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Pulses for Sustainable Livelihood and Food Security

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Abstract

Pulses has important role in contributing to food and nutritional security and replenishing soil nutrients having a huge potential in addressing needs like future global food security, nutrition and environmental sustainability needs. They also play an important role in mitigating greenhouse gas emissions in agriculture production by lowering GHG emissions. Farmers in grain and oilseed production have found economic benefits from lower input costs and increased profits by including a pulse crop in their rotation. In the face of shrinking natural resources and high population growths, enhancing production of pulses is now a major concern for Bihar in particular and nation as whole . The current shortfall in pulse availability is mainly due to less seed replacement rate of improved varieties, poor adoption of improved technologies by the farmers, abrupt climatic changes, complex disease pest syndrome, and emergence of new biotypes and races of key pests and pathogens and declining total factor productivity. The possibility of improving pulse productivity two to three times through existing varieties and available package of technologies has been demonstrated in FLDs by adoption of entirely new but simple and farmer-friendly technologies and tools. Considering that the frontiers of expansion of cultivated area are negligent, high demand of pulses must come from increase in yield by strengthening adaptive research and technology assessment, refinement and transfer capabilities, so that the existing technology transfer gaps can be bridged. For this, an appropriate network of extension service needs to be created to stimulate and encourage both top-down and bottom-up flows of information between farmers, extension workers, and research scientists to promote generation, adoption, and evaluation of location-specific farm technologies.

Key Words: Pulses, Constraints in pulses production, Area Expansion under pulses, Bihar

Introduction

Pulses has important role in contributing to food and nutritional security and replenishing soil nutrients having a huge potential in addressing needs like future global food security, nutrition and environmental sustainability needs. For both large and small farmers, pulses represent important economic opportunities to boost income and reduce risk by diversifying their crop and income stream portfolio. Besides the environmental benefits of adding pulses to crop rotations, there is an also social and economic benefit of pulse production as it helps needs for protein, minimize soil degradation, and support diversification in food production and consumption. The livelihood and development impacts of increased pulse production and consumption are to be understood by pulse producers and all stakeholders.

Benefits of Pulses Production

Environmental benefits

Nitrogen fixation

Nitrogen in the form of synthetic fertilizer is most commonly applied plant nutrient and also most deficient in soils around the world. Pulses crop plays a unique role in the global nitrogen cycle, as they fix atmospheric nitrogen in soils by symbiotic association with rhizobia, soil bacteria, fixing it, making them self-sufficient in nitrogen, and enabling them to grow in almost any soil without fertilizer inputs. From 1960 to 2000, nitrogen fertilizer use increased by roughly 800%, with half of that being utilized for wheat, rice, and maize production (Canfield et al, 2010). Cereal crops like wheat, rice and maize utilize 40% of fertilizer applied, leading to significant waste and environmental impacts such as eutrophication of coastal waters and creation of hypoxic zones (Canfield et al, 2010). Incorporation of pulses in crop rotation reduces the fertilizer requirement for self as well as following cereal crop. Systematic crop rotation based on incorporating pulses into cereal based systems reduces synthetic fertilizer use, and optimizing the timing and amounts of fertilizer applied to crops are two most important interventions to decrease nitrogen application (Canfield et al, 2010). Biological nitrogen fixation is a crucial alternative source of nitrogen which can be enhanced along with other integrated nutrient management strategies such as animal manure as well as recycling the nutrients contained in crop residues (Lal, 2004). The higher available nitrogen to subsequent cereal crops also benefits yields of those cereal crops. Findings in south-eastern Australia showed that the inclusion of pulses in cropping sequences results in higher available soil nitrogen for next crops, along with additional 40 to 90 kg N/ha in the first year and 20 to 35 kg N/ha for the second year, as compared to cereal- cereal sequences (Peoples *et al*, 2015). Besides yield other benefits includes disruption of the buildup of disease and pests that occurs when a particular crop is grown year after year.

Conservation tillage

Conventional plow-based farming leaves soil vulnerable to water and wind erosion, increases agricultural runoff, degrades soil productivity and releases GHG emissions both from soil disturbance and fossil fuel use. No-till or direct seeding under a mulch layer from the previous crop, reverses this process by implementing a package of practices, which includes minimum mechanical soil disturbance, permanent organic soil cover, diversification of crop species grown in sequences and/or associations (FAO, 2013). Implementing conservation tillage practices involves introduction of pulses and oilseeds into cereal based crop rotation. Studies have demonstrated that the nitrogen fixation benefits of conservation- or no-tillage, with pulse and oilseed bean nodulation improves after multiple years of no-till and nitrogen fixation rates too increases (Van Kessel and Hartley, 2000).

Reduced greenhouse gas emissions

The pulse crops plays an important role in mitigating greenhouse gas emissions in agriculture production by lowering GHG emissions due to lower fertilizer requirements, supplying their own nitrogen as well as contributing nitrogen to succeeding crops (Lemke et al, 2007).

Social Benefits

Nutrition

It is established fact that a human body requires a daily intake of about 50 gm of protein whereas, in India the per capita daily intake is only about 10 gm have direct bearing on health and affects work performance of the people. Out of the 22 amino acids required in the human diet, the body supplies 14, the rest eight have to come from food. If all the eight amino acids are present in a single food item, it is called a complete protein food. For vegetarian population the main sources of protein are leguminous plants to which the pulses belong. Eighty-four percent of the protein in common bean is readily absorbed after consumption, and 94% of the protein from cowpea is available However, in general, pulses have lower concentrations of protein than animal sources. Besides, none of the pulses except soybeans are complete proteins. Therefore, combinations of two or more pulses are needed in a vegetarian diet. Given the important role that pulses play in the human diet, their availability needs to be increased indigenously. Pulses consumption levels has declined globally and in particular among developing countries as in China's from 30 g per capita per day in 1963, to only 3 g per capita by 2003 (Kearney, 2010). Pulses in India are source of protein accounting for almost 13% of overall protein intake (OECD-FAO, 2014). They are the most efficient natural foods for production of proteins. They are the primary producers of proteins harnessing natural elements like sunlight, soil nutrients and water, but the domestic supply of pulses is not able to meet the growing demand of our consumers.

About 26 million hectares of land is under pulses cultivation in India producing about 17 million tons of pulses annually and are largest producer and consumer, and the country grows the largest varieties of pulses in the world accounting for about 32% of the area and 26% of world production. Indian pulse crops include chickpea, pigeonpea, urd bean, mung bean, lentil and field pea with production reaching a record level of 18.4 Mt in 2012-13, up from 15 Mt in 2007-08. Pulse crop yields have increased from 0.63 t/ha in 2007-08 to 0.79 t/ha in 2012-13, and annual yield growth is expected to outpace growth in production area, indicating better production efficiency. However, the average productivity of pulses in India still remains below the global average. It is expected that the production will not keep pace with demand and imports are anticipated to grow to 5.1 Mt by 2023 (OECD-FAO, 2014) leading to a progressive decline in per capita availability of pulses in India, falling from 69 grams in 1961 to 32 grams in 2005. Climate change, resource depletion, and demographics have a strong impact on the availability and price of agricultural commodities (MSCI, 2012). Pulses are an important contributor of micronutrient rich intake along with fruits and vegetables (Kearney, 2010).

Economic Benefits

Farmers in grain and oilseed production have found economic benefits from lower input costs and increased profits by including a pulse crop in their rotation, the benefits accruing through enhancing the efficiency of nitrogen fertilizer use, reducing tillage and, in some cases reducing pesticide use. Reduced and altered tillage practices reduce reliance on fossil fuels and lowers overall fuel bills. No-till systems with pulses provide a basis for sustainable agricultural intensification, including integrated crop approaches. It is estimated that farmers save between 30-40% of time, labour and fossil fuels using no-till, compared to conventional tillage (FAO, 2001; Lorenzatti, 2006). Including pulses to rotations in economically backward areas in Bihar could bring much needed nourishment and income to small landholders solely dependent on agriculture for their livelihoods. About 12 million hectares that are under rice production during the rainy season in India remain fallow in the subsequent post-rainy (rabi) season. Efforts to introduce pulses in these rabi conditions could have significant economic and poverty alleviation benefits (Joshi *et al*, 2002).

The skyrocketing prices of pulses since 2008 can be attributed to almost stagnant production leading to a decline in per capita availability of pulses. The pulses are generally grown in postmonsoon period and are prone to losses due to drought stress if there is scarcity of rain. Presently about 25 to 26 million hectares of land is under pulses cultivation in India producing about 17 million tons of pulses annually. To meet the demand, about 2-3 million tons of pulses need to be imported every year as yield (around 700kg a hectare) is less than the global average and the per capita availability, one-fifth lower than what nutritionists recommend. The demand for pulses in India is bound to increase further with a growing population as well as sustained and inclusive economic growth.

Sustainability of Indian agriculture system as a whole in long run is a major concern due to consistent reduction in the soil fertility and loss of essential soil nutrients on account of exhaustive cropping systems being followed after green revolution. Although green revolution provided self-sufficiency in cereal production in country, but it pushed pulses to rainfed environments which led to their poor productivity, besides leading to an imbalance in soil micronutrients. A balanced approach including judicious use of natural resources, protecting soil microflora and lesser application of chemical pesticides and fertilizer are needed to sustain the ecosystem. Pulses improves soil health by enriching nitrogen status, long-term fertility and sustainability of the cropping system so their inclusion in cereal-based cropping systems contributes to soil fertility by enriching organic nitrogen, reducing the demand of chemical fertilizers, enhancing soil micro flora as well as supplement protein diet for large population of the country suffering from protein malnutrition or “hidden hunger”. Though substantial progress has been made in evolving techniques to obtain high yields of pulses, their production has stagnated for the last several decades, primarily due to the number of biotic and abiotic constraints under rainfed environments.

In the face of shrinking natural resources and high population growths, enhancing production of pulses is now a major concern for Bihar in particular and nation as whole . The current shortfall in pulse availability is mainly due to less seed replacement rate of improved varieties, poor adoption of improved technologies by the farmers, abrupt climatic changes, complex disease pest syndrome, and emergence of new biotypes and races of key pests and pathogens and declining total factor productivity. Reduction in yield as a result of climate change will be more pronounced for rainfed pulses, especially those cultivated in areas frequently prone to drought. Intergovernmental Panel on Climate Change (IPCC) projected rise of temperature by 2-3 degrees by 2050 over current levels. The predicted changes in temperature and their associated impacts on water availability, pests, disease, and extreme weather events are likely to affect the potential of pulse production. The pulse requirement in the country is projected at 50 million tonnes by the year 2050 necessitating an annual growth rate *of* 4.2%.

The major R & D issues identified for pulses are low genetic yield potential, poor and unstable yield, huge post-harvest losses, inadequate adoption of improved technologies and low profitability which need to be tackled through integration of conventional approaches with cutting edge technologies such as genomics, molecular marker assisted breeding, transgenics, molecular approaches for stress management, high input use efficiency, quality improvement, bio- fortification, resource conservation technologies, value addition and food safety. Exploitation of heterosis and yield genes from wild relatives has also been identified as a promising avenue for breaking yield plateau. To meet the projected requirement, the productivity needs to uplift at about 1500 kg per ha and about 3 to 5 million ha additional area has to be brought under pulses besides drastically reducing the post-harvest losses. With dramatic changes in global agricultural scenario on account of implementation of WTO and IPR, pulses have to play a far greater role in providing overall prosperity of the marginal farmers, which would mean better nutritional security by way of meeting dietary protein requirement, improvement in the production base through conservation of natural resources, and high net returns to farmers though value addition and lowering the cost of production with an eye on export.

Challenges

Rainfed agriculture plays a very important role in our economy, contributing about 60% of the cropped area and 45% of total agricultural produce, contributing more than 80% of the pulses and oilseeds as well as a substantial part of horticulture and animal husbandry products. Immediate attention is to be meant for management of water, which is going to be scarcest factor in the twenty-first century. Our irrigation efficiency is estimated to be around 30% which needs to be raised to at least 50% which could contribute significantly in increasing agricultural production. In view of climate change the immediate problems that our farmers face is intra-seasonal variability of rainfall, extreme events and unseasonal rains causeing heavy losses to our crops every year. So there is urgent need to speed up efforts to evolve climate-resilient crop varieties, cropping patterns and management practices. Development of efficient *in situ* soil moisture conservation and water management strategies and popularization of micro-irrigation techniques for enhancing pulse productivity (such as drip and sprinkler irrigation), resource conservation technique, climate resilient varieties of pulse crops, eco-friendly bio-pesticides/fungicides for control of emerging pests and diseases, aggressive technology demonstration in farmers' fields, linking farmers with profitable markets, promotion of export of pulses like lentil and *kabuli* chickpea, production of value added products, development of short duration climate resilient cultivars suitable to new niches all needs to be done.

Accent on Diversification of Agriculture and Value Addition

To combat ever increasing demand for food and agricultural production and shrinking natural resources, agricultural intensification is the way for future growth of agriculture in the region. Attention should be high on post-harvest handling, agro-processing and value addition technologies not only to reduce the heavy post-harvest losses but also to improve quality through proper storage, packaging, handling and transport. The role of biotechnology in postharvest management and value addition deserves to be enhanced. The agro-processing facilities should preferably be located in the vicinity of production in rural areas promoting off-farm employment. Agricultural cooperatives and Gram Panchayats must play a leading role in this effort keeping in mind the needs of small farmers.

Increased Investment in Agriculture and Infrastructure

Nearly 70 per cent of Bihar still lives in villages and agricultural growth continues to be the engine of economic growth and development as well as natural resource conservation along with food security and poverty alleviation. Accelerated investments are needed to facilitate agricultural and rural development. The productivity of pulses have increased by only 45% between 1951 and 2008 while the area under pulse production has grown by only 25%, which is lower than any other food grain. Per capita availability of pulses has decreased from 60g/day in 1970-71 to 36g/day in 2007-08. About 30% of farm produce is wasted every year for want of storage, transportation, cold chain and other infrastructure facilities. There is a great scope to produce pulses in the rainfed areas using resource conservation and water harvesting techniques. Providing incentives for growing, pulses are also one option. Nitrogen credits to farmers as well as tie-ups with research institutes for better technology will encourage the cultivation of pulses along with introduction of improved varieties that can enhance productivity ensuring availability of pulses to a larger population at an affordable price.

Fighting Poverty and Hunger

There is higher concentration of poor and hungry people in rainfed areas as compared with those in irrigated zones. Even with 20 percent increase of the irrigation intensity, there is a sharp fall in the proportion of hunger and poverty and it remains there irrespective of further intensification of irrigation reducing poverty and hunger as well as promoting equity, environmental protection and natural resource conservation. An effective water policy and institutional support is needed to ensure judicious and equitable allocation, distribution and exploitation of water and water resources.

Accent on Empowering the Small Farmers

Contributions of small and marginal farmers in securing food for ever growing population have increased considerably even though they are most insecure and vulnerable group in the society. The off-farm and non-farm employment opportunities to this group of farmers can play an important role. Knowledge and skill development of rural people both in agriculture and non-agriculture sectors is essential for achieving economic and social goals. A careful balance will therefore be needed to be maintained between the agricultural and nonagricultural employment and farm and non-farm economy, as the two sectors are closely interconnected. Raising agricultural productivity requires continuing investments in human resource development, agricultural research and development, improved information and extension, market, roads and related infrastructure development, efficient small-scale, farmer-controlled irrigation technologies, and custom hiring services for costlier mechanical inputs. Such investments would give small farmers the options and flexibility to adjust and respond to market conditions. Improved agricultural technology, irrigation, livestock sector and literacy will be most important instruments for improving the nutritional security of the farm-households. Watershed development and water conservation techniques will have far reaching implications in increasing agricultural production and therefore, raising calorie intake in the rainfed areas. Need based and location-specific community programs, which promise to raise nutritional security, should be identified and effectively implemented. Development of the post-harvest sector, co-operatives, roads, education, and research and development should be an investment priority. A congenial policy environment is needed to enable smaller holders to take the advantage of available techniques of production, which can generate more incomes and employment in villages. For this poor farmer needs the support of necessary services in the form of backward and forward linkages. Small-mechanised tools, which minimise drudgery labour productivity. Special safety nets should be designed and implemented for them. There is need to disseminate widely post-harvest handling and agro-processing and value addition technologies not only to reduce the heavy post-harvest losses but also improve quality through proper storage, packaging, handling and transport.

Assured procurement can boost pulses production

By providing a respectable price to growers in the form of MSP, the government has made its intention clear that it is looking forward to increase crop productivity by attracting more farmers to undertake cultivation of pulses. Higher prices have to be backed up by creating an environment for the farmers to invest in pulses constraints for horizontal increase in area under pulses in Bihar. With better yields, development of biotic and abiotic stress resistant varieties, increased backup of MSP and exchange of knowledge, farmer will take to pulses with increased acreage and ease the supply side constraint. Bihar being most densely populated has high population pressure on land and other resources to meet its food and development needs. The gaps between potential yield and realized yield of pulses varieties are high which need to be plugged. The technology should be tailored according to the needs of farmers which are mostly of small land holding. To meet the projected requirement of 50 million tons of pulses, the productivity needs to be raised to about 1500 kg per ha and about 5.0 million ha additional area has to be brought under pulses.

Constraints analysis for pulse production

Decline in Area of Pulses in plains, Tal and Diara areas

Bihar which used to be the major area of pulses production is at present characterized by reduced area under pulse cultivation due to many reasons including extensive irrigation network, leading to cultivation of cereals and cash crop, epidemics of *Ascochyta* blight and incidence of *Helicoverpa armigera* in pulses like chickpea, incentive for rice-wheat production and less economic viability of pulses than cereals

Huge gap in potential and field realized yield

Narrow genetic base, inefficient plant types are some of the inherent reasons of low harvest index of pulses. Pulses are grown in harsher environments and resource limited conditions due to low farmer's preference and less remuneration as compared to paddy, wheat and maize. The

Pulses crops have been relegated to low productivity zone from high productivity zone, mostly grown in rainfed areas (87%) with poor crop management.

Instability in Production of Pulses

The production and productivity of pulses over the years have shown large instability being highly sensitive to environmental fluctuations, experiencing drought at critical growth stages as mostly grown in rainfed condition, highly sensitive to abiotic (temperature extremities, excessive moisture & salinity) and biotic stresses (insect-pests, diseases)

Climate change risk

Asymmetric changes in temperature rise i.e. more rapid increase in night minimum temperature than the day maximum affects photoperiodic responses, flowering and source sink relation. Extreme weather conditions such as abrupt shifting of temperatures i.e. low and high temperature beyond threshold level of tolerance cause massive flower drop and shorten the reproductive period and lower grain yield. The effects of climate change in pulses are more pronounced in plains as high night temperature adversely affects productivity of winter pulses temperature extremities (both high and low) adversely affects reproductive physiology and grain filling in almost all pulses and widens scope of disease spread and pest incidence in more disastrous form.

Poor Seed Replacement

Availability of good quality seeds and high seed replacement rate are important for higher productivity but seed replacement rate in pulses is very poor leading to low yield. There is less preference to pulse seed production by central and state seed corporations as well as private seed companies also.

Post Harvest Losses

Lack of efficient and good quality harvesting and threshing equipments; high infestation of stored grain pests (bruchids); as well as traditional *dal* mills with low *dal* recovery; accounts for 20 to 30% of post harvest losses in pulses which can be resolved by improving post-harvest machineries.

Wide Fluctuation in Prices

Unorganized market and no assured procurement have led to wide fluctuation in prices of pulses need to be addressed on priority basis besides all critical inputs are also poorly available to pulse grower mostly marginal and small farmers.

Transfer of Technology for pulse growers

Pulse growers which are mostly poor or marginal farming community do not have access to technologies that are developed in Agricultural Institutes/state Agricultural Universities. Lack of awareness to latest pulse-production technologies is a critical gap leading to low productivity of pulses. The farmers are less exposed to improved technologies due to lack of trained extension personnel as well as poor interface between state departments of agriculture, research organizations and private agencies

Bringing Additional Area under Pulses

Pulses needs to be incorporated in rice – wheat cropping system through popularization of short duration varieties of pigeonpea, *kabuli* chickpea, fieldpea and summer mungbean. Besides large areas of agricultural field remain fallow and bringing these additional area under pulses like lentil can improve this prospects including promotion of pulses in intercropping viz., short duration thermo-insensitive varieties of mungbean/urdbean with spring sugarcane; pre-rabi chickpea with mustard/linseed; pigeonpea with groundnut/soybean/millets, etc.

Conclusion

India is the largest producer of pulses in the world but our demand outstrips our domestic production because of which we have to resort to imports every year. Compared to other food grains crops, yield potential of the pulses has been rather low. Newer varieties of pulses need to be developed so that the crop cycle fits well into cropping systems that the farmers adopt. Another important issue is limited mechanization potential especially for harvesting of the crop. Suitable plant types need to be developed for mechanical harvesting with pods above the canopy and sturdier plants. Due to the high protein content in pulses, the crop is highly vulnerable to pests and diseases and estimated that about 30 % of pulses crops is lost on account of pest attacks and diseases every year. Attack by pod borer and pod fly is so severe that the entire standing crop is devastated at several times. Research efforts need to be prioritized in this direction by employing modern biotechnological tools for crops developing pest resistant varieties of pulses.

Another problem peculiar to Bihar plains is the menace of large scale grazing by blue bulls. We need to support the efforts of the farmers for higher acreage under pulses crops without contravening the legal provisions of the Wild Life Protection Act which prohibits killing of these animals. There is need to address the issues relating to farmers' preference for the competing crops to pulses through development and promotion of crop production and crop protection technologies. The Government have significantly increased the MSP of the pulses and strengthened pulses procurement mechanism by designating additional central agencies to support the farmers. In fact, the minimum support price has been doubled in last three year with quantum jump given this year with an increase of more than 50 %.

With better yields, development of pest resistant and hardier varieties and increased MSP support the Indian farmer will definitely adopt pulse based cropping systems to produce more pulses with increased acreage easing the supply side constraint which the country faces. To meet the challenges faced by the pulses sector, research efforts for developing biotic stress resistant and stress tolerant varieties of pulses needs to be encouraged along with public-private initiatives for better logistics planning and handling of pulses. Besides the ease of farming operations and low yields of the crop, other limitations are the optimum crop cycle and genetic potential of the crop. The crop cycle should be such as to fit into the overall cropping system that the farmer takes during the year. With increased MSP pulse procurement mechanism has to be strengthened by designating additional central agencies. The possibility of improving pulse productivity two to three times through existing varieties and available package of technologies has been demonstrated in FLDs by adoption of entirely new but simple and farmer-friendly technologies and tools. Considering that the frontiers of expansion of cultivated area are negligent high demand of pulses must come from increase in yield by strengthening adaptive research and technology assessment, refinement and transfer capabilities, so that the existing technology transfer gaps can be bridged. For this, an appropriate network of extension service needs to be created to stimulate and encourage both top-down and bottom-up flows of information between farmers, extension workers, and research scientists to promote generation, adoption, and evaluation of location-specific farm technologies.

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