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# Enhancing the Productivity and Production of Pulses in India

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Source

Pulses are major sources of proteins among the vegetarians in India, and complement the staple cereals in the diets with proteins, essential amino acids, vitamins and minerals. They contain 22-24% protein, which is almost twice the protein in wheat and thrice that of rice. Pulses provide significant nutritional and health benefits, and are known to reduce several non-communicable diseases such as colon cancer and cardiovascular diseases. India is the largest producer and consumer of pulses in the world. Major pulses grown in India include chickpea or bengal gram (*Cicer arietinum*), pigeonpea or red gram (*Cajanus cajan*), lentil (*Lens culinaris*), urdbean or black gram (*Vigna mungo*), mungbean or green gram (*Vigna radiata*), lablab bean (*Lablab purpureus*), moth bean (*Vigna aconitifolia*), horse gram (*Dolichos uniflorus*), pea (*Pisum sativum* var. arvense), grass pea or khesari (*Lathyrus sativus*), cowpea (*Vigna unguiculata*), and broad bean or faba bean (*Vicia faba*). More popular among these are chickpea, pigeonpea, mungbean, urdbean and lentil.

Area, production and yields of pulses in India. India ranks first in the world in terms of pulse production (25% of total worlds production) (FAOSTAT 2010). Madhya Pradesh, Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka and Rajasthan are the major states growing pulses in India. These six states contribute 80% of total pulse production and area (Directorate of Economics and Statistics, Department of Agriculture and Cooperation, 2010). 147 More than 90% of lentil area is covered by Madhya Pradesh and Uttar Pradesh states which contribute more than 70% of country's production during 2010 (Directorate of Economics and Statistics, Department of Agriculture and Cooperation, 2010). Pigeonpea is mainly grown in Maharashtra, Karnataka and Andhra Pradesh states (>60% area in India) with 60% of production (1.4 million tons) coming from these three states. Madhya Pradesh has the highest area (38%) under chickpea, followed by Maharashtra (16%), Karnataka (12%), Rajasthan (11%), Andhra Pradesh (8%) and Uttar Pradesh (8%). Andhra Pradesh leads in the total pulse productivity with an average increase of 81-100% in the yield of two major pulses, chickpea and pigeonpea in the past two decades (1991 to 2010). This significant increase has surpassed the national average increase in the total productivity.

## Constraints to pulse production

Pulse production faces a number of constraints that can limit yields and overall production. These constraints can be broadly categorized into biotic, abiotic, and socio-economic factors.

**Biotic Constraints in Pulse Production: A Deeper Look**

Biotic constraints are living organisms that negatively impact pulse production. They can be categorized into three main groups:

**Pests:** These are insects and other invertebrates that feed on the pulse plants themselves.

Some common examples include pod borers, beetles, and bruchids. Pod borers burrow into developing pods and consume seeds, directly reducing yield. Beetles and bruchids can damage stored pulses after harvest, causing economic losses.

**Diseases:**

These are caused by fungi, bacteria, viruses, and other pathogens that infect pulse plants. Common diseases include wilt, rust, and blight. Wilt diseases cause plants to wilt and die, while rust and blight cause lesions on leaves and stems, reducing plant growth and pod production.

**Weeds:** These are unwanted plants that compete with pulses for water, nutrients, and sunlight. Weeds can also harbor pests and diseases, further impacting pulse crops.

**Impact of Biotic Constraints:** The impact of biotic constraints on pulse production can be significant:

**Reduced Yields:** Pest feeding, disease damage, and competition from weeds can all lead to lower yields of pulses.

**Poor Quality:** Pest damage and disease can also affect the quality of harvested pulses, making them less marketable.

**Increased Production Costs:** Farmers may need to spend more money on pesticides, fungicides, herbicides, and other control measures to manage biotic constraints.

**Abiotic Constraints**

**Drought**: Pulses are generally drought-tolerant crops, but they can still be affected by severe drought conditions. Drought stress can reduce plant growth, flowering, and pod set, leading to lower yields.

**Unfavorable weather conditions**: Pulses are also sensitive to extreme temperatures, such as frost or heat stress. These conditions can damage plants and reduce yields.

**Soil infertility:** Pulses require well-drained soils with good fertility. However, many pulses are grown on marginal lands with poor soil fertility. This can limit yields and make crops more susceptible to other stresses.

**Socio-economic Constraints:**

**Low seed replacement rate**: Many farmers save their own seeds for planting, which can lead to a decline in genetic diversity and yield potential.

**Poor management practices:** Some farmers may not be using the best agronomic practices for pulse production, such as proper planting density, fertilization, and weed control. This can limit yields.

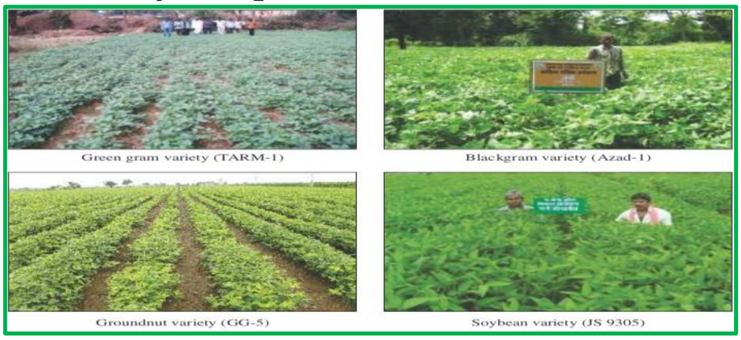
**Lack of access to inputs:** In some areas, farmers may not have access to high-yielding varieties of seed, fertilizers, or pesticides. This can limit their ability to improve yields.

**Unstable prices:** The prices of pulses can be volatile, which can discourage farmers from planting these crops.

These are just some of the constraints that can limit pulse production. By addressing these constraints, farmers can improve yields and help to meet the growing demand for pulses**.**

## Strategies to improve pulse productivity and production

There are a few available technologies that can increase the productivity and production of pulses. A few examples are given in this paper, mostly from chickpea and pigeonpea where the authors have experience. Similar technologies are available for most major pulses grown in India.



a. **Short-duration, high-yielding varieties Matching:** Crop maturity duration to available cropping window, including soil moisture availability, is a major strategy to avoid drought stress. Hence, emphasis in crop improvement programs has been to develop high-yielding, short-duration cultivars which escape terminal drought. These short duration varieties provide opportunities for inclusion of a given crop variety in the cropping systems with a narrow cropping window or new production niches. The key factors for this significant increase in chickpea area and production in central and southern India are:

(i) Introduction of high yielding, short duration, Fusarium wilt resistant varieties adopted to short season, warmer environments of southern India.
(ii) High adoption of improved cultivars and production technologies.
(iii) Successful Introduction of commercial cultivation through mechanized field operations and effective management of pod-borer; and
(iv) Availability of grain storage facilities to farmers at local level at affordable cost.

**b. Improved varieties with drought tolerance:** The drought tolerant varieties can provide cost-effective long-term solutions against adverse effects of drought. Returns to investment in breeding for drought tolerance are likely to be higher compared to those in other drought management strategies. A wider dissemination of drought-tolerant material would provide sustenance to the livelihoods of farmers who are more vulnerable to shocks of crop failure. On the other hand even though the potential economic benefits of drought-tolerance breeding research are attractive, farmers may not benefit from it if appropriate institutional arrangements are not in place for multiplication and distribution of seeds of improved varieties. This is more so in the case of large seeded pulses whose seed requirement is very high.

c. **New niches:** Pulse crops have great diversity of maturity durations that enable their cultivation in many niches and different production systems to increase production. A few examples are given below, but there are many more in other crops and niches that can be exploited successfully.

1. **Chickpea in rice fallows:** The Indo-Gangetic Plains (IGP) spread over South Asia's four countries-Bangladesh, India, Nepal and Pakistan- is agriculturally one of the most important regions of the world. About 14.3 million ha of the rice area in IGP remains fallow during the winter season. These rice-fallows offer a huge potential for expansion of the area of rabi pulses such as chickpea, lentil and grasspea. Large-scale on-farm trials conducted by several State Agriculture Universities in five states of India (Chhattisgarh, Jharkhand, Orissa, West Bengal and eastern Madhya Pradesh) have clearly shown that short-duration varieties of chickpea and lentil can be successfully grown after rice harvest, and with reasonably high yield levels of 1 to 2.5 $ha^{-1}$. For example, short-duration desi and kabuli chickpea varieties were found suitable, and the farmers preferred the kabuli varieties ICCV 2, KAK 2 and JGK 1 in most areas as they fetch high market prices.:
2. **Pigeonpea in rice-wheat cropping systems:** Rice–wheat cropping system is popular in the Indo Gangetic Plain region of India. However, continuous mono-cropping of cereals has lead to depletion of soil fertility and increased incidence of pests and diseases, and is posing a serious threat to sustainability of the entire rice-wheat cropping system. The inclusion of legumes in rice–wheat cropping system would greatly help restore soil fertility and reduce other associated problems. Several on-station and on-farm trials during 1999-2002 in Haryana and Western Uttar Pradesh with extra-short duration pigeonpea varieties (such as ICPL 88039, now released as VP Arhar 1) indicated that pigeonpea can be grown profitably in place of rice during the kharif season (sown in late-

May and harvested in late October or early November), allowing timely sowing of wheat crop.

3. **Pigeonpea at high altitudes:** Extra-short duration pigeonpea was successfully cultivated up to the elevation of 2000 m above sea level in Uttarakhand. A pilot study in collaboration with Vivekananda Parvathiya Krishi Anusandhan Sansthan (VPKAS), Almora and the Department of Agriculture, Uttarakhand, with several on-farm trials across different elevations in the state during 2007-10 indicated that pigeonpea variety 'VL Arhar-1' (ICPL 88039) can be grown successfully in low and medium hill regions. VL Arhar-1 showed high adaptability to high elevation regions and produced as high as 1,800 kg $ha^{-1}$ of grains. Since the extended periods of cold and frost can severely damage the foliage and flowers of pigeonpea, its cultivation should be limited to only low and mid hill regions. Extra-short duration pigeonpea cultivar VL Arhar 1 is now extensively cultivated in Uttarkhand.

d. **Seed systems:** Despite a long list of improved pulses varieties released for cultivation, their impact has not yet been fully realized by the resource-poor farmers in many states in India. The accessibility of smallholder farmers to quality seed of improved pulses varieties is constrained by both inadequate demand creation and limited supply. This situation is also compounded by unfavorable and inadequate policy support and regulatory frameworks, inadequate institutional and organizational arrangements, and deficiencies in production and supply infrastructure and farmers' socio-economic situation.

e. **put supply (micro-nutrients and fertilizer application):** Legumes fix atmospheric nitrogen. However, availability of quality of Rhizobium inoculum is limiting. Phosphorous is becoming a limiting macro-nutrient which will affect the pulses production. A common difficulty in recovering P from the soil is that it is not readily available to plants because P reacts with aluminum, iron and calcium in the soil to form complexes. These nutrients are essentially insoluble resulting in very little movement of P in the soil solution, and none of the complexes can be taken up directly by roots. The use of phosphate solubilizing bacteria (strains from the genera of Pseudomonas, Bacillus and Rhizobium are among the most powerful P solubilizers) as inoculants simultaneously increases P uptake by the plant and thus crop yields (Khan et al, 2009). A recent study by ICRISAT indicated that soils in many states in India are deficient in micro-nutrients such as boron, sulfur, zinc and magnesium (Wani et al. 2012). Application of small quantities (0.5 to 2 kg ha-1) has resulted in 40-120% increase in grain yield. Hence, making these micro-nutrient fertilizers easily available to smallholder farmers in remote areas will go a long way in enhancing productivity and production of pulses. Under a mission to boost productivity of rainfed agriculture through science-led interventions in Karnataka (called the Bhoochetana project) the improved management practices (including application of micronutrients) have increased the yield by 31-57% in green gram, 26-38% in pigeonpea and 27- 39% in chickpea during 2010-11. Similarly in 2011-12 black gram and green gram grain yields increased by 33-42% in response to improved management when compared to farmers management

f. **Response to irrigation:** In many areas, grain legumes are grown under moisture stress conditions. Crops such as cowpea, pigeonpea, and chickpea are grown where soil water may be substantially limiting. Yields are necessarily limited by the amount of water available to support growth. Supplemental irrigation with a limited amount of water, if applied to rainfed crops during critical stages can result in substantial improvement in yield and water productivity.

g. **Mechanization:** Many pulses are harvested by hand in India because the available cultivars are not suited to mechanical harvesting. In developed countries, such as Australia, Canada and USA, pulses like chickpea, lentils etc. are harvested mechanically. With continuously increasing labor cost, manual harvesting has become an expensive field operation for many crops including pulses in India and farmers are increasingly opting for mechanical harvesting where it is feasible. The other production practice where cost of cultivation can be reduced substantially is by promoting use of post-emergence herbicides in controlling weeds by developing herbicide tolerant cultivars. In general, pulses are sensitive to herbicides and manual weeding is currently the only option for weed control. Management of weeds in pulses is becoming expensive and in some cases uneconomical due to high labor cost involve in manual weeding. Herbicide-tolerant cultivars offer opportunity of controlling weeds through need-based applications of herbicides. Weed management through herbicides is not only economical but also facilitate zero-tillage or minimum tillage methods.

## Conclusion

In conclusion, enhancing the productivity and production of pulses in India is crucial for ensuring food security, improving nutrition, and fostering economic growth, particularly in rural areas. Despite facing numerous constraints and challenges such as low yields, climate change impacts, inadequate infrastructure, and market instability, there are tangible opportunities for improvement.

By addressing these challenges through targeted interventions and holistic strategies, India can unlock the full potential of its pulse sector. This includes investing in research and development to develop high-yielding and climate-resilient pulse varieties, strengthening extension services to disseminate best agronomic practices, promoting sustainable water and soil management techniques, and implementing supportive policies and market interventions.

Moreover, fostering partnerships and collaboration among government agencies, research institutions, farmers, private sector entities, and civil society organizations is essential for driving systemic change and achieving sustainable growth in pulse production.

Overall, by prioritizing the enhancement of pulse productivity and production, India can not only meet the growing demand for pulses domestically but also contribute to global food security efforts while improving the livelihoods of millions of farmers across the country.