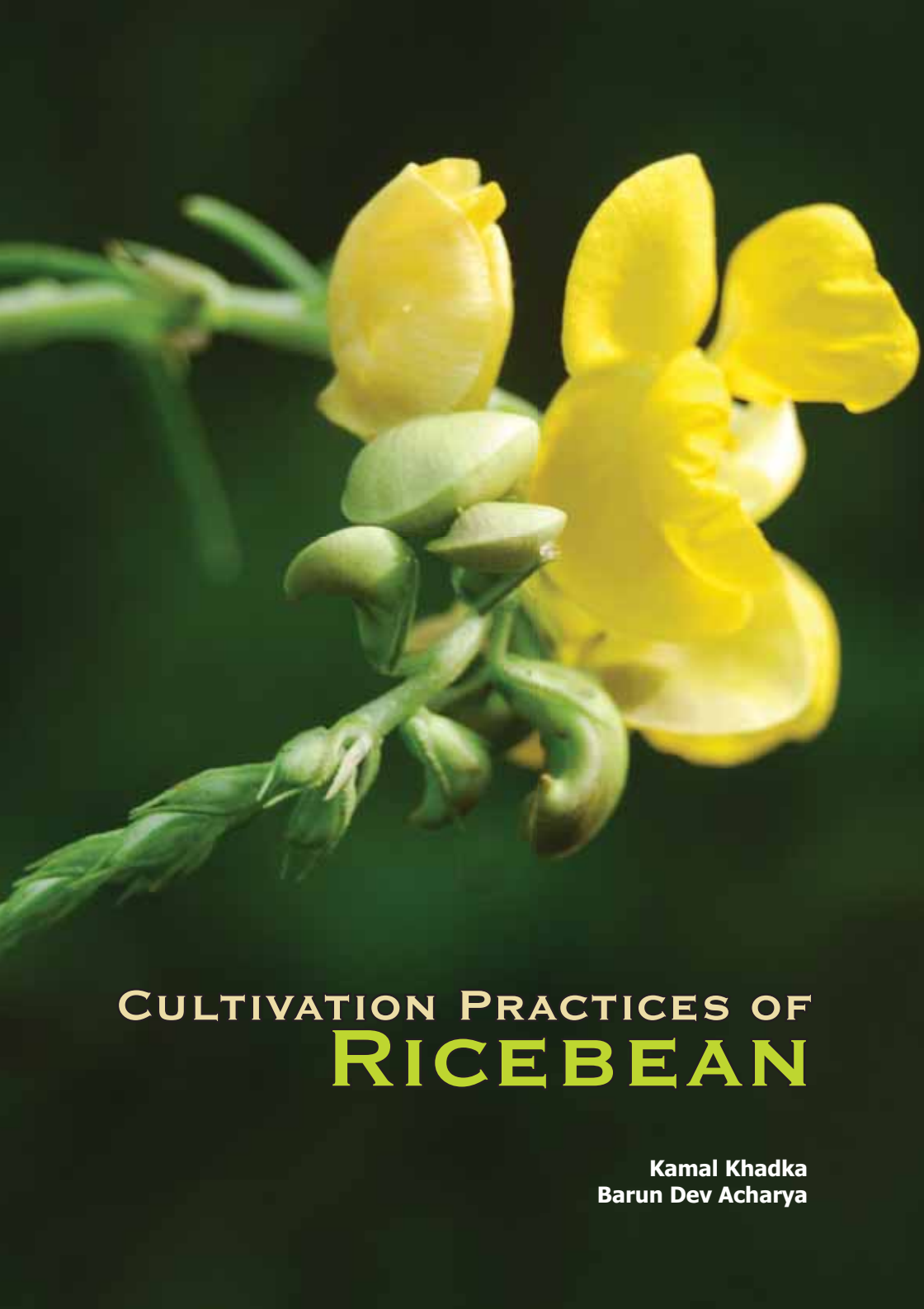

Cultivation Practices of Ricebean

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Barun Dev Acharya

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LI-BIRD
CBDC Biodiversity Conservation Natural Resources
Ricebean Network
SIXTH FRAMEWORK PROGRAMME

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PREFACE

Ricebean is one of the summer legumes grown under diverse conditions ranging from marginal lands to rain-fed *tars* and drought prone areas in the hills of Nepal. It is noted to be very rich in protein, minerals and vitamins, and has significance as nutritious fodder, green manure, and a crop for soil conservation. Nevertheless, the area of cultivation and utilization of this important legume is gradually decreasing. Lack of awareness on potential nutritional and economic use value of ricebean and its narrow socio-traditional perceptions amongst most users are observed to be the barriers to its large scale demand and production. Hence, immediate attention for its conservation and utilization is critical to prevent the loss of this multipurpose crop.

LI-BIRD is leading a study which documents local knowledge on ricebean and promotes the crop nationwide to enhance food security with additive nutritional qualities. LI-BIRD envisages ricebean as one of the most cost effective potential options for reducing pervasive malnutrition in Nepal while ensuring food security and enhancing livelihood of marginal farmers. However, it will take a consorted effort of civil society, researchers, farmers, and policy makers to realize this goal.

This booklet is an attempt to disseminate learning of the LI-BIRD study to raise general awareness among the users, farmers, researchers, students and policy makers. It is envisaged that this initiative will help attract further research and extension work to promote ricebean as a major crop. Moreover, it is hoped to foster collaborative efforts among the key actors resulting into focused programme and policies on ricebean promotion and uses.

Last but not the least, I would like to thank the authors for taking this initiative, and acknowledge everyone involved for their hard work in preparing this booklet.

Rajju Malla-Dhakal
Executive Director
LI-BIRD

FOREWORD

Grain legumes contribute to human health as cheap sources of protein, improve soil fertility and have capacity to utilize atmospheric nitrogen. The emphasis laid upon grain legume cultivation has resulted into an increasing trend in production and productivity of few legumes such as lentil, soybean, black gram and chick pea. But the minor legumes are getting less attention from the commodity research programme in Nepal compared to major legumes. Ricebean is one of those minor legumes which attracted very little research studies to assess diversity, use value and market potential.

Ricebean is a legume with multiple use value. It is an important crop for food, fodder and green manure. Although the total area under ricebean cultivation is very low, it is observed to generate cash in some specific pockets of poor and marginal farmers. Considering its significance as a multipurpose crop, it is appropriate to promote ricebean cultivation for food and nutritional security of the people. However, assessment of ricebean diversity, development of high yielding varieties through plant breeding and dissemination of knowledge are some of the main challenges ahead of us. In this context, LI-BIRD and NARC have undertaken a pioneer multi-partner project 'Food security through ricebean research in India and Nepal (FOSRIN)', in collaboration with CAZS-NR to address these issues.

This publication is based on knowledge generated from the implementation of FOSRIN project in Nepal. We believe that it will be of great value to the researchers and extension workers interested in ricebean. We also hope that this publication will help in promoting ricebean cultivation in the country.

Finally, we would like to acknowledge everyone involved directly and indirectly in the preparation of this document.

Authors

CONTENTS

1. Introduction

Ricebean (*Vigna umbellata* [Thunb] Ohwi and Ohashi) is one of the summer legumes grown by subsistence farmers in hill areas of Nepal. It is known by different local names in different parts of the country, such as *Masyang, Jhilinge, Gurous or Siltung*. It is a neglected crop grown under diverse conditions with no additional inputs. It thrives well in marginal lands, rain-fed *tars*, drought-prone areas and exhausted soils. It is generally grown as a mixed crop or intercrop with maize. It is also cultivated along rice bunds and terrace-margins in the midhills.

Ricebean is one of the minor legumes grown by Nepalese farmers and its area under cultivation is too low compared to other legumes as lentil, blackgram and chickpea. There is an increasing trend in area, production and productivity of grain legumes in the country (Neupane, 2003). However, in recent years farmers are gradually decreasing ricebean cultivation and the productivity has also gone down. The shading effect of the high yielding maize varieties and increasing use of chemical fertilizers in maize field has led to excessive vegetative growth, poor pod formation and low productivity of ricebean. Moreover, its consumption is declining due to increased availability of other preferred pulses in local markets (Joshi *et al.*, 2006).

There are many landraces of ricebean under cultivation in Nepal. These landraces are low yielding as there are no improved ricebean varieties. Plant breeding efforts for genetic improvement and development of new varieties of ricebean have not as yet been implemented.

Ricebean is a multipurpose crop. It is mainly used for human dietary uptake, with a smaller proportion used for fodder and green manuring (Joshi *et al.*, 2006). It forms an important part of cereal-based diet as the dried grains are rich in protein, minerals and vitamins. Besides, it carries social and cultural values in some communities in the country. Promotion of this crop could play an important role in improving diet and food security of people.

2. Origin and Distribution

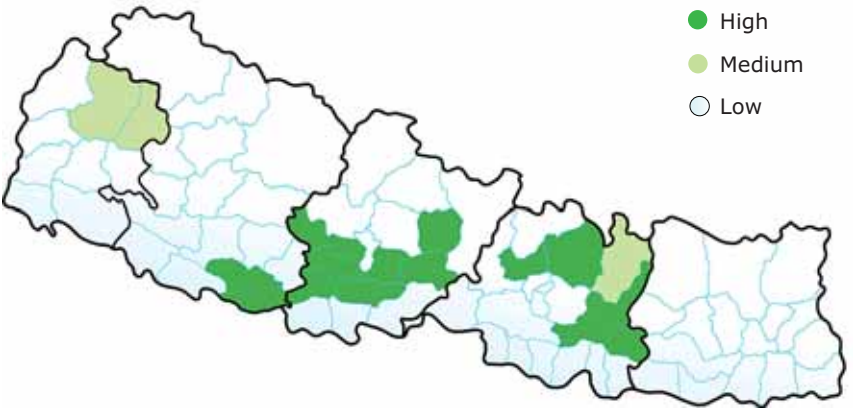
The centre of origin and diversity of ricebean is considered to be Indo-China (Tamooka *et al.,* 1991). It is believed that ricebean evolved from its wild form, *Vigna umbellata* var. *gracilis*, which is typically small leaved, fine-stemmed, freely branching, photoperiod sensitive with indeterminate growth habit, sporadic and asynchronous flowering and strongly dehiscent pods with small and hard seeds. Ricebean is known for its diverse distribution and range of adaptation from humid subtropical to warm and cool temperate climate.

Ricebean is distributed from southern China through the north of Vietnam, Laos and Thailand to Burma, India and Nepal. Its successful cultivation in Queensland and East Africa has also been reported. Furthermore, there are reports that ricebean cultivation is common in Honduras, Brazil and Mexico too. In Nepal, it is cultivated in marginal lands of midhills and few farmers from inner terai grow ricebean in their home gardens. Potential districts of Nepal growing ricebean are categorised on the basis of the area of coverage. The comparison of ricebean growing districts indicates that the area under this crop is higher in the Western Development Region of Nepal (Table 1).

Table 1. Categorization of ricebean growing districts in Nepal based on expert knowledge of District Agricultural Development Offices (DADOs)

Category	Index	Districts
<40 ha	Low	Makwanpur, Pyuthan, Kaski, Dhading, Chitwan, Parbat, Salyan, Gorkha, Ilam, Terathum, all Terai and high mountain districts
40-90 ha	Medium	Bajura, Bajhang, Dolakha
>90 ha	High	Ramechhap, Sindhuli, Tanahun, Lamjung, Palpa, Gulmi, Arghakhanchi, Baglung, Dang, Nuwakot, Sindhupalchok, Syangja

Source: LI-BIRD, 2007 and Gautam et al., 2007



Ricebean crop distribution in Nepal (by area coverage)

Source: LI-BIRD, 2007

3. Varietal Diversity of Ricebean

Ricebean is an annual legume with an erect to semi-erect vine that may grow to more than three metres height. It produces profuse branching. Leaves are tri-foliate, leaflets being comparatively broader and hairy. Flowers are conspicuously bright yellow and borne in clusters. Some researches in India have shown that ricebean has the highest growth efficiency and lowest respiratory loss of seed reserves. Ricebean is a diploid (2n=22) and there is some evidence of natural out-crossing (Sastrapradja and Sutarno, 1977). It has elongated, slightly curved and beaked seeds of variable size and colour with predominant hilum.

In Nepal, there are very few scientific studies conducted on ricebean, and little has been done to assess its diversity and to promote it as a livelihood supporting grain legume.

The preliminary studies have indicated that there exists a high diversity of ricebean landraces in Nepal. The locally collected ricebean accessions exhibited a range of molecular diversity in a study screening the SSR markers for polymeric loci. It has given insight to genetic structure and relationships of these accessions which could be used in breeding of improved varieties of ricebean (Bajracharya *et al.,* 2008). The study on preferred trait analysis showed that farmers gave different names to ricebean landraces based on grain colour and size. A study in Gulmi district indicated that farmers cultivate mainly four types of ricebean landraces: red (*Rato Jhilinge*), brown big (*Khairo Thulo*), white big (*Seto Thulo*), and early maturing small-grained semi-determinate (*Bhadaure*). The distinct characteristics of these landraces with their positive and negative traits as identified by farmers are presented in Table 2.

Table 2. Positive and negative traits of ricebean landraces as identified by farmers of Darbar Devisthan VDC, Gulmi district

Landrace	Distinguishing Traits	Positive Traits	Negative Traits
Rato (red)	Red colour, small to medium sized grains, medium in maturity	Least affected by rainfall, medium in maturity (third-fourth week of October)	Not very tasty, coarse grain, low grain yield
Khairo Thulo (brown big)	Brown striped colour, big sized grains, late in maturity	Better taste compare to *Rato*, better grain yield, good fodder yield	Late in maturity (third week of November)
Seto Thulo (white big)	White to yellowish colour, big sized grains, late in maturity	Taste is better, better cooking quality, high grain yield, high fodder yield	Late in maturity (third week of November)
Bhadaure (early small-grained)	Greenish to yellowish colour, small sized grains, early in maturity	Early maturing (third week of September)	Low grain yield, low fodder yield, difficult to harvest as it is harvested along with maize

Source: LI-BIRD, 2007

The twining habit of ricebean landraces makes them highly suitable to grow as intercrop with maize. However, it also makes them difficult to harvest mechanically, and in extreme cases additional staking is required to support the weight of vegetative growth. The landraces are susceptible to shattering. Hard-seededness is common in ricebean, although this trait does not appear to be consistent within varieties.

4. Nutritive Value

Ricebean is highly nutritious. The dry seeds of ricebean are good sources of carbohydrates, proteins, minerals and vitamins. Protein in ricebean is rich in limiting amino acids methionine and trytophan (Carvalho and Vieira, 1996). The seeds are also rich in other amino acids including valine, tyrosine and lysine (Mohan and Janardhan, 1994). The seeds contain vitamins such as thiamine, riboflavin, niacin and ascorbic acid (Joshi *et al.*, 2006). A laboratory study by Buergelt (2009) has also proven ricebean to be a good source of various nutrients (Table 3).

Table 3. Biochemical constituents of ricebean

Constituent	Range (%)
Carbohydrate	58.2 - 72.0
Crude protein	18.3 - 32.2
Ash	3.5 - 4.9
Soluble ether extract	0.1 - 0.5
Crude fibre	3.6 - 5.5

Source: Buergelt et al., 2009

5. Common Uses of Ricebean

Ricebean is a crop with multiple use values. Several food items are prepared locally from ricebean. The seeds, which are the primary products, are usually taken as a soup or as a pulse (*Dal*) with rice. The grains from young pods are used as vegetable. *Batuk, Bara, Biraunla, Masyaura, Kwanti, Rot, Furaula,* and *Khichadi* are other major local recipes prepared from ricebean.

Ricebean has cultural and religious values in Nepalese society. *Batuk* and *Bara* are used during marital ceremony and other social functions in Magar and Newar communities respectively. The Newar community has a tradition of preparing soup *(Kwanti)* from a mixture of nine grain legumes during the festival of *Janai-Purnima* and ricebean constitutes one of these grain legumes. *Khichadi* is a traditional dish prepared from a mixture of rice and black gram or ricebean on the occasion of *Maghe-Sankranti*, a festival celebrated by Nepalese during mid-January. During *Gaura Parba*, a festival celebrated widely in far-western region of Nepal, ricebean is one of the five grains used in preparing *Biruda*, an offering that is made to the festival deity.

Ricebean foliage is highly nutritious animal fodder. Some farmers include this crop in their cropping system to increase soil fertility. Ricebean is also used as a cover crop in hills as it is deterrent against soil erosion.

Farmers prefer ricebean varieties that have high potential grain yield. Also, they equally consider fodder yield while selecting a ricebean variety because livestock is an integral part of the Nepalese farming system (Table 4).

Table 4. Preferred ricebean landraces and their traits as distinguished by farmers of Darvar Devisthan VDC, Gulmi district

Order	Use Value in order of preference	Preferred Traits	Preferred Landraces
1	Food (*Dal*/soup, fried grain, *Batuk* and nuggets)	Bold grains, high grain yield, medium maturity, non-shattering, determinate to semi-determinate type, tasty, rainfall tolerant	*Seto Thulo* (white big), *Khairo Thulo* (brown big)
2	Fodder for livestock	Indeterminate type with luxurious vine growth, late maturity	Any late maturing indeterminate landrace
3	Green manuring crop	Indeterminate type with luxurious vine growth	Any late maturing indeterminate landrace

Source: LI-BIRD, 2007

6. Climatic Conditions for Ricebean

Study shows that ricebean can be grown in diverse environments due to its wide adaptation. Normally, it is sown in late-May to end-June in Nepal. The middle hills (700-1,400m asl) with warm south facing aspects are suitable for ricebean, although there is evidence that it can thrive in altitudes as high as 2,000m asl (Lohani, 1980). A temperature range of 25-35° C and average rainfall of 1,000-1,500mm per annum is optimal for healthy vegetative growth and proper pod development. Farmers believe that heavy rain during flowering period affects the pod development and hampers ricebean production (Poudel, 2008). Most varieties are photoperiod-sensitive, tend to be late in flowering, and produce vigorous vegetative growth when grown under

conditions of ample water and warm temperature in the subtropics. Studies in Assam of India (S. B. Neog pers. com.) and Jhapa district of Nepal (own data) have shown some possibility of promoting this crop in winter fallows, although it needs verification. If this is verified, then winter fallows in the Terai region of Nepal could be better utilised by farmers (LI-BIRD, 2008). Ricebean as a post rainy season crop in *Ghaiya* (upland rice) based and maize based system has also shown promise in low hills of Nepal.

7. Cultivation Practices

7.1. Land Selection

Ricebean is best adapted to drought-prone sloping areas and flat rain-fed *tars*. It is grown preferably in marginal lands. Preliminary studies have shown that ricebean can be grown in different types of soil including grey, black, yellow or cream coloured soils. However, red soil, which is moderate in fertility status, is considered best for ricebean cultivation (Khanal and Poudel, 2008). Based on indigenous knowledge of farmers, ricebean cultivation on highly fertile soil only promotes vegetative growth rather than an increment in yield.
It does not perform well under shade or in north-facing aspects.

7.2. Cropping Patterns

In Nepal, farmers follow various cropping patterns for ricebean cultivation. Some of the common cropping patterns are discussed below:

A. Mixed Cropping /Intercropping

Mixed cropping is the most common cropping system followed by Nepalese farmers. It involves broadcasting of seeds. For proper intercropping, farmers dibble seeds in between maize plants. Farmers usually prefer varieties that mature in 140 to 150 days for intercropping with maize. In the case of relay cropping of maize and millet, ricebean is sown at the margins (*deel*) of the maize field.

B. Sole Cropping

Some farmers grow ricebean in home gardens and in small pieces of land around the homestead as a sole crop. In this case, ricebean is produced for consumption within the family. The green tender beans are used as fresh vegetables. Landraces with long pods and bold grains are generally cultivated for this purpose.

C. Planting on Rice Bunds

Planting small seeded determinate or semi-determinate ricebean on rice bunds is a very common practice in mid-western and far-western regions of Nepal. Farmers sow the seeds on bunds, and when vegetative growth takes place the plants are guided along the slopes of the terraces.

D. Margins of *Bari* Land

Planting ricebean at the margins of *bari* land (upland) is one of the most common practices in western midhills. The seeds are dibbled when maize plants are almost knee height. When vegetative growth is attained by the ricebean, they are guided along the slope of the *bari* land.

7.3. Sowing Method and Seed Rate

Attractive, well-formed grains free from pest infestation should be selected for sowing. Immature, shriveled and old grains should not be used as seeds. Pods for seeds are usually collected from the middle portion of the plant. The upper portion generally has smaller pods with poorly formed seeds. As ricebean has a problem of hard seeds, it is common practice among farmers to soak the seeds overnight (10-12 hours) before sowing. This is beneficial not only to sort out hard seeds, but also to promote better seed germination. Seeds are either broadcasted or sown by dibbling. Usually, in case of intercropping with maize or other crops, it is broadcasted along with maize. However, if it is sown on rice bunds and in kitchen gardens, dibbling is more commonly used. Seed rates as suggested by preliminary studies are indicated in Table 5.

Table 5. Seed rate for ricebean cultivation

Sowing Procedures	Seed Rate		
	(*mana* */ *hal* **)	(*mana* / *ropani* ***)	(kg/ha)
Broadcasting	9-12	4-5	30-37
Dibbling	5-7	2-3	15-22

Source: Poudel, 2008

**'Mana' is a local weight measure based on volume (1 mana = ca. 415g of ricebean) and **'1 hal' is that area of land which can be completely ploughed by a pair of oxen in one day. ***20 ropani =1 ha*

7.4. Intercultural Operations

Grain legumes are traditionally included in cropping systems to improve soil fertility. Ricebean has the ability to utilise atmospheric nitrogen through symbiotic nitrogen fixation and thus, plays a key role in maintaining soil fertility.

Weeds are not a major problem with this crop. However, 2-3 weedings could be beneficial at about six weeks after sowing seeds and before flowering. In case of mixed cropping and intercropping, weeding provided for the main crop is adequate for proper growth and development of ricebean.

Farmers usually do not apply any chemical fertilizers to this crop. In case of intercropping with maize, fertilizers applied to maize is sufficient for ricebean. For post rainy season crop or sole crop, inorganic fertilizers at the rate 20:40:20 kgNPK/ha or five tons of compost manure could be benificial for better production (R. Shrestha pers. com.). A study conducted in University of Agriculture, Faisalabad, Pakistan showed that application of N and P_2O_5 at the rate of 40 and 60 kg/ha, respectively, resulted in highest leaf area index, crop growth rate, number of pods/plant, number of seeds/pod, 1000-seed weight and grain yield (Zaman and Malik, 1999).

During the rapid vegetative growth, farmers commonly practice cutting off the tip of the plant which promotes more lateral branching and higher grain yield. Farmers call it *'khasi parne'* (de-topping) in their colloquial language. In sole cropping, stakes are provided to save pods from rodents and fungal attack.

7.5. Drainage

Ricebean is a drought tolerant crop, and normal rain water is sufficient for its proper growth and development. It is susceptible to water-logging or excess moisture conditions, which ultimately kill the plants. Hence, it requires proper drainage facilities for its healthy growth and development.

7.6. Harvesting

Ricebean is normally ready to harvest in 120-150 days after sowing. The higher the altitude, the longer is the crop duration. The early varieties are ready for harvest along with maize, but medium and late varieties require an additional 3-4 weeks. It can be harvested when approximately 75% of the pods turn brown. To obtain a good yield, it is advisable to harvest the pods in 2-3 or more pickings as per need. To save seed loss from pod shattering, it is worth collecting pods during the morning and late afternoon.

The common practice by the locals is to harvest the whole plant when majority of the pods are dry and then sun-dry the plants on the threshing floor for 3-4 days. After this, the pods along with the whole plant are beaten with sticks to collect seeds.

7.7. Storage

Farmers' experiences indicate that if dried properly, ricebean can be stored for longer period compared to any other grain legumes in ambient conditions. Thus, before storage, ricebean is dried in the sun for 3-4 days so that fungal and insect attack is reduced. Farmers usually store seeds in '*Ghaito*' (mud pot) as it protects seeds from external moisture. Mixing some '*Neem' (Azadirachta indica)* dust with ricebean seeds during storage is a local method of protecting seeds from storage grain pests.

7.8. Productivity

Findings from group discussions have shown that farmers who intercrop ricebean with maize in Ramechhap district produce ricebean in quantities equal to half the amount of maize production. The national productivity of maize is just above 2 tons per hectare. This shows that farmers harvest almost 1 ton of ricebean from 1 hectare of land. The preliminary finding of the FOSRIN project also showed that productivity of ricebean under farmer-managed conditions is approximately 1-1.2 tons per hectare (50-60 Kg/ropani).

8. Diseases

Farmers believe that ricebean is a grain legume least prone to diseases. However, Rust, Cercospora leaf spot, Powdery mildew, Rhizoctonia blight and Bacterial blight are the diseases of ricebean common in Nepal.

8.1. Rust

Uromyces appendiculatus (Pers.) Unger

Rust is caused by *Uromyces spp*. The rust pustules are evident on leaves of ricebean, and they rarely appear on stem and pods. Initially, rust pustules are whitish, minute and slightly raised. In the later stage, pustules become reddish-brown and are seen distinctly under the leaves. If rust attacks the leaves during vegetative growth period, premature leaf drop is the major problem which directly affects yield. If rust appears in the maturing stage, it has less impact on yield.

Destruction of crop promptly after harvest is essential to control rust. If this is not done, then rust can continue to develop and serve as a major source of inoculum. Crop rotation also checks the build up of innoculum. At present, the most important method for controlling rust is periodic application of protectant fungicides. Spraying Maneb (Indofil M 45) at rates of 3 grams per litre of water before or immediately at appearance of rust pustules could be beneficial.

8.2. Powdery Mildew

Oidiopsis taurica (Lev.) Salmon

When the fungus attacks, a powdery coat appears on leaves, stems and pods. Severely affected plant parts get shriveled and distorted. The affected leaves turn yellow then brown, curl and then dry before defoliation occurs. Pods are not formed, if formed they are malformed, small in size and reduced in number. It is prominently observed in areas with temperatures between 20-35° C and high humidity.

It is essential not to plant the next crop in the same infected field. Planting the crop slightly late can help to reduce the disease development. Spraying Triadimefun-Bayletan 25% EC at 0.03% and Carbendazim 0.5 gram per litre water is beneficial to minimize the disease.

8.3. Rhizoctonia Blight

Rhizoctonia solani

The symptoms start with the development of small, irregular, water-soaked, pale-greenish spots with damp appearance on the lower leaves from where it extends towards the apex. During high humidity, the spread of disease is very fast and the spots cover greater parts of leaf blade and stem. This is very conspicuous and destructive phase of the disease. The leaflets and pods shrivel, turn brown and dry up. Affected parts of the plant rot rapidly in wet weather. If the pods are infected in the initial stage the seeds are not formed and in case of late infection the seeds are poorly formed. In some cases, the plants are killed before flowering.

It is better to combine cultural management with chemical application for disease management. Collecting and burning infected plants, sowing late, planting sparsely and maintaining crop rotation and proper drainage are beneficial. Seed treatment with Bavistin at the rate of 1 gram per kilogram seed is advised.

8.4. Bacterial Blight

Pseudomonas spp.

The pathogen is seed-borne, which is the main source of primary inoculum in new area. In the beginning small, round or irregular, flat, water soaked spots surrounded by a greenish-yellow zone appear on leaf. The infection spreads along the vein-lets and veins turning them brown and necrotic and cause distortion of the leaflet.

Use of disease free seed is the primary method to control bacterial leaf blight. Crop rotation and alteration of sowing date so that the least favorable weather conditions for the pathogen prevail are effective in reducing the disease. Seed treatment with Streptomycin may help to reduce the pathogen.

8.5. Cercospora Leaf Spot

Cercospora spp.

The *Cercospora* fungus belongs to the group of imperfect fungi or Deuteromycetes, in the Order Moniliales. The disease causes spots on leaves and defoliation in several legumes including ricebean. Small dry spots (may be round or shapeless) initially appear on leaves and get larger and ultimately defoliate the plants.

For *Cercospora* disease management, the most important task is to select seeds from healthy plants. Similarly, it is suggested not to use infected fields in the following year. Spraying Maneb (Indofil M 45) at rates of 3 grams per litre of water before or immediately at the appearance of dry spots could be beneficial.

9. Insects

Relatively speaking ricebean is a pest-free crop, even comparatively immune to most storage insect (Duke, 1981). The seeds are resistant to storage grain pests including bruchids, which generally damage other pulses during storage. Insects are not a big problem in ricebean plants as in other grain legumes according to farmers. On the other hand, as ricebean is not a priority crop, farmers do not spend sufficient time studying and managing insects that attack ricebean. Some of the insects that are commonly noticed in ricebean are discussed below.

9.1. Pod Borers

A. Helicoverpa armigera Hubner

Larvae of the pod borer, *Helicoverpa armigera* are more destructive than adults. A full grown larva has a pale body lined with rows of conspicuous black spots on its dorsal surface. Eggs are laid in small clusters of 10-15 on leaves, buds, and flowers. Larvae feed from inside a webbed mass of leaves, buds, and pods.

Chemical control is difficult as larvae live in well-protected webs. Systemic pesticides may accomplish more restraint than contact insecticides. Spraying Margosom, Nemarin at rates of 1.5ml per litre of water is beneficial.

B. Lampides boeticus L.

Caterpillar of pod borer, *Lampides boeticus* is green or light green in colour and damages ricebean after pod formation and seed development.

Pesticides based on '*Neem*' (*Azadirachta indica*) or Malathion (0.05%) can control this pest.

9.2. Soybean Hairy Caterpillar
Spilarctia casignata Kollar

Young larvae feed gregariously on chlorophyll mostly on the lower surface of the leaves, due to which the leaves look papery brownish-yellow in colour. The insects begin to attack ricebean plant during the last week of August.

Mechanically, the insect may be controlled by collecting and destroying infested plant parts, eggs and young larvae. The infested plant parts are collected and burnt or buried in the soil.

Spraying artificial pyrethroids like Deltamethrin, Cypermethrin and Fenvalerate can be beneficial. Pesticides based on '*Neem*' (*Azadirachta indica*) are also used to control this pest.

9.3. Banded Blister Beetle
Mylabris pustulata Thunberg

Blister beetles vary by species in shape, size (3/8 to 1 inch long) and colour (solid gray to black or with paler wing margins, metallic, yellowish striped or spotted). Most of them are long, cylindrical narrow-bodied beetles which have heads wider than the first thoracic segment (pronotum). Mouthparts are specialized for chewing. Blister

beetle species feed on flowers and foliage of a wide variety of crops including rice-bean. Adults usually occur in loose groups or swarms and are more detrimental.

Adult blister beetles are very mobile and may move from one area of the field to another in a short period of time. These can be controlled manually by hand picking. Spraying insecticides of artificial pyrethroid groups can be beneficial in managing these insects.

9.4. Aphid

Aphis craccivora Koch

Aphids are dark-purple to black coloured insects which are usually wingless, although some may have clear membranous wings. They occur in colonies that contain different sizes of nymphs and adults. As newly born nymphs increase in size, molting occurs and the white exoskeleton is left on the leaf surface. Development of nymphs is rapid and many generations occur each season. Aphids feed by inserting their stylet or beak into the plant tissue and removing plant sap in large amounts. Mould may develop on the excreta of aphids. Heavily infested plants develop yellow curled foliage, distorted pods, wilt and may be killed.

Numerous beneficial organisms control aphids including naturally occurring insect pathogens, parasites and predators. Excessive aphid populations may be managed with foliar insecticides but the benefits may be very limited. Dimethoate (0.03%) may be useful to lower the number of aphids.

9.5. Pod Sucking Bugs

Anoplocnemis spp.

These pests suck sap from immature seeds within the pod. The seeds become wrinkled and black spotted. Such seeds will not germinate and are also not fit for human consumption.

Systemic pesticides such as Dimethoate and Monocrotophos are effective against these pests.

9.6. Pod Weevils

Apion spp.

Weevil adults are small and black in colour. Young ones (caterpillars) feed on immature seeds inside the pod. Adults feed on leaves and flowers as well.

There are no recommended preventive measures or management practices for this pest. However, use of Dimethoate, Monocrotophos and artificial Pyrethroids may be beneficial.

9.7. Green Stink Bugs

Nezara spp.

Both nymphs and adults of green stink bugs suck sap from leaves, stem and pods with their needlelike mouthparts. The degree of damage depends, to some extent, on the developmental stage of the plant when it is pierced by stink bugs. Thus, the whole plant becomes

weak, as well as withered. Immature fruit and pods punctured by bugs become deformed as they develop. Seeds are often flattened and shriveled. Germination is reduced.

Bugs can be manually managed by collecting and destroying the nymphs as well as adults.

9.8. Leaf Folder

Hedylepta indicata Fab.

Leaf folders can attack ricebean leaves from the early vegetative stage. They fold the leaves and form a web of many leaves.

Manual and biological control is most effective in controlling leaf folders. However, spraying Monocrotophos and Dichlorvos is also beneficial.

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Some useful websites:

www.fspublishers.org
www.gardenorganic.org.uk
www.ricebean.org
www.springerlink.com

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