in raised bed in Khumaltar on 5th August, 2008 and netted to control unwanted crossing whereas in Rampur there were two crossing blocks, one sown in June and the other in August. Emasculation was done in morning and pollination in afternoon.

Hardseededness in ricebean germplasm:

50 accessions from the core collection were evaluated by NARC for hard seeds on fresh seeds produced in Khumaltar in 2007. These comprised NPGR and LRGR collections from 35 districts of Nepal. One hundred seeds of each accession were soaked in water overnight and then plated 25 seeds each in 4 replications in between moistened germination papers at room temperature and observed for sprout seeds and hard seeds (seeds not absorbing water).

Seed multiplication

Seeds of 10 accessions from the mother trial at NARC were increased for scaling up. The seed production was carried in research farms in small plots under sole cropping system (Annex I). Community based seed production (CBSP) was also initiated by LI-BIRD, including various other activities for dissemination of information on ricebean.

Winter adaptation trials

Ricebean is a summer legume and the traditional practice to sow ricebean seeds is during July. However, experiences from several field visits and knowledge shared among different people and FOSRIN developed the idea of ricebean cultivation during the winter (Rabi) season. A trial was designed to test the adaptation of ricebean during winter. In Nepal, trials were conducted by LI-BIRD in the *Terai* (Table 2.4.6) in Dang and Jhapa districts, using six accessions where ricebean was intercropped with maize. NARC also tested 212 accessions intercropped with maize in lowland conditions at Rampur, planted in April, 2008. In Assam, *rabi* ricebean was tested in Assam, where 38 entries were sown.

Table 2.4.6. Details of the accessions selected for winter adaptation trials by LI-BIRD

Accession	Source district
NPGR 00012	Nuwakot
NPGR 00194	Kavre
NPGR 05420	Dhankuta
LRGR 103	Palpa
LRGR 111	Gulmi
LRGR 117	Gulmi

The plot size of the trials with LI-BIRD was 2 m^2 and spacing was maintained at 50 x 25 cm (Appendix 3). Ricebean seeds were sown on 28 and 29 November in Jhapa district whereas seeds were sown on 28 November in Dang district with 2 seeds per hill.

Effect of seed priming of rice bean in maize + rice bean intercropping system

Ten treatment combinations were tested on the experimental farm of CSK Himachal Pradesh Agricultural University, Palampur in a randomized block design with three replicates during Kharif (summer) 2008. Each treatment comprised 6 rows of 4 m length with row to row spacing of maize 60 cm. The plant to plant spacing of ricebean was 15 cm, and of maize 20 cm. The objective was to assess the effect of priming with small amounts of phosphate on ricebean emergence and yield in various systems, with or without the application of P fertilizer. Priming with phosphate has been suggested as a way of overcoming soil P deficiencies that is cheaper and more convenient than the application of phosphatic fertilizer to the soil. Results

Mother trials

Table 2.4.7. Mean data of mother trials conducted during *Kharif* 2008 (GVT)

Observation/Variety	PRR-1	PRR-2	RBL-6	JR-1	JCR-08-49	JCR-08-50
Seedling vigour (S,M,F)	F	F	F	F	M	M
Days to 50% flowering	56	54	54	61	97	*
Plant growth habit (E, SE, T)	T	T	T	T	SE	SE
Number of pods per plant	27.3	26.9	26.8	27.9	26.8	*
Days to maturity	91	86	98	125	145	*
Pod length (cm)	4.16	4.29	4.19	4.53	4.19	*
Number of seeds per pod	4.36	4.27	4.49	4.59	4.24	*
100 seed weight (g)	4.81	5.27	4.73	4.56	6.47	*
Plant height (cm)	93.65	102	104.6	116.9	135.8	*
Grain Yield (t/ha)	0.20	0.18	0.17	0.21	0.14	*

[1]M=Medium, S=Slow, F=Fast; [2]E=Erect, SE=semi erect, T= trailing

At GVT, JR-1 had the highest yield (0.21 t ha^{-1}) followed by PRR-1 (0.20 t/ha), PRR-2 (0.18 t/ha) and RBL-6 (0.17 t/ha) (Table 2.4.7). RBL-6, PRR-1 and PRR-2 were also earliest to flower (54, 56 and 54 days respectively) and to mature (98, 91 and 86 days) respectively. JR-1 had more pods per plant. JCR-08-49 had the highest 100-seed weight (6.47 g). Four lines (JR-1, RBL-6, PRR-1 and PRR-2) were of a trailing type, and two (JCR-08-49 and JCR-08-50) were semi-erect. All entries showed indeterminate maturity except JCR-08-50 which did not flower

Table 2.4.8: Mean data of matrix ranking of mother trials during *Kharif* 2008 (GVT)

Characters	PRR-1	PRR-2	RBL-6	JR-1	JCR-08-49	JCR-08-50
Seedling vigour	4	4	4	5	5	5
Days to 50% flowering	5	5	5	5	4	2
Plant growth habit	5	4	5	5	5	3
Number of pods per plant	5	5	5	6	4	-
Days to maturity	5	6	4	4	4	-
Type of maturity	6	5	5	5	5	-
Pod length	5	6	5	6	5	-
Number of seeds per pod	5	5	6	6	5	-
Seed size	5	5	5	6	6	-
Grain yield	6	6	5	5	5	-
Dry straw yield	-	-	-	-	-	-
Total	**51**	**51**	**49**	**53**	**48**	**10**

Table 2.4.8 shows matrix rankings from farmer evaluations of the trials. Overall, JR-1, PRR-1 and PRR-2 were preferred by farmers over the other genotypes due to their early maturity.

In the Mother trials in Assam (Table 2.4.9), highest yield was from JCR-08-49 followed by JCR-08-50 and JR-1. Yield attributing characters were also higher in these entries. JR-1 was the latest to mature, while PRR-1, RBL-6 and PRR-2 matured early. Highest 100 seed weight was also

found in JCR-08-50. The mean data for matrix ranking (Table 2.4.10) indicated that farmers had a preference for JCR-08-49.

Table 2.4.9 Mean data of mother trials conducted during *Kharif* 2008 (Assam)

Observation	Entry					
	PRR-1	**JCR-08-49**	**JR-1**	**JCR-08-50**	**PRR-2**	**RBL-6**
Seedling vigour (S,M,F)	M	F	M	F	M	M
Days to 50% flowering	47	92	108	93	47	49
Plant growth habit (E,SE,T)	T	SE	T	SE	T	T
Number of pods per plant	85-110	185-265	100-160	120-250	85-150	85-115
Days to maturity	113	135	159	136	112	112
Type of maturity (S,C)	C	C	C	C	C	C
Pod length (cm)	10	10.5	8	10.5	9	10
Number of seeds per pod	10	9	12	9	9	10
100 seed weight (g)	5.8	14	7.5	16	6.8	7.5
Plant height (cm)	130	350	285	300	124	132
Grain Yield (t/ha)	0.77	1.37	0.90	1.36	0.75	0.80

*M=Medium, S=Slow, F=Fast, C=Continuous, Synchronized, E=Erect, SE=semi erect, T= trailing

Table 2.4.10 Mean data of matrix ranking of mother trials during *Kharif* 2008 (Assam)

Characters	Entry					
	PRR-1	**JCR-08-49**	**JR-1**	**JCR-08-50**	**PRR-2**	**RBL-6**
Seedling vigour	4	5	3	5	4	4
Days to 50% flowering	4	3	2	3	4	4
Plant growth habit	3	4	3	4	3	3
Number of pods per plant	2	3	4	3	2	2
Days to maturity	4	3	2	3	4	4
Type of maturity	4	3	2	3	4	4
Pod length	3	4	3	4	2	2
Number of seeds per pod	4	3	4	3	3	4
Seed size	3	4	3	4	3	3
Grain Yield	2	5	3	4	2	3
Dry straw yield	-	-	-	-	-	-
Total	**33**	**37**	**29**	**36**	**31**	**33**

In Himachal Pradesh, RBL-6 (0.82 t/ha) was the highest yielder followed by PRR-1, PRR-2 and RBHP-6. PRR-2 was quickest to 50% flowering, followed by PRR-1. The tallest plants were produced by the line PRR-2. The mean performance of the six genotypes in Trilokpur, Ladruhin and Ghar is shown in Table 2.4.11.

Table 2.4.11: Mean performance of mother trials during *Kharif* 2008 (CSK HPAU)

Entries	Plant Height (cm)				Grain yield (t ha^{-1})				Days to 50% flowering			
	L-I	**L-II**	**L-III**	**Mean**	**L-I**	**L-II**	**L-III**	**Mean**	**L-I**	**L-II**	**L-III**	**Mean**
RBL-6	116.2	98.6	100.4	105.1	0.94	0.56	0.96	0.82	96	103	103	100
PRR-1	115.4	95.5	106.1	105.7	0.78	0.52	0.81	0.70	92	100	102	98
PRR-2	125.6	111.6	98.6	111.9	0.72	0.58	0.78	0.69	90	101	101	97
RBHP-6	106.0	98.8	95.8	100.2	0.55	0.39	0.41	0.45	94	100	101	98
RBHP-38	113.0	98.6	101.8	104.5	0.60	0.39	0.62	0.54	95	101	102	99
RBHP-42	107.6	102.6	96.8	102.3	0.61	0.44	0.67	0.57	95	99	103	99

L-I=Trilokpur, L-II= Ladruhin L-III= Ghar.

Table 2.4.11: Mean data of matrix ranking of mother trials during *Kharif (Summer)* 2008 (CSK HPAU)

Characters	RBL-6	PRR-1	PRR-2	RBHP-6	RBHP-38	RBHP-42
Seedling vigour	5	4	4	6	6	5
Days to 50% flowering	3	6	6	5	5	4
Plant growth habit	3	6	5	6	5	4
Number of pods per plant	6	5	4	2	3	4
Days to maturity	4	5	6	5	4	4
Type of maturity	4	5	6	4	5	4
Pod length	6	5	5	3	4	6
Number of seeds per pod	6	4	5	4	5	5
Seed size	5	4	4	4	5	3
Grain Yield	6	5	4	2	3	3
Dry straw yield	4	4	6	5	5	4
Total	**52**	**53**	**55**	**46**	**50**	**46**

PRR-2, PRR-1 and RBL-6 were liked by the farmers compared to RBHP-6, RBHP-38 and RBHP-42. Of the local genotypes, PRR-2 was preferred, particularly for its better yield, earliness and other yield attributes (Table 2.4.11).

Mother Trial at experimental farm of CSK HPAU

The six entries were evaluated for grain and fodder purpose in a randomized block design with three replications at the experimental farm of CSK Himachal Pradesh Agricultural University, Palampur. Mean performance for grain production is shown in Table 2.4.12. The variation in plant height, dry biomass, pods/plant, pod length, seeds per pod and seed yield was not significant.

Table 2.4.12: Mean performance of mother trial for grain at experimental field of CSK HPAU during *Kharif (summer)* 2008

Entries	Plant height (cm)	Dry biomass /plant (kg)	Days to 50% flowering	Pods / plant	Pod length	Seeds / pod	Seed yield (t/ha)
RBL-6	88.1	0.06	100	96.7	7.99	6	0.78
PRR-1	86.0	0.08	97	98.5	8.17	7	0.74
PRR-2	111.3	0.07	98	108.7	8.16	7	0.76
RBHP-6	88.6	0.08	99	93.3	7.72	6	0.72
RBHP-38	85.5	0.07	98	95.3	8.20	7	0.78
RBHP-42	78.1	0.07	98	109.0	8.11	7	0.76
Mean	**89.6**	**0.07**	**98**	**100.3**	**8.06**	**6.67**	**0.76**
CD (5%)	NS	NS	NS	NS	NS	NS	NS

The same set of six entries from the mother trial were also tested for fodder production at the CSKHPKV university farm (Table 2.4.13). Entry RBHP-38 produced the highest fodder yield, followed by PRR-1 and RBHP-6, and RBL-6 produced the last.

Table 2.4.13. Mean performance of mother trial for fodder at CSK HPAU

Entries	Green fodder yield (t/ha)
RBL- 6	23
PRR - 1	34
PRR- 2	26
RBHP- 6	34
RBHP- 38	35
RBHP- 42	31
CD 5%	4

Nepal

Table 2.4.14. Mean results of agronomic traits in mother trials, Tanahun, 2008

Genotype	DE (days)	50 % FL (days)	Height (cm)	PL (cm)	DM (days)	Pods/P	Seed/P	Hundred grain weight (g)	Yield (kg/ha)
LRGR 42	5.0	130	263	10.40	171	79.0	7.35	12.57	878
NPGR 00015	5.7	123	271	9.31	159	131.9	8.08	10.27	934
NPGR 00076	5.3	122	268	8.41	159	244.5	7.89	6.07	1555
NPGR 00194	5.3	124	262	8.82	167	100.8	7.89	9.93	739
NPGR 05364	5.3	129	218	8.45	168	147.3	8.00	7.77	1328
NPGR 05420	5.3	123	195	8.77	164	99.4	7.05	11.23	705
LRGR 75	5.3	125	249	8.37	161	155.0	8.24	7.00	955
LRGR 91	5.7	128	253	8.57	167	105.9	7.61	8.60	785
LRGR 99	5.7	125	272	7.80	161	111.1	7.51	6.07	799
LRGR 103	5.3	128	264	9.26	169	94.8	7.89	9.93	1146
LRGR 111	5.3	124	281	8.03	162	151.5	7.48	8.87	1116
LRGR 117	5.3	127	274	8.54	162	186.9	8.00	7.37	1091
Mean	5.4	126	256	8.73	164	134.0	7.75	7.75	1003
Probability	ns	*	*	**	ns	*	ns	**	ns
LSD	-	4.7	46.3	0.477	-	75.32	-	1.71	-

† DE=days to emergence, 50% FL=days to 50% flowering, PH=plant height, PL=pod length, DM=days to maturity, Pods/P=pods per plant, Seed/P=seeds per pod

There were 3 mother trials conducted in Tanahun district in 2008 season (Table 2.4.14). They varied significantly for days to 50% flowering, height, pod length, pods/plant and hundred grain weight. LRGR 42 (130 days) was latest to flower, while NPGR 00076 (122 days) was earliest. LRGR 111 (289.9 cm) was tallest, and NPGR 05420 (194.5 cm) shortest. Pod length of LRGR 42 (10.4 cm) was longest, and NPGR 00076 (244.5) had the highest number of pods per plant. Hundred grain weight of LRGR 42 (12.57 gm) was the highest followed by NPGR 00015 (10.27 gm). Although the genotypes evaluated did not display significant variation in yield, NPGR 00076 (1555 kg/ha) and NPGR 05364 (1328 kg/ha) appeared superior followed LRGR 103 (1146 kg/ha), LRGR 111 (1116 kg/ha) and LRGR 117 (1091 kg/ha).

In Darbar Devisthan VDC, 3 mother trials were conducted (Table 2.4.15). There were significant differences for 50% flowering and hundred grain weight. NPGR 00048 (107 days) was the earliest and NPGR 05364 (111 days) was the latest to flower, while NPGR 00015 (11.7 gm) had the highest hundred grain weight. Mean yield indicated NPGR 06756 (1494 kg/ha) and NPGR 05364 (1140 kg/ha) were better, and LRGR 91 (939 kg/ha), NPGR 00015 (907 kg/ha) and NPGR 99 (848 kg/ha) also showed promise I terms of yield.

Table 2.4.15. Mean results for agronomic traits in mother trials, Darbar Devisthan VDC, Gulmi, 2008

Genotype	50% flowering (days)	Height (cm)	Pods	Days to maturity	Pod length (cm)	Seeds per pod	100 grain weight (gm)	Yield (kg/ha)
NPGR 00048	107.3	181.0	65.4	161.7	9.57	9.40	10.33	326
NPGR 00015	108.0	189.7	81.5	157.7	9.10	8.53	11.67	907
NPGR 00076	108.3	171.7	79.1	158.3	9.23	8.07	11.33	737
NPGR 00194	109.0	221.3	101.0	161.0	9.97	8.67	11.00	830
NPGR 05364	111.0	219.0	138.9	161.0	9.23	8.67	7.67	1140
NPGR 05420	109.0	206.7	107.2	159.3	9.83	8.13	11.00	895
NPGR 06756	107.0	225.3	140.7	157.0	9.90	9.00	10.33	1494
LRGR 91	108.3	180.0	106.3	161.0	9.73	7.53	10.33	939
LRGR 99	110.7	157.7	105.7	160.0	8.53	7.20	8.33	848
LRGR 103	110.3	172.7	91.0	160.0	9.07	9.13	9.67	631
LRGR 111	108.7	187.0	93.7	161.0	9.57	9.00	8.67	428
LRGR 117	110.7	173.7	66.1	165.0	8.97	8.30	9.00	571
GM	109.0	190.5	98.0	160.25	9.39	8.47	9.94	812.
F test	*	ns	ns	ns	ns	ns	*	ns
LSD	2.19	-	-	-	-	-	1.903	-

† 50% FL=days to 50% flowering, PH=plant height, PL=pod length, DM=days to maturity, Pods/P=pods per plant, Seed/P=seeds per pod, HGW=hundred grain weight, Y=yield

Table 2.4.16. Mean results of agronomic traits in mother trials, Simichaur VDC, Gulmi, 2008

Genotype	Days to emergence	50% flowering (days)	Height (cm)	Pod length (cm)	100 grain weight (g)	Yield (kg)/ha)
NPGR 00008	7.00	126	175.3	8.600	11.67	800
NPGR 00015	7.00	127	225.0	9.267	12.00	986
NPGR 00076	7.67	125	194.3	8.467	9.67	857
NPGR 00194	7.00	127.	204.0	8.200	14.33	565
NPGR 05364	7.00	126.67	202.3	9.533	11.67	786
NPGR 05420	7.00	125.33	204.4	9.600	16.33	684
NPGR 06756	7.00	133.00	211.7	9.600	16.33	570
LRGR 91	7.33	132.33	182.3	8.333	12.00	675
LRGR 99	8.00	129.67	203.3	8.300	12.00	438
LRGR 103	8.00	130.67	205.3	9.200	12.00	519
LRGR 111	7.00	132.67	210.9	8.733	10.67	815
LRGR 117	6.67	131.67	182.3	8.600	11.00	772
GM	7.22	128.94	200.1	8.869	12.47	705
F test	*	*	ns	*	*	ns
LSD	0.686	5.719	-	0.735	3.146	-

†DE=days to emergence, 50% FL=days to 50% flowering, PH=plant height, PL=pod length, HGW=hundred grain weight, Y=yield

Three mother trials were conducted in Simichaur VDC, Gulmi district (Table 2.4.16). There was significant variation for days to emergence, 50% flowering, pod length and hundred grain weight. NPGR 00076 (125 days) was earliest and NPGR 06756 (133 days) was latest to flower. Longest pods were exhibited by NPGR 05420 (9.6 cm) and NPGR 06756 (9.6 cm). Correspondingly, highest hundred grain weight was also shown by 05420 (16.33 gm) and NPGR 06756 (16.33 gm) followed by NPGR 00194 (14.33 gm). In terms of grain yield NPGR 00015 (986 kg/ha), 00076 (857 kg/ha), LRGR 111 (815 kg/ha), NPGR 00008 (800 kg/ha), NPGR 05364 (786 kg/ha) and LRGR 117 (772 kg/ha) appeared to be more promising.

In Sindhuli evaluation was based on seed size and colour, as the trial was damaged by monkeys during maturity period. The bold seeded NPGR 00015 and LRGR 42 were preferred by farmers. The farmers also liked the maroon colour of LRGR 111 (Table 2.4.17).

Table 2.4.17. Mean results of agronomic traits in mother trials, Sindhuli, 2008

Genotype	Days to emergence	50% flowering (days)	Height (cm)	100 grain weight (g)	Pod length (cm)	Seeds per pod
LRGR 42	6.00	125.5	198.6	14.40	9.90	5.05
NPGR 00015	6.00	119.5	140.0	11.05	8.40	5.75
NPGR 000 76	6.00	123.0	100.3	7.85	6.70	5.90
NPGR 00194	6.00	117.0	108.9	10.45	5.95	4.50
NPGR 05364	6.00	122.5	68.2	8.05	6.60	5.00
NPGR 5420	6.00	122.0	109.4	9.74	8.10	5.20
LRGR 75	6.00	123.0	141.5	8.49	7.70	5.30
LRGR 91	6.00	128.0	132.9	11.95	7.90	3.90
LRGR 99	6.00	128.0	124.5	7.75	5.90	6.60
LRGR 103	6.00	111.0	147.1	11.80	7.90	5.20
LRGR 117	6.00	111.5	157.1	10.60	8.00	5.40
LRGR 111	6.00	111.0	173.9	9.50	6.70	7.50
GM	6.00	120.2	133.5	10.14	7.48	5.44
F test	ns	ns	ns	ns	ns	ns
LSD	-	-	-	-	-	-

†DE=days to emergence, 50% FL=days to 50% flowering, PH=plant height, PL=pod length, HGW=hundred grain weight, Seed/P=seeds per pod

While comparing the yield performance of genotypes in mother trials in Darbar Devisthan and Simichaur VDCs, NPGR 06756, NPGR 05364, NPGR 00015 and NPGR 91 had better performance across the 2 sites (Table 2.4.18). Similarly, looking at the hundred grain weight of the seeds of all 12 accessions in the mother trials, almost all the accessions (except NPGR 00076) exhibited boldness.

Table 2.4.18. Comparison of performance of twelve genotypes in mother trials at Darbar Devisthan and Simichaur VDC of Gulmi district in 2008

Genotype	Hundred grain weight (g)		Yield (kg/ha)	
	Darbar	Simichaur	Darbar	Simichaur
NPGR 00008	10.33	11.67	326	800
NPGR 00015	11.67	12.00	907	986
NPGR 00076	11.33	9.67	737	857
NPGR 00194	11.00	14.33	830	565
NPGR 05364	7.67	11.67	1140	786
NPGR 05420	11.00	16.33	895	684
NPGR 06756	10.33	16.33	1494	570
LRGR 91	10.33	12.00	939	675
LRGR 99	8.33	12.00	848	438
LRGR 103	9.67	12.00	631	519
LRGR 111	8.67	10.67	428	815
LRGR 117	9.00	11.00	571	772

At NARC, ricebean genotypes exhibited a varied response for most agronomic traits. There was significant variation for height, pod length, seeds per pod, hundred seeds weight and biomass yield in Khumaltar (Table 2.4.19) but no significant difference in grain yield and days to

maturity. Overall, growth was not satisfactory and there was significant seed shedding. Heavy and continuous rainfall during the crop season led to poor performance overall. On the basis of observed combined yield traits, NPGR 00008, NPGR 05420, LRGR 91 and LRGR 117 were designated as promising for grain, although NPGR 00015 and LRGR 103 had the highest biomass yields (12447 kg and 9333 kg respectively).

Table 2.4.19: Performance of ricebean in mother trial in Khumaltar (June, 2008)

Genotypes	DM	Height (cm)	Pod length (cm)	Pods / plant	Seeds / pod	HSW (g)	Grain yield / plant (g)	Yield (kg/ha)	Biomass (kg/ha)
NPGR 00008	143	71	5.8	109	7	8.3	103	686.7	3113.5
NPGR 00015	146	113	10.1	122	7	7.2	94	626.7	12447.3
NPGR 00076	139	83	8.7	115	7	7.4	97	646.7	4886.9
NPGR 00194	149	90.3	7.2	112	8	8.1	74	493.4	4446.9
NPGR 05364	141	83	4.4	120	7	6.8	84	560.0	4000.2
NPGR 05420	142	88.0	3.9	124	6	9.4	102	680.0	3113.5
NPGR 06756	149	83	6.4	129	7	7.8	93	620.0	1780.1
LRGR 91	133	81	8.9	139	8	5.4	129	860.0	3553.5
LRGR 99	137	87	8.8	122	8	6.4	91	606.7	4000.2
LRGR 111	146	80	8.6	103	6	7.5	78	520.0	5333.6
LRGR 103	149	98	9.1	107	7	8.7	90	600.0	9333.8
LRGR 117	150	87.3	9.2	131	7	7.4	125	833.4	867
Probability	ns	**	*	ns	**	***	ns	ns	***
CV	0.04	0.12	0.23	0.09	0.07	0.14	0.18	0.18	0.80

Among the genotypes at Dolakha there were no significant differences for the measured traits (Table 2.4.20), although there was high CV (3 - 48 %). NPGR 05420 gave the highest grain yield (751 kg/ha) followed by LRGR 99 (672 kg/ha). The high CV% for grain yield, straw yield and biomass yield might be due to large variation in nutrient content in experimental plots. NPGR 06756 was the only determinate type and was earliest in flowering (54 days). At this site, plant populations could not be maintained due to shading effect of maize and the trial was badly affected by disease and insect pests.

In on-station evaluation at NGLRP, Rampur, vegetative growth and overall performance was very poor due to unusual heavy rainfall this year during monsoon. As a result there was poor setting of pods and little grain was harvested.

Table 2.4.20: Performance of ricebean in mother trial on-station at HCRP, Dolakha (June, 2008)

Genotypes	DM	HSW (g)	Grain yield (kg/ha)	Fodder yield (kg/ha)	Biomass (kg/ha)
NPGR 00008	144	7.0	536	2125	2661
NPGR 00015	140	7.0	593	1583	2176
NPGR 00076	140	6.3	492	1708	2200
NPGR 00194	140	7.0	592	2292	2884
NPGR 05364	139	6.0	567	1458	2026
NPGR 05420	145	6.7	751	1792	2543
NPGR 06756	0	0	0	0	0
LRGR 91	141	5.7	662	2083	2746
LRGR 99	149	6.3	672	1333	2006
LRGR 111	138	6.3	622	1675	2297
Probability	ns	ns	ns	ns	ns
CV	0.03	0.11	0.48	0.44	0.34

These genotypes on late planting and on-farm evaluation at Khanikhola (mid-hill) and Hariya (lowland, Chitwan) performed differently and produced grain yield as much as in normal plantings (Table 2.4.19, 2.4.20 and 2.4.21). A luxurious vegetative growth was observed at Khanikhola, Dhading (mid-hill) and morphology tended to become determinate and bushy, with

clusters of flowers and pods. NPGR 00008, LRGR 91 and LRGR 99 were high yielding for both on-farm study sites. In disease reaction, powdery mildew, *cercospora* leaf spot and rust symptoms were observed across the genotypes and study sites. However, further investigation in this aspect is essential.

Table 2.4.21: Performances of ricebean genotypes in on-farm Mother trial at Khanikhola (mid-hill) and Hariya (lowland) in August planting (2008)

Genotypes	HSW (g)		Grain yield / plant (g)		Grain yield (kg/ha)		Biomass (kg/ha)
	Khanikhola	Hariya	Khanikhola	Hariya	Khanikhola	Hariya	Khanikhola
NPGR 00008	6.6	7.0	32.5	81.0	216.7	540.0	180.0
NPGR 00015	7.5	6.0	25.5	80.5	170.0	540.0	93.3
NPGR 00076	6.1	6.8	22.5	32.5	170.0	450.0	86.7
NPGR 00194	7.2	9.0	25.5	82.5	170.0	513.6	260.0
NPGR 05364	7.3	7.8	27.5	61.5	183.3	410.0	133.3
NPGR 05420	7.2	6.0	17.5	45.0	116.7	300.0	146.7
NPGR 09391	8.3	6.8	25.0	68.5	166.7	456.6	166.7
LRGR 91	5.8	6.6	42.5	127.0	283.4	513.6	326.7
LRGR 99	7.8	7.6	14.0	108.0	93.4	720.4	100.0
LRGR 111	7.9	7.4	28.5	55.0	190.0	366.7	166.7

Baby trials: A large number of baby trials were conducted on farmers' fields in India and managed by farmers in many different locations (Table 2.4.22).

Table 2.4.22 Entries in baby trials

Entry	Source
GVT and ASSAM	
JR-1	GVT
JCR-07-16	Assam
RBD-1	Himachal
CSKHPAU	
RBD-1	Himachal
RBD-2	Himachal
RBD-3	Himachal

These were designed to test all combinations of three genotypes, at each location. Farmers were given assistance with plot layout and sowing but managed the plots using their own methods. The trials were sown at a row spacing of 45 cm, and 250 g seed of each line was provided to the farmers. GVT carried out 42 trials in 13 villages in four districts, sown in late July 2008. In Assam, AAU conducted 30 trials in two villages (Danichapori and Rongkangthir) in two districts (Dergaon and Diphu respectively), sown in July-August, while in HP 30 baby trials at three locations in two districts were conducted. No trials received either chemical fertilizer, green manure or herbicides, and none was attacked by disease. Trials in HP were affected by insects and sprayed as required – other trials were not sprayed. Trials at GVT did not receive organic manure, while all others received farmyard manure according to local practice: The plots at GVT were ploughed twice, and at the other locations either two or three times.

From sowing to maturity, project staff visited each farmer's field and conducted a preference analysis in which farmers were asked to rank each variety using plant type, maturity, grain size, grain yield, grain colour, taste, fodder palatability, cooking quality. They were then asked to indicate positive and negative characteristics of varieties, and which varieties they would continue to grow next year. Yield data were collected after harvest. Table 2.4.23 shows the farmer preference data from these trials. All varieties grown were indeterminate. The main preference in MP, Assam and HP was for JR-1, JCR-07-16 and RBD-1, respectively.

Table 2.4.23: Mean data from baby trials conducted during *Kharif (Summer)* 2008 in India

Particulars	Location								
	GVT			Assam			HP		
	JR-1	RBD-1	JCR-07-16	JR-1	RBD-1	JCR-07-16	RBD-1	RBD-2	RBD-3
Soil type	Black / stony			Sandy loam, sandy clay			Silty clay loam / clay loam		
Ploughings	2	2	2	2/3	2/3	2/3	2-3	2-3	2-3
Flowering*	M	L	L	L	E	M	E	E	E
Maturity*	M	E	L	L	E	M	M	M	M
Pod size†	S	S	L	S	S	L	M	M	M
Pods‡	H	M	L	H	M	M	H	H	H
Seeds per pod‡	H	H	L	H	H	L	H	L	L
Shattering•	Y	Y	Y	N	N	N	Y	Y	Y
Grain type†	M	M	L	M	M	L	M	M	M
Fodder quality∫	G	G	G	-	-	-	G	G	G
Overall liking∫	VG	G	G	G	G	VG	VG	G	G

* E = early, M = medium, L = late
† S = small, M = medium, L = large
‡ H = high, M = medium, L = low
• Y = yes, N = no
∫G = good, VG = very good

Preliminary crossing in ricebean

Out of 540 reciprocal crosses among 4 ricebean genotypes (LRGR 111, LRGR 91, NPGR 07882 and NPGR 09391), 79 were successful and produced pods in controlled conditions at Khumaltar. The preliminary crossings revealed variability for seed colour, a maternally-inherited trait. (Table 2.4.23), and the cause of this was not clear. Likewise in Rampur about 150 crosses were made, but there was no successful pollination, and flowers were found to be damaged by thrips and bud weevils.

Table 2.4.23: Performance of crosses and their products seed coat colour carried in Khumaltar (August, 2008).

Cross combinations	Female parent	Male parent	Crosses made	Pods harvested	No of F1 pods of particular seed coat colours			
					Mottled	Red	Cream yellow	Dark yellow
NPGR 07882 X LRGR 111	Mottled	Red	80	10	7	3		
NPGR 07882 X LRGR 91	Mottled	Yellow	40	7			7	
NPGR 09391 X LRGR 91	Mottled	Yellow	72	15	15			
NPGR 09391 X LRGR 111	Mottled	Red	25	3	3			
LRGR 91 X NPGR 07882	Yellow	Mottled	7	1			1	
LRGR 91 X NPGR 09391	Yellow	Mottled	102	11	1		10	
LRGR 111 X NPGR 07882	Red	Mottled	15	6		2	4	
LRGR 111 X NPGR 09391	Red	Mottled	139	20		15	5	
LRGR 117 X NPGR 09391	Dark brown	Mottled	60	6				6
Total harvest			**540**	**79**	**26**	**20**	**27**	**6**

Evaluation of ricebean accessions for hardseededness

In preliminary evaluation of 50 accessions of ricebean accessions from the core collection of 2007 harvest in Khumaltar, 28 accessions exhibited no hardseededness. In rest of accessions 1 to 24 % hard seeds were detected with highest 24 % in NPGR 05373 (a collection from Gorkha, high-hill). Among the test samples of ricebean for hardseededness, NPGR 05391, NPGR 00015, LRGR, 42, NPGR 00087, NPGR 05382, NPGR 06757 found comparatively with higher number of hard seeds (6-24 %). Most these genotypes represented the high-hill agro-ecosystems and vary

in seed coat colour (Table 2.4.24). Moreover, the hardseededness in ricebean was irrespective of seed coat colour, however the production environment could have association with hardseededness. It is therefore suggested for further investigation in 2009 to include the all production environments.

Table 2.4.24: Ricebean accessions showing hardseededness in fresh harvested seeds

Genotypes	Districts	% hard seeds	Seed colour	Genotypes	Districts	% hard seeds	Seed colour
NPGR 05364	Bhojpur	1.0	Yellow	LRGR 129	Palpa	2.0	Yellow
NPGR 09391	Syangja	1.0	Mottled	NPGR 00073	Gulmi	1.0	Mottled
LRGR 102	Palpa	3.0	Yellow	NPGR 05565	Okhaldhunga	2.0	Red
NPGR 05432	Baitadi	1.0	Yellow	LRGR 111	Gulmi	1.0	Red
NPGR 00007	Nuwakot	2.0	C.Yellow	**LRGR 42**	**Surkhet**	**6.0**	**Mottled**
NPGR 05384	Mugu	1.0	C.Yellow	LRGR 99	Palpa	2.0	Yellow
LRGR 107	Palpa	1.0	Mottled	**NPGR 05373**	**Gorkha**	**24.0**	**C.Yellow**
NPGR 08382	Baglung	3.0	Mottled	**NPGR 00015**	**Bhaktapur**	**10.0**	**Yellow**
NPGR 00194	Kabhre	2.2	C.Yellow	NPGR 06756	**Humla**	**6.0**	**Yellow**
NPGR 05391	**Bajura**	**10.0**	**Yellow**	NPGR 05382	**Tanahun**	**6.0**	**Yellow**
NPGR 00090	Dang	1.0	Mottled	NPGR 00087	Pyuthan	4.0	Yellow

Seed multiplication

In Nepal, seeds were packaged in 200 gram packets and distributed for PVS in Darbar Devisthan and Simichaur VDCs in Gulmi. The project team was optimistic that farmers were keen to grow ricebean and advised them to produce seed based on the concept of Community-Based-Seed Production (CBSP). A total of 71 farmers participated in this activity (Appendix 4). The farmers were provided orientation and other technical inputs by the project. We had expected to collect approximately 2 tons of seeds. However, farmers failed to produce this due to unfavourable weather during flowering period. There was continuous rainfall for a week which damaged the flowers substantially. Seed of only 1 accession was collected in a significant amount (LRGR 103).

Twelve promising genotypes from the mother trials were increased for seed by NARC in three research stations in small plots for scaling up these genotypes in farmer's fields. The total quantity of seeds harvested and available for further seed increase is given in Table 2.4.25.

Table 2.4.25: Quantity of seeds produced in three research stations in 2008 crop season.

Accession No	Districts	Seed harvested (kg)	Accession No	Districts	Seed harvested (kg)
NPGR 00008	Nuwakot	2.3	NPGR 06756	Humla	Few seeds
NPGR 00015	Bhaktapur	2.0	LRGR 91	Dang	2.6
NPGR 00076	Arghakhanchi	2.4	LRGR 99	Palpa	2.3
NPGR 00194	Dolakha	2.3	LRGR 111	Gulmi	2.4
NPGR 05364	Bhojpur	2.5	LRGR 103	Palpa	0.4
NPGR 05420	Dhankuta	2.0	LRGR 117	Gulmi	0.2

Winter adaptation trials

It was the end of November when the seeds were sown by LI-BIRD. Hence, due to cold environment there was low and late germination. Seeds of all six took a long time to germinate in both the districts, although germination was more in Jhapa compared to that in Dang. Ricebean at Dang did not develop vegetative growth even after late February. So, the trials failed in Dang.

However, trials conducted in Jhapa have something to offer for generating new technology. In fact, there was low germination. However, the germinated seeds developed vegetative growth, flowers and pods as well. Some of the accessions are in harvesting stage and some are developing pods. The data is yet to come from Jhapa. Hence, further information has not been included in this periodic report.

Out of 207 accessions evaluated in the spring season by NARC, only a few accessions showed prolonged vegetative growth, and there were very few flowers. Eighty accessions did not respond at all and only 5 (NPGR 00184, NPGR 00189, NPGR 05565, LRGR 87 and LRGR 97) yielded grain (between 101 and 200 g/m^2).

In Assam, some seed was set, but was very poor compared to the normal monsoon season crop.

Seed priming

Priming ricebean seed showed no significant effect on emergence. However, P application had a significant effect on yield of both the crop components. Seed priming of ricebean with P also shows promising results in relation to better seed yield of this crop: where no P was applied, then priming with a 1% P solution significantly increased ricebean yields, and even where it was applied at the recommended rates then priming with both 0.1 and 1.0% solutions was beneficial (Table 2.4.26).

Table 2.4.26: Effect of priming treatments on yield of maize and ricebean

Treatments	**Maize yield (t/ha)**	**Ricebean yield (t/ha)**
No P - Sole maize	1.14	-
No P + Maize + rice bean (not primed)	1.22	0.31
No P + Maize + rice bean (primed with water)	1.31	0.41
No P + Maize + rice bean (primed with 0.1 % P)	1.36	0.48
No P + Maize + rice bean (primed with 1 % P)	1.37	0.67
Recommended P + Sole maize	1.87	-
Recommended P + Maize + rice bean (not primed	2.05	0.60
Recommended P + Maize + rice bean (primed with water)	2.03	0.71
Recommended P + Maize + rice bean (primed with 0.1 % P)	2.06	1.04
Recommended P + Maize + rice bean (primed with 1 % P)	2.20	1.02
CD 5%	0.13	0.201

2.5 Workpackage 5: Nutrition and health

2.5.1 Objective

The objective of WP 5 is *"to assess the potential impact of enhanced pulse availability on local human nutrition"*. The WP is led by Bergen, with field work in Asia carried out by GVT, CSKHPKV AAU, NARC and LI-BIRD. The rationale has been to study the relative role of ricebean, actual and potential, in areas with different staple crops and with and without ricebean present in their dietary system. In order to make the analysis manageable, the study is focused on women of reproductive age, a group which hypothetically could be more at risk of inadequate nutrition than males and other age groups.

2.5.2. Summary of work in years 1 and 2

A comprehensive literature survey on the nutritional qualities of ricebean, the state of the art of nutritional survey design, and the extent of malnutrition in the region was undertaken by the University of Bergen (UB). The survey has to some extent reduced the need for chemical analyses, although some additional analyses will have to be undertaken. It also showed that the suggested strategy of WP5 was justified, as no comprehensive studies in the region have been published on diet composition and adequacy, and the relative contribution of pulses in the diets is largely unknown. The dietary survey will provide new scientific knowledge essential to FOSRIN but also generally publishable.

In extension of the kick-off meeting, a preliminary field appraisal was carried out in Ilam district, Eastern Nepal. This provided very valuable information on different types of cultivation as well as the integrated role of ricebean in the farming system. Knowledge on preferential traits was collected as part of WP4, providing a good basis for the design of more extensive field efforts in mid-2007.

An intensive training session was held in Palampur and attended by the Asian partners. The purpose was to train project staff in the various techniques that would be needed to carry out the dietary surveys, and to standardise the methodologies. The training workshop was followed by a practical session in the field.

A questionnaire and standard food models were developed, and surveys carried out on three aspects at three periods over six months in 2007, in 6 areas in Nepal and two States in India. The survey was carried out in 100 households in each district, using women in the 25-45 age group. The information is being used to identify nutritional values and status of these groups to draw the general nutritional structure in villages of Nepal with and without ricebean in their dietary system. The data were formatted for the WorldFood2 standard programme.

With the aim of analysis of the specific nutritional value of ricebean, a full range of nutrient figures was also compiled in WorldFood2 format. Most values were compiled from existing literature and, due to geographic variation in the sources, and the variability of ricebean, were selected according to what appears to be consensus, from what can be assumed as the best, peer reviewed literature.

Information obtained so far shows that ricebean has a moderate raw protein content but with high digestibility and a very beneficial amino acid composition for human consumption. Its vitamin and mineral content is comparable to other pulses, and it has a low fat content dominated by unsaturated lipids. There are no specific problems concerning toxic or allergenic substances, and no unusual anti-nutrients. However, the low levels of the crop in diets mean there is no significant benefit in terms of these nutrients at present.

A number of dissemination activities have concentrated on WP5 in India, where a range of recipes have been tested with consumers to try to develop value-added products. Of ten basic products, there was keen interest shown in nine: *dhal,* nuggets, *kandals*, stuffed *roti*, *namkeen*, *pakoras* and sprouted *chat*, supporting the view that there is a potential market for value-added products from ricebean. Further organoleptic evaluations will be carried out over the coming year.

2.5.3 Workpackage progress of the period

WP5 has continued the work on establishing the current knowledge on the nutritive value of ricebean, and its present and potential role in human nutrition and food security at local level. The work on nutritive value of ricebean *per se* is based on the extensive use of scientific literature, supplemented by chemical analysis of selected nutrients in cases where no information was found in the existing literature, or where conflicting evidence suggested the need for additional information. The work has been carried out with the aim of being linked to the dietary surveys which are described below, and should provide values for all the parameters that are being used in the WorldFood2 programme used in dietary analysis.

Chemical analysis of B vitamins has been redone on the background of experiences from dietary surveys on food processing and preliminary calculations of the relative importance of pulses in provision of various water soluble vitamins. The analysis was originally planned to be carried out on sub-contracting basis by University of Life Sciences (UMB) in Norway, but was done by the private EUROFINS laboratory under Steins Laboratories in Denmark. The reason for this was changed policies from UMB with respect to analysis of organic compounds, and based on their advice. The cost of this analysis has been relatively modest.

The values on nutritive values found in the literature are generally from a small number of samples and varieties, and it is likely that there will be substantial variations between different varieties, and between crops grown under various conditions, but there appears to quite consistent trends in the results presented by various authors and analyses.

Some important general observations concerning ricebean appears to be

- a very favourable amino acid composition for human consumption
- a substantial content of B vitamins and some minerals
- the absence of toxic and allergenic substances

This last point is of importance since many other pulses may have a substantial content of for instance cyanides, allergenic compounds or enzyme inhibitors that need special concern in breeding work and nutritional extension work. Ricebean is not completely free from for instance trypsin inhibitors, but the existing evidence suggests that there are no specific risk problems with ricebean as a source of food for humans. The content of flatulence producing factors in ricebean is according to chemical analysis not higher than that of similar pulses, and would rather be in a lower range. However, mild gastritis is noted in connection with consumption of ricebean. The effects of these factors are affected by cooking methods, and the use of overnight soaking before boiling as a *dal* should be encouraged in extension work, also since soaking is increasing the bioavailability of several nutrients.

In Table 2.5.1 below, the main nutritive characteristics of ricebean have been summarised. The values have been calculated as the potential contribution of each nutrient compared to the Recommended Daily Intake (RDI) for adult women at a consumption of 60 grams ricebean per day, which is an empirically based estimate of pulse consumption if availability and price are not restricting.

Table 2.5.1: Potential provision of nutrients as % of recommended intake for adult women.

Nutrient from Wfood2 list	Nutrient content units / 100 g bean	Reference	% of RDI at consumption of 60 g/day
Total protein	18 g	Kaur & Kapoor, 1992	28.4
Threonine	0.536 g	Mohan & Janardhanan, 1994	32.8
Isoleucine	0.942 g	Mohan & Janardhanan, 1994	60.7
Leucine	1.304 g	Mohan & Janardhanan, 1994	38.0
Lysine	1.074 g	Mohan & Janardhanan, 1994	34.6
Methionine + cysteine	0.421 g	Mohan & Janardhanan, 1994	27.1
Histidine	0.648 g	Mohan & Janardhanan, 1994	56.7
Tryptophane	0.171 g	Mal, 1994	56.7
Phenylanaline + tyrosine	1.349 g	Mohan & Janardhanan, 1994	50.0
Valine	1.022g	Mohan & Janardhanan, 1994	312.0
Fibres	7.0 g	Kaur & Kapoor, 1992	9.3
Vitamin A (retinol)	<21µg	*EUROFINS	-
Vitamin B1 (thiamin)	0.49 mg	Duke, 1981	32.6
Vitamin B2 (riboflavin)	0.31 mg	Kaur & Kapoor, 1992	34.4
Vitamin B3 (niacin)	2.88 mg	*EUROFINS	15.7
Vitamin B5 (pantotenic acid)	1.1 mg	*EUROFINS	13.2
Vitamin B6 (pyridoxine)	0.14 mg	*EUROFINS	6.5
Vitamin B7 (biotin)	3.98 µg	*EUROFINS	8.0
Vitamin B9 (folate)	131 µg	*EUROFINS	24.6
Vitamin B12 (cobalamin)	<0.01 µg	*EUROFINS	-
Vitamin C	1.4 mg	Kaur & Kapoor, 1992	1.4
Vitamin D3	<0.5 µg	*EUROFINS	-
Vitamin E	<0.08 mg	*EUROFINS	-
Ca	264 mg	Mohan & Janardhanan, 1994	15.8
P	124 mg	Mohan & Janardhanan, 1994	10.6
Mg	73 mg	Mohan & Janardhanan, 1994	13.7
K	2875 mg	Mohan & Janardhanan, 1994	36.7
Na	6 mg	Mohan & Janardhanan, 1994	0.3
Fe	6.7 mg	Kaur & Kapoor, 1992	22.3
Zn	3.1 mg	Kaur & Kapoor, 1992	23.5
Cu	1.46 mg	Kaur & Kapoor, 1992	97.3
Mn	2.70 mg	Kaur & Kapoor, 1992	90.0

The report on nutrient content (Deliverable 5.2) has been finalised and submitted, and work is ongoing on Deliverable 5.1.

The further work on assessing the present and potential role of ricebean is linking the nutrient content in ricebean to the actual nutritional status of various groups in the project areas, assessing the relative and complementary role of the crop in different diets. he main activities in the reporting period have been connected to data processing and analysis of the data from dietary surveys carried out by teams led by four partners in the consortium, two in Nepal and two in India. Each survey team collected dietary recalls three times from 200 individuals (adult women). The level of detail was grams of each ingredient in all meals the day before the recall, so the total number of records in the database is around 20000. This has required substantial work in terms of critical assessment of data and data management before and after data entry. Entering of the data

took place at the IT department of the Teaching Hospital, Tribhuvan University, Kathmandu. The software applied was the WorldFood2 package, using the Indian food tables for calculating the contribution of each record for 47 nutrient variables. The data have been analysed using statistical software STATA and SPSS. The main conclusions from the dietary recalls were summarised and presented at a project Technical Workshop held at NARC in Kathmandu in February 2009. The data are sufficient to make some firm conclusions about the nutritional problems in the different sites, how they relate to differences in diets with respect to staples, animal source foods and other food groups, and in particular the role of ricebean and other pulses in providing food security and meeting the specific dietary needs of the populations.

Table 2.5.2: Frequency of recorded pulse intake in the four different sites, out of 3 x 200 recalls in each site

	Location			
Pulse	Dolakha	Gulmi	HP	Assam
Lentil	200	133	445	340
Field bean	138	193	13	13
Cowpea	77	153	6	29
Chickpea	8	6	232	
Pigeon pea	47	69	37	8
Ricebean	29	12	80	23
Soybean, raw	60	15	16	11
French bean	17	4	37	5
Soybean, black	29	6	6	21
Mung bean	4		56	
Horsegram	7	1	2	

The dietary surveys gave a rich source of information concerning differences in diets between the sites. Lentil is the most common pulse consumed overall (Table 2.5.2), while field bean is coming second. Chickpea is very commonly consumed in the predominantly vegetarian Himachal Pradesh where it serves as a second pulse per day. Ricebean was the fifth most important pulse item, most commonly consumed in Himachal Pradesh.

A major difference between the field sites is the composition of staple grains. Very distinctively, the people in Assam are taking rice as their main staple (Table 2.5.3). The Nepalese sites also have rice as a main staple, but maize and wheat are taken as alternative grain staples. In Himachal Pradesh, it is a clear pattern that the women are having rice as well as wheat in most days.

Table 2.5.3: Frequency of grain staples in the four survey areas, 3 x 200 recalls per site

	Location			
Grain staple	Dolkha	Gulmi	Palampur	Assam
Rice	572	424	554	558
Beaten rice	172	23		
Wheat and bread	107	175	608	24
Maize flour	164	155	16	2
Green maize	62	121		21
Millet	63	68		
Noodles, pasta	28	31	2	

Pulses are in general assumed to be an important source of protein, and ricebean is a particularly good composition of essential amino acids. However, while the pulses in the survey were found to make a considerable contribution to the protein supply, protein and essential amino acids were not found to be a nutritional risk factor in the populations, due to relatively varied other sources

of protein, either in terms of milk products (Himalayan sites) or fish and pork (Assam). Table 2.5.4 shows the main sources of some vitamins, and how large a share of this which is coming from pulses. As a source of vitamins, the pulses are primarily important with respect to B vitamins, and especially B1 and B9 (folic acid).

The calculated values showed mainly low intakes of vitamins A, B9, B12, C, D, E, and of calcium and potassium. Somewhat surprisingly, the supply of iron and zinc was not found to be critical in the survey sites.

The most critical contributions of ricebean and other pulses compared to the recorded levels of inadequate nutrient supplies were vitamin B9, calcium and potassium.

Table 2.5.4: Food items as sources of some vitamins in dietary survey, all sites.

Vitamin	Main source in dietary recalls	% of supply from pulses
A	Leafy vegetables, milk	1 %
B_1	Rice, wheat, maize	8.4 %
B_6	Rice, potato, wheat, maize	4.4 %
B_9	Leafy vegetables, lentils, rice	26.7 %
B_{12}	Milk, fish, red meat	0 %
C	Leafy vegetables, potato	4.9 %
D	Fish (86 %), pork	0 %
E	Leafy vegetables, wheat, maize	3.9 %

The findings from the dietary survey are in the process of being written up for a project report. The study contains a number of findings that are expected to have broader interest and it will be considered to have it published in for instance *Social Science and Medicine.*

Finally, a paper on challenges in research, development and promotion of under-utilized crops, using ricebean as a case example was presented at the annual meeting of the American Association of Geographers in Las Vegas in March 2009. It was placed in one of several sessions on “Geographies of Food”, apparently a theme with substantially increasing focus. It was well received and the paper has been invited to peer reviewed publication.

Table 2.6: Deliverables list for the period

List all deliverables, giving date of submission and any proposed revision to plans.

***) if available**

Del. no. [19]	**Deliverable name**	**WP no.**	**Due date**[22] (project month)	**Actual/Forecast delivery date**	**Estimated indicative person-months *)**	**Used indicative person-months *)**	**Lead participant**
D1.1	Empirically estimated hedonic demand function for legumes	1	27	Draft ready: already presented in conference. Expected July	24	24	CAU Kiel
D1.2	Legumes Trait Value Index for guiding ricebean breeding	1	27	In preparation: already presented in conference.	18	16	CAU Kiel
D1.3	Strategy for introducing ricebean into the legumes supply-chain	1	30	42	11	8	CAU Kiel
D1.4	Final report (thesis) on ricebean marketing	1	35	48	15	12	CAU Kiel
D1.5	Article on ricebean marketing in a research journal	1	36	48	3	0	CAU Kiel
D2.1	National distributions of ricebean published	2	12	Draft submitted May 2007 (Final June 2007)	24	24	LI-BIRD
D2.2	Analysis of local knowledge of rice bean diversity and uses from selected study areas published	2	24	Draft for edits May 2008, final submitted with this report	45	45	LI-BIRD
D2.3	Analysis of ricebean diversity published in a research journal	2	30	40. In preparation	6	1	LI-BIRD
D3.1	Polymorphic markers identified and published	3	24	Draft submitted May 2008, final submitted with this report	45	45	NARC
D3.2	Diversity in Nepal and India on the basis of molecular markers described and published	3	36	48. Further work required and delayed due to 12 h a day load-shedding in Nepal	9	7	NARC
D5.1	Diet and food preparation documented and published	5	24	In preparation, expected July. Results presented at KTM meeting Feb 2009	30		UB

Del. no. [19]	**Deliverable name**	**WP no.**	**Due date**[22] (project month)	**Actual/Forecast delivery date**	**Estimated indicative person-months *)**	**Used indicative person-months *)**	**Lead participant**
D5.2	Nutrient content analysed, documented and published	5	30	Submitted with this report	16	16	UB
D5.3	Analysis of health and nutrition impact published	5	29	Expected October	15		UB
D7.1	Dissemination strategy established and reviewed quarterly	7	3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36	3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36, 39, 42, 45	4.5	4.5	CAZS-NR
D7.2	Project website set up	7	3	3	1.5	3	CAZS-NR
D7.3	Project brochures and posters	7	15, 25, 35	15 and on-going	3	3	CAZS-NR
D7.4	Technical documentation for dissemination to farmers and extension workers	7	15, 25, 35	15 and on-going	3	4	CAZS-NR
D7.5	Press articles and broadcasts	7	6, 18, 30	18 and ongoing	2	2	CAZS-NR
D7.6	Demonstrations "on-farm"	7	6, 18, 30	18 and ongoing	5	5	CAZS-NR
D7.7	Outputs on CD-Rom and/or video	7	18	40. Clips produced and incorporated but final edits required	2	2	CAZS-NR

Table 2.7: Milestones List

List all milestones, giving date of achievement and any proposed revision to plans.

Milestone no.	Milestone name	Workpackage no.	Date due	Actual/Forecast delivery date	Lead contractor
2	Documentation of national distribution of ricebean	WP2	3	15	LI-BIRD
4	Field survey, India and Nepal	WP5	4	18	UB
5	Dissemination strategy	WP7	6	Ongoing	CAZS-NR
6	Website	WP7	6	ongoing	CAZS-NR
7	Literature review, supply chain	WP1	7	12	CAU
8	Ricebean diversity surveys	WP2	10	12	LI-BIRD
9	Report on dietary patterns and nutrition	WP5	10	40	UB
10	Identification of polymorphic markers	WP3	12	24	NARC
11	Annual meeting	WP6	12	18	CAZS-NR / all
12	Completion of second year of mother and baby trials	WP4	24	24	GVT
13	Membership of networks	WP6	12	Ongoing	All
14	2nd diet and nutrition report	WP5	24	36	UB
15	Lab analyses of nutrient contents	WP5	17	17	UB
16	Complete supply-chain field work	WP1	18	42	CAU
17	Complete field work for agro-morphological characterisation	WP2	18, 24	18, 24, 36, 48	LI-BIRD
18	Germplasm evaluation with markers	WP3	24	42	NARC

Additional milestones for year 4

19	Field trials for effect of sowing date completed	WP2	46	46	LI-BIRD

20	Studies of outcrossing and population genetics completed	WP4	46	46	NARC
21	Study of hardseededness completed	WP4	46	46	GVT

Section 3 – Consortium management

3.1 Consortium management tasks and their achievement; problems which have occurred and how they were solved

Management tasks for this period were as follows:

WP6: Coordination, management, integration and synthesis

These remained basically the same as for the previous year. They were to:

To maintain internal procedures for the project. The various internal procedures finalized at the initial workshop held in Kathmandu were kept under review over year 3.

To hold the 3rd Annual Meeting. This was held at the Wild Grass Resort, Ullensvang, Norway in October 2008. The minutes are submitted with this report.

To elaborate the detailed workplan. This was adjusted again at the 3rd Annual Meeting, and the updated barchart is attached. Experimental protocols were reviewed and updated if necessary at Technical Meetings held in Kathmandu in February 2009, and in Bhopal in late spring 2008.

To ensure partners joined relevant S Asian and other networks of relevance. A number of networks were joined in the first year, and staff remain involved in electronic discussions and on mailing lists. Staff participate in the Asia Pacific Mountain Forum (http://www.mtnforum.org/rn/apmn.cfm) from ICIMOD. Other networks include the International Centre for Underutilised Crops, the European and International Associations of Agricultural Economists and a number of German organisations including the Arbeitsgemeinschaft für Tropische und Subtropische Agrarforschung (Council for Tropical and Subtropical Agricultural Research). Project deliverables previously submitted to the website of the GFU are awaiting the new site for ICUC. Dr Joshi in Kathmandu is actively building stronger linkages with ICIMOD, which we hope to see also publishing project outputs this year.

To maintain financial reporting and monitoring procedures. The various procedures discussed and finalized at the initial project workshop have been adhered to, and further assistance has been given to partners since then with regard to completion of the various reporting formats.

To provide assistance to partners with travel arrangements. Assistance has been provided to the Asian partners with their travel arrangements both for internal travel (within India) and internationally (India – Nepal, Nepal – India, an Asia - Europe). This has included invitation letters for visas, as well as requests to institutional administrations to allow staff to travel – obtaining permission to be "off-station" is often a problem for even senior staff in the Asian institutions.

To maintain quality control. This was set up at the initial workshop, and consists of one senior staff member, not involved in the project, from each participating institution.

WP7: Output and dissemination / knowledge management

To develop the dissemination strategy. This was drafted during the project preparation phase, refined during the first year of the project, and was further refined in years 2 and 3. The Asian partners are particularly experienced in disseminating outputs, and are playing a major role in these activities.

The findings from the participatory evaluation of ricebean germplasm in India and Nepal have been summarized in local languages and disseminated to communities through the most effective media, for example FM Radio networks (particularly in Nepal), TV, local papers and magazines.

The scientific findings from these studies will be published in refereed journals and also posted in the project web site and linked with the web site of under utilized crops networks. They will be further disseminated through networks in India and Nepal, and efforts will be made to strengthen the effectiveness of these networks by creating linkages between the networks of both the countries.

To produce the project website. The domain name http://www.ricebean.org was registered as soon as the project was approved, and the website went live in December 2006. It has so far (May 2009) received over 10,000 hits (verified by http://www.statcounter.com). Content so far includes staff and institutional profiles, a description of the project, and detailed information about ricebean cultivation, including a comprehensive and regularly updated bibliography of work on ricebean and related species (in particular other *Vigna* spp. and *Phaseolus vulgaris*). This includes links either to abstracts or to full papers where copyright restrictions permit. Work to provide a secure area for to allow project staff to exchange documents and other material that needs to remain confidential has been shelved due to the ready availability of other means of communication, and administrative delays with IT support for this in Bangor.

Other dissemination activities are noted in Annexe 1 to avoid repetition.

WP8: Monitoring and review

The tasks for this WP were to ensure physical progress in accordance with schedule and budget; assess the preliminary response by stakeholders to project activities; reporting to the coordinator and pre-meeting briefings. This has continued in a satisfactory fashion over the year. Monitoring of the progress of the field sites took place in India, and in Nepal.

3.3 Coordination activities

We have continued to contact scientists working on other underutilized crops. Several staff attended meetings outside the project, and these are noted in Annexe 1 to avoid duplication. Contacts in India with the All India Coordinated Research Project on Underutilised Crops of the Indian Council of Agricultural Research have been further strengthened. In Nepal, linkages have been maintained with the NGOs noted in earlier reports. Other working relationships have been established with farmers' groups and government Agricultural Development Offices in Nepal.

Partners have been in almost continuous communication by email and telephone, as well as face to face meetings, and the CAZS Regional Coordinator has visited all the Asian partners at least once. In addition to the Annual Meeting in October (minutes attached) several other meetings have taken place (Table 3.4.1).

Table 3.4.1. Details of meetings held in year 3

Date	Location	Attendance	Purpose	Management outcomes*
April 24-25, 2008	Bhopal	Dr JP Yadavendra (GVT); Dr N Kumar (CSKHPKV); Dr SB Neog (AAU)	Annual technical programme meeting of the Indian partners	*Scientific only*
October 7 – 11, 2008	Ullensvang, Norway	Dr PA Hollington (Coordinator), Prof JR Witcombe, Dr D Harris, Dr KD Joshi (CAZS NR); Prof RAE Mueller, Ms D Bürgelt (CAU); Dr P Andersen (UB); Dr S B Neog, (AAU Jorhat); Dr JP Yadavendra (GVT Dahod); Dr N Kumar, (CSJHPKV, Palampur); Mr K Khadkha (LI-BIRD, Pokhara); Dr J Bajracharya (NARC Kathmandu)	3rd annual meeting. Administrative and budget reports for year 2; Overview of scientific progress, Status of deliverables, Detailed scientific reports by WP, Dissemination and outreach activities, Plan for disseminating knowledge; Plans for next reporting period; Issues directly affecting farmers and industry; Analysis of Mother and baby trials, data formats and yield units; field visits to ricebean growing areas	Partners agreed to contribute additional website pages. Agreed to continue working to obtain permission for germplasm exchange from India Planned field activities for year 4; Review timings of deliverables and workplan adjustments
October, 2008	Himachal Pradesh, India	Dr JP Yadavendra, Dr N Kumar, Dr SB Neog	Monitoring and evaluation of field sites	*Scientific only*
20 – 25 October, 2008	Chitwan, Kathmandu, Kavre and Ramechap, Nepal	Dr J Bajracharya, (NARC), Dr RC Prasad (ARS Kavre Coordinator), Dr Renuka Shrestha (NARC), Mr K Khadka (LI-BIRD	Monitoring and evaluation of field sites in Nepal	*Scientific only*
Feb 9 – 10, 2009	Kathmandu, Nepal	Dr PA Hollington (Coordinator), Prof JR Witcombe, Dr D Harris, Dr KD Joshi (CAZS NR); Mr K Khadkha (LI-BIRD, Pokhara); Dr J Bajracharya (NARC Kathmandu) + others	Technical meeting for Nepali partners to develop work programme for the coming season	Scientific, plus discussion of new equipment for NARC

*Scientific outcomes of the meetings are noted in the respective section of the progress report.

Section 4 – Other issues

Not relevant to this report

Annex 1 – Plan for using and disseminating the knowledge

Section 1 - Exploitable knowledge and its use

As noted in both the project proposal and confirmed in Annexe 1, this project involves the participation of a large number of stakeholders, most of whom are small resource-poor farmers. So far as intellectual property is concerned, the property rights and other ethical issues concerned with Participatory Technology Development are far behind technical advances. However, we are of the firm opinion that that joint collaboration should mean joint benefit sharing. The major outputs of the project, improved technologies (which includes germplasm), are public goods and will be placed in the public domain, so the question of exploitable results for industrial or commercial exploitation does not in the main arise. However, great care will be taken when disseminating germplasm to protect the IPR of the project partners, and all organisations requesting germplasm or DNA will be required to sign a materials transfer agreement.

However, this does not mean we are unaware of the potential for commercial exploitation, although this is unlikely for ricebean as a protein crop targeted at the poorest sectors of society in India and Nepal. If improved germplasm is developed it may well attract the interest of seed companies, and if this is the case it will be licensed to them on a basis that ensures the interests of both the partners and the participating stakeholders are maintained and protected.

The two economic results that are capable of exploitation in any sense are the MLTVI, and the knowledge of the supply chain for ricebean and other legumes in Nepal and India. These will be developed by Kiel, working with the Asian partners. However, nothing that comes out of the economics research is commercially exploitable because IPRs cannot be assigned to economics data, ideas, concepts, results of hypothesis testing, and insights. Such things are not embodied in some technique and cannot be patented, even in principle. Without IPR there is nothing to sell and therefore these results are of no commercial value. In a sense, the economics research is purely for benefit of the public at large.

However, the knowledge produced will clearly be of benefit to various groups as mentioned in the table. Market systems analysis in both India and Nepal will be helpful if fully exploiting the market potential of the crop. The partners working on this work package will need to closely work with the partners working for market analysis of ricebean.

Promising ricebean landraces and the better understanding about the nutritional value of ricebean will form the basis for future research. For example, most promising landraces can be utilized as parents for ricebean improvement. Similarly new knowledge generated from nutrient analysis will be widely disseminated using various media promoting the use of ricebean largely. This will also create new market demand for the crop ultimately contributing to greater use and conservation of ricebean. This material will be developed by the partners working with farmers. It is our intention that it should be in the public domain, although subject to materials transfer agreements in order to protect the interests of the farmers in particular. Wider adoption of farmer preferred and high yielding ricebean landraces will lead to substantial increase in the yield of ricebean, contributing to increase in income, food and nutritional security of the farmers. The wider adoption of ricebean, and work to improve it, will be assisted by two of the early deliverables of the project.

Publication in India and Nepal of Deliverable 3.1 on the national distributions of ricebean will benefit researchers and the agricultural sector generally by providing information on the geographical distribution and pocket areas of the crop. It is hoped that at some stage we will also be able to incorporate this information into a GIS using GPS. Similarly, publication of the local knowledge will provide information on use and diversity of crop, farmer-preferred traits,

problems associated with ricebean and so on, to allow the incorporation of this with scientific knowledge and so contribute to crop improvement.

The molecular material, the responsibility of CAZS-NR and NARC, is somewhat complicated as markers will be developed using existing material obtained under an MTA, Primer sequences and markers will be placed in the public domain, and any tests for distinguishing varieties will be available under a licence, subject to the necessary agreement of these other parties.

The core of the nutrition WP is to establish better knowledge of a variety of South Asian diets, and the role of pulses and in particular ricebean in that. These data are presently largely unknown and will fall into a basic research category but can be crucial for further research on nutrition intervention and impact analysis of agrarian change. UB will take responsibility for this aspect of the project, but again the data will be in the public domain.

Overview table

Exploitable Knowledge (description)	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable for commercial use	Patents or other IPR protection	Owner & Other Partner(s) involved
Analysis of consumer demand for ricebean and other legumes	Market-price based Legumes Trait Value Index for ricebean	Plant breeding, food industry	Not commercial	Not applicable	Public domain
Better knowledge of a variety of S Asian diets, and the role of pulses, particularly ricebean	Information	Nutritional research Impact analysis of the value of agrarian change	Not commercial	Not applicable	Public domain
Cultivation practices and associated information	Booklet of ricebean in English and farmer friendly language (Nepali)	Farming communities, agriculture	2008-09		Farmers' group, partners
Germplasm of improved varieties of ricebean and associated knowledge	1. Seeds of agronomically improved varieties	Agriculture and food security	2010	Materials transfer agreement or licence	All partners and participating farmers
	2. Molecular markers	Plant breeding	2010	Materials transfer agreement	CAZS-NR, NARC
	3. Test to distinguish between varieties	Food industry, government, plant breeders	2010	Licence	CAZS-NR, NARC
	4. Seeds of varieties with better nutritive content	Food industry, hotels and restaurants Nutritional security	2009	Materials transfer agreement or licence	All partners and participating farmers

Exploitable Knowledge (description)	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable for commercial use	Patents or other IPR protection	Owner & Other Partner(s) involved
Knowledge of the supply-chain for ricebean and other legumes	Hedonic demand function for legumes	Food industry, agriculture, government	Not commercial	Not applicable	Public domain
Local knowledge regarding ricebean diversity and uses	Published document on analysis of local knowledge associated with diversity and uses	Food security and crop improvement	2009	Not applicable	Farmers and farmers, group
National distribution of ricebean	Published document on Distribution of ricebean in India and Nepal	Agriculture and food security	2009	Not applicable	Government Organizations, GVT, India
Ricebean crop and project information	Project information brochure in Nepali language	Farming community, agriculture	2008-09	Not applicable	Farmers, District Agriculture offices and public domain
Ricebean crop information, associated knowledge and findings of the project	A video documentary on ricebean and associated information in English and Nepali	Agricultural research, food security, farmers and researchers	2008-09	Not applicable	Farmers, District Agriculture offices and public domain
Ricebean germplasm and associated knowledge	Most promising farmer preferred landraces	Agriculture (food security); crop improvement	2009	Not applicable (public domain	Public domain, GVT, India
Understanding of ricebean diversity and its distribution	Documentation of national distribution Documentation of local knowledge	Plant breeding, genetic resources, biodiversity, food security	Not commercial	Not applicable	Public domain

Section 2 – Dissemination of knowledge

Overview table

Planned/actual dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible /involved
November 2006	On-farm demonstration	Farmers	Nepal	60	LI-BIRD
December 2006	Project web-site: www.ricebean.org	Scientists, development workers, general public, government	All	Thousands	CAZS-NR with other partners
February 2007	Conference	Economists	All	< 100	CAU
April 2007	Seeds of promising accessions	National partner	Nepal		NARC, LI-BIRD
May 2007	Ricebean crop and project information (display in All Nepal Farmers' Convention)	Farmers and public	Nepal	Hundreds	LI-BIRD
May 2007	Training / workshop	Researchers	Nepal	< 100	NARC
May-June 2007	Project information brochure published	General Public	Nepal	Thousands	LI-BIRD
May 2007	National distribution of ricebean in India and Nepal (D2.1) compiled, submitted and posted on web	Project partners	Nepal and India		LI-BIRD, GVT, AAU, CHSKPAU, CAZS-NR
June 2007	Article in UK parliamentary magazine	MPs, ministers, opinion formers	Mainly UK but also outside	Hundreds	CAZS-NR
September 2007	Conference	Research / higher education	India	Hundreds	AAU, CSK HPKV
September 2007	Conference – oral and poster presentation	Scientists, higher education, development workers	All	< 100	CAZS-NR
October 2007	Press release (press/radio/TV)	General public	India and Nepal	Thousands	GVT, AAU, CSK HPKV, LI-BIRD
October 2007	Flyers	General public	India, Nepal	Thousands	AAU, CSK HPKV, GVT
October / November 2007	Training course	Farmers and villagers	India	450	CSKHPKV
November 2007	TV news item	Farmers	Nepal	Thousands	NARC
November-December, 2007	Media briefing	General public	India and Nepal	Thousands	GVT, AAU, CSK HPKV, LI-BIRD

Planned/actual dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible /involved
January / February 2008	Exhibition	Farmers, consumers, traders, processing industries, researchers, development workers	India	Thousands	AAU, CSK HPKV, GVT
February 2008	Information of crop, landraces, nutrient value and importance (Through agro-fair)	Farmers, researchers and general public	Nepal	45,000	LI-BIRD
February 2008	Ricebean recipes and nutrient value (through food fair of underutilised species)	Farmers, consumers, researchers and general public	Nepal	Thousands	LI-BIRD
March 2008	Project information (through published organizational calendar)	General public	Nepal	Thousands	LI-BIRD
March 2008	Project information updated (in organization web site)	General public,	All	Thousands	LI-BIRD
March 2009	Local knowledge documentation and analysis report (D2.2) submitted	Project partners, farming communities	Nepal		LI-BIRD, GVT, AAU, CHSKPAU, CAZS-NR
March 2007	Documentation on polymorphic markers (D3.1) submitted	Project partners, researchers	Nepal, India	Hundreds	NARC, CAZS-NR
June 2008	Conference poster on opportunities for ricebean as a niche crop	Scientists, higher education, development workers	All	< 100	CAU
February 2009	Wikipaedia page	Scientists, development workers, general public, government	All	Thousands	CAZS-NR
2008 onwards	Scientific journal publications	Scientists	All	Hundreds	All
2008 onwards	Direct e-mailing	Scientists, higher education, government, development workers	All	< 100	CAZS-NR
2009 onwards	Film/video	Scientists, development workers, general public, government	All	< 100	CAZS-NR with partners

Planned/actual dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible /involved
2009 onwards	Information on Cordis	Scientists, higher education, government, development workers; general public	All	Thousands	CAZS-NR
March 2009	Documentation on nutrient content of ricebean submitted	Project partners, researchers	Nepal, India	Hundreds	UB
February 2009	Conference paper on MLTVI	Scientists, higher education, development workers	All	< 100	CAU / GVT
March 2009	Conference paper on ricebean nutrient content	Scientists, higher education	All	< 100	UB

On-farm germplasm evaluation trials were visited by project staff at the tours held before the initial workshop, and after the second annual workshop, and a number of farmers their families participated in the event, discussing ricebean with the project staff. In 2007 project staff attended two conferences, one in the UK in September, and one in India. These brought the project activities to a wide audience. A number of the scheduled dissemination activities for the first year were postponed as a result of the late start to the project activities but began in year 2 and continued through year 3. We intend to try to develop a mechanism of mentoring with the participating communities after the completion of the project, and if possible to conduct a separate impact assessment five years post-project. This will be carried out by LI-BIRD in Nepal, and funds will be sought to allow the same to take place in India. We remain strongly of the opinion that outcomes should be subject to intensive upscaling efforts both during and after the project.

Website

The website http://www.ricebean.org has received over 10,000 hits (as at 1 May 2009). Content so far includes staff and institutional profiles, project reports, presentations and deliverables, a project description, background information about ricebean, page on the nutritional aspects and on hill farming in S Asia, and a comprehensive bibliography on ricebean and related species (in particular other *Vigna* spp. and *Phaseolus vulgaris*), as well as links to either abstracts or to full papers where copyright restrictions permit. Attempts are being made to enable the comprehensive bibliography, now containing 1600 references on ricebean and related species (in particular other *Vigna* spp. and *Phaseolus vulgaris*) to be made available through the ZOTERO add-on to Firefox, so that other users outside the project can access it in that format. A recent addition was the MPhil thesis of a Nepali student working in Bergen and a page on hill farming in NE India.

Networking activities

Contacts have been continued with the All-India Coordinated Research Project on Underutilised Crops of the Indian Council of Agricultural Research, and Dr Yadavendra was invited to give a presentation at their Network Meeting in New Delhi in May 2008. Project staff from India and Germany attended the International Conference on Grain legumes held in Kanpur, India in February2009. In Nepal, linkages have been continued with a range of NGOs and with ICIMOD. Dr Andersen gave a presentation at the Annual Meeting of the American Association of

Geographers in Las Vegas in March 2009. In Nepal, linkages have been made with several NGOs: the SUPPORT Foundation (a local NGO in the far-west), and the Rapti Agriculture Graduates Society (RAS)-Nepal (a local network of agricultural graduates in the mid-western region of Nepal), as well as with the International Centre for Integrated Mountain development (ICIMOD). We developed other relationships with farmers' groups and government Agricultural Development Offices in Nepal. A number of scientific and technical meetings have been attended (Table A1-1).

Table A1-1: Participation in national and international group meetings/symposia

Period	Event	Organizer	Venue	Participants
15 – 17 May, 2007	1st International European Forum on Innovation and System Dynamics in Food Networks		Innsbruck-Igls, Austria	Prof RAE Mueller, Ms D Buergeldt
May 2007	Workshop on species diversity mapping	Western Terai Landscape Conservation Programme, Nepal		Dr Jwala Bajracharya
3 – 4 Sept, 2007	5th International Symposium on Underutilised crops,		Southampton University, UK	Dr PA Hollington, Dr KD Joshi
17 – 20 April, 2008	National group meeting of AICRP on Forage Crops	Project Coordinator, AICRP on Forage Crops, ICAR, Jhansi	MPKV Rahuri, Maharashtra, India	Dr Naveen Kumar Dr Seuji B. Neog
June 2008	Int. Sci. Conf. "Agri-Food Business: Global challenges, innovative solutions		Halle, Germany	Buergelt, von Oppen and Mueller
12 – 14 Ma, 2008	National group meeting of Network on Underutilized Crops	Project Coordinator, All India Network on Underutilized crops, NBPGR, ICAR, New Delhi	Zonal Research Station, Rajasthan Agric. University, Jodhpur, India	Dr JP Yadavendra
12 – 14 Sept, 2008	National group meeting of AICRP on Forage Crops	Project Coordinator, AICRP on Forage Crops, ICAR, Jhansi	ANGRAU Hyderabad (AP) , India	Dr Naveen Kumar Dr Seuji B. Neog
12 – 14 Feb, 2009	International Conference on Grain Legumes	Director, Indian Institute of Pulses Research, ICAR, Kanpur	IIPR, Kanpur, India	Dr JP Yadavendra; Ms D Buergeldt
22 – 27 Mar, 2009	Doing away with biodiversity: farmers' preferences in cultivation of ricebean in Asia	American Association of Geographers	Las Vegas	Dr P Andersen
April 5-7, 2009	National group meeting of AICRP on Forage Crops	Project Coordinator, AICRP on Forage Crops, ICAR, Jhansi	Anand Agric. University, Anand, India	Dr Naveen Kumar Dr Seuji B Neog

Project staff continued to participate in various electronic discussions and mailing lists as noted in the previous reports, and the Mountain Forum and Asia Pacific Mountain Network were added to the list. Project deliverables, and a summary of the work on ricebean, are posted at the GFU website http://www.underutilized-species.org/default.asp

Farmer and community activities

In 2007/08, Dr Naveen provided 25 demonstrations of promising ricebean lines in different areas of Himachal Pradesh. A number of focus group discussions and farm field days on ricebean at different places of project area in India were conducted during the crop season and after harvesting of the crop, and 20-40 farmers attended each of these programmes. Three field days were organised by GVT, and two each by CSKHPKV and AAU, while GVT organised three, and CSKHPKV two, focus group discussions. AAU held an exhibition in which ricebean was featured, while a number of demonstrations with farmers to show ricebean growing as a mixed crop with maize were held, including 52 in Himachal Pradesh. In Nepal, the various mother and baby trials are acting as demonstrations, and in India GVT carried out a large-scale demonstration and seed production trial. Stakeholder groups, including farmers, government staff, etc., did participatory monitoring of all project sites in India and Nepal.

Focus group discussions (FGD) and field days on ricebean at different places in India were conducted during the 2008/09 crop season and after harvesting of the crop (Table A1-2), and 20-40 farmers attended these.

Table A1-2 Details of field days and FGDs conducted in India during 2008/09:

	Field day	**FGD**	**Exhibitions**	**Demonstrations on farmers fields (sole rice bean/intercropped with maize)**
GVT	4	7	-	5
ASSAM	-	3	-	15
HP	-	32	-	32 +10*

***Intercropped with Maize

At AAU, demonstrations of ricebean grown as a sole crop were held in 15 sites in Ramenghi Village (Karbi Anglong District), and 6 each in Kasari Gaon and Dubi Gaon, (Golaghat District). In addition, 32 one day interaction camps were held, also in these Districts. These looked at ricebean production technology, utility and quality aspects. Two popular articles were published in the local press, one in Assamese, and one in Karbi. Two leaflets were published in English, 2 in Assamese and 1 in Karbi.

A large number of dissemination activities were undertaken by CSKHPKV during *Kharif* (summer) 2008. Thirty two involved sole crops of ricebean, and 10 mixed crops with maize. They were held at Trilokpur and at Pahra and Bahura, in Kangra District, and at Ladruhin (Mandi District). In addition, one-day interaction camps with farmers were held in Ladruhin and Trilokpur, covering ricebean cultivation, while 14 were held in Khundian and 16 in Trilokpur on nutritional aspects, for example organoleptic tests and to educate villagers on the qualitative importance of ricebean. One article in Hindi was submitted for publication in a university magazine.

LI-BIRD has been analyzing new and existing strategies that allow for the broadest possible dissemination of knowledge. It has taken multiple approaches, each suitable to different categories of target groups. The project has two major target groups; the first is the poor and marginalized rural farming community, and the second one is the research community and different organizations who play a key role in raising awareness and support the farming

communities. Depending upon we have visualized different means of dissemination to convey the message to different target groups.

Awareness raising campaign

Mass awareness campaigns play a key role in raising farmers' levels of understanding and bringing positive change in them. Such campaigns can use any media to disseminate a sequence of basic messages on a particular topic in a coordinated fashion aimed at a loosely segmented target population, although careful planning is necessary first.

In October and November 2007, Dr Kumar organised awareness-raising sessions in eight villages in two districts of HP. Around 450 farmers and villagers (both males and females) took part, and received nutritional advice on the importance of pulses and vegetables in the diet, and were shown different methods of preparation for ricebean. Out of ten products or preparations offered, there was interest in seven.

LI-BIRD organized a two-day nutritional awareness campaign in two VDCs in Gulmi district, to raise awareness on the role ricebean could play in family nutrition. The first was in Darbar Devisthan VDC on 1 January 2009, where 36 farmers participated (Annexe 8), and the second in Simichaur VDC on 2 January 2009, with 48 farmers (Annexe 7). The FOSRIN team initially briefed farmers on ricebeans's nutritive value. Then, farmers and the team discussed local ricebean recipes. Finally, women farmers prepared local recipes such as *batuk*, *biramla*, *pakaura*, *selroti*, and *furaula*. All the participants were satisfied with the taste of the local recipes, and assured the team that they would henceforth include ricebean in their normal diet.

Exhibitions

In Nepal, LI-BIRD participated in the All-Nepal Farmers Conference, with a stand to show ricebean samples and highlight the activities of the project in 2007. Over 10,000 farmers from throughout the country attended. LI-BIRD also maintained a ricebean exhibition in the conference hall at their headquarters in Pokhara.

Mr AR Khanal from LI-BIRD participated in and displayed ricebean samples and nutritional information, and organized a display of ricebean recipes in the Agro fair held from 8-11 February 2008 in Butwal, Nepal. The Fair was inaugurated by the Honourable Minister for Agriculture and Cooperatives, Mr. Chhabilal Bishwakarma, and a total of 45 Agro Enterprises, organizations and farmers' groups exhibited. The fair was attended by around 45,000 visitors. Twenty diverse ricebean samples collected from various parts of Nepal with differing seed size and colour were displayed along with relevant information (Figure A1-1). Visitors were surprised by the diversity of the ricebean seeds, and requested information on the nutritional value: some also asked for seeds of their preferred varieties.

A flex-printed poster (1200 x 1800 mm) entitled "*Bahupayogi Jhilunge Bali: Samrachhan ra Prabardhan Garaun*." (Let's conserve and promote our traditional multipurpose crop ricebean) was displayed (Figure A1-1) in the fair. Information and importance of ricebean crop were mentioned in the poster.

Figure A1-1: Display of ricebean samples in the fair (left) and flex-printed poster (right)

Figure A1-2: Food fair organized by LI-BIRD during agro-fair (left) and *Batuk*, a popular recipe prepared from ricebean (right).

On 10th February 2008, a food fair for underutilized species was organised in collaboration with *Bhuneshwor Gharbagaicha mahila Krishak Samuha* (Women farmers' group of Rupandehi). Recipes were displayed with preparation techniques and information on the crop (Figure A1-2), recipes including *Batuk, Biramala,* and local recipes of the Tharu ethnic communities such as *Dhikari*, *Anadi ko Bhuja* were offered to the visitors and their responses collected.

Visitors were interested in the diversity of ricebean recipes available, and the display of ricebean information and its nutritional value made them aware of the hidden treasure of this traditional crop. Most visitors requested more information on ricebean. The Fair seemed to be supportive in two way communication for sharing experiences about ricebean between researchers and farmers (Figure A1-3). Beside, we prepared different recipes from ricebean and offered to visitors to taste them. The Food Fair showing different recipes not only made rural visitors inquisitive, but was equally helpful to spread ricebean more than locally popular in urban areas, and some visitors asked for seeds of their preferred landraces.

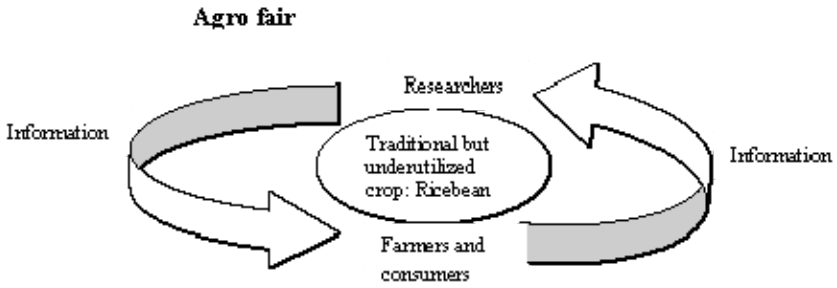


Figure A1-3. Model for information sharing between researchers and farmers through agro-fair.

LI-BIRD participated in an agro-fair organized by Lekhnath Chamber of Commerce from 22 January to 31 January, 2009 in Bhandardhik of Lekhnath Municipality, Kaski district. *Namuna Prangarik Krishi Sahakari Sanstha* (a farmers' co-operative) of Arba Vijaya VDC of Kaski district collaborated with the FOSRIN team to spread information on ricebean. The combined team rented a stall in the agro-fair. The co-operative displayed various organic products prepared by the local farmers of Arba Vijaya. The FOSRIN project displayed a poster with broad information on significance of ricebean. Sample seeds of 12 ricebean accessions from mother trials of 2008 season and 21 accessions from observation nursery of 2008 season were also demonstrated. In addition, FOSRIN project brochures in English and Nepali were distributed to interested people. Some people were surprised to see colourful ricebean varieties, while others wanted to purchase seed materials. The FOSRIN team of LI-BIRD was successful in disseminating knowledge on ricebean through this agro-fair.

A demonstration agro-fair was organized for six days by All Nepal Farmers' Association affiliated to Communist Party of Nepal-UML in Butawal of Rupandehi district during the eighteenth general convention of the party from 16 to 21 February, 2009. Thousands of people from all over Nepal had gathered in Butwal to participate in the general convention. Thus, Farmers' Association took the opportunity to organize the demonstration fair in this town. LI-BIRD participated to deliver information on its role in agriculture development in Nepal. Many rice varieties in pipeline developed by LI-BIRD through participatory plant breeding (PPB) and two pipeline maize varieties were displayed. The FOSRIN project exhibited seed samples of 12 accessions along with related information. It was a good experience that many people were curious to know more on ricebean.

Value addition

LI-BIRD has also developed the idea of promoting ricebean through value addition, by involving specialists from Pokhara Tourism Training Centre in this activity. This is on-going, and we are very optimistic for a positive output. This is expected to create a new pavement for promoting ricebean far and wide.

Publications

Although no journal articles have yet been produced the project has produced a number of scientific publications to date:

1) Mueller, R.A.E., Buergelt, D. and Seidel-Lass, L. (2007): *Supply Chains and Social Network Analysis.* Paper presented at the 1st International European Forum on Innovation and System Dynamics in Food Networks, 15.-17.2.2007, Innsbruck-Igls, Austria.

2) Joshi, K.D., Bhandari, B., Gautam, R., Bajracharya, J. and Hollington, P.A. (2007) *Ricebean: a multipurpose underutilised legume*. Paper presented at the 5th International Symposium on Underutilised crops, Southampton University, UK, September 3-4, 2007.

3) Gautam, R., Kumar, N., Yadavendra, J.P., Neog, S.B., Thakur, S., Khanal, A., Bhandari, B. and Hollington, P.A. (2007) *Distribution of ricebean in India and Nepal.* Food Security through Ricebean Research in India and Nepal (FOSRIN) Report 1. Pokhara, Nepal, Local Initiatives for Biodiversity, Research and Development and Bangor, Wales, UK, CAZS Natural Resources, College of Natural Sciences, Bangor University, 30 pp.

4) Bajracharya, J., Singh, S., Dangol, B., Hollington, P.A. and Witcombe, J.R. (2008) *Identification of polymorphic markers in ricebean* (*Vigna umbellata*) Food Security through Ricebean Research in India and Nepal (FOSRIN) Report 2. Kathmandu, Nepal, Nepal

Agriculture Research Council and Bangor, Wales, UK, CAZS Natural Resources, College of Natural Sciences, Bangor University, 20 pp

5) Buergeldt, D; Mueller, RAE & von Oppen, M (2008) Contributions from economics towards the improvement of an under-utilized pulse in Nepal and India. Proc. Int. Sci. Conf. "Agri-Food Business: Global challenges, innovative solutions. Halle, Germany

6) Andersen, P (2009) *Doing away with biodiversity: farmers' preferences in cultivation of ricebean in Asia*. Presented at the Annual Meeting of the American Association of Geographers, Las Vegas, March 2009

7) Buergeldt, D (2009) *Quality parameters in relation to consumer's preference in ricebean*. International Conference on Grain Legumes: Quality Improvement, Value Addition and Trade held at IIPR, Kanpur, India, February 14-16, 2009

8) Andersen, P (2009) *Nutritional qualities of ricebean.* Food Security through Ricebean Research in India and Nepal (FOSRIN) Report 3. Department of Geography, Universitat Bergen, Norway, 13 pp.

9) Khanal, A.R., Khadka, K., Poudel, I and Hollington, P.A. (2009) *Farmers' local knowledge associated with the production, utilization and diversity of ricebean (Vigna umbellata) in Nepal*. Food Security through Ricebean Research in India and Nepal (FOSRIN) Report 4. Pokhara, Nepal, Local Initiatives for Biodiversity, Research and Development and Bangor, Wales, UK, CAZS Natural Resources, College of Natural Sciences, Bangor University, 30 pp.

Other publications

10) Hollington, P.A. (2007) Ricebean Network: research to promote the adoption of "orphan" crops to improve food security in marginal areas. *The House Magazine*, June 2007, pp 54-55.

11) Kumar, N., Bhandari, J.C., Thakur, S.J. and Chahota, R. (2007) *Successful production of ricebean in north-western Himalaya*. Fodder Production and Grassland Management Centre, CSKHP Agriculture University, Palampur, India. 6 pp. (Also available in Hindi)

A number of other publications have also been produced (brochures were attached to the First Interim Report):

- Popular article published in Assamese Daily.
- Leaflets in three languages (Assamese, English and *Karbi*)
- Bulletin published in Assamese and English.
- A brochure also made, containing the ricebean cultivation package and practices which may be useful to ricebean growers and also help to disseminate of our project activities in the target area by GVT
- Two pamphlets published from Palampur on ricebean cultivation
- An article (submitted with the First Interim Report) has appeared in the UK Parliamentary magazine, "The House" with wide circulation among opinion formers.
- LI-BIRD produced and distributed a project information brochure in Nepal, and uploaded project information to their website.
- In HP, Dr Naveen has produced extension booklets in English and in Hindi covering ricebean, as well as a popular article in Hindi, and a Hindi article for the CSKHPKV university magazine.
- A general project brochure has been produced in Bangor, and templates circulated to partners for more specific WP-related ones.
- We have produced a template for a FOSRIN poster.
- A leaflet on traditional dishes prepared from ricebean

A FOSRIN project brochure in Nepali was published by LI-BIRD in July 2008 to deliver information on the project, its objectives, major activities and partners.

LI-BIRD has published a poster to flow information on ricebean. This includes a poem on the significance of ricebean, and urges farmers to cultivate and conserve it. A total of 1000 copies have been produced. These will be distributed to farmers, farmers' groups, community based organizations (CBOs), schools, colleges (priority to agriculture colleges) and different organizations involved in agriculture development.

LI-BIRD has also published two booklets on cultivation practices of ricebean in Nepal. One is in English and the target groups are students, researchers and various organizations involved in agriculture research and development. The other booklet, in simple terms, is published in Nepali and the target groups are literate farmers. For both, 500 copies have been published.

A project desk calendar was also brought out by GVT in 2008 for the dissemination of our project activities among the stakeholders and farmers. LI-BIRD also highlighted the project in their calendars for Nepali years 2064 (April 2007 – April 2008) and 2065 (April 2008 – April 2009). Each year, over 1000 copies of this are published.

Press, TV and radio

In Nepal, hardly any newspapers prioritize news related to agriculture, although some national newspapers give some space to agriculture. 'The Kantipur Daily' is the most popular daily newspaper in Nepal, and on Sundays it devotes a column to agriculture. LI-BIRD published an article on ricebean in this paper on 19 January, 2009, possibly this was the first time that any national media covered detailed information on ricebean. The article focussed on the initiative taken by the farmers of Gulmi to conserve ricebean in their farms.

कान्तिपुर दैनिक, माघ ५, २०६५ Kantipur, Nepali National Daily, Sunday, 13th Jan, 2009

लोपोन्मुख बालीको संरक्षणमा जुटे कृषक

■ ज्ञानश्याम गौतम

गुल्मी, ४ माघ- सरकारी संरक्षण अभावमा लोपोन्मुख हुँदै गएको बहुउपयोगी कोसेबाली भस्याङको संरक्षण गर्न यहाँका कृषक जुटेका छन् ।

पोषण युक्त दानादार बालीका रूपमा चिनिने भस्याङ खेती लोपोन्मुख बाली बन्दै गएको छ । जिल्लाका अधिकांश गाविसमा लगाइने यो बाली पछिल्ला वर्ष हराउँदै गएपछि मिमीचौर र दरबार देवीस्थानका किसान संरक्षणमा जुटेका हुन् ।

प्रशस्त मात्रामा पाइने, कुपोषणको समस्या भएको अवस्थामा भस्याङसहित पोषक तत्व बालुवाका रूपमा समेत प्रशस्त रहेको छ । प्रोटिनको महत्वपूर्ण स्रोत मानिने यो बालीको झ्याउ र कुनाउरी ।कुनाउरी: गाईवस्तुका लागि समेत पौष्टिक आहार हो ।

यसमा प्रोटिन र कार्बोहाइड्रेटका अतिरिक्त मिथायोनिन तथा ट्रिप्टोफ्यानजस्ता एमिनो एसिड पाइनुका साथै थायमिन, नियासिन, रिबोफ्लाविनजस्ता भिटामिन पनि पाइन्छ । कुपोषणको समस्या भएको अञ्चलमा भस्याङ खेती गरेका छन् ।

दरबार देवीस्थानमा पनि ७० घर परिवारले परीक्षणकै रूपमा खेती गरेका छन् । लि-बर्डका सामुदायिक संगठक बलभद्र पौडेलका अनुसार पछिल्लो समयमा सरकारले यस क्षेत्रलाई प्राविधिक सहयोगबाहेक सबै तरा कटौती गरेको छ ।

दानादार कोसे बाली भएको र वर्षा कम हुने तथा रुखो पाखाबारीमा समेत हुने भएकाले धेरै कृषक यस खेतीतर्फ आकर्षित भएको लि-बर्डले जनाएको छ । यो बाली अन्तरप्रणाली अन्तर्गत पनि उत्पादन हुने चाली हो । 'मेकीभित्र लगाए पनि हुने रहेछ,' सिमीचौरकी कर्की कृषक सरिता लिकले भनिन्, 'राम्रो हुन्छ भनेर निःशुल्क बीउ दिएपछि लगाएकी हुँ ।'

मालिका बहुउद्देश्यीय संस्थाका अनुसार मिमीचौर गाविसमा मात्र यस वर्ष करीब ३५ किलो बीउ उत्पादन भएको छ । परीक्षणका रूपमा २ सय ६० जातका बीउ लगाएकामा त्यसबाट छनोट भएका १२ जातका बीउलाई मात्र अझैसम्म 'मात् परीक्षण' का रूपमा लगाएको उनीहरूले बताए । पोषणयुक्त भस्याङबाट गाई घरमा चहक, विरौला, मस्यौरा, दाल, ज्यौंदी, रोट, खिचडी, फुरीलालगायत परिकार बनाउन सकिन्छ ।

त्यस्तै यसको झ्याउ र कुनाउरीसमेत गाईवस्तुका लागि निकै पौष्टिक वस्तु मानिन्छ । किलिङ्गेको कुनाउरो र झ्याउ पकाएर खुवाएमा गाई-भैंसीले दूध बढाउँछन्,' शान्तिपुरका कृषक सुन्दिवर गौतमले भने, 'हरे पछिल्ला वर्षमा खेतका डिलमा हुन छोडेपछि यसको खेती गै हराउन थालेको छ । संरक्षण आवश्यक भएको पनि उनले बताए । यो बाली रुखो जमिनलाई मलिलो बनाउने, भू-क्षय रोक्न महत्व गर्ने तथा भौसमको विविधतालाई सहनसक्ने क्षमता रहेको बालीको रूपमा समेत चिनिन्छ ।

Plate 1. Article published in The Kantipur Daily news paper.

LI-BIRD has taken an initiative to develop a documentary on ricebean. This revolves around the experiences and lessons which have emerged during project implementation, and has been prepared in both Nepali and English languages. The one in Nepali will be used to deliver information to the rural farming community and the one in English will be shared with different project partners, GOs/NGOs etc. The documentary will also be displayed in the project website

and shown in national and local televisions. We hope that this initiative will shore up wide distribution and dissemination of knowledge, wisdom on uses of ricebean.

Among all electronic means of communications radio is the easiest media to transfer information in any community, particularly to rural and illiterate people. In Nepal, FM radio is particularly useful in reaching rural communities. The Nepal FM network consists of 49 FM radio stations, and is proposing to broadcast a programme on FOSRIN. The Regional Broadcasting Centre of Far Western Development Region of Nepal (part of the national radio service) is also proposing a programme on ricebean. The financial implications of these are currently being discussed, and we hope that the programme will be broadcast over the next ricebean season.

During the preparation phase for this, LI-BIRD approached various community FM stations in Chitwan, Gulmi and Pokhara districts. One of these, "Radio Chitwan 94.4" M Hz agreed to broadcast two episodes on ricebean. The first, based on food security issues in relation to ricebean, was on 31 January, 2009 and the second, related to the overall importance of ricebean, on 18 March, 2009.

Dr Bajracharya participated in the Nepalese TV Agricultural News Programme on November 23, 2007 concerning FOSRIN and the activities going at Khumaltar and other research sites, as well as a brief introduction of the crop itself. She also gave a talk in 2007 to scientific and technical staff in the ABD, NARC about FOSRIN and its on-going activities in NARC and other partner institutions.

Section 3 - Publishable results

Not applicable at this stage: published results without exploitable potential are listed in Section 2.

Annexe 2: Evaluation of selected genotypes of ricebean landraces of Nepal, 2008

Introduction

Two hundred and eighteen accessions of ricebean collected from different districts of the country in early 1970's and in 2006 were evaluated in 4 different production environments for agro-morphological characterization and genetic diversity. The accessions were categorized into core and non-core collection for agro-morphological characterization in 4 sites: Gulmi (on-farm), Khumaltar, Kavre and Rampur on respective research stations in 2007. The best performed accessions under these two evaluation trials were selected for further evaluation for yield traits in 2008. Selected accessions from core collection will be further tested in mother trial across the sites and those from non-core collection will be included in observation nursery for further testing across the sites.

Objectives:

- to evaluate the selected genotypes for yield potential traits
- to identify the superior genotypes for further enhancement and identify as cross parents for improvement of genotypes

Expected output:

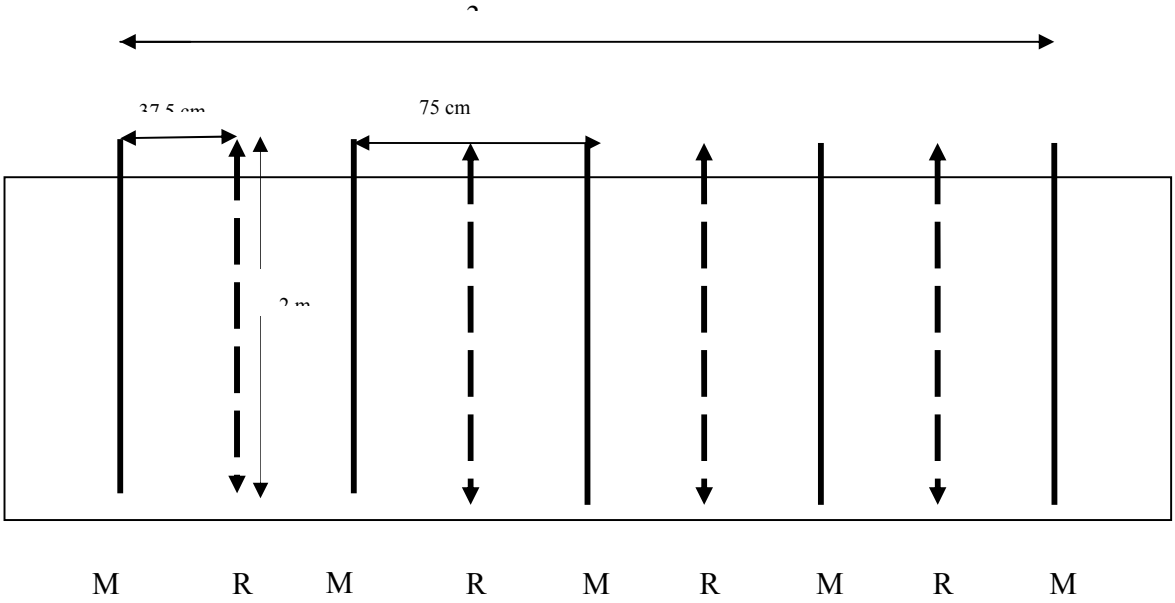
Superior genotypes with desired traits will be identified and multiplied for seed further evaluation in different locations.

For these objectives and outputs, following research projects and production programme were planned and developed the protocol by Nepalese project team in the meeting held at CIMMYT on 20 April, 2008.

1 Mother trial intercropped with maize

Twelve best performed accessions in the field trial of agro-morphological characterization of core collection on 4 different project sites were selected. These accessions were selected on basis of few quantitative traits with significant variation among the genotypes under study. These traits were plant height, number of pods per plant, pod length, days to maturity, grain yield, number of seeds per pod and 100 seed weight. The accessions with higher scores for these traits in matrix analysis were selected as best genotypes and included in mother trial for further evaluation. These genotypes will be assessed for yield contributing traits under maize intercropping in research farms and farmer's fields across the project sites at Gulmi, Tanahu, Sindhuli, Ramechhap, Dolakha, Khumaltar and Rampur. The materials and process/methods/steps will be carried as per the details described below:

Particulars	**Trial details**
Number of accessions	12 accessions from core collection (Accessions details in Table 1 below)
Number of trials	15 on-farm–3 trials at each site- Darbar, Simichaur (Gulmi), Tanahu and Sindhuli under LIBIRD; Ramechhap under (NARC) 3 On-station – ABD Khumaltar; HCRP Dolakha and NGLRP, Rampur, under NARC (RCBD with 3 replications)
Trial design	1 farmer-1 replication for on-farm trials RCBD with 3 replications for on-station trials
Plot size (4 rows per plot)	6 m^2 (2 x 3) per accession (4 rows of 2 m long)
Spacing	Maize crop: 75 cm x 50 cm (4 rows of 2 m length) Ricebean: 75 cm x 50 cm (4 rows of 2 m length; 16 plants/plot)
Land preparation, manures and fertilizers	As per farmers practice. (Record the quantity of FYM or compost used). Do not apply chemical fertilizers
Time and method of planting	Normal time of planting: third week of April (Baisakh 2nd week) for maize and plant ricebean after one month of planting maize Plant maize and ricebean in alternate but continuous rows Dibbling of ricebean in between maize rows after first digging (30 days after maize seeding) in a spacing of 0.75m x 0.5 m
Variety of maize used	Any improved variety adapted in the area
Plant Population per plot	16 ricebean plants per plot
Seed rate	For both the crops, plant two seeds per hill but retain only single plant after full establishment in case of ricebean
Intercultural operations	One weeding of maize before ricebean seeding as per farmers practice One weeding for ricebean at the time of maize earthing up No need for any other intercultural operations Staking provided for accessions as per need otherwise maize plant will be used for staking
Harvesting, threshing, storage	As per the farmers practice. Avoid any chance of varietal mixtures during harvesting, threshing and storage. Sun dry seeds thoroughly and store in air tight containers, e.g. plastic bottles. Use naphthalene balls to avoid insect damage
Experimental data collection, computation and analysis	The observed data will be compiled and multivariate analysis will be carried and the results on agro-morphological diversity will be compared with genetic diversity at DNA level using SSR markers.



Note: M=Maize row and R=Ricebean row and plot size = 6 m^2

Figure 1. Field lay-out plan for mother trial of ricebean with maize intercropping

Table 1: **Details of accessions in mother trial, 2008**

Serial No	Accession No	Districts	Selected from
1	NPGR 00008 (LRGR 42)*	Nuwakot	Rampr and Kabre
2	NPGR 00015	Bhaktapur	Rampur and Khumatar
3	NPGR 00076	Arghakhanchi	Kabre and Khumaltar
4	NPGR 00194	Dolakha	Kabre and Khumaltar
5	NPGR 05364	Bhojpur	Rampur
6	NPGR 05420	Dhankuta	Khumaltar
7	NPGR 06756 (LRGR 75)*	Humla	Poor in yield but included for determinate type
8	LRGR 91	Dang	Kabre
9	LRGR 99	Palpa	Rampur and Khumaltar
10	LRGR 103	Palpa	Gulmi (mother trial and core collection)
11	LRGR 111	Gulmi	Kavre
12	LRGR 117	gulmi	Gulmi (mother trial and core collection)

***** *Seed supplied by NARC insufficient / hence promising lines from Gulmi included in the mother trial set. The seed supplied by NARC was sufficient just for two trials.*

Agronomic traits to be recorded:

1) Date of planting, flowering and maturity and all phenological traits

2) Plant height at maturity (Average of five plants)

3) Pod length in cm

5) Number of pods per plant

6) Number of seeds per pod: (Five pods each from lower, Medium and upper strata of sample plant)

7) Total grain yield per plant: (Average of five sample plants)

8) 100 seed weight

9) Biomass yield

10) Disease and insect reactions

2 Observation nursery under sole cropping

*7 best performed genotypes from each of non-core collection agro-morphological sets from Rampur, Kabre and Khumatar study sites in total 21 seven genotypes were selected

** 12 best performing genotypes from core collection and 11 best performing genotypes from non-core collections at Gulmi study site in total 23 genotypes were selected.

These genotypes will be further evaluated in observation trial in 2008 season for their agronomic traits. This study will be carried on farm and on station under sole cropping.

Particulars	**Trial details**
Number of accessions	*21 accessions selected 7 each from 3 sets of non-core collections from Kabre, Rampur and master trial in Khumaltar (Accession details in Table 2 below) **23 accessions selected from core and non-core sets at Gulmi-2007 (Accession details in Table 3 below)
Design and plot size	Non-replicated observation nursery 2 rows of 3 m length (12 plants/plot)
Number of trials	*One in each location (Khumaltar, Kavre, Rampur, Gulmi and Tanahun) **Two replications at Gulmi
Land preparation	As per farmers practice
Manures and fertilizers	As per the farmers' practice (record the quantity of FYM or compost used). No need to apply chemical fertilizers.
Number of seeds per hill	Plant two seeds per hill but retain only single plant after full establishment Plant on raised bed to avoid any loss of plants due to water logging
Spacing	75 cm x 50 cm continuous plots
Intercultural operations	Keep the crop free from the weeds. Provide stakes for the indeterminate landraces. No need for any other intercultural operations
Harvesting, threshing, storage	As per the farmers' practice. Avoid any chance of varietal mixtures during harvesting, threshing and storage. Sun dry seeds thoroughly and store in air tight containers, e.g. plastic bottles. Use naphthalene balls to avoid insect damage
Experimental data collection, computation and analysis	The observed data will be compiled and multivariate analysis will be carried and the results on agromorphological diversity will be compared with genetic diversity at DNA level using SSR markers.

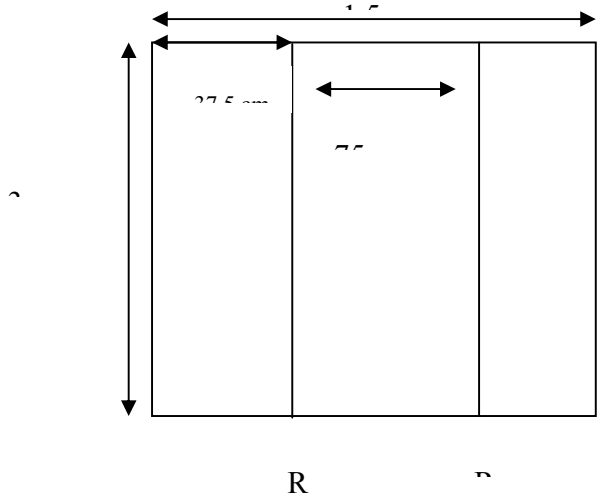


Figure 2: Field lay-out plan for Ricebean observation trial under sole cropping

Table 2*: Accession details in observation nursery, 2008 (NARC and LI-BIRD set)

Serial No	Accession No	Districts	Selected from
1	NPGR 00005	Nuwakot	Kabre
2	NPGR 00184	Kabre	Kabre and Khumaltar
3	NPGR 00191	Dang	Kabre and Khumaltar
4	NPGR 05422	Dhankuta	Kabre
5	NPGR 05424	Dhankuta	Kabre
6	NPGR 05383	Tanahu	Rampur
7	NPGR 05381	Lamjung	Rampur
8	NPGR 05425	Dhankuta	Rampur
9	NPGR 05367	Bhojpur	Rampur
10	NPGR 08381	Myagdi	Rampur
11	NPGR 05374	Goukha	Khumaltar
12	NPGR 05372	Gorkha	Khumaltar
13	NPGR 00189	Kabre	Khumaltar
14	LRGR 143	Kaski	Khumaltar
15	LRGR 153	Kavre	Khumaltar
16	NPGR 05410		Khumaltar
17	LRGR 87	Dang	Khumaltar
18	LRGR 113	Gulmi	Khumaltar
19	LRGR 123	Palpa	Khumaltar
20	LRGR 139	Kaski	Khumaltar
21	LRGR 133	Palpa	Khumaltar

**LI-BIRD- 2 replications (One at Darbar Devisthan, Gulmi and the other at Tanahun)*

**NARC- 3 replications (Khumaltar, Kavre and Rampur)*

Table 3*: Accession details in observation nursery, 2008 (NARC and LI-BIRD set)*

Serial No	Accession No	Districts	Selected from
1	LRGR43	Surkhet	Gulmi
2	LRGR44	Surkhet	Gulmi
3	LRGR73	Pyuthan	Gulmi
4	LRGR97	Nuwakot	Gulmi
5	LRGR107	Palpa	Gulmi
6	LRGR116	Gulmi	Gulmi
7	LRGR124	palpa	Gulmi
8	LRGR126	palpa	Gulmi
9	LRGR129	Palpa	Gulmi
10	LRGR130	Palpa	Gulmi
11	LRGR132	Gulmi	Gulmi
12	LRGR135	Palpa	Gulmi
13	LRGR138	kaski	Gulmi
14	LRGR148	Kavre	Gulmi
15	LRGR160	Kaski	Gulmi
16	NPGR-00007	Nuwakot	Gulmi
17	NPGR-01975	Baitadi	Gulmi
18	NPGR-05382	Tanahu	Gulmi
19	NPGR-06591	Mugu	Gulmi
20	NPGR-07583	Jhapa	Gulmi
21	NPGR-08380	Myagdi	Gulmi

***LI-BIRD- 2 replications (Darbar Devisthan, Gulmi)*

Agro-morphological traits to be recorded:

1) Date of planting, flowering and maturity and all phenological traits

2) Plant height at maturity (Average of five plants)

3) Pod length in cm

5) Number of pods per plant

6) Number of seeds per pod: (Five pods each from lower, Medium and upper strata of sample plant)

7) Total grain yield per plant: (Average of five sample plants)

8) 100 seed weight

9) Biomass yield

10) Disease and insect reactions

.

3. Seed multiplication of better performing accessions in mother trials under sole cropping in each study sites

Particulars	**Mixed planting with maize**
Number of accessions	12 entries of mother trial
Locations	ABD, Khumaltar; HCRP, Dolakha; NGLRP, Rampur and LIBIRD, (Simichaur and Darbar VDC of Gulmi)
All other details including plot size and design	Same as for the observation nursery under sole cropping and plot size could be changed as per the availability of seed of respective accessions.

DATA-SHEET
Collaborating farmer/research stations:
Altitude: **Plot size:**
Soil fertility status: (Low/ Medium/High)
Date of planting: **Date of harvesting:**

SN	Accessions #	Date of emergence	Date of 50% flowering	Plant height at maturity (cm)	Pod length (cm)	Days to maturity	Plant stand at harvest (no.)	Growth habit	No. of pods/ plant	No of seeds /pod	100 grain wt (g)	Grain yield/ plot	Total biomass yield	Seed colour	Disease (1-5)	Insect (1-5)	Overall ranking †
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	

Annexe 3: Off types seeds selected for evaluation for outcrossing, 2008

SN	Accession	Original colour	Colour of the off type	No of seed selected	Size of off type	Basis of selection
1	NPGR 00012	Yellow	Mottled	16	Large	Colour
2	NPGR 05364	Yellow	Brown	16	Medium	Colour
3	NPGR 05373	Brown	Black	16	Medium	Colour
4	NPGR 05386	Red	Mottled	16	Medium	Colour
5	NPGR 05396	Yellow	Mottled	16	Medium	Colour
6	NPGR 05420	Yellow	Black	16	Medium	Colour
7	NPGR 05423	Yellow	Yellow-Late in maturity but bold grain	16	Large	Selected due to size
8	NPGR 06657	Yellow	Yellowish brown	16	Large	Colour
9	NPGR 08382	Yellow	Mottled	16	Medium	Colour
10	LRGR 43	Yellow	Mottled	16	Medium	Colour
11	LRGR 107	Mottled	Light mottled	16	Medium	Colour
12	LRGR 129	Yellow	Mottled	16	Medium	Colour
13	LRGR 101	Mottled	yellow	16	Large	Bold grain type

Annexe 4: Protocol for winter adaptation ricebean trials

Introduction

Ricebean is a summer legume and the traditional practice to sow ricebean seeds is during July. However, the experiences during several field visits and knowledge shared among different people and FOSRIN partners a rare possibility of ricebean cultivation during winter season has been envisaged. Thus, a trial for winter season ricebean has been designed.

Lines selected for the trial

In order to test the possibility of ricebean cultivation during winter season altogether six promising lines has been selected (Table 1).

Table 1. Ricebean accessions selected for winter season planting

S.N.	Accession	Source district	Seed color
1	NPGR 00012*	Nuwakot	
2	NPGR 00194	Kavre	
3	NPGR 05420	Dhankuta	
4	LRGR 103	Palpa	
5	LRGR 111	Gulmi	
6	LRGR 117	Gulmi	

**note: seeds will be made available by NARC*

Trial details

In order to test these ricebean lines it may be a wise decision to set the trials at 3 major geographic locations in the terai belt. So, Jhapa, Chitwan and Dang have been proposed strategically. The trial at Chitwan will be coordinated by NARC and LI-BIRD will conduct trials in Jhapa and Dang. One of the NGO partners of LI-BIRD forward will be proposed to conduct a trial in Morang district.

Table 2. Details of ricebean trials for winter season

Particulars	Details
Locations	Jhapa (LI-BIRD), Morang (FORWARD), Sarlahi (NARC), Jitpur (NARC), Chitwan (NARC), Dang (LI-BIRD), Chitwan (NGLRP)
Number of replications	2
Plot size	2 m2
Spacing	Row to row- 50cm, plant to plant-25cm (4 rows of ricebean per accession)
Number of plants per accession per plot	16
Time of planting	Within November
Seed rate	2 seeds per hill

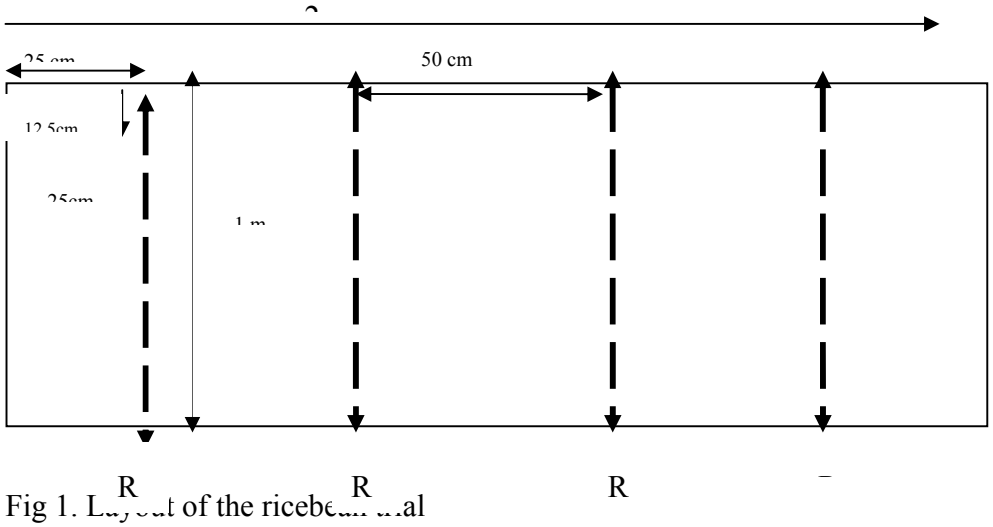


Fig 1. Layout of the ricebean trial

Trial layout- Replication I

LRGR 103	**NPGR 00012**	**LRGR 111**	**NPGR 00194**	**LRGR 117**	**NPGR 05420**

Trial layout- Replication II

NPGR 00012	**LRGR 117**	**NPGR 05420**	**LRGR 103**	**NPGR 00194**	**LRGR 111**

Data sheet

Name of the farmer:

Address:

Replication 1

Name of the entry	Date of sowing	Date of emergence	Number of plants retained	No of pods per plant	Pod length	Yield per plant (gm)	Yield per plot (gm)
LRGR 103							
NPGR 00012*							
LRGR 111							
NPGR 00194							
LRGR 117							
NPGR 05420							

Replication 2

Name of the entry	Date of sowing	Date of emergence	Number of plants retained	No of pods per plant	Pod length	Yield per plant (gm)	Yield per plot (gm)
NPGR 00012*							
LRGR 117							
NPGR 05420							
LRGR 103							
NPGR 00194							
LRGR 111							

Annexe 5: Farmers participating in community based seed production (CBSP)

S.N.	Farmer's Name	Address	Village	Accessions
1	Lalkumari Basnet	Simichaur-2	Daha	NPGR-00015
2	Bhojraj Ghimire	Simichaur-6	Kabre	NPGR-00194
3	Durga Bdr Balal	Simichaur-5	Banapata	LRGR-99
4	Ghanashyam Balal	Simichaur-5	Raiya	NPGR-0076
5	Agni Prasad Aryal	Simichaur-5	Raiya	NPGR-05364
6	Tikaram Aryal	Simichaur-5	Raiya	NPGR-05420
7	Lal Bdr Balal	Simichaur-5	Banapata	LRGR-111
8	Binita Basnet	Simichaur-6	Daha	LRGR-103
9	Indra Bdr Balal	Simichaur-5	Banapata	LRGR-111
10	Mankala Thapa	Simichaur-3	Simichaur	LRGR- 91
11	Bhupendra Thapa	Simichaur-3	Simichaur	LRGR-117
12	Chandrakala Kuwanr	Simichaur-3	Simichaur	LRGR-75
13	Ramesh Aryal	Simichaur-5	Raiya	LRGR-44
14	Nunikala Basnet	Simichaur-6	Daha	LRGR- 103
15	Kalpana Basnet	Simichaur-5	Kabre	LRGR-99
16	Mina Ghimire	Simichaur-5	Kabre	LRGR-75
17	Bhagawati Pandey	Simichaur-8	Rangbash	LRGR-111
18	Liladevi Kunwar	Simichaur-7	Bihichaur	LRGR-111
19	Pabitra Basnet	Simichaur-6	Shalghari	LRGR-117
20	Gunkala Ghimire	Simichaur-5	Katti	LRGR-111
21	Sumitra Basnet	Simichaur-6	Shalghari	LRGR-111
22	Til Kumari Bucha	Simichaur-9	Rangbash	LRGR-103
23	Nandikala Pandey	Simichaur-5	Raiya	LRGR-103
24	Bhojendra Pandey	Simichaur-4	Amdanda	LRGR- 75
25	Lalkumari Neupani	Simichaur-2	Simichaur	LRGR- 91
26	Sumitra B.K	Simichaur-4	Simichaur	LRGR-91
27	Kamala Ghimire	Simichaur-3	Simichaur	LRGR-152
28	Chom Bdr Jogi Kunwar	Simichaur-5	Daha	LRGR-103
29	Ramakala Basnet	Simichaur-2	Masar	LRGR-117
30	Premraj Marasini	Simichaur-5	Banapata	LRGR-117
31	Gopal Nepali	Simichaur-3	Simichaur	LRGR-117
32	Jibalal Aryal	Simichaur-5	Banapata	LRGR-111
33	Rishiram Aryal	Simichaur-5	Banapata	LRGR-111
34	Pharshuram Pandey	Simichaur-5	Banapata	LRGR-117
35	Jaya Pd Aryal	Simichaur-5	Banapata	LRGR-44
36	Dilliraj Aryal	Simichaur-5	Raiya	LRGR-91
37	Kamala Aryal	Simichaur-5	Raiya	LRGR-111
38	Jumkala Aryal	Simichaur-5	Raiya	LRGR-111
39	Amba Aryal	Simichaur-5	Raiya	LRGR-111
40	Kalpana Aryal	Simichaur-5	Raiya	LRGR-111
41	Dolraj Panthi	Simichaur-5	Banapata	LRGR-111
42	Gita Aryal	Simichaur-5	Raiya	LRGR-111
43	Hutaraj Aryal	Simichaur-5	Raiya	LRGR-111
44	Man Bdr Basnet	Simichaur-3	Simichaur	LRGR-111
45	Janaka Pokhrel	Simichaur-5	Daha	LRGR-42

46	Durga Pokhrel	Simichaur-5	Kabre	LRGR-152
47	Devkala Aryal	Simichaur-5	Raiya	LRGR-152
48	Khumananda Pandey	Simichaur-4	Kalleri	LRGR-152
49	Thanikala Pandey	Simichaur-3	Simichaur	LRGR-91
50	Topkala Aryal	Simichaur-5	Raiya	LRGR-103
51	Padam Aryal	Simichaur-5	Raiya	LRGR-103
52	Krishna Aryal	Simichaur-5	Raiya	LRGR-103
53	Baburam Arial	Simichaur-5	Raiya	LRGR-103
54	Dhanmaya Karki	Darbar Devisthan 3		LRGR-103
55	Dornacharya Panthi	Darbar Devisthan 3		LRGR-103
56	Hira Bdr Khatri	Darbar Devisthan 3		LRGR-44
57	Budhikala Aryal	Darbar Devisthan 3		LRGR-44
58	Niru Aryal	Darbar Devisthan 3		LRGR-75
59	Lakkima Aryal	Darbar Devisthan 3		LRGR-91
60	Bharat Aryal	Amararbathok 7		LRGR-103
61	Hira Panthi	Darbar Devisthan 2		LRGR- 75
62	Hum Bde Khatri	Darbar Devisthan 3		LRGR-117
63	Sibakala Khatri	Darbar Devisthan 3		LRGR-111
64	Krishna Pd Aryal	Darbar Devisthan 3		LRGR-117
65	Sarswati Aryal	Darbar Devisthan 3		LRGR- 75
66	Dek Raj Aryal	Darbar Devisthan 3		LRGR-117
67	Chandra Bdr Basnet	Darbar Devisthan 5		LRGR-91
68	Susila Aryal	Darbar Devisthan 3		LRGR-75
69	Laxman Aryal	Darbar Devisthan 3		LRGR-103
70	Rundhata Aryal	Darbar Devisthan 3		LRGR-75
71	Ruk Bdr Basnet	Darbar Devisthan 5		NPGR-00194

Annexe 6: GPS coordinates of the places from where the ricebean germplasm was collected in 2006

S.N.	Farmer's Name	District	Address	Longitude	Latitude	Altitude (m asl)
1	Keshar Kunwar	Achham	Maltikot VDC 2,Padesra	081º22.059'	29º09.432'	1437
2	Damber Devi Bhandari	Achham	Maltikot VDC 2,Padesra	081º22.059'	29º09.432'	1437
3	Parbati Bhandari	Achham	Maltikot VDC 2,Padesra	081º22.059'	29º09.432'	1437
4	Hirdaya Raj Devkota	Achham	Chaphamandu VDC 7, Devkoti Gaun	081º22.350'	29º09.393'	1457
5	Mani Raj Devkota	Achham	Chaphamandu VDC 7, Devkoti Gaun	081º22.972'	29º09.278'	1476
6	Lok Bahadur Thapa Magar	Achham	Santada VDC 4, Kalapani	081º23.505'	29º08.417'	1627
7	Padam Bahadur Budhamagar	Achham	Santada VDC 4, Kalapani	081º23.505'	29º08.417'	1627
8	Laxman Budhamagar	Achham	Santada VDC 4, Kalapani	081º23.505'	29º08.417'	1627
9	Nara Bahadur Rawal	Achham	Chaphamandu VDC 6, Muja	081º22.792'	29º09.598'	1354
10	Champha Devi Sodari	Achham	KalaGaun VDC 9, Bajed	081º20.122'	29º09.393'	1139
11	Kasheri Sodari	Achham	KalaGaun VDC 9, Bajed	081º20.122'	29º09.393'	1139
12	Dev Raj Badu	Baitadi	Gurkhola VDC 2, Goghariser	080°29.450'	29°31.535'	1760
13	Amba Datta Badu	Baitadi	Gurkhola VDC 2, Luita	080°29.440'	29°31.532'	1750
14	Prakash Chandra Bhatta	Baitadi	Gurkhola VDC 4, Khal	080°29.053'	29°31.370'	1830
15	Sagar Bhandari	Baitadi	Dehimandu VDC 8, Mellau	080°28.432'	29°31.530'	1776
16	Chandra Singh Bhandari	Baitadi	Dehimandu VDC 8, Daula	080°28.432'	29°31.532'	1800
17	Udhav Bahadur Bohara	Baitadi	Dehimandu VDC 6, Melauli	080°28.112'	29°31.403'	2013
18	Bhagirathi Badu	Baitadi	Gurukhola VDC 2, Luita	080°29.331'	29°31.290'	1775
19	Ganesh Datta Bohora	Baitadi	Gurukhola VDC 9, Pali	080°29.045'	29°30.547'	1788
20	Dal Bahadur Bhandari	Baitadi	Dehimandu VDC 8, Koirali	080°28.432'	29°31.524'	1813
21	Jaya Bdr Khadka	Bajhang	Sunkuda VDC 8, Suwakot	080°50.360'	29°30.361'	1798
22	Laxmi Malla	Bajhang	Sunkuda VDC 3, Suwakot	080°52.347'	29°30.246'	1343
23	Harka Bahadur Malla	Bajhang	Sunkuda VDC 3, Khalpata	080°51.832'	29°30.150'	1424
24	Min Bahadur Bohara	Bajhang	Deulek VDC 2, Talla Bhadana	080°48.883'	29°31.335'	1948
25	Jayaman Dhami	Bajhang	Deulek VDC 7, Talla Bhadana	080°48.750'	29°31.180'	1750
26	Nain Singh Bohara	Bajhang	Deulek VDC 3, Malla bhadana	080°48.994'	29°31.644'	1979
27	Lalit Bdr Bohara	Bajhang	Deulek VDC 1, Deulek	080°49.185'	29°31.361'	1957
28	Tara Bdr Bohara	Bajhang	Shali VDC 3, Lim	080°48.175'	29°32.292'	1968
29	Ajan Shing Bohara	Bajhang	Shali VDC 7, Bitthad	080°45.277'	29°32.909'	2270
30	Jaganath Joshi	Bajura	Kanda VDC 5, BahunGaun	081º13.634'	29º22.098'	1685
31	Gopi Raj Joshi	Bajura	Kanda VDC 5, BahunGaun	081º13.634'	29º22.098'	1685
32	Om Prakas Joshi	Bajura	Kanda VDC 5, BahunGaun	081º13.634'	29º22.098'	1685
33	Prayag Raj Joshi	Bajura	Kanda VDC 5, BahunGaun	081º13.634'	29º22.098'	1685
34	Hansa Rokaya	Bajura	Kanda VDC 4, Meltola	081º13.110'	29º22.146'	1697
35	Chauthe Rokaya	Bajura	Kanda VDC 2, SheraGaun	081º12.734'	29º22.321'	1925
36	Parbat Rawal	Bajura	Kanda VDC 3, TalGaun	081º12.423'	29º22.339'	1833
37	Gagan Singh Rawal	Bajura	Kanda VDC 3, TalGaun	081º12.423'	29º22.339'	1833
38	Bhim Bahadur Sharki	Bajura	Kanda VDC 6, Jarimtola	081º13.501'	29º22.514'	1885
39	Gambhir Singh Khadka	Dadeldhura	Samaiji VDC 7, Koteli	080°35.546'	29°20.952'	1606
40	Kashev Singh Ayer	Dadeldhura	Ajayamar VDC 1, Basana	080°33.700'	29°20.550'	1493
41	Durki Sharki	Dadeldhura	Amargadhi Municipality 8, Tatar	080°36.559'	29°19.330'	1540
42	Dambar Raj Joshi	Dadeldhura	Amargadhi Municipality 8, Tatar	080°36.550'	29°19.300'	1080
43	Shiva Raj Pandey	Dadeldhura	Amargadhi Municipality 8, Khanbadha	080°36.480'	29°19.820'	1500
44	Ishori Shahu	Dadeldhura	Amargadhi Municipality 7, Siraula	080°36.428'	29°20.462'	1558
45	Mahani Singh Sharki	Dadeldhura	Amargadhi Municipality 2, Joshina	080°34.462'	29°17.476'	1631

46	Shiva Sharki	Dadeldhura	Amargadhi Municipality 3, Dhad	080°34.263'	29°17.464'	1617
47	Deepak Mal	Dadeldhura	Amargadhi Municipality 2 , Aait	080°33.962'	29°17.553'	1650
48	Raj Sharki	Dadeldhura	Amargadhi Municipality 3, HatGaun	080°34.346'	29°17.100'	1534
49	Laxmi Singh Thagunna	Darchula	Gokule VDC 2, Jharkana	080°31.877’	29°39.828’	1459
50	Hari Singh Thagunna	Darchula	Gokule VDC 2, Jharkana	080°31.675’	29°42.056’	1430
51	Naba Raj Bista	Darchula	Gokule VDC 6, Godhari	080°32.697’	29°42.050’	1200
52	Dev Singh Thagunna	Darchula	Gokule VDC 2, Jharkana	080°31.680’	29°41.651’	1450
53	Jiban Bista	Darchula	Gokule VDC 6, Thulisaini	080°32.698’	29°42.052’	1410
54	Basu Devi Jaisi	Doti	Bhumiraj VDC 9, Phaledi	080º56.619’	29º12.234’	1463
55	Chet Raj Jaisi	Doti	Bhumiraj VDC 9, Phaledi	080º56.619’	29º12.234’	1463
56	Hira Devi Joshi	Doti	Bhumiraj VDC 9, Phaledi	080º56.619’	29º12.234’	1463
57	Kalasi Jaisi	Doti	Bhumiraj VDC 9, Phaledi	080º56.619’	29º12.234’	1463
58	Nirjana Bhatta	Doti	Bhumiraj VDC 8, Kolgade	080º56.583’	29º11.568’	1620
59	Jamuna Devi Bhatta	Doti	Bhumiraj VDC 8, Kolgade	080º56.583’	29º11.568’	1620
60	Radha Devi Jaisi	Doti	RanaGaun VDC 3, Kulaun	080º57.084’	29º12.133’	1481
61	Tika Ram Thapa	Doti	Kapalleki VDC 3, Guthuri	080º53.762’	29º11.776’	1637
62	Amar Bahadur Shahi	Doti	Kapalleki VDC 3, Guthari Thek	080º53.316’	29º11.847’	1581
63	Dal Bahadur Shahi	Doti	Kapalleki VDC 3, Guthuri Parsebata	080º53.759’	29º11.777’	1626
64	Purandhar Joshi	Doti	Bhumiraj VDC 9, Lindesain	080º56.855’	29º12.709’	1307
65	Dal Bd. Gurung	Kaski	Maajhethana-5, Jyamire, Kaski	084° 07.275’	28° 11.962’	1029
66	Nand Maya Gurung	Kaski	Maajhethana-5, Jyamire, Kaski	084° 07.266’	28° 11.983’	1044
67	Basana Gurung	Kaski	Maajhethana-5, Jyamire, Kaski	084° 07.275’	28° 11.962’	1029
68	Hira Gurung	Kaski	Maajhethana-5, Jyamire, Kaski	084° 07.243’	28° 11.996’	1069
69	Maina Thapa	Kaski	Lekhnath N. P. 11, Chaur, Kaski	084° 07.595’	28° 10.063’	665
70	Ganga Maya Basaula	Kaski	Lekhnath N. P. 11, Chaur, Kaski	084° 07.499’	28° 10.106’	728
71	Jay Bhd. Thapa	Kaski	Lekhnath N. P. 11, Chaur, Kaski	084° 07.606’	28° 10.068’	675
72	Subedar Ram Bhd. Thapa	Kaski	Lekhnath N. P. 11, Chaur, Kaski	084° 07.499’	28° 10.106’	728
73	Kamala Magar	Kaski	Lekhnath N.P. 11, Sundaridanda	084° 06.885’’	28° 09.935’	737
74	Lekhnath Dhakal	Kaski	Lekhnath N.P. 11, Sundaridanda	084° 06.940’	28° 09.950’	730
75	Budhhi Maya Magar	Kaski	Lekhnath N.P. 11, Sundaridanda	084° 06.885’	28° 09.935’	737
76	Chetman Khatri (Subedi)	Gulmi	Darbar Devisthan 3, Khirbip	083°17.105’	28°01.136’	1384
77	Shiva Kala Khatri (Subedi)	Gulmi	Darbar Devisthan 3, Khirbip	083°17.083’	28°01.118’	1418
78	Shiva Kala Khatri (Subedi)	Gulmi	Darbar Devisthan 3, Khirbip	083°17.083’	28°01.118’	1418
79	Tej Narayan Aryal	Gulmi	Darbar Devisthan 3, Khirbip	083°17.036’	28°01.031’	1449
80	Mithhu Khatri	Gulmi	Darbar Devisthan 2, Sharukhark	083°17.279’	28°01.513’	1385
81	Mithhu Khatri	Gulmi	Darbar Devisthan 2, Sharukhark	083°17.279’	28°01.513’	1385
82	Padam Bhd Thapa	Gulmi	Darbar Devisthan 2, Lamadrada	083°17.974’	28°01.734’	1298
83	Padam Bhd Thapa	Gulmi	Darbar Devisthan 2, Lamadrada	083°17.974’	28°01.734’	1298
84	Khadkant Rayamajhi	Gulmi	Darbar Devisthan 2, Lamadrada	083°17.951’	28°01.741’	1039
85	Jit Bhd Thapa	Gulmi	Darbar Devisthan 3, Bajarmare	083°17.179’	28°01.411’	1422
86	Sita Gyawali	Gulmi	Baletaksar 4, Drada gulmi	083°23.648’	27°59.387’	1454
87	Narbada Bhandari	Gulmi	Hula 1 Thulo Pokhari	083°23.648’	27°59.387’	1454
88	Bishnu Khatri	Gulmi	DarbarDevisthan 3 Khirtip	083°23.648’	27°59.387’	1454
89	Sant Bahadur Rana	Palpa	Kusumkhola-4, Nayatola	083° 27.132’	27° 50.760’	1193
90	Urju Singh Sunar	Palpa	Kusumkhola-4, Nayatola	083° 27.931’	27° 50.923’	1121
91	Lok Bahadur pachbhaiya	Palpa	Kusumkhola-4, Nayatola	083° 26.960’	27° 51.015’	1123
92	Judhha Bir Pachbhaiya	Palpa	Kusumkhola-4, Nayatola	083° 27.053’	27° 50.968’	1124
93	Dambar Bd. Karki	Palpa	Kusumkhola-4, Nayatola	083° 27.159’	27° 50.873’	1118
94	Bhim Bd. Rana	Palpa	Kusumkhola-4, Nayatola	083° 26.895’	27° 50.896’	1185
95	Bhanu Bhakta Pandey	Palpa	Arghali 2, Tipre	083° 27.908’	27° 55.098’	617
96	Om Pd. Subedi	Palpa	Arghali 1, Pujeri Gaun	083° 27.309’	27° 55.566’	678
97	Om Pd. Subedi	Palpa	Arghali 1, Pujeri Gaun	083° 27.309’	27° 55.566’	678
98	Tilak Ram Paudel	Palpa	Madanpokhara 5, Dolenidrada	083° 32.832’	27° 49.977’	873

99	Mohan Shrestha	Palpa	NayarNamtlesh 4, Aryabhanjyang	083° 37.180’	27° 50.963’	1063
100	Bal Kumari Shrestha	Palpa	NayarNamtlesh 4, Aryabhanjyang	083° 37.191’	27° 50.960’	1063
101	Sabitri Gyawali	Palpa	NayarNamtlesh 4, Aryabhanjyang	083° 36.938’	27° 50.985’	1088
102	Prem Bd. Gaha	Palpa	NayarNamtlesh 4, Sinchas	083° 36.741’	27° 50.937’	1021
103	Sam Singh Somai	Palpa	Archale 4, Simaldada	083° 36.741’	27° 50.937’	1021
104	Rim Kumari Shrestha	Palpa	Siluwa 6, Hatiya	083° 50.072’	27° 50.203’	1111
105	Bishnu Kumari Shrestha	Palpa	Siluwa 6, Hatiya	083° 50.213’	27° 49.997’	1075
106	Suk Maya B.K.	Palpa	Siluwa 6, Golipatan	083° 50.287’	27° 49.948’	1116
107	Gyanendra Kumar Pulami	Palpa	Siluwa 6, Golipatan	083° 50.282’	27° 49.958’	1119
108	Bishnu B.K.	Palpa	Siluwa 6, Golipatan	083° 50.282’	27° 49.945’	1113
109	Kumari Bagale	Palpa	Nayarnamtlesh 1, Sinchas	083° 36.793’	27° 51.015’	1020
110	Mrs. Indraa Dhakal	Palpa	Siluwa 6, Hariya	083° 50.216’	27° 49.937’	1070
111	Gyan Bd. Gaha	Palpa	Nayarnamtlesh 1, Sinchas	083° 36.741’	27° 50.937’	1021
112	Rim Kumari Shrestha	Palpa	Siluwa 6, Hatiya	083° 50.072’	27° 50.203’	1111
113	Gopal Pahari	Kavre	Satthighar Bhagwati - 6, Dhandagaun	85° 41.902’	27° 37.178’	1318
114	Sukmaya Pahari	Kavre	Satthighar Bhagwati - 6, Dhandagaun	85° 41.941’	27° 37.097’	1322
115	Buddhalaxmi Shrestha	Kavre	Kharelthok – 1, Simalchaur	85° 40.661’	27° 36.853’	1324
116	Chetnath Aryal	Nuwakot	Khadga Bhanjyang – 7, Shreekhaali	85° 05.552’	27° 51.854’	482
117	Arjun Prasad Aryal	Nuwakot	Khadga Bhanjyang – 7, Shreekhaali	85° 05.624’	27° 51.798’	474
118	Sita Gajurel	Nuwakot	Bidur N. P. – 7, Pipaltari	85° 07.713’	27° 51.965’	605
119	Durga Neupane	Nuwakot	Bidur N. P. – 7, Pipaltari	85° 07.713’	27° 51.965’	605
120	Tulasi Prasad Nepal	Nuwakot	Bageshwari 7, Phalante	85° 12.357’	27° 55.941’	998
121	Hum Kumari Nepal	Nuwakot	Bageshwari 7, Phalante	85° 12.357’	27° 55.941’	998
122	Hem Kumari Khanal	Nuwakot	Bageshwari 7, Bhaterchaur	85° 12.327’	27° 55.852’	945
123	Bajari Chaudhary	Surkhet	Uttarganga VDC 7, Guptipur	081°35.812'	28°33.242'	612
124	Sushila Chaudhary	Surkhet	Uttarganga VDC 7, KholiGaun	081°35.753'	28°33.677'	640
125	Joyti Chaudhary	Surkhet	Uttarganga VDC 7, KholiGaun	081°35.756'	28°33.716'	643
126	Dabal Bahadur Hamal	Salyan	Khalanga VDC 3, Patneri	82°10.764'	28°22.212'	1040
127	Krishnaman Reudi	Salyan	Khalanga VDC 4, Jabdikhola	82°11.491'	28°22.538'	981
128	Kamala Dangi	Salyan	Khalanga VDC 4, Jabdikhola	82°11.360'	28°22.489'	1014
129	Dhwajbir Dangi	Salyan	Dhanbanj VDC-7 Kapurkot, Salyan	82°20.698'	28°13.661'	1564
130	Sher Bdr. K.C.	Dang	Municipality -4, Patikhola Tulsipur	082°18.159'	28°08.613'	690
131	Lal Bdr Rawat	Dang	Sisnia-5, Kalapani Deukhuri	082°38.766'	28°50.653'	244
132	Pradeep Ghimire	Dang	Chailahi -4, Khairi Deukhuri	082°30.536'	28°51.255'	222
133	Geeta Chaudhary	Dang	Municipality -5, Baruwagaon, Tulsipur	082°17.994'	28°07.895'	654
134	Ramdev Chaudhary	Dang	Sonpur-4, Shreegaun Deukhuri	082°33.932'	28°51.411'	241
135	Ram K. Chaudhary	Dang	Halbar-1 Budhagaun	082°19.587'	28°07.439'	640
136	Chandrika K. Chaudhary	Dang	Sisniya-1 Deukhuri Badki, Sisnia	082°39.088'	28°50.548'	243
137	K. P. Ghimire	Dang	Sonpur	082°37.189'	28°51.240'	230
138	Gopal Khanal	Dang	Municipality -11 (Tri) Bharatpur, Ghorahi	082°29.427'	28°01.890'	650
139	Raj Kumar Chaudhary	Dang	Pawan Nagar VDC-6 Balapur	082°14.203'	28°07.165'	604
140	Gajendra Chaudhary	Dang	Harigaun VDC-8 Golowari	082°17.129'	28°06.086'	283
141	Khim Bdr Khadka	Dang	Halbar VDC-7 Chhopdemar	082°20.481'	28°10.859'	797

Annexe 7: Farmers participating in nutritional awareness campaign in Simichaur VDC, Gulmi, 2008

S. N.	Name	Address
1	Jaya Prasad Aryal	Simichaur VDC, Gulmi
2	Tara Prasad Basyal	Tansen, Palpa
3	Padam Aryal	Simichaur VDC, Gulmi
4	Dilli Raj Aryal	Simichaur VDC, Gulmi
5	Deepak Aryal	Simichaur VDC, Gulmi
6	Deviram Aryal	Simichaur VDC, Gulmi
7	Suresh Aryal	Simichaur VDC, Gulmi
8	Krishna Prasad Aryal	Simichaur VDC, Gulmi
9	Parshuram Pandey	Simichaur VDC, Gulmi
10	Krishna Bahadur Kunwar	Simichaur VDC, Gulmi
11	Baburam Aryal	Simichaur VDC, Gulmi
12	Kalpana Aryal	Simichaur VDC, Gulmi
13	Govindi Panthi	Simichaur VDC, Gulmi
14	Radhika Aryal	Simichaur VDC, Gulmi
15	Damantaa Aryal	Simichaur VDC, Gulmi
16	Nirmala Pandey	Simichaur VDC, Gulmi
17	Kunta Devi Aryal	Simichaur VDC, Gulmi
18	Dhan Kunmari Marasini	Simichaur VDC, Gulmi
19	Bel Kumari Pandey	Simichaur VDC, Gulmi
20	Goma Aryal	Simichaur VDC, Gulmi
21	Sarita Aryal	Simichaur VDC, Gulmi
22	Kamala Aryal	Simichaur VDC, Gulmi
23	Bindu Aryal	Simichaur VDC, Gulmi
24	Topalaa Aryal	Simichaur VDC, Gulmi
25	Jumkala Aryal	Simichaur VDC, Gulmi
26	Mina Balaal	Simichaur VDC, Gulmi
27	Ambika Balaal	Simichaur VDC, Gulmi
28	Bina Pandey	Simichaur VDC, Gulmi
29	Ranjana Pandey	Simichaur VDC, Gulmi
30	Nandakala Balaal	Simichaur VDC, Gulmi
31	Saraswati Aryal	Simichaur VDC, Gulmi
32	Goma Aryal	Simichaur VDC, Gulmi
33	Amba Aryal	Simichaur VDC, Gulmi
34	Tara Gamaal	Simichaur VDC, Gulmi
35	Parbati Gamaal	Simichaur VDC, Gulmi
36	Krishna Kumari Pun	Simichaur VDC, Gulmi
37	Hrishiram Aryal	Simichaur VDC, Gulmi
38	Ramakala Aryal	Simichaur VDC, Gulmi
39	Geeta Aryal	Simichaur VDC, Gulmi
40	Harikala Aryal	Simichaur VDC, Gulmi
41	Kabita Pandey	Nayagaun VDC, Ward No. 8
42	Romnath Aryal	Simichaur VDC, Gulmi
46	Kamal Khadka	LI-BIRD, Pokhara
47	Sarmila Aryal	Simichaur VDC, Gulmi
48	Prem Raj Marasini	Simichaur VDC, Gulmi

Annexe 8: Farmers participating in nutritional awareness campaign in Darbar Devisthan VDC, Gulmi, 2008

S.N.	Name	Address
1	Rishi Ram Panthi	Darbar Devisthan VDC, Gulmi
2	Jit Bahadur Thapa	Darbar Devisthan VDC, Gulmi
3	Prithvi Bahadur Karki	Darbar Devisthan VDC, Gulmi
4	Chet Man Singh Khatri	Darbar Devisthan VDC, Gulmi
5	Laxman Aryal	Darbar Devisthan VDC, Gulmi
6	Ram Chandra Aryal	Darbar Devisthan VDC, Gulmi
7	MitraLal Gyawali	Darbar Devisthan VDC, Gulmi
8	Chandra Mani Panthi	Darbar Devisthan VDC, Gulmi
9	Durga Bahadur Khatri	Darbar Devisthan VDC, Gulmi
10	Tek Raj Aryal	Darbar Devisthan VDC, Gulmi
11	Parbati Tuwata	Darbar Devisthan VDC, Gulmi
12	Parbatyi Sunar	Darbar Devisthan VDC, Gulmi
13	Sita Gyawali	Darbar Devisthan VDC, Gulmi
14	Manikala Gyawali	Darbar Devisthan VDC, Gulmi
15	Mina Chudali	Darbar Devisthan VDC, Gulmi
16	Hira Panthi	Darbar Devisthan VDC, Gulmi
17	Gita Aryal	Darbar Devisthan VDC, Gulmi
18	Lakima Aryal	Darbar Devisthan VDC, Gulmi
19	Budhi Kala Aryal	Darbar Devisthan VDC, Gulmi
20	Mina Karki (Ka)	Darbar Devisthan VDC, Gulmi
21	Mina Karki (Kha)	Darbar Devisthan VDC, Gulmi
22	Kamala Khatri	Darbar Devisthan VDC, Gulmi
23	Goma Panthi	Darbar Devisthan VDC, Gulmi
24	Rupa Tandan	Darbar Devisthan VDC, Gulmi
25	Yamkala Khatri	Darbar Devisthan VDC, Gulmi
26	Laxmi Aryal	Darbar Devisthan VDC, Gulmi
27	Radhika Panthi	Darbar Devisthan VDC, Gulmi
28	Punam Panthi	Darbar Devisthan VDC, Gulmi
29	Anju Panthi	Darbar Devisthan VDC, Gulmi
30	Mithu Khatri	Darbar Devisthan VDC, Gulmi
31	Sita Aryal	Darbar Devisthan VDC, Gulmi
32	Kamala Aryal	Darbar Devisthan VDC, Gulmi
33	Sushila Dhakal	Darbar Devisthan VDC, Gulmi
34	Sumita Bhandari	Darbar Devisthan VDC, Gulmi
35	Hari Gyawali	Darbar Devisthan VDC, Gulmi
36	Tara Prasad Basyal	Darbar Devisthan VDC, Gulmi

Annexe 9: Protocol for molecular marker diversity of ricebean germplasm

Background and introduction

A tremendous diversity of rice bean at various levels in plant type, seed morphologies and use values has been found under cultivation. It is adapted to range of altitudes from humid subtropical to warm and cool temperate regions of diverse agro-ecosystems from lowland to high-hills of Nepal. Its cultivation extends from east to western limits of the country. It is an important food legume particularly for mid-hills of Nepal with a pivotal role as pulse in dietary components supporting the food security of the rural poor in mid-hills. A good collection of rice bean germplasm is held with NARC genebank as landrace accessions collected by Agriculture Botany Division (ABD), the Plant Genetic Resource Unit (PGRU) from different districts of the country. In addition, FOSRIN on its implementation have collected 156 accessions from 16 districts in 2006. These germplasm under evaluation and characterization using agro-morphological characters have shown a wide variation and a set of information on agro-morphological characterization of these accessions have been generated. However, for exploitation of germplasm in breeding programme, it is always valuable and good to generate the molecular data on genetic diversity. Knowledge on genetic diversity among these valuable resources is therefore important for effective conservation and success of a breeding programme. Under the work package (WP3) there has screened out 109 SSR primer pairs of adzuki bean on a stratified random samples of rice bean and have detected 35 primers polymorphic with 2-4 alleles per locus. Likewise, a comprehensive collection of landraces have been selected for this SSR diversity. The selection of accessions is based on information on agro-morphological and physic-graphical distribution of diversity.

Objective

- To evaluate the rice bean germplasm collection for molecular marker diversity and understand the relationship of molecular and agro-morphological diversity in rice bean of Nepal

Materials

- All 50 accessions under core collection field evaluation in 2007/08 in 4 different environments
- Stratified selection of 41 accessions under non-core collection field evaluation in 2007/08 in 4 different environments
- Adjuki bean (*Vigna angularis*) as check sample for primers
- Bold seeded, climbing rice bean from Illam (*Vigna umbellata*) as check sample for rice bean samples under study
- In total there will be (50 + 41) + 2 checks

Methodology/process/steps

Sampling

- Selection of the landraces for the study is based on the distribution and the agro-morphological diversity.
- Criteria for selection of random samples from non-core collection was the aggregate values of PC1 and PC2 for qualitative and quantitative traits together, which was then sorted in EXCEL from descending to ascending values and picked one accession for every fourth from a total of 164 accessions. It is done with the idea to capture the diversity in totality.

SSR primers

- Thirty five polymorphic SSR primers will be used for microsatellite analysis on these samples. Sequence and motifs of these polymorphic SSR primers are given in list below.

DNA isolation

- Phytopure Genomic DNA extraction kit for bulk grain will be used
- Bulk DNA of 15 seeds of each accession under this study will be used.

Thermal cycling and electrophoresis

- PCR volume will be 20 µl contained with 4-5 ng of genomic DNA, 10 µl of Reddy Mix™ PCR Master Mix contained of 3.0 mM $MgCl_2$; 10xPCR buffer, Taq polymerase and blue dye (ABgene, Epsom, Surrey, UK) and 20 µM of forward and reverse primers.
- The PCR thermal cycling programme to be used will be of initial denaturation at 94^{o}C for 2 mins followed by 35 cycles of: denaturation at 94^{o}C for 30 secs, annealing at 50^{o}C for 30 secs and elongation at 68^{o}C for 30 secs followed by further elongation at 68^{o}C for 2 mins and finally to hold at 4^{o}C for infinite.
- Amplified products will be checked by electrophoresis in 2.5 % high resolution Biorad Midi agarose gel at constant voltage of 90 for 4 hrs.

Statistical analysis

- Banding pattern and size documentation will be carried under bio-doc gel analyzer and binary data matrix will be generated.
- Diversity parameters like allelic richness, number of alleles per locus, frequencies of alleles, heterozygosity level, genetic relationship and diversity indices will be calculated based on the size, number and distance traveled by the bands.
- Agro-morphological diversity and molecular diversity will be compared and relate this diversity with biophysical and socio-economic values of rice bean germplasm
- NTSYS pc version 2.02; excel and others related tools will be used.

Expected results

- Evaluation of stratified sample of rice bean with identified markers
- Analysis of molecular marker data
- Comparison of molecular data with agro-morphological data

Project deliverables

- Rice bean diversity in Nepal described on the basis of molecular markers (D3.2)
- The value of diversity estimates using agro-morphological or molecular markers described in relation to biophysical and socio-economic variables

List of Adzuki bean SSR primers pairs screened with polymorphism (*Han et al.*, 2005)

Primers	Linkage	Forward Primer (5'-3')	Reverse Primer (5'-3')	Motif
CEDG127	4	GGTTAGCATCTGAGCTTCTTCGTC	CTCCTCACTTGGTCTGAAACTC	(TG)3(AG)9
CEDG018	5	AGCGTGTTTGTGGTGATAGC	ACACAGGAACGAACAAACCC	(AG)32
CEDG150	10	GAAGGGAATGAAAATGAAACCC	GTTCAATCCATTCAGTCTCC	(AG)14
CEDG214	5	CACTCACTGCAAAGAGCAAC	CTACCTATCTGAGGGACAC	(AG)4 AA(AG)31
CEDAAG002	2	GCAGCAACGCACAGTTTCATGG	GCAAAACTTTTCACCGGTACGACC	(AAG)16
CEDG204	7	CCTTGGTTGGAGCAGCAGC	CACAGACACCCTCGCGATG	(AG)15
CEDG043	3	AGGATTGTGGTTGGTGCATG	ACTATTTCCAACCTGCTGGG	(AG)14
CEDG021	10	GCAGAATTTTAGCCACCGAG	AAAGGATGCGAGAGTGTAGC	(AG)26
CEDG084	3	ATCAACTGAGGAGCATCATCGA	CAACATTTCAACCTTGGGACAG	(AG)13
CEDG015	1	CCCGATGAACGCTAATGCTG	CGCCAAAGGAAACGCAGAAC	(AG)27
CEDG026	2	TCAGCAATCACTCATGTGGG	TGGGACAAACCTCATGGTTG	(AG)26
CEDG073	8	CCCCGAAATTCCCCTACAC	AACACCCGCCTCTTTCTCC	(AG)24
CEDG007				
CEDG008	5	AGGCGAGGTTTCGTTTCAAG	GCCCATATTTTTACGCCCAC	(AG)26
CEDG286	2	CGAGCAGAACACTGATCATG	CCTCTTAGAGGTCATTGCTC	(AG)23
CEDG294	3	CACCTTCTTAATCTCTTCACC	GGGTTTCTCTTAATTCATTGAGTC	(AT)27(AG)15
CEDG232	9	GATGACCAAGGTAACGTG	GGACAGATCCAAAACGTG	(AG)16
CEDG071	8	GGTCCATTGAGACGGATCGAG	TCCCACCTCAGCGGAATCC	(AG)9
CEDG253	8	CACTTCCATGATGACTCACC	CACCCTTCTTTATCCTCTTCG	(AG)30
CEDG090	1	ATAAGTAGAAATTGGTTCAAATG	GGTTCGTTAAAGTAACTTTTAAT	(AG)28
CEDG044	11	TCAGCAACCTTGCATTGCAG	TTTCCCGTCACTCTTCTAGG	(GT)10 AT(AG)18
CEDG141	1	CCAGGCATCCATGATGACC	GAAGTTGTTGGTAATGGTTGCCTC	(AT)6(AG)13
CEDG178	1	CGGAAGAAGAACGCAGAGTG	GCATCAACAAGGACTTCTGC	(AG)10 G(AG)5
CEDG118	6	AACCCAACCAACCCTTGTGGTAAG	GCTGGAATCATAATACCGCCTTGT	(AG)21
CEDG154	4	GTCCTTGTTTTCCTCTCCATGG	CATCAGCTGTTCAACACCCTGTG	(AG)14
CEDG037	6	GAAGAAGAACCCTACCACAG	CACCAAAAACGTTCCCTCAG	(AG)16 AC(AG)8
CEDG195	6	GAGGGTCTCCACTTTTGAAACCC	GATACTAAGGCTTTCTCCACCCAC	(AG)11
CEDG134	10	CTCCGTGTTGAAACAATGACG	GGTCTTTCTGATCTACGAACTTG	(AG)11
CEDG104	11	TATGGCCCGAGCAAACCTTG	CCGTTCGGTCTTCGGTTGAA	(AG)13
CEDG050	2	GGCAGAATCGTACAAGTG	GTCAGATTCTCGCTTGCATG	(AG)12

Annexe 10: Germplasm Evaluation during *Kharif* 2008 in India

S.N	Name	Days to flowering	Plant height (cm)	Type of maturity	Growth habit	Maturity	Seed Colour	Seed size	Seed yield per plant (g)
Assam									
1	JCR-07-7	91	149.50	C	SE	132	Light Yellow	Bold	145
2	JCR-07-15	97	154.30	C	SE	132	Greenish yellow	Medium	136
3	JCR-07-16	99	158.90	C	SE	136	Black smoky	Bold	145
4	JCR-07-22	96	157.00	C	SE	135	Blackish	medium	143
	JCR-07-26	95	145.26	C	SE	128	Yellow	Medium	135
5	JCR-2008-1	84	145.67	C	SE	123	Light yellow	small	120
6	JCR-2008-2	90	147.90	C	SE	125	Brown	Small	102
7	JCR-2008-4	107	167.98	C	SE	137	Grey	Bold	140
8	JCR-2008-5	88	162.5	C	SE	25	Light yellow	Small	128
9	JCR-2008-6	87	156.00	C	SE	127	Black	Bold	140
10	JCR-2008-7	98	147.85	C	SE	128	Black	Bold	142
11	JCR-2008-9	98	142.34	C	SE	138	Brown	Bold	140
12	JCR-2008-10	103	167.80	C	SE	140	Light Yellow	Bold	145
13	JCR-2008-11	91	149.50	C	SE	132	Light Yellow	Small	135
14	JCR-2008-12	106	152.80	C	SE	134	Light Yellow	Small	132
15	JCR-2008-13	100	167.11	C	SE	137	Light Brown	Small	125
16	JCR-2008-14	86	156.90	C	SE	128	Light Red	Small	120
17	JCR-2008-17	96	149.00	C	SE	136	Light Yellow	Small	115
18	JCR-2008-19	88	145.55	C	SE	129	Brown	Small	107
19	JCR-2008-20	100	137.90	C	SE	134	Brown	Bold	140
20	JCR-2008-24	95	135.88	C	SE	127	Brown	Bold	146
21	JCR-2008-25	97	154.30	C	SE	132	Grey	Small	126
22	JCR-2008-26	80	145.2	C	SE	125	Brown	Small	122
23	JCR-2008-27	85	158.90	C	SE	136	Yellow	Bold	145
24	JCR-2008-29	87	146.66	C	SE	128	Light Yellow	Small	135
25	JCR-2008-30	80	135.25	C	SE	125	Yellow	Small	118
26	JCR-2008-31	85	136.00	C	SE	124	Light Yellow	Small	127
27	JCR-2008-32	88	145.55	C	SE	128	Light Yellow	Small	120
28	JCR-2008-33	87	146.85	C	SE	130	Brown	Big	135
29	JCR-2008-34	90	135.25	C	SE	125	Light Red	Small	125
30	JCR-2008-36	92	172.50	C	SE	130	Brown	Small	118
31	JCR-2008-37	93	225.00	C	SE	135	Light Yellow	Bold	140
32	JCR-2008-40	91	187.50	C	SE	130	Light Yellow	Small	125
33	JCR-2008-41	90	175.25	C	SE	122	Light Yellow	Bold	142
34	JCR-2008-45	88	195.25	C	SE	125	Brown	Small	118
35	JCR-2008-46	93	230.40	C	SE	130	Black	Small	123
36	JCR-2008-47	94	175.85	C	SE	128	Brown	Bold	144
37	JCR-2008-49	93	299.50	C	SE	138	Light Yellow	Bold	152
38	JCR-2008-50	92	280.00	C	SE	137	Light yellow	Bold	148
39	LRB-158	95	125.25	C	SE	125	Grey	Small	128
40	LRB-5	91	128.50	C	SE	125	Brown	Bold	145
41	LRB-260	93	132.25	C	SE	130	Grey	Bold	145
42	LRB-33	92	133.30	C	SE	132	Brown	Bold	143
43	LRB-31	100	135.60	C	SE	135	Grey	Small	138
44	LRB-65	96	132.10	C	SE	138	Grey	Small	138
45	NRB-32	102	135.20	C	SE	132	Yellow	Small	137
46	LRB-160	99	139.50	C	SE	136	Grey	Bold	146
47	LRB-57	98	142.50	C	SE	130	Brown	Bold	142

S.N	Name	Days to flowering	Plant height (cm)	Type of maturity	Growth habit	Maturity	Seed Colour	Seed size	Seed yield per plant (g)
48	LRB-54	85	128.40	C	SE	135	Yellow	Bold	143
49	LRB-55	87	132.40	C	SE	128	Brown	Big	145
50	LRB-71-3	92	138.54	C	SE	125	Grey	Bold	148
51	NRB-3	97	122.25	C	SE	138	Brown	Bold	140
52	LRB-21	102	142.20	C	SE	144	Yellow	Small	138
53	LRB-164	99	135.20	C	SE	135	Yellow	Bold	145
54	LRB-254	87	124.52	C	SE	130	Grey	Bold	147
55	LRB-145	90	128.50	C	SE	135	Green	Bold	142
56	LRB-193	93	132.30	C	SE	137	Brown	Bold	145
57	NRB-14	95	135.00	C	SE	128	Brown	Small	135
58	LRB-22	97	142.25	C	SE	135	Yellow	Small	137
59	LRB-54	105	135.20	C	SE	128	Yellow	Bold	148
60	LRB-4	100	141.00	C	SE	137	Brown	Bold	146
61	LRB-188	95	132.00	C	SE	132	Brown	Small	135
62	LRB-72-1	92	135.00	C	SE	126	Grey	Small	138
63	LRB-264	98	146.50	C	SE	138	Grey	Bold	146
64	LRB-148	85	125.40	C	SE	122	Yellow	Small	135
65	LRB-28	87	122.25	C	SE	118	Brown	Bold	141
66	LRB-23	92	136.50	C	SE	135	Brown	Small	135
67	LRB-34	94	130.45	C	SE	130	Yellow	Small	132
68	NRB-31	97	125.45	C	SE	128	Grey	Small	130
69	LRB-27	87	136.25	C	SE	130	Grey	Bold	138
70	LRB-58	95	128.70	C	SE	120	Yellow	Small	125
71	LRB-61	93	134.00	C	SE	134	Yellow	Small	132
72	LRB-48	97	146.25	C	SE	138	Brown	Bold	149
73	NRB-9	91	135.40	C	SE	135	Grey	Small	135
74	LRB-40-2	94	138.50	C	SE	134	Brown	Small	138
75	LRB-191	98	142.25	C	SE	138	Green	Bold	145
76	LRB-239	101	144.50	C	SE	142	Brown	Bold	148
77	LRB-159	91	138.50	C	SE	128	Green	Small	132
78	LRB-22-2	87	135.40	C	SE	122	Yellow	Small	134
79	LRB-113	96	137.80	C	SE	135	Brown	Small	128
80	JCR-51	93	156.00	C	SE	140	Yellow	Small	138
81	JCR-52	94	145.00	C	SE	138	Red	Medium	142
82	JCR-53	95	138.50	C	SE	135	Yellow	Medium	140
83	JCR-54	97	140.00	C	SE	140	Grey	Bold	146
Palampur									
1	RBHP - 14	89	97	C	S	138	Green	Medium	786
2	RBHP - 53	90	124	C	SE	138	Black	Bold	598
3	RBHP - 38	91	139	C	S	142	Green	Bold	681
4	RBHP - 20	90	94	C	E	142	Green	Medium	497
5	RBHP - 23	89	76	C	S	131	Red	Medium	271
6	RBHP - 49	90	91	C	SE	138	Spotted Green	Medium	257
7	RBHP - 27	89	90	C	E	134	Red	Medium	409
8	RBHP - 36	89	123	C	S	138	Black	Bold	598
9	RBHP - 30	89	106	C	SE	136	Red	Medium	642
10	RBHP - 31	91	104	C	SE	141	Light Yellow	Medium	397
11	RBHP - 44 (A)	90	113	C	S	138	Spotted Green	Bold	595
12	RBHP - 61	87	101	C	S	138	Spotted Green	Bold	760
13	RBHP - 39	88	91	C	SE	139	Red	Medium	617
14	RBHP - 11	89	100	C	S	135	Light Yellow	Small	536
15	RBHP - 1	86	105	C	SE	134	Light Yellow	Medium	520
16	RBHP - 3	87	109	C	SE	134	Light Green	Medium	460
17	RBHP - 13	88	104	C	SE	134	Spotted Green	Small	249

S.N	Name	Days to flowering	Plant height (cm)	Type of maturity	Growth habit	Maturity	Seed Colour	Seed size	Seed yield per plant (g)
18	RBHP - 25	88	95	C	E	132	Light Green	Medium	284
19	RBHP - 52	88	124	C	SE	136	Spotted Green	Bold	558
20	RBHP - 74	86	118	C	SE	136	Light Green	Small	294
21	RBHP - 75	89	104	C	SE	138	Black		530
22	RBHP - 78	85	90	C	S	133	Spotted Green	Small	296
23	RBHP - 81	97	114	C	SE	142	Red	Small	284
24	RBHP - 82	96	121	C	SE	141	Spotted Brown	Medium	349
25	RBHP - 83	95	107	C	S	138	Light Green	Medium	315
26	RBHP - 84	92	104	C	SE	138	Spotted Green	Medium	350
27	RBHP - 28	89	89	C	SE	131	Black	Medium	132
28	RBHP - 60	84	160	C	SE	138	Spotted Green	Bold	648
29	RBHP - 7	89	128	C	SE	138	Light Yellow	Bold	231
30	RBHP - 86	96	114	C	E	138	Yellow	Bold	394
31	RBHP - 65	89	104	C	SE	138	Spotted Green	Medium	394
32	RBHP - 54	88	125	C	SE	138	Spotted Green	Medium	233
33	RBHP - 24	90	96	C	S	138	Light Yellow	Small	529
34	RBHP - 48	89	124	C	E	138	Spotted Green	Medium	286
35	RBHP - 26	88	142	C	SE	140	Black	Bold	377
36	RBHP - 55	89	140	C	S	138	Spotted Green	Medium	490
37	RBHP - 47	89	109	C	SE	138	Spotted Green	Bold	315
38	RBHP - 57	89	12008	C	SE	137	Spotted Green	Bold	226
39	RBHP - 62 (A)	90	130	C	E	139	Spotted Green	Medium	395
40	RBHP - 44(B)	88	144	C	S	140	Light Yellow	Bold	523
41	RBHP - 41	86	132	C	E	138	Greenish	Medium	914
42	RBHP - 59	87	88	C	SE	131	Greenish	Medium	365
43	RBHP - 10	86	133	C	S	133	Greenish	Medium	331
44	RBHP - 6	86	98	C	S	131	Greenish	Bold	461
45	RBHP - 66	85	78	C	SE	132	Spotted Green	Bold	366
46	RBHP - 50	88	117	C	S	138	Red	Bold	532
47	RBHP - 37	90	114	C	SE	138	Yellowish Green	Bold	405
48	RBHP - 19	89	107	C	E	138	Yellowish Green	Medium	435
49	RBHP - 44 (C)	90	132	C	S	138	Spotted Green	Bold	485
50	RBHP - 34	76	12008	C	S	127	Spotted Green	Medium	434
51	RBHP - 63	88	111	C	S	138	Spotted Green	Bold	480
52	RBHP - 42	89	121	C	S	138	Light Green	Bold	486
53	RBHP - 29	90	106	C	S	129	Greenish	Medium	357
54	RBHP - 70	88	116	C	SE	134	Spotted Green	Medium	332
55	RBHP - 17	88	83	C	SE	136	Greenish	Medium	534
56	RBHP - 43	88	132	C	S	138	Spotted Brown	Bold	741
57	RBHP - 35	91	117	C	S	138	Spotted Green	Medium	630
58	RBHP - 51	90	129	C	SE	138	Spotted Green	Medium	571
59	RBHP - 56	87	120	C	S	140	Spotted Green	Bold	494
60	RBHP - 64	92	117	C	S	138	Spotted Green	Bold	567
61	RBHP - 76	87	92	C	S	135	Red	Small	423
62	RBHP - 77	89	93	C	S	135	Spotted Green	Small	255
63	RBHP - 89	76	115	C	S	133	Spotted Green	Small	364
64	RBHP - 79	88	12008	C	SE	137	Spotted green	Small	450
65	RBHP - 80	89	77	C	S	130	Spotted Green	Small	402
66	RBHP - 85	95	102	C	SE	143	Yellowish Brown	Medium	506
67	RBHP - 97	89	96	C	SE	138	Light Green	Medium	624
68	RBHP - 2	88	90	C	SE	140	Red	Medium	231
69	RBHP - 8	88	82	C	E	142	Light Yellow	Bold	312
70	RBHP - 87	96	87	C	SE	138	Light Brown	Medium	359

S.N	Name	Days to flowering	Plant height (cm)	Type of maturity	Growth habit	Maturity	Seed Colour	Seed size	Seed yield per plant (g)
71	RBHP - 88	96	95	C	SE	138	Spotted Green	Medium	278
72	RBHP - 32	90	100	C	SE	135	Spotted Green	Medium	437
73	RBHP - 16	90	91	C	SE	136	Light yellow	Medium	407
74	RBHP - 71	90	113	C	S	138	Spotted Green	Medium	477
75	RBHP - 72	89	133	C	S	136	Red	Medium	454
76	RBHP - 5	90	105	C	E	135	Light Yellow	Bold	350
77	RBHP - 73	90	145	C	S	138	Brown	Medium	367
78	RBHP - 90	92	98	C	S	138	Spotted Green	Medium	405
79	RBHP - 62(B)	92	115	C		135	Spotted Green	Bold	352
80	RBHP - 67	97	110	C	SE	149	Light Yellow	Bold	389
81	RBHP - 91	88	114	C	S	134	Light Yellow	Medium	229
82	RBHP - 92	89	96	C	SE	131	Red	Medium	188
83	RBHP - 68	89	114	C	SE	134	Light Green	Bold	214
84	RBHP - 34	89	90	C	SE	133	Spotted Green	Medium	176
85	RBHP - 45	88	113	C	E	132	Light Yellow	Medium	425
86	RBHP - 9	88	96	C	SE	133	Light Yellow	Small	158
87	RBHP - 33	88	96	C	S	130	Light Green	Small	103
88	RBHP - 4	88	70	C	SE	130	Spotted Green	Medium	77.5
89	RBHP - 98	90	83	C	S	140	Red	Small	95
90	RBHP - 99	88	66	C	S	137	Greenish	Small	251
91	RBHP - 93	90	112	C	E	136	Spotted Green	Medium	376
92	RBHP - 95	88	98	C	SE	136	Red	Small	401
93	RBHP - 96	90	91	C	SE	137	Light Yellow	Small	435
94	RBHP - 58	89	70	C	SE	137	Spotted Green	Medium	448
95	RBHP - 69	90	119	C	SE	138	Light Yellow	Bold	567
96	RBHP - 18	88	91	C	SE	141	Light Yellow	Small	485
97	RBHP - 22	90	70	C	S	142	Light Yellow	Medium	305
98	RBHP - 12	90	84	C	S	141	Light Yellow	Medium	150
99	RBHP - 46	88	99	C	S	139	Spotted Green	Medium	300
100	RBHP - 100	88	89	C	S	138	Red	Medium	380
101	Check-1 (BRS-II)	88	134	C	SE	138	Light green	Bold	482
102	Check-2 (BRS-I)	87	126	C	SE	139	Blackish brown	Bold	461
103	Check-3 (Nainy)	88	136	C	SE	138	Light green	Bold	502
GVT									
1	JR-1	53	88	C	SE	95	Light yellow	Medium	70
2	JR-2	62	110	C	E	100	Brown	Medium	100
3	JR-3	59	87	C	SE	95	Yellow	Small	75
4	JR-4	53	96	C	E	124	Grey	Medium	70
5	JR-5	55	78	C	E	135	Brown	Small	70
6	JR-6	70	92	C	SE	145	Yellow	Medium	110
7	JR-7	64	89	C	SE	140	Brown	Small	80
8	JR-8	63	100	C	SE	140	Light brown	Medium	75
9	JR-9	55	87	C	E	130	Yellow	Small	65
10	JR-10	57	98	C	SE	97	Brown	Small	65
11	JR11	75	76	C	E	140	Variegated	Small	90
12	JR-12	61	98	C	SE	100	Blackish	Small	105
13	JR-13	58	92	C	SE	98	Brown	Small	75
14	JR14	53	95	C	E	96	Yellow	Small	65
15	JR15	58	95	C	E	89	Yellow	medium	73
16	JR-16	56	97	C	E	90	Yellow	Small	64
17	JR-17	NA	112	C	E	NA	NA	NA	NA
18	JR-18	NA	105	C	SE	NA	NA	NA	NA
19	JR-19	NA	107	C	E	NA	NA	NA	NA

S.N	Name	Days to flowering	Plant height (cm)	Type of maturity	Growth habit	Maturity	Seed Colour	Seed size	Seed yield per plant (g)
20	JR-20	54	87	C	E	135	Black Brown	Medium	65
21	JR-21	NA	112	C	SE	NA	NA	NA	NA
22	JR-22	NA	110	C	SE	NA	NA	NA	NA
23	JR-23	NA	110	C	SE	NA	NA	NA	NA
24	JR-24	NA	124	C	SE	NA	NA	NA	NA
25	JR-25	65	75	C	E	95	Light Yellow	Small	90
26	JR-26	54	70	C	E	80	Black Brown	Small	85
27	JR-27	NA	110	C	SE	NA	NA	NA	NA
28	JR-28	NA	95	C	SE	NA	NA	NA	NA
29	JR-29	NA	80	C	SE	NA	NA	NA	NA
30	JR-30	NA	115	C	SE	NA	NA	NA	NA
31	JR-31	60	75	C	E	135	Black gray	Medium	65
32	JR-32	NA	90	C	SE	NA	NA	NA	NA
33	JR-33	55	70	C	E	95	Light yellow	Small	70
34	JR-34	58	68	C	E	100	Light yellow	Medium	70
35	JR-35	NA	110	C	SE	NA	NA	NA	NA
36	JR36	NA	112	C	SE	NA	NA	NA	NA
37	JR-37	NA	98	C	SE	NA	NA	NA	NA
38	JR-38	68	82	C	E	120	Reddish Gray	Medium	75
39	JR-39	75	85	C	E	135	Yellow	Medium	90
40	JR-40	60	75	C	E	110	Light Brown	Medium	70
41	JR-41	NA	90	C	E	NA	NA	NA	NA
42	JR-42	56	65	C	E	95	Light yellow	Small	75
43	JR-43	75	74	C	E	125	Light yellow	Medium	100
44	JR-44	80	75	C	E	140	Brown	Medium	110
45	JR-45	75	77	C	E	135	Brown	Medium	110
46	JR-46	75	87	C	E	135	Light Brown	Medium	100
47	JR-47	70	80	C	E	135	Brown	Medium	95
48	JR-48	NA	110	C	SE	NA	NA	NA	NA
49	JR-49	NA	98	C	SE	NA	NA	NA	NA
50	JR-50	55	78	C	E	90	Brown	Small	75
51	JR-51	NA	100	C	SE	NA	NA	NA	NA
52	JR-52	NA	115	C	SE	NA	NA	NA	NA
53	JR-53	53	80	C	E	90	Light yellow	Small	75
54	JR-54	59	85	C	E	95	Brown	Small	85
55	JR-55	NA	110	C	SE	NA	NA	NA	NA
56	JR-56	NA	140	C	SE	NA	NA	NA	NA
57	JR-57	58	95	C	E	95	Yellow	Medium	75
58	JR-58	65	110	C	E	104	Light Brown	Small	85
59	JR-59	61	120	C	E	100	Light Brown	Medium	70
60	JR-60	64	110	C	SE	100	Brown	Medium	75
61	JR-61	NA	108	C	SE	NA	NA	NA	NA
62	JR-62	59	126	C	E	100	Brown	Medium	70
63	JR-63	NA	121	C	SE	NA	NA	NA	NA
64	JR-64	65	141	C	SE	110	Light yellow	Medium	80
65	JR-65	63	130	C	SE	105	Light yellow	Medium	75
66	JR-66	64	125	C	SE	105	Yellow	Medium	75