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Trends of Pulses Production: A Study on Current Scenario and Strategies in India with Special Reference to Bihar

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ABSTRACT

Bihar is one of the important pulse growing state of India with productivity of 839.3 kg/ha in 2010-11 which is projected to attain 1461.3 kg/ha by 2050-51, highest in eastern India. With nearly 2.2 million ha of rice fallows, a small technological intervention can transform the rice- fallow to rice-gram or rice-lentil system bringing about pulse revolution. The present study tries to review and analyze the current policy environment and suggests ways and means to improve the pulses production scenario in the country. It advocates, the need to diversify from cereal–based cropping systems to pulses-based cropping system with certain policy decisions like identification of additional rice fallow lands largely in Eastern India, crop diversification, improving seed replacement rate, improved crop production techniques etc. Study also suggests that provisions should be made for easy credit, insurance, attractive Minimum Support Price (MSP) with procurement and appropriate incentives for pulse producers as well as creating necessary infrastructure for processing, marketing and value-addition. This paper analyses status of pulse crop in India as whole and Bihar in particular along with paradigm shift required in policy decision, pulse research, technology generation and dissemination, commercialization along with capacity building of farmers and frontier areas of research and extension.

Keywords: Pulses, pulses production, consumption, import, Bihar, India

India is the world's largest producer and consumer of a wide variety of pulses which is dominated by tropical and sub-tropical crops such as chickpea, black gram, red gram (pigion pea), green gram (mungbean), and lentil and so on, high in protein, fiber, vitamins and also suppliers of high quality carbohydrates, minerals and vitamins. The carbohydrates provided by pulses are released slowly as compared to cereals and so have a high value for maintaining optimal blood sugar levels and restoring energy over a long period of time after the meals. Pulses in general are one of most sustainable crop utilizing just 359 liter of water to produce one kg of pulses, as compared with 1,802 for soybeans and 3,071 for groundnut. They also contribute to soil quality by fixing nitrogen in the soil. In India, production of pulses is around 19.3 million tons (ESI 2015) with a very low average productivity of 764 kg/ha. Currently, total area under pulses is 26.3 million ha (Choudhary and Suri 2014), there is a massive yield gap between India and other developed countries and also within India, between research station yield and farmers' yields. Pulses are rich sources of protein and energy but largely cultivated under energy starved conditions, mostly on marginal and sub-marginal land and more than three-fourth of the area under pulses is still rainfed resulting in poor crop productivity (Choudhary 2013).

The world pulse production, area and yield during 2013 was 73 million tons (MT), in nearly 80.8 million ha and 904 kg ha^{-1} respectively (FAOSTAT 2015) as compared to India's production of different pulses like chickpea (13.1 MT), pigeon pea (4.74 MT), lentils (1.13, MT), dry peas (0.6 MT), groundnut with shell (9.4 MT) and soybean (11.95 MT) (FAOSTAT 2015).

Chickpea (*gram or chana*), pigeon pea (*tur*), *mungbean* (green gram or *mungbean*), *urdbean* (black gram or mash), lentil (*masoor*) and field pea (*matar*) are most common pulses grown in India. During 2013-14, India produced 19.27 MT of pulses, and about 3.18 MT of pulses worth more than ₹ 11038 crore (US$1.8 billion) were imported from Canada, Australia, Myanmar, Turkey, Syria, Tanzania, etc. during same year. India has witnessed an impressive growth in pulses production during last 5 years growth rate of pulse production (2.61%) during last one decade being higher than the growth rate of rice (1.59%), wheat (1.89%) and total cereals (1.88%), with highest growth rate observed in chickpea (5.89%) followed by pigeon pea (2.61%), the overall productivity of pulses increasing to an impressive 786 kg ha-1 during 2012-13 as compared to 577 kg ha-1during 2004-05. The credit for which goes to the improved varieties and production of breeder seed, demonstration of pulses production technologies through technology demonstrations, frontline demonstrations, policy support and various schemes like National Food Security Mission (NFSM), Rashtriya Krishi Vikas Yojana (RKVY), and accelerated pulses production program (A3P) etc. launched by the government to promote pulses cultivation. In order to ensure self-sufficiency, the requirement for pulses in the country is projected at 39 million tons by the year 2050; at an annual growth rate of 2.2%. This will require a pragmatic change in research and developmental strategies, beside good policy support from the government.

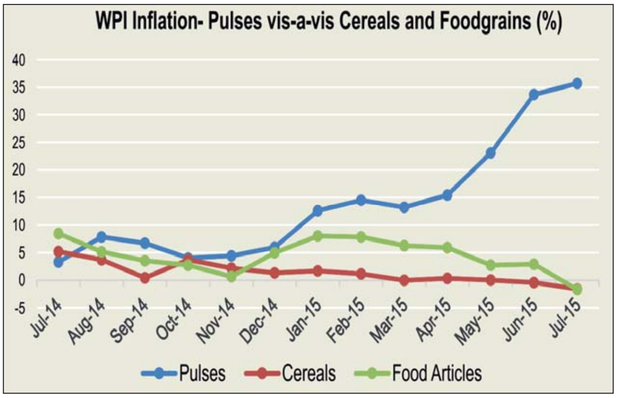
Policy Neglect towards Pulses Production

Introduction and popularisation of package technology in the irrigated areas of the country lead to spurt in growth of production of cereals crops like wheat and rice. As a result the food grain production has increased consistently as it was 264 million tonnes in 2013-14 and it is expected to touch 280 million tonnes in 2020-21. But the green revolution adversely affected the acreage of pulses causing displacement by rice-wheat cultivation leading to shift of pulse crops in marginal dry lands in the country resulting in decline in the yield of pulses during last few decades, fertile lands were diverted to cereal crops and pulses were relegated to marginal pieces of land cultivated by marginal farmers. Core pulse areas have shifted from northern states to central and southern India in last 30-35 years. North India is said to have the right climatic conditions for pulses but as irrigation improved, pulses were replaced with wheat, paddy and sugarcane and the pulse area gained in central and southern India was dry and rainfed land.

Only 10% of pulse growers use certified seeds. Research institutes provide breeder seeds and agencies like the National Seeds Corporation distribute them as certified seeds after a few cycles, till now 400 improved varieties of pulses have been released for cultivation since coordinated pulse improvement programme started in 1967, but only 124 varieties are in the production chain and only a dozen are popular among farmers (Reddy, 2009). Private seed companies have mostly kept away from pulses as they found that developing and marketing is not economical, since pulses are mostly pushed to marginal farms, catering to farmers scattered over large areas and involving greater logistic cost. So basically seed production is restricted to public-sector research organizations. Pulses crop being rich in protein are loved by pests and Blue Bulls (neelgais), they are also extremely sensitive to heat and cold, besides they are slow crops as they need a lot of heat energy to break down the protein molecules required for growth, all these factors contributes in high fluctuations in yield. Little wonder the yield of pulses has remained nearly stagnant in the past 40 years at 600 kg/ha, while the yield of crops like rice, wheat and maize has increased to between 2,000 kg/ha and 3,500 kg/ha. The policy emphasis on cereal–based input intensive technology enhanced yield gap between major cereals and pulses yield levels of pulse crops are nearly stagnant increasing only by 12.2% from 1966 to 2009 as against 162.6% increase in yield of wheat.

Demand and Supply Scenario of Pulses

India's rank in pulses productivity is 24, 9, 23, 104, 52th in chickpea, pigeon pea, lentil, dry bean, field pea, respectively and even though pulses production has increased by 3.45% per annum during 2000-10, the subsequent increase in cost of production and steep increase in prices of pulses due to supply constraints has made unaffordable for the common man of India. The growth rate for area, production and productivity has remained very low (0.06%, 0.65% and 0.59%) as compared to cereals due to which India has to import 3-4 million tones (MT) of pulses every year to meet its domestic demand. During the 1980s there was negative growth in area of total pulses and growth in production and yield was 1.52% and 1.61 percent respectively. During the period 2000-01 to 2011-12, the indices of area, production and yield of pulses have grown up by 1.70%, 3.47% and 1.91% all this has led to huge volatile situation and disparity in demand- supply scenario. During the period from April 2012 to July 2015, price for Gram/chickpeas were higher in the wholesale domestic market of India than that of the international market, similarly, the domestic prices for *Tur/Arhar* have been higher than that of international prices for over last two years up to February 2015. The price fluctuations in the international markets were higher for lentil, green gram (since sept.2012) and *urdbean* April to August 2014 and November 2014 to June, 2015 than that of the domestic market (Commodity profile, 2015). Post January 2015, WPI of pulses *vis-à-vis* cereals and food articles indicates double digit trend, crossing 30% during June and July 2015, so the rate of inflation of cereals has been very low and of food articles moderate in comparison to that of pulses during the corresponding period (Chand, *et al.*, 2015).



Source: *Chand, et al. 2015*

Price Policy and Market Price

Pulse markets are thin and fragmented and even though the market prices are higher the production yield hasn't increased due to lack of input investment, risky rainfed conditions all leading to pulse crop vulnerability to biotic and abiotic stress. Pulse farmer sell their produce to local village trader at lowest price which goes through the marketing channel to processor and ultimately to rural/ urban consumer. Hence, there is no marketing infrastructure for storage, warehousing, post-harvest processing and milling facilities near production centres.

The disadvantages and risks involved in growing pulses are not compensated by the MSP. For pigeon-pea the MSP of ₹ 2,300 per 100 kg is higher than the MSP of ₹ 1,080 per 100 kg for paddy. But while paddy yields about 3,000 kg per ha, pulses have a national average yield of 600 kg per ha. Even when market prices of pigeon-pea were ruling above ₹ 100 per kg, the MSP was ₹ 23 per kg.

Prices of pulses have consistently increased from 2005 to 2010, thereafter there was downward movement of pulses except chickpea up to 2012, but chickpea prices steeply decreased after 2012-13 before recent rise again. While prices of *mungbean* and *urdbean* showed upward trends after 2013. Price indices of chickpea are always moderate compared to other pulse crops throughout the period, except between 2012 and 2013. The spike in the chickpea prices during the 2012 was mainly due to the higher world prices up to August 2012; thereafter domestic prices were higher than world prices due to short supply and higher MSP, although overall both domestic and world prices moderated after 2012. Pigeon pea, *mungbean* and *urdbean* showed rising trend in prices with less fluctuation, while lentil showed higher fluctuation in prices with overall upward trend. There has been an upward movement in the prices of total pulses and several peaks are also seen especially after 2005. In 2006, there was a surge in imports of pulses and the gradual pass through of high global prices continued in further years. The year 2009 was a poor agricultural year therefore prices also aggravated. In 2012, high MSP and world prices along with the depreciation of Indian Rupee led to elevated prices.

As against total pulse requirements of 18.33 MT for 2009–10, the domestic production was only 14.60 Mt. The annual import of 2–3 MT provides only partial relief and checks escalation in the market price. By 2050, the domestic requirement is estimated to be 26.50 MT necessitating stepping up production by 81.50%, i.e. 11.9 MT additional produce at 1.86% annual growth rate. The additional production of 7.90 Mt has to come through productivity enhancement and the rest (2.50 Mt) from horizontal expansion in area. The growth rate of pulse production was just 1.52% in the 1980s and 0.59% in the 1990s. It has significantly increased to 1.42% during 2001–08. At present the growth rate in production is only 0.6%. The growth rate in the total area under pulses was negative both in the 1980s and 1990s. Assuming that the area remains constant, as seen during last four decades, 2.05% annual growth rate in productivity will be required to achieve 26.5 Mt by 2050. Some states like Andhra Pradesh, Maharashtra and Karnataka have already demonstrated high productivity growth in chickpea (51–125%) and pigeon pea (64–110%) during 1991–93 to 2006–08. This assures that the targets as shown in projections can be achieved with appropriate technology back-up and special efforts for promotion of production in the country.

Strategies for Enhancing Pulses Production and Productivity

In order to achieve self-sufficiency in pulses, the projected requirement by the year 2025 is estimated at 27.5 MT, to meet this requirement, the productivity needs to be enhanced to 1000 kg/ha, and an additional area of about 3-4 M ha has to be brought under pulses besides reducing post-harvest losses (Ali and Kumar 2005; ICAR Annual Report 2014). All this will require proactive strategy from researchers, planners, policy-makers, extension workers, market forces and farmers for boosting the productivity as well as reducing the production costs.

Major pulse crops in India are chickpea, pigeon pea, green gram (*mungbean*), black gram (*urdbean*), lentil and field pea as these are widely grown and consumed. Chickpea recorded impressive growth in area, production and productivity in 2011 as its production exceeded 8 MT for the first time and the area reached 9.2 m ha, which was~0.4 m ha less than the highest chickpea area recorded in 1962 (~9.57 m ha). During 1965-67 to 2010-12, the chickpea area drastically declined from 4.7 to 0.7 million ha in northern states like Punjab, Haryana and Uttar Pradesh, while it increased from 2.1 to 6.1 million ha in central and southern states of Madhya Pradesh, Maharashtra, Andhra Pradesh and Karnataka. The most important pulse crop pigeon pea was cultivated in 4.65 m ha with production of 3.02 MT and yield of 650.0 kg ha^{-1} during 2013. It is grown as sole crop or intercrop with urdbean, mungbean, castor, sorghum, soybean, cotton, maize and groundnut in different states like Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Gujarat, Jharkhand, Rajasthan Odisha, Punjab and Haryana. Lentil or masoor, is one of the most nutritious amongst cool season pulse, grown in the northern and central India, was cultivated in 1.42 m ha area in 2012-13 with a production of 1.13 MT. In the last two decades, the area under this crop has increased by 28% and production by 24% with a productivity increase of 6%. Lentil is mainly cultivated in Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Jharkhand, Bihar and West Bengal and grown as rainfed crop during *rabi* season after rice, maize, pearl millet or *kharif* fallow. It is also grown as intercrop with barley, linseed, mustard and occasionally with autumn planted sugarcane. In north-eastern part lentil is also cultivated as sequential crop after rice, where seeds of lentil are broadcast in the standing crop of paddy just before its harvest. Another important pulse crop green gram or mungbean in 2012-13, had yield of 1.19 MT from 2.71 m ha area distributed over different seasons. Rajasthan, Andhra Pradesh, Maharashtra, Odisha, Uttar Pradesh, Bihar, Punjab, Tamil Nadu, Karnataka, Gujarat etc. are major green gram producing states, mostly during *kharif* but with development of short duration and disease resistant varieties its cultivation during spring/summer season (Singh, *et al.,* 2014) is gaining popularity in almost all parts of country and during *rabi* season (rice fallows) in peninsular India.

The area, production and productivity of another important pulse crop urdbean have increased from 1.87 m ha in 1971–72 to 3.11 m ha during 2012-13 with production level of 1.90 MT. This increase in production is mainly attributed to additional area brought under the crop as well as productivity gains (from 0.5 to 1.3 t/ha). Summer cultivation in northern India and winter cultivation in rice fallows in southern and coastal areas of the country also added to additional acreage. In India, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, Maharashtra, Rajasthan, Odisha, Bihar, Karnataka and West Bengal are major urdbean producing states. Field pea another important rabi pulse crop is grown in about 0.76 m ha areas with an annual production of 0.84 MT showing productivity of >1.1 t/ ha during

2012-13. Crop is largely cultivated in Uttar Pradesh, Madhya Pradesh, Bihar, Maharashtra, Haryana and Rajasthan. Its cultivation is also confined to the rainfed, marginal and sub-marginal lands with poor soil fertility, however, with the development of input responsive dwarf type varieties farmers often irrigate crop to achieve higher yields in central and northern India.

Developing Input responsive and non-lodging varieties and short duration varieties

Re-introducing pulses for crop diversification in cereal-dominated cropping system of northern India is needed for enhancing and sustaining cropping system productivity. The chickpea crop can be made more profitable and competitive by developing chickpea varieties which are non-lodging, responsive to high input conditions, early to extra-early maturity and tolerant to reproductive stage heat tolerance. An early maturing heat tolerant chickpea variety JG 14 (ICCV 92944) is already becoming popular in Eastern India.

Development of extra-short duration genotypes (< 120 days maturity) of pigeon pea

Extra-short duration pigeon pea has a potential to be cultivated in new niches, it can grow in diverse areas like in Uttarakhand, Rajasthan, Odisha and Punjab. Short duration pigeon pea variety ICPL 88039 has been very well adopted in the states of Rajasthan, Uttarakhand and Odisha, in addition to ICPL 88039, extra short duration pigeon pea varieties ICPL 85010 and ICPL 84031 varieties were also released earlier in Himachal Pradesh and Andhra Pradesh allowing farmers to grow pigeon pea in various cropping systems.

Breeding program initiated at ICRISAT in 2006 to develop super-early maturing (< 100 days) pigeon pea lines resulted in very stable photo- and thermo-insensitive lines in determinate (ICPL 20340, ICPL 20338, ICPL11255) and non-determinate group (ICPL 20325, ICPL 20326, ICPL 11301). These lines provide number of opportunities like pigeon pea–wheat cropping system since pigeon pea matures by 100 days allowing time to prepare the land for wheat which is not possible with traditional medium duration varieties. It escapes drought, and pod borer attacks if planted early in June and harvested before those stresses occur. Introduction of super-early pigeon pea in rice-fallows will not only generates additional income but also improve soil health and productivity.

Early maturing varieties for rice fallow areas

A substantial area of lentil is sown under late sown condition in rice-fallow fields of Indo-Gangetic plains. Early maturing varieties possessing high biomass and tolerance to high temperature at reproductive stage are required. Varieties should have resistance to diseases like stemphylium blight, rust and wilt; tolerance to low temperature at vegetative stage and high temperature at reproductive stage, and terminal soil moisture stress will b very desirable.

Short duration varieties for crop diversification

There is need to reduce maturity duration at least by another 8-10 days to fit *mungbean* varieties for sustainability of wheat-rice dominated cropping system. Reduction in maturity duration will also reduce water requirement ensuring more profit to summer *mungbean* growers as well as additional area of 2.7 m ha under *mungbean* is possible in southern and coastal India during *rabi* season under rice-rice cropping system. Inclusion of *mungbean* in between rice and wheat and rice-rice cropping systems will provide for long term sustainability and help in protecting the environment from the risk associated with mono-cropping and high input agriculture Results of the front-line demonstrations have clearly indicated the scope for enhancing yields at farmers' fields following systematic technology transfer particularly in spring/summer season. Since the crop fits well in small window after harvest of *rabi* crop (such as wheat and *rabi* maize) and *kharif* cereals (such as rice and sorghum) in irrigated conditions, *mungbean* cultivation will help in sustaining productivity of the cereal based cropping systems in different parts of the country. The expansion of cereal –cereal rotation poses a serious threat to the sustainability of production system as indicated by a decline in total factor productivity in high input agriculture of Haryana, Punjab and western Uttar Pradesh (IIPR Vision 2050).

Abiotic Stress Tolerance

Drought and heat are the major abiotic stresses affecting chickpea at reproductive and terminal phases of crop growth especially in central and southern India. The residual nature of soil moisture coupled with progressively receding soil moisture conditions and increasing temperatures towards end of the crop season impact the crop severely. Early maturing and stress tolerant cultivars are required to combat these stress conditions. Breeding lines with enhanced drought tolerance have been developed through marker-assisted breeding, which can be developed to combine both drought and heat tolerance. The chickpea is a very suitable pulse crop for rice-fallows, provided suitable varieties and technologies for crop establishment are available. The most important traits required in chickpea varieties for rice fallows include early to extra-early maturity and tolerance to reproductive stage heat tolerance. An early maturing heat tolerant chickpea variety JG 14 (ICCV 92944) is already becoming popular in Eastern India. This variety can be further promoted and used as a benchmark for developing better performing varieties.

Biotic Stress Tolerance

Dry root rot (DRR) and Fusarium wilt have emerged as highly devastating root diseases of chickpea in central and southern India. There are many wilt resistant varieties, but there is a need to enhance efforts on identifying sources of resistance to DRR in the germplasm of cultivated and wild species and combine resistance to DRR and wilt in the varieties developed for central and southern India. Pod borer (*Helicoverpa armigera*) continues to remain a major and challenging insect-pest of basically all pulses but devastating for chickpea and pigeon pea. Greater chances for development of pod borer resistant cultivars exist through application of transgenic technology. Concerted efforts are needed on using different transgenes and promoter options for developing transgenic events and their evaluations for effectiveness and bio-safety. It has been observed that the overall cost of cultivation decreased with the increasing adoption of Integrated Pest Management, along with promotion of improved disease resistant varieties of pigeon pea and chickpea widely grown. The integrated pest management technologies dealing with avoidance of virus inoculums, vector control (for sterility mosaic disease), management of pod borer implemented in farmer participatory approach helps in reducing input cost.

Use of molecular technologies and transgenic crop

Pyramiding of genes for resistant to major insect pests (thrips, jassids and pod borer) and diseases (yellow mosaic virus, anthracnose, powdery mildew, Cercospora leaf spot, etc.) for which high level of resistance is not available in cultivated germplasm, and identification of donors from diverse germplasm is of paramount importance. Pyramiding of useful genes to develop multiple stress resistant varieties is needed through deployment of molecular markers in breeding programs. Similarly, incorporation of bruchids resistance will help in minimizing post-harvest losses during storage. For a major breakthrough in yield, there is urgent need to broaden the genetic base by strengthening pre-breeding and developing core sets of germplasm; harnessing hybrid vigor through development of CMS-based hybrids in pigeon pea; mapping and tagging of genes/ QTLs and marker assisted selection for resistance to insect pests and diseases, yield and grain quality; gene pyramiding for stable resistance; development of transgenics in chickpea, pigeon pea for problems hitherto unsolved through conventional means like Helicoverpa pod borer and drought, and genomic research for understanding the structure and function of genes. High yielding and input-responsive genes are yet to be searched and transgressed in common varieties

Pulses in Bihar

Bihar is an important pulse growing centre of India predominated by lentil, pigeon pea, Lathyrus (*Khesari*), gram, green gram etc cultivation. *Tal* lands spread over south Bihar districts where Lentil is cultivated primarily was earlier dominated by gram cultivation (Singh and Singh 2014). But with time the cultivation has shifted to cereal based cropping system with pulses being marginalized (Singh, *et al.*, 1990, Chaudhary, *et al.*, 1993).

In a study regarding impact of NFSM on pulse production, marketing it was found that in NFSM and non NFSM district about 64% of sample farmers mainly grows pulses for home consumption needs, followed by lack of irrigation and inferior land (14% each) and profitability ranked important only by large farmers (8%). In NFSM and non-NFSM districts of Bihar pest problem has been mentioned as main limitation (28-30%), other being lower profitability (24%), yield instability (20%) and lack of assured market (16%) were listed as main reasons for shifting away from pulse cultivation (Singh, *et al.*, 2013).

Table 1: Projected decadal growth in pulses productivity (Kg/ha) in Eastern India

States	Pulses productivity (kg/ha)				
	2010 -11	2020-21	2030-31	2040-41	2050-51
Assam	800.0	912.3	1055.6	1221.5	1392.9
Bihar	839.3	957.1	1107.5	1281.5	1461.3
Chhattisgarh	604.9	689.8	798.2	923.6	1053.3
Eastern UP	787.4	897.9	1039.0	1202.2	1371.0
Jharkhand	687.5	784.0	907.2	1049.7	1197.0
Odisha	459.8	524.3	606.7	702.0	800.5
West Bengal	833.3	950.3	1099.6	1272.4	1450.9
Eastern India	680.8	787.8	911.5	1054.7	1185.4

Source: Singh et al. 2013

Availability of improved varieties, better pest management techniques, assured procurement and better market price will defiantly act as incentive for pulse cultivation across all farmers group. Projections clearly indicate that Bihar will be the leading states among the eastern state in pulses productivity front with (1461.3 kg/ha) during 2050 which in year 2011-12 is 839.3kg/ha (Singh *et al.*, 2013).

The Way Forward

The scope for introduction of pulse crops in rice-fallows (mostly un-irrigated) needs to be exploited with supplemental irrigation. There is vast area of fallow land in MP (78% of *kharif* rice area, which accounts for 4.4 million ha), Bihar (2.2million ha) and in West Bengal (1.7 million ha), which are most suitable for pulses cultivation. Task force on pulses by Dr Alagh identified the areas with potential expansion (Reddy, 2015):

1. identification of additional area by utilization of rice fallow lands (3 to 4 million ha) largely in Eastern India and which can yield around 2.5 million tones,
2. diversification of about 5 lakh ha area of upland rice, 4.5 lakh ha area of millets and 3 lakh ha area under barley, mustard and

Table 2: Bringing additional area under pulses

	Potential crop/cropping systems/Niche	Specific area
1	Intercropping	
	Mungbean with ratooned Sugarcane during spring/summer (irrigated)	Uttar Pradesh (excluding Bundelkhand parts),Bihar, Maharashtra, Andhra Pradesh and Tamil Nadu
	Mungbean with cotton and millets (rainfed uplands)	
	Pigeon pea with soybean, sorghum, cotton, millets and groundnut (rainfed upland)	Andhra Pradesh, Malwa region of Madhya Pradesh, Vidarbha of Maharashtra, North Karnataka, Tamil Nadu
	Chickpea as intercrop with barley, mustard, linseed and safflower (rainfed)	South East Rajasthan, Punjab, Haryana, Uttar Pradesh, Bihar, Vidharbha region of Maharashtra
	Chickpea or lentil with autumn planted sugarcane	Maharashtra, Uttar Pradesh, Bihar
2	Mungbean: sole crop in spring/summer season (irrigated)	Western and Central Uttar Pradesh, Haryana, Punjab, Bihar, West Bengal
3	**Rice fallow areas**	
	Chickpea	Eastern Uttar Pradesh, Bihar, Jharkhand, Orissa, Chhattisgarh, West Bengal
	Urdbean/Mungbean	Andhra Pradesh , Tamil Nadu, Orissa, Karnataka
	Lentil	Eastern U.P., Bihar, West Bengal, Assam, Jharkhand
	Lentil/field pea	North-East
4	Urdbean in *Kharif* fallow of Bundelkhand	Uttar Pradesh and Madhya Pradesh
5	Lentil in Diara lands	Uttar Pradesh and Bihar
6	Pigeon pea in foot hills of Terrain sloping lands	Uttarakhand, North Bihar

Source: *www.comodityindia.com, 2015* wheat, currently giving low yields can be brought under kharif/ rabi pulses,

3. About 16.5 lakh ha area vacated by wheat, peas, potato and sugarcane can be used for raising 60-65 day summer mungbean crop in the UP, Punjab, Haryana, Bihar, Gujarat, and West Bengal where adequate irrigation facilities exist and the menace of blue bull contained, pigeon pea on rice bunds and intercropping in specific agro climatic regimes is identified.

CONCLUSION

As discussed a combination of factors like low productivity, vulnerability to climate changes, competition from other remunerative crops and emergence of more productive and profit-oriented production systems all have led to a serious threat to existence of pulses in farming system. Overall pulse production is estimated to increase by just 1% as the second year of drought has taken its toll with pigeon pea production dipping by 9% from last year and 20% over 2014-15, and bringing decrease by 12% compared to non- drought year 2013-14 (2015-16 data based on 2nd advance estimate, TOI, April,27 2016). So, the challenge of untangling the future of pulse production from this pessimistic scenario remains acute given the need to develop inclusive and environmentally friendly production systems, which should emphasize not only productivity but also maintenance of soil fertility, nutritional status of the people, environmental sustainability and concern of smallholder farmers

Changes in the mindset of policy-makers

The time has arrived to consider food security inseparably from nutrition security, calling for publicly funded research and extension system to review priorities of research agenda and allocation of research budgets that acknowledge the overarching importance of boosting productivity of pulses and addressing other constraints that stand in the way of improving competitiveness of pulse crops and making them economically attractive.

Research

Pulses are least researched crops both at national and international levels, therefore thrust should be given to initiating a vibrant breeding programme to develop varieties not only with high-yielding attributes but also with characteristics that allow fitting them in existing farming systems of the smallholder farmers. Modern tools and techniques of biotechnology should be used for developing varieties with novel traits that would make them climate smart.

Pulse germplasm

There is an urgent need for collection, conservation of pulse germplasm, which has hardly received any attention, leading to loss of valuable germplasm with movement of agricultural production system from subsistence to intensive farming. Attention is required on collection of pulse germplasm and their characterization to identify climate smart germplasm. Priority should be given to increase awareness on the importance and contribution of pulse genetic resources to food and nutrition security and challenges and opportunities in integrating genetic resources into national breeding programmes.

Research on multiple cropping

Pulses are most suitable crops for multiple cropping as inter-cropping, relay-cropping and mixed-cropping due to their short duration, less requirement of human labour and other inputs. As farmers keep their cropping system changing based on circumstances, they should have choices of multiple cropping that best suit their farming systems. Research results have shown that through intercrop and double crop systems, production of pulses can be increased without unduly sacrificing the yields of cereals and other crops, as found that inclusion of black gram and green gram in rice-based cropping system increased the yield of succeeding crop of rice.

Extension services

Besides public institutions like (ICAR, SAUs), development departments and other organizations like NGOs, seed companies, farmers' associations, civilized societies and private entrepreneurs should also be involved in promoting pulse production. They should be involved by way of quality seed production, transfer of technology, processing and value addition, and supply of critical inputs to enhance the production of pulses.

Bridging yield gap

The yield capacity of modern varieties of pulses is low but then to the existing yield gaps are also significant. Efforts to minimize yield gap can be an important viable strategy to increase productivity and production of pulses. Non-monetary inputs, including improved agronomic practices, such as timely availability of all inputs and their application in the fields, timely sowing, pest management practices, regular mechanical weeding, timely harvesting and post-harvest handling also could help increase pulse production.

Climate smart technology

High-yielding pulse varieties will play important role , developing management technologies is also equally important not only for achieving higher yield but also allow adjusting to changing crop growing environments likely to be increasingly unfavorable due to adverse impacts of climate change. Crop management technologies that permit crops to cope with and thrive under stressed environmental conditions by nature should be location-specific by drawing on supporting elements arising from local ecosystems and landscapes.

Value chain approach

The value chain approach is a way of empowering smallholder farmers by linking them with markets and other upstream post-production activities that will boost their overall income and strengthen rural economy. This requires a closer look at the processes and operations that start from on-farm production of primary commodities and span post-harvest handling, processing, packaging, transportation and marketing. At each stage there is opportunity for adding value to the primary product and thus benefit smallholder farmers by fostering horizontal and vertical linkages that integrate them in the value chain. The focus on product quality and end-use characteristics within a value chain perspective also create preconditions for commercialization thus improving competitiveness of pulse.

Today the need is to forge a holistic understanding of the issues affecting the pulses overall production, value chain, reforms in agri-food policies, increased need for more R&D on the input side and food processing innovations, increase awareness as well as interest of consumers, policy makers, food industry and NGOs in pulses and their health, nutrition and environmentally sustainable benefits.

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