Rice bean in India with Particular Emphasis on the Himalayan Region

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Rice bean Growing States/ Areas in India

• North – Eastern states viz. Assam, Meghalaya, Manipur Mizoram, Arunahchal Pradesh and Nagaland.
• Sikkim, West Bengal (North), Jharkhand and Chhattisgarh
• Eastern and Western Ghats (involving several states)
• Himachal Pradesh and Uttarakhand
Himalayan Region

- **Eastern Himalaya**: Moist subtropical, Shifting cultivation (Jhoom), High biodiversity

- **Western Himalaya**: Dry temperate, Terraced farming, Low biodiversity
## Himalayan Agro Ecosystems

<table>
<thead>
<tr>
<th>Zone</th>
<th>Altitude (m asl)</th>
<th>Share of area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigated Lower Hills</td>
<td>600-1200 m</td>
<td>12</td>
</tr>
<tr>
<td>Rainfed Lower Hills</td>
<td>600-1200 m</td>
<td>08</td>
</tr>
<tr>
<td>Mid Hills South Aspect</td>
<td>1200-1700 m</td>
<td>36</td>
</tr>
<tr>
<td>Mid Hills North Aspect</td>
<td>1200-1700 m</td>
<td>24</td>
</tr>
<tr>
<td>High Hills</td>
<td>1700-2500 m</td>
<td>12</td>
</tr>
<tr>
<td>Very High Hills</td>
<td>2500-3500 m</td>
<td>04</td>
</tr>
<tr>
<td>Alpine Pastures</td>
<td>Above 3500 m</td>
<td>04</td>
</tr>
</tbody>
</table>
Altitudewise Distribution of Area in Uttarakhand

Altitude-wise Area (%) of Uttarakhand

- <1000: 13%
- 1000-2000: 26%
- 2000-3000: 33%
- >3000: 28%
Size of Holdings in Uttarakhand

Kumaon
- Marginal (< 1 Ha): 15.19
- Small (1-2 Ha): 11.22
- Medium (2-10 ha): 0.35
- Large (>10ha): 73.24

Garhwal
- Marginal (< 1 Ha): 18.69
- Small (1-2 Ha): 13.01
- Medium (2-10 ha): 0.22
- Large (>10ha): 68.08
Inclusion of Rice bean in AICRP on Underutilized Crops

• During 1988-89 (Before this, rice bean was included in AICRP on Pulses)
Exploitation of Rice bean in the AICRP on UC

- Largely as a food grain crop in the project.
- Fodder value of rice bean is being dealt with under AICRP on Forage Crops.
- Potential of grain types mainly in the hills and fodder types mostly in the plains.
Major Cropping Systems Involving Underutilized Crops in the Hills

Ricebean+Fingermillet – Wheat

Ricebean+Grain amaranth – Wheat

Ricebean+ Other pulses -Wheat/ Barley
Germplasm Accessions Evaluated at GBPUAT, Hill Campus

- Germplasm evaluated so far: 2300
- Germplasm lines maintained: 125
## Varieties Developed by GBPUAT, Hill Campus

<table>
<thead>
<tr>
<th>Variety</th>
<th>Year</th>
<th>Important Characteristics</th>
<th>Recommended area</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRR 1</td>
<td>1998</td>
<td>Black seed</td>
<td>Hills of Uttarakhand</td>
</tr>
<tr>
<td>PRR 2</td>
<td>1999</td>
<td>Light yellow seed</td>
<td>North Western Himalaya</td>
</tr>
<tr>
<td>PRR 9401*</td>
<td>2006</td>
<td>Chocolate seed</td>
<td>Identified but could not be released</td>
</tr>
</tbody>
</table>
# Seed Production (kg) at Hill Campus

<table>
<thead>
<tr>
<th>Variety/Year</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRR 1</td>
<td>42.0</td>
<td>15.0</td>
<td>8.0</td>
<td>6.0</td>
<td>5.0</td>
<td>15.0</td>
<td>18.0</td>
<td>10.0</td>
</tr>
<tr>
<td>PRR 2</td>
<td>23.0</td>
<td>9.0</td>
<td>12.0</td>
<td>8.0</td>
<td>5.0</td>
<td>8.0</td>
<td>16.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Total</td>
<td>65.0</td>
<td>24.0</td>
<td>20.0</td>
<td>14.0</td>
<td>10.0</td>
<td>23.0</td>
<td>34.0</td>
<td>15.0 (205)</td>
</tr>
</tbody>
</table>
## Seed Production (kg) at Research Sub-Station, Gaja

<table>
<thead>
<tr>
<th>Variety</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRR 1</td>
<td>30.0</td>
<td>73.0</td>
<td>23.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10.0</td>
<td>100.0</td>
</tr>
<tr>
<td>PRR 2</td>
<td>32.0</td>
<td>74.0</td>
<td>22.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15.0</td>
</tr>
<tr>
<td>Total</td>
<td>62.0</td>
<td>147.0</td>
<td>45.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10.0</td>
<td>115.0</td>
</tr>
</tbody>
</table>

Note: Total yield is (379) kg
Agro-techniques Developed

- Planting geometry in rice bean (30x15 cm).
- Source and level of phosphorus in rice bean (acidulated rock phosphate 60 kg /ha).
- Time of sowing and seed rate in rice bean (15 May and 20 kg /ha).
- Acid soil reclamation (Most efficient genotype, RBL 2).
- Nodulation studies in rice bean genotypes (Best genotypes, RBL 100 and RBL 17).
- Nitrogen level in rice bean (40 kg /ha).
- Cropping system and fertility level in rice bean (Rice bean - pea, N$_{20}$ P$_{20}$ kg / ha).
- Rice bean genotype suitable for fodder (BRS 1).
Other Studies

- Cooking parameters in rice bean.
- Seed hardness, flower drop and nodulation studies in rice bean.
- Molecular characterization (RAPD) of rice bean parents and their cross derivatives.
- Interspecific crosses of ricebean with cowpea.
- Residual effect of rice bean in succeeding wheat crop.
# Cooking Quality of Rice bean as Compared to Green gram

<table>
<thead>
<tr>
<th>Entry</th>
<th>PRR-1</th>
<th>PRR-2</th>
<th>Green gram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed volume (ml/seed)</td>
<td>0.040</td>
<td>0.047</td>
<td>0.027</td>
</tr>
<tr>
<td>Seed density (g/ml)</td>
<td>1.460</td>
<td>1.250</td>
<td>1.055</td>
</tr>
<tr>
<td>Swelling capacity/seeds</td>
<td>0.0200</td>
<td>0.0370</td>
<td>0.0005</td>
</tr>
<tr>
<td>Hydration capacity/seed</td>
<td>0.0250</td>
<td>0.0440</td>
<td>0.0006</td>
</tr>
<tr>
<td>Closed pan cooking</td>
<td>96.0</td>
<td>96.0</td>
<td>98.5</td>
</tr>
<tr>
<td>Presoaking (42 hr)+ cooking (max. 50 min)</td>
<td>91.0</td>
<td>90.0</td>
<td>98.5</td>
</tr>
<tr>
<td>Pressure cooking (10 min)</td>
<td>98.0</td>
<td>96.0</td>
<td>96.0</td>
</tr>
</tbody>
</table>
Seed Vigour and Methods to Overcome Seed Hardness

- Field emergence was higher in small seeded types which were high yielding as well.
- Seed viability and vigour index was positively correlated with field emergence.
- Per cent hard seeds ranged from 4.16 to 41.66.
- Among the six treatments applied conc. H$_2$SO$_4$ for 120 seconds was found most effective in overcoming seed hardness with an overall germination of 84.08%.
Promising Genotypes Evolved through Hybridization
DNA Fingerprint Patterns Revealed for 13 Rice bean Varieties and their 11 Cross Derivatives by a. Primer No. D17 and b. Primer No. D18
Cluster Analysis with UPGMA Utilizing SED of the RAPD Fragments Generated by 13 Rice bean Varieties and their 11 Cross Derivatives
Value Added Food Products

• Estimated Vitamin C content of sprouted rice bean.

• Developed multipurpose food products (MFP) using rice bean with small millets and grain amaranth for nutritionally vulnerable groups.

• Rice bean as a substitute of black gram in South Indian snacks like Idli, Vada, Dosa etc. (UAS, Bangalore).
Training on Value Added Food Products
Popularization of Improved Technologies

- Conducted Front Line Demonstrations (FLDs)
- Imparted On- and Off- Campus Training
- Organized Farmers’ Fairs & Field Days
- Organized Food and Biodiversity Fairs
- Developed Popular Literature (Folder, Pamphlet etc)
- Broadcast Radio and TV Programmes
Linkage and Coordination

- ICUC and GFU on UC, currently Crops for the Future
- GFAR, IFAD, Bioversity International, MSSRF
- Agro-biodiversity Platform
- NARS, SAUs
- State Departments
- Seed Production Agencies
- Organic Commodity Board
Future Thrust Areas

- Extensive collection of genetic resources through national and international collaboration.
- Biochemical and molecular characterization of germplasm lines.
- Development of both grain, vegetable (WVC, Taiwan) and fodder types.
- Extensive hybridization for development of determinate, early and synchronous maturing, high yielding genotypes.
Future Thrust Areas

- Interspecific hybridization and marker assisted selection (MAS).
- Study of genetics of seed coat colour to develop uniform coloured seeds preferably green/black.
- Removal of anti-nutritional factors e.g. phytate.
- Removal of seed hardness for quick and uniform germination.
- Developing leaf blight (Phoma sp.) resistant genotypes for the hills.
- Participatory research including participatory plant breeding.
- Marketing strategies.
Thanks