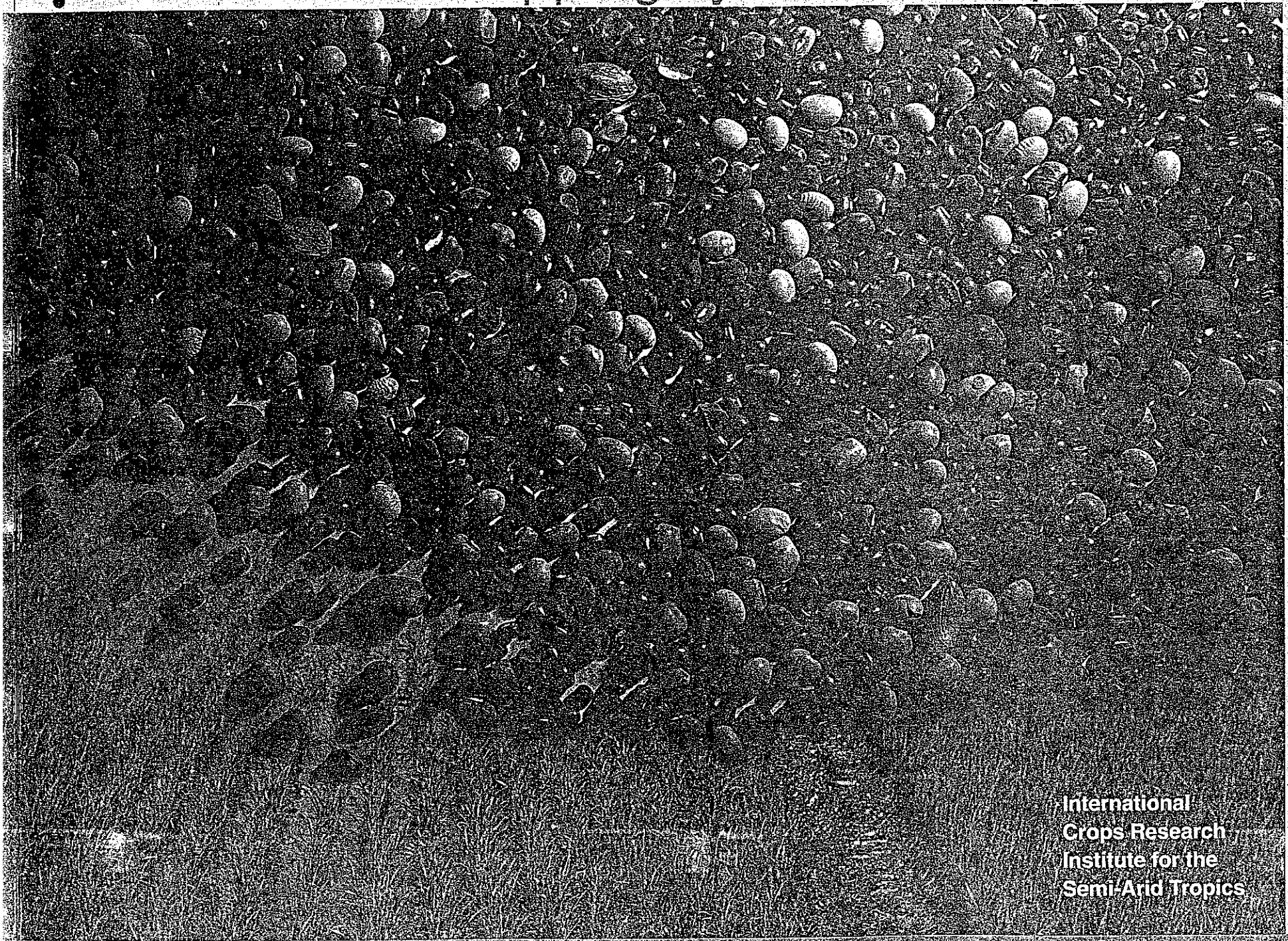
Legumes in rice-based cropping systems in tropical Asia



International Crops Research Institute for the Semi-Arid Tropics

Legumes in Rice-based Cropping Systems in Tropical Asia

Constraints and Opportunities

Edited by

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13. Priorities for Research and Development of Legumes in Tropical Rice-based Cropping Systems of Asia

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The country papers presented in the earlier chapters of this book have discussed the importance and role of legumes in the tropical rice (*Oryza sativa* L.)-based cropping systems in each country. These, together with the regional outlook papers on oilseeds, pulses, and green manures, provide ample insights into the current situation, trends, and future prospects for increased inclusion of legumes in the Asian tropical rice-based cropping systems. Overall, there are many similarities between the study on the role of legumes in the rice and wheat (*Triticum aestivum* L.) cropping systems in the Indo-Gangetic Plains (Johansen et al. 2000) and this study, in tropical rice-based systems of Asia. The commonalities are in terms of rice ecosystem (especially lowland, and irrigated rice) and legumes [pigeonpea (*Cajanus cajan* (L.) Millsp.), chickpea (*Cicer arietinum* L.), groundnut (*Arachis hypogaea* L.), mung bean (*Vigna radiata* (L.) Wilczek), and black gram (*Vigna mungo* (L.) Hepper)] in different cropping systems. Hence, some of the statements and conclusions in this book are likely to be common and may overlap.

Characterization of the Ecosystem

Intensive monocropping of rice is reported to be leading to productivity declines or plateauing of yields in many countries. Although not substantiated, many authors have indicated degradation of rice lands due to intensification following introduction of high-yielding varieties of rice in the mid-1960s and early 1970s, and suggested a break in the rice monocropping with an upland crop.

The characterization exercise of tropical rice ecosystem was much more difficult than envisaged in the beginning. This was due to: (i) non-availability of statistics on crop area and production and constraints (biotic and abiotic) to production of legumes, and (ii) non-uniformity in geographic information system (GIS) maps in different countries due to different sets of maps using varied softwares. The GIS workshop held in 1997 (Pande et al. 1999) helped in training the scientists of the national agricultural research systems (NARS) in the use of GIS. However, we were not fully successful in getting standard sets of maps for all countries. Legumes being secondary crops, accurate and up-to-date data were not published or readily available in many countries. However, the authors of country papers were able to assemble and report the most recent and reliable data. Due to lack of complete information, we were not able to delineate the areas/zones suitable for legumes in all the countries. Similarly, information on location and extent of soil acidity, salinity, and nutrient deficiency and toxicity was not available to delineate areas unsuited to legume cultivation. Since the maps are on GIS, we will be able to update these as and when additional information becomes available.

Policy Issues

The regional and country papers presented in this volume, and the earlier volume on scope for legumes in the Indo-Gangetic Plain (Johansen et al. 2000) clearly indicate the excellent opportunities for increased inclusion of legumes in the rice-based cropping system. It is evident that water for rice cultivation is becoming scarce, and we need to incorporate crops that have high water-use efficiency (WUE), such as the legumes and other upland crops. However, policy support for non-staple crops (such as legumes) is not very encouraging. Some national governments have emphasized crop diversification to increase WUE and also as a means of widening the food basket (with many diverse crops) and for sustainability of the production system. But, the efforts are dispersed and disjointed to show the needed impacts in crop diversification. There are many success stories of introducing and/or increasing the area and production of legumes in many countries (Muehlbauer et al. 1998, Johansen et al. 2000). The success was due to suitable crop varieties, management practices and policy support by governments to reduce or partially alleviate the production constraints. We should learn from these and implement the elements that provided impetus for success in legume adoption in those countries.

As clearly enunciated by Palaniappan et al. (this volume), the potential of green manure crops in improving soil fertility and reducing the need for chemical fertilizers is immense and needs consideration by policy makers. However, adoption of green manuring by farmers is low. There is need to consider production of nitrogen-rich organic material in situ by growing fast growing nitrogen-fixing green manure crops on the farm bunds. This is becoming much more relevant as the cost of chemical fertilizers is increasing. Both grain legume and green manure species have a major role in sustainable agriculture, and need support (such as for seed multiplication and supply) by governments in all countries.

Global trade under trade liberalization will have a bearing on prices for legumes. Countries that produce legumes at lower costs will have the competitiveness to survive. Hence, it is essential for governments to provide policy

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support, and infrastructure to achieve cost effectiveness in production. Policies that promote rural credit facilities, better road and transport to bring the produce to markets at low cost, storage infrastructure, small scale and cottage industries for postharvest handling and processing are essential. Emphasis and policy support is also needed for providing appropriate machinery for sowing (to ensure optimum plant stand) and harvest (to reduce postharvest losses). Consumers' eating habits are changing, driven by urbanization. Hence value addition by processed foods will not only increase the demand for legumes, but also improve the health of people, especially children and women.

Research Needs

Despite the spectacular progress in crop improvement during the last two decades, legumes are still not as high-yielding as the cereals. Possibility of hybrid cultivars in pigeonpea has provided a limited yield advantage, but hybrid production in other legumes is only a distant possibility. Hence, efforts should be to improve the yield potential through ideotype breeding. Concerted efforts are needed to design crop improvement strategies to improve the yield levels of legumes to become competitive with cereal crops. On the other hand, efforts should continue to breed short-duration varieties to fit into cropping system niches in rice-based systems, without unduly affecting the yield levels. Considering the various stresses faced by legumes, the following traits need to be incorporated in different agroclimatic areas: (i) resistance to prevailing diseases and pests, (ii) increased ability to fix nitrogen under stress conditions, (iii) tolerance to waterlogging (early in the season) and drought tolerance (late in the season), (iv) resistance to shattering and pre-harvest sprouting, (v) fresh seed dormancy, and (vi) tolerance to acidity, salinity, and other soil toxicities. It is difficult to incorporate all the traits mentioned above, but the aim should be to incorporate essential tolerance/resistance in varieties for the given agroclimatic conditions. Using sophisticated techniques in molecular biology, it should now be possible to transfer desirable characters using marker-assisted selection for accelerated breeding. With emphasis on processed and value-added products in the future, quality traits of individual legumes will be important in high-yielding varieties.

A few national programs are still weak and are in early stages of development, especially for research on legume improvement and management. Therefore, stronger NARS and international agricultural research centers and programs should help the weaker NARS to develop and strengthen their base for legumes research and development. Research to refine technologies to suit local conditions and meet farmers' needs is a continuous need in all countries to meet the emerging challenges to legumes production. Similarly, research to provide resource conservation technologies (zero or minimum tillage) and machinery and management practices to reduce demand for labor are essential to mechanize and commercialize legume cultivation. Other research needs are listed by Johansen et al. (2000).

Development Needs and Activities

Although the current potential yields of legumes is around 3–5 t ha^{-1}, the average yields across Asia is only around 1 t ha^{-1}. Hence, the yield gap is 2–4 t ha^{-1} among different legumes (Johansen and Nageswara Rao 1996). With proper planning and policy support the productivity of legumes can be improved by good crop husbandry. Farmer participatory on-farm research is appropriate to generate and refine technologies to meet the needs of farmers in different agroecosystems (Gowda et al. 1993). Researcher-extension-farmer linkages should also be strengthened to popularize necessary technologies and information and to get feedback for supportive and backup research. Similarly farmer-trader-processor linkage is essential, with necessary government support to ensure proper pricing, transport, processing, and distribution of legumes and legume products. This will provide the necessary conduit for legumes' demand that in turn will keep the prices at a profitable level for farmers.

One of the major constraints to adoption of improved varieties reported by farmers is the non-availability of quality seed of improved varieties. Efforts of government seed corporations and distribution agencies are geared towards the major staple cereals and commercial crops. It is therefore necessary to develop institutional mechanisms and strategies for seed production and distribution of improved legume varieties. Involvement of non-governmental organizations (NGOs), and farmers' organizations and cooperatives is necessary to ensure supply of quality seeds at a reasonable cost and at proper time. This also needs involvement of farmers (especially women farmers) in seed production and storage at community or village level. Similarly, supply of other inputs such as fertilizers, pesticides (biological and chemical), machinery, and irrigation should be improved.

Public sector extension system is either weak or not efficient in many countries. On the other hand, many NGOs and the private sector are becoming involved in rural development activities, including technology transfer. Hence, both NGOs and private sector should be partners in development activities. Efforts should be towards intensification of legume production in traditional areas (to enhance sustainability) and extending legumes to non-traditional areas (to improve land use, e.g., by using legumes as intercrops in new plantations).

Conclusions

Demand for legumes is increasing in most countries. However, production is not keeping pace with the demand although there are regional production increases

in some countries (such as black gram in Andhra Pradesh, India). Many South and Southeast Asian countries are importing legumes to meet the local demand. There are ample opportunities and good scope for increasing the area and production of legumes in the rice-based cropping system in all tropical Asian countries. Emphasis should be on both varietal improvement and agronomic management, including development of new crop ideotypes and bridging the yield gap. "Food Legume Councils" that involve farmers, traders, and processors should be created in each country, by levying tax on legumes and legume products, to support research and development (Gowda et al. 2000). This strategy of enhancing research and development of legumes has succeeded in countries such as Australia and Turkey. Overall, a concerted effort involving public sector, private sector, NGOs, and farmers' organizations is essential to enhance legume production to improve human health and sustainability of rice-based cropping systems in Asia.

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