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Food Legume Improvement and Development

Proceedings of a workshop held at The University of Aleppo, Syria, 2-7 May 1978

Geoffrey C. Hawtin and George J. Chancellor, Editors

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Food Legumes in India

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India possesses the largest area in the world under grain legume cultivation. Grain legumes have proved to be the mainstay of Indian agriculture for the past few decades, enabling the land to produce reasonable quantities of food grains despite the almost total lack of manuring or fertilization. This has primarily resulted from the legumes' ability to fix atmospheric nitrogen, which gives them a comparative advantage under these growing conditions. In addition to this, as a group the legumes exhibit considerably higher drought tolerance than other crops and have thus found a niche in areas characterized by regular moisture stress. Because of these characteristics, legume crops are invariably included in rotations throughout the country and also figure prominantly in crop mixtures.

Apart from these agronomic advantages, grain legumes occupy an important place in dietary considerations, supplying, as they do, most of the protein requirements of India's predominantly vegetarian population. Some of the crops also serve as excellent forages and grain concentrates in the feed of the country's large cattle population and others are favoured for use as green manures.

Production Position

In 1976, the area under pulse crops was approximately 24 million ha, or 20% of the total area under food grain crops, and the production from this was about 13 million tonnes. The major pulse crops and their relative importance to Indian agriculture are given in Table 1.

Chick-pea is by far the most important food legume crop in India, occupying an area of 8.37 million ha throughout the country. The others are of less importance overall, but

TABLE 1. Major pulse crops of India and their relative importance in the country's agriculture.

Crop		% of total	
Botanical name	English name	Area (ha)	Prod.
Cicer arietinum Linn.	Gram or Bengal gram	41.0	51.0
Cajanus cajan (Linn.) Millsp	Pigeon pea or red gram	9.8	11.2
Lathyrus sativus Linn.	Chickling vetch	7.9	7.6
Vigna mungo	Black gram	6.5	3.9
Dolichos biflorus Linn.	Horse gram	6.3	3.0
Phaseolus aconitifolius Jacq	Moth	6.2	2.6
Pisum arvense Linn. and *Pisum sativum* Linn.	Peas	5.4	9.8
Vigna radiata (L.) Wilczek	Green gram	5.4	2.5
Lens culinaris Mebic.	Lentil	3.3	2.9
Other pulses[a]			

[a] Includes: *Vigna unguiculata* L. (cowpea), *Cyamopsis tetragonoleba* L. (clusterbean), *Dolichos lablab* L. (Indian bean or field bean), *Phaseolus vulgaris* L. (French bean), *Phaseolus trilobus* L. (pillipesara), *Glycine max*. L. (soybean).

each crop has its own unique place in the agriculture of the country dependent upon its suitability for particular rotations and crop mixtures and/or its adaptation to specific agroecological conditions. Among the less widely cultivated pulses for example, cowpea and *Phaseolus* bean are grown in most regions of the country, whereas soybean is a staple pulse only in the temperate regions of the Himalayas. Similarly, french bean cultivation is restricted to regions with a cool monsoon season; guar is an important field crop in the western part of the Indo-Gangetic Plain in the north; and pillipesara assumes more importance in the south of the country. The cultivation of some crops (e.g., soybean), which are relatively more productive and tolerant to adverse conditions, is now tending to spread from their more traditional niches into the plains of northern and central India.

Madhya Pradesh, Uttar Pradesh, Rajasthan, Mahrashtra, and Bihar are considered to be the most important food legume-growing areas in the country (Fig. 1).

Agronomic and Nutritional Uses

Pulses as Food and Fodder

In most parts of India, pulses form an essential part of the daily diet of the population and serve as the major source of dietary protein. They are thus used as food in a wide

Fig. 1. Provincial divisions of India; Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, and Bihar are the most important food legume-growing areas in the country.

variety of forms. The most common of these is soup; the split grains are boiled in spiced water and seasoned to form "dal" or "sambar." The grains may also be ground and boiled, roasted or fried; sprouted and then cooked; made into sweetmeats; or used as a flour in the preparation of bread and other foodstuffs. The grain and pods of some pulses (e.g., pea, guar, cowpea, and *Phaseolus* beans) are often cooked and eaten in the green condition. It is largely the brown seeded desi types of chick-pea that are cultivated for human consumption in India; the pink, green, and black kabuli types are used only to a very limited extent in the country.

Some of the pulse crops, such as guar, cowpea, pea, chickling vetch, horse gram, and pillipesara, are commonly used as fodder for draft and milk animals. Legume grains are also used to some extent as concentrates in the diets of animals. Guar grain is especially preferred for this purpose for draft animals and chick-pea is held in high esteem for feeding bullocks and horses.

Pulses as Green Manures

Legume crops, such as green gram, clusterbean, cowpea, and pillipesara, are excellent green manure crops, although their use for this purpose is secondary to that of the well-recognized green manure sunn hemp (*Crotalaria juncea*). This is mainly because they provide less organic matter, and hence possibly also less nitrogen, to the soil when turned in. However, they are considered to be very useful as manures because, by virtue of their rapid rate of decomposition, they become thoroughly incorporated into the soil at a much faster rate than the more woody, conventional green manure crops.

Pulses in Crop Mixtures and Rotations

Their ability to thrive under a wide range of soil and climatic conditions ensures the legumes an important place in a large number of crop mixtures and rotations throughout India.

Pigeon pea is generally grown in a mixture with millets or cotton, or as a border crop in sugarcane fields. In the northern and central parts of the country, where late (250-day) or medium (200-day) maturing varieties are grown, they are almost invariably mixed with millets such as "jowar" (*Sorghum vulgare*), "bojra" (*Pennisetum typhoides*), or "kodon" (*Paspalum scrobiculatum*). Sometimes a small proportion of other crops, such as green gram, black gram, or sesamum, are also added to the mixture. These mixtures are normally broadcast sown in the months of June or July, depending upon the onset of the monsoon. During the first 4 months, the more rapidly growing millet is the dominant crop, but after the millet harvest in October–November the pigeon pea crop grows rapidly to give complete field cover by the end of the winter season. As it flowers and forms pods after the associated millet crop is removed, and has a full season in which to complete its growth and development, the pigeon pea crop recovers well from its earlier cramping, giving reasonable yields. The sowing of this mixture is popular throughout the country as it enables two, or sometimes more crops to be grown within one season under dryland farming conditions; it also causes a marked reduction in the incidence of wilt disease in pigeon pea plants. Although generally grown as a single crop, chick-pea is often sown in a mixture with wheat, barley, linseed, or mustard in the unirrigated areas of Uttar Pradesh and Madhya Pradesh. This is primarily because, having a deeper rooting system than cereal crops, the chick-pea component of the mixture provides a certain amount of guarantee against crop failure in the event of the winter rains being insufficient to support the cereal component. Similarly, horse gram is usually grown as a single crop, but is often grown in a mixture with castor, groundnut, or cotton in Karnataka and other areas. Other legume crops commonly included in mixed cropping regimes include short duration varieties of black gram with maize; field bean (*Dolichos lablab*) in "ragi" (*Eleusine coracana*) mixtures; and cowpea and black gram with millets and oilseeds.

Grain legume crops figure prominently in rotations all over India. They may occupy a field once in every 2 or 3 years or often even more frequently, because of their ability to grow well under conditions of limited soil moisture and at the same time improve soil fertility. In Northern India rotation of dryland paddy, which matures in 80–90 days, with

chick-pea is a widespread practice. Where the paddy crop is of a long duration, however, field pea (*Pisum sativum*) or *Lathyrus sativus* replaces the gram crop in the rotation.

To ensure good germination of the legume crop in this rotation it is customary in the important paddy-growing areas of Bihar, Orissa, and Madhya Pradesh to sow the pulse into a standing paddy crop just prior to harvest when the soil is still wet. However, the crop most commonly involved in this rotation, *Lathyrus sativus*, contains a neurotoxin, which may accumulate in the body and cause paralysis of the lower limbs (lathyrism). It has proved hard to identify an alternative to replace *Lathyrus* in the rotation, as this crop is ideally suited to growing in paddy soils, which on drying become as hard as steel and when wetted are quickly waterlogged. Such conditions preclude the utilization of chick-peas, lentils, or peas, which are sensitive to both drought and overwatering. Investigations continue and results to date indicate that some lentil varieties that are better adapted to these conditions might be used to replace the currently grown *Lathyrus* cultivars. A recently developed low-neurotoxin *Lathyrus* line (Pusa 24) might also be used as a replacement.

Under rainfed conditions chick-pea and lentil are almost invariably grown as a single crop in rotation with a cereal, millet, oilseed, or cotton, depending upon the region. In irrigated areas, however, double cropping is frequently practiced. This has been made possible through the evolution of short duration genotypes of green gram, black gram, and cowpea, which are also tending to popularize multiple cropping under rainfed conditions, especially on land that usually remains fallow for 5–6 months of the year.

Pulses and Soil Improvement

The value of leguminous crops to Indian agriculture, by virtue of their ability, in symbiosis with *Rhizobium* bacteria, to fix atmospheric nitrogen and supply it to the soil, is immense. Some of the nitrogenous compounds formed in this way are able to pass into the soil in the vicinity of the plant roots. These compounds are easily assimilable by nonleguminous plants, and the advantages obtained by crops grown in association with legumes may be one of the major reasons for their popularity in crop mixtures.

Besides their undoubted contribution to soil fertility, grain legumes have a considerable improvement effect on soil structure, their deep and extensive rooting systems opening out the subsoil layer and providing a large amount of organic matter to this layer upon death or shedding. Such deep rooting systems and spreading growth habits also mean that the legumes are important for their erosion-resistant properties. This attribute is often exploited by planting legumes either singly or between spaced rows of other crops on erosion-prone soils.

Unfortunately, however, the fact that food legume crops possess such important agronomic advantages is tending to mitigate against achieving yield improvements in many parts of India. This results from the farmers' traditional and continuing reliance upon legumes to replenish soil fertility, to assist other crops, to reduce soil damage and erosion, and to produce yields from very marginal lands, under minimum input conditions. In using legumes in this way it is often forgotten that, in common with other food crops, high soil fertility is required for the production of high yields. There is thus considerable potential for yield improvement in India, and indeed throughout the Middle East, through the widespread introduction of improved methods of agronomy, especially phosphate fertilization, coupled with an inherent change in the way that legume crops are perceived at the farmers' level.