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Status and Strategies for Development of Pulses in Bundelkhand Region of India: A Review

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ABSTRACT

Bundelkhand region of India is primarily agrarian, vulnerable to natural calamities with low levels of industrialization and urbanization. Poor crop productivity, declining and irregular rainfall pattern and poor income levels make livelihood uncertain in the region. Pulse crops assume a special significance to the farm economy in Bundelkhand region as well as daily diets of local habitants. Chickpea, lentil, field pea, urdbean, mungbean and pigeon pea are the major pulse crops cultivated in the region. Data from Department of economics and statistics, Department of Agriculture and Cooperation and Farmers Welfare, New Delhi and the studies on pulses development of Bundelkhand region of India were analyzed. Pulses account for 32% of total agriculture produce and occupy about 33.6% of gross cropped area in the region. However, decline in area coverage of pulses has been observed in the region, in contrast to overall increase in gross cropped area in the region. The paper discusses about the various challenges confronting pulses cultivation in the region along with the possible intervention points for bringing out an enhanced pulse production.

Key words: Economy, Productivity, Pulses development, Strategies.

Bundelkhand region is the central semi-arid plateau of India that spans over about 7.1 million hectares area. The region covers 14 districts comprising Jhansi, Jalaun, Lalitpur, Hamirpur, Mahoba, Banda and Chitrakoot of Uttar Pradesh (UP) and Newari, Datia, Tikamgarh, Chattarpur Damoh, Sagar and Panna district in Madhya Pradesh (MP) state. The region is complex, rainfed, risky, under invested, vulnerable, socio-economical heterogeneous, ethically unique, agrarian and backward (Samra, 2008). Among all the nine agro-climatic zones of UP state, Bundelkhand region of UP has the lowest average annual household income (Tripathi, 2019) and lowest livelihood security (Singh and Nayak, 2020). Bundelkhand region suffers from water scarcity, natural resource degradation, low crop productivity (1-1.5 q/ha), low rainwater use efficiency (35-45%), high erosion, poor soil fertility, frequent droughts, poor irrigation facilities, inadequate vegetation cover and frequent crop failure resulting in scarcity of food, fodder and fuel (Palsaniya *et al*., 2008). The region experiences extremes of temperature, varying from more than 45°C during summers to about 1°C in winters and receives average 800-900 mm annual rainfall. The occurrence and distribution of rains however has no definite pattern rendering farmers unprepared for timely crop sowing and almost every year they faced the problem of drought even during good rainfall year (Sandhu *et al*., 2016). A declining and irregular trend of annual rainfall and a gradual drying up of the region has emerged as a challenge to sustain crop yield in the region (Ahmed *et al.,* 2019). Droughts, short-term rain and flooding in fields add to the uncertainties. Based on the composite drought hazard analysis, eight districts of Bundelkhand region are under severe to moderate drought vulnerability (Gupta *et al*., 2014).

Bundelkhand region is home to 18.3 million of which 79.1% are rural dwellers (Census, 2011). More than one third of the households in this region are Below Poverty Line (BPL). With low levels of industrialization and urbanization, living conditions are difficult for the rural poor who depend mainly on agricultural incomes for sustenance. Highly vulnerable to natural calamities and poor infrastructural development has made agricultural productivity very low and livelihood uncertain in the region (Chavan *et al*., 2016).

About 54 per cent (3.8 m ha) of the total reported area (7.1 m ha) in Bundelkhand region is under cultivation. The uncultivated land and fallow land together account for about 15 per cent of the total reported area in the region. Cropping intensity of the region (145%) is lower against the cropping intensity in UP state (159%) and MP state (155%) (Table 1).

Wheat, chickpea, sorghum, barley, lentil, sesame, mustard, groundnut, linseed, soybean, peas, urd bean, pigeon pea and mungbean are the major crops cultivated in the region. During 2015-16, the area coverage as percentage of gross cropped area in the region was highest under cereals and millets (37%), followed by pulses (33.6%) and oilseeds (26.8%) (Table 2). Productivity of crops in the region is severely constrained by water scarce conditions as the

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irrigation sources are primarily seasonal and dependent on annual precipitation (Gupta *et al*., 2014). Pulses like lentil, mungbean and urd bean are widely cultivated in the region with lesser use of yield enhancing inputs (Sharma and Sisoda, 2008).

Pulses in the Bundelkhand region

Pulse crops assume a special significance to the farm economy in Bundelkhand region as well as daily diets of local habitants. Pulses are affordable source of dietary protein and contain on an average 20-25% proteins, which is almost double the value found in cereals. Pulse crops also serve as a source of fodder and fuel for the farm families in the region. These low inputs crops have an important role in ameliorating physical, chemical and biological properties of soil.

Bundelkhand region is termed as 'Pulse bowl' of Uttar Pradesh state as it significantly contributes to total pulse production. Chickpea, lentil, field pea, urdbean, mungbean and pigeon pea are the major pulse crops cultivated on 2.03 m ha area in the region. Pulses account for 32% of total agriculture produce (Samra, 2008) and occupy about 33.6% of gross cropped area in the region. The region accounts for a major portion of total pulse area in UP (44%) followed by MP (21%). These crops are primarily cultivated under rainfed production situations with minimum use of external inputs. Only about 29.6 per cent of total pulse area in the region is under irrigation (Table 2). These crops are important constituent of popular cropping sequences in the region like fallow-chickpea/lentil, sesame-chickpea/lentil/field pea, pearl millet- chickpea/lentil/field pea, pigeon pea-mungbean, *etc*.

Table 1: Land use classification of Bundelkhand region of India (2015-16).

Head	Area (million ha)	% change (2006-07 to 2015-16)
Reported area	7.09	0.2
Forest area	1.42 (20.1)	0.1
Area not available for cultivation	0.78 (11.1)	3.4
Uncultivated land excluding fallow land	0.50 (7.0)	-11.8
Fallow land	0.55 (7.8)	-3.1
Net area sown	3.84 (54.1)	1.8
Gross cropped area	5.58	16.2
Area sown more than once	1.74	68.4
Cropping intensity	145	

Source: Calculations from data from DES, DAC&FW, New Delhi. (Figures in parentheses are percentage of gross cropped area).

Bundelkhand region contributes 8.4 per cent (1377 tonnes) of total pulse production in the country. The contribution of the region to total area and production of crops like field pea, lentil and urdbean is highly significant as it contributes about 43, 16 and 11.5 per cent of total national production of field pea, urdbean and lentil in the country (Table 3). The overall productivity level of pulses in the region (677 kg/ha) was slightly higher than national average (655 kg/ha), the yield levels of field pea, chickpea and lentil crops were also higher as compared to the national average (2015-16).

Temporal analysis of area coverage of pulses with reference to other crop groups was done for 2006-07 to 2015-16 (Fig 1) and it was observed that the gross cropped area as well as area under cereals and millets combined and oilseeds crops showed a continuous upward trend. Area under pulse crops however showed a declining trend from 2009-10 to 2015-16 after an initial rise from 2006-07 to 2009-10. In contrast, the fallow area continuously declined during the period except for increase during 2014-15 to 2015-16. The gross cropped area showed continuous increasing trend during the period except during 2015-16. The trend indicates that the additional area brought under cultivation over the years was primarily utilized for cultivation of oilseed crops and cereals and millets (Fig 1). During 2006-07 to 2015-16, gross cropped area in Bundelkhand increased by 16 per cent while 14.9 per cent reduction was recorded in uncultivated land.

Challenges to pulse production

Climate variations

Bundelkhand region is one of the most vulnerable regions of India with respect to climate change (Bisht and Shaikh, 2015). Variability in temperature and rainfall has affected adversely to the livelihoods of farmers in the region (Singh, 2020). Pulse crops in the region are primarily cultivated under climate-sensitive rainfed production situation. Mid season, terminal soil moisture stress and high temperature in *Rabi* season pulses and water logging in *Kharif* pulses

Table 2: Area under different crops in Bundelkhand region of India 2015-16.

Area under crops (in thousand ha)	UP Bundelkhand	% area of UP state	MP Bundelkhand	% area of MP state	Total area Bundelkhand	% of gross cropped
Cereals and millets	1105	6	956	10.1	2061	36.9
Pulses	833	44.3	1202	21	2035.3	33.6
Oilseeds	560	41.6	937	12.3	1497	26.8
Gross cropped area	2551	9.7	3050.5	12.8	5601.5	100.0
Area sown more than once	681	7	1063	12.6	1744	31.3
Net area sown	1870	11.4	1964	13	3834	68.7
Cropping intensity	159		155			145

Table 3: Details of pulse production scenario in Bundelkhand region of India (2015-16).

Crops	Area (000 ha)		Production (000 kg)		Yield (kg/ha)	
	Bundelkhand	% of India	Bundelkhand	% of India	Bundelkhand	India
Pigeon pea	116.8	2.9	60.3	2.4	516	643
Urdbean	670.2	19.0	223.5	11.5	333	537
Mung bean	58.5	1.5	14.8	0.9	253	416
Other *Rabi* pulses	0.1	-	0.05	-	450	-
Chickpea	680.0	8.1	600.1	8.5	883	840
Field pea	313.0	34.7	321.3	43.4	1026	821
Lentil	195.9	15.4	156.8	16.1	800	765
Other*Rabi* pulses	0.8		0.3		449	
Total Pulses	2035.3	8.2	1377.2	8.4	677	655

Source: Authors calculations from secondary data from UPDES, Lucknow (UP) and DES, GoI, New Delhi.

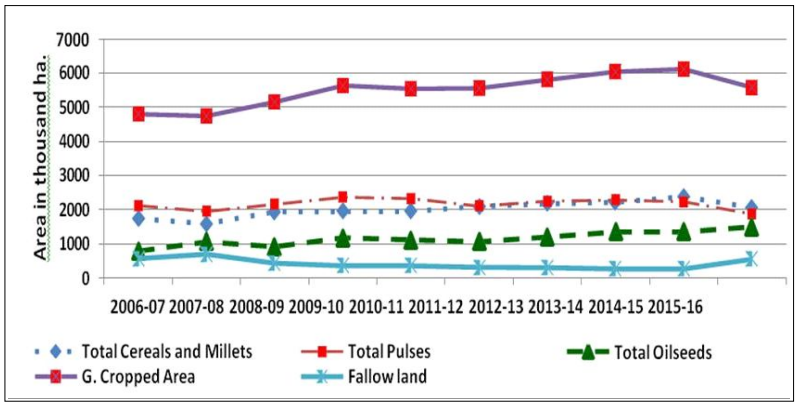


Fig 1: Temporal trend of area under different crops in Bundelkhand region of India (2006-07 to 2015-16).

are major abiotic constraints of pulses production in the region.

Climatic modeling experiments predicted that temperatures are likely to increase by about 2 to 3.5°C in Bundelkhand region by the end of this century (Kedia, 2010). Further, the rainfall is projected to increase by 5-10% towards 2050s, with decrease in the number but more intense rainy days (Bisht and Shaikh, 2015). It was estimated that in Bundelkhand region with every 0.1°C increase in maximum temperature during crop period would lead to yield reduction by 38.5 kg/ha, 40.7 kg/ha and 26.9 kg/ha in chickpea, lentil and pigeon pea, respectively. In addition, with every 10 mm reduction on average annual rainfall, the corresponding decline in yield was estimated to be 12.3 kg/ha, 13.06 kg/ha and 8.6 kg/ha (Dubey *et al.,* 2011). With regard to adaptation to climate change, low level of livelihood status, fewer non-farm employment opportunities and low cropped area under irrigation emerge as the main barriers (Singh, 2020). Addressing the potential impacts of climate change on pulses production in Bundelkhand region requires increased attention on mitigation strategies.

Irrigation facilities

Lack of assured irrigation during crop growing season coupled with poor soils and frequent droughts translate into poor crop productivity levels in most parts of Bundelkhand region. During 2015-16, the share of irrigated area to total cropped area in UP Bundelkhand region was 49.7% (1.27 m ha) against about 80 per cent in UP state, while it was 37% (1.13 m ha) in MP Bundelkhand region as compared to 42 per cent in MP state. Irrigation sources like dams, ponds, tanks, lakes, streams, wells, bore wells and irrigation canals exist in the region. However, low and erratic rainfall in the region has lead to heavy dependence on ground water for irrigation. About 42% of gross sown area in Bundelkhand region is under irrigation and irrigation through canal accounts for coverage of 24.7% of gross irrigated area. Tube wells are the largest source of irrigation covering about 64 percent of the gross irrigated area in the region. The situation has lead to over exploitation of underground water for irrigation purpose in this water scarce region (Samra 2008; Palsaniya *et al*., 2011). Inadequate soil and water conservation practices and run-off water harvesting structures also lead to distressed farming that has serious implications on poverty, food security and out migration.

Heavy infestation of diseases, insect pest and weeds

Mono-cropping of pulses year-after-year has intensified the incidences of diseases, insect-pests and weeds in pulse crops in Bundelkhand region. In pigeon pea, chickpea and lentil crops, *Fusarium wilt* is the important biotic stresses affecting production. In pigeon pea crop, sterility mosaic and

Phytopthora blight are the other important diseases in the region. Yellow mosaic disease in mung bean and urdbean crops while powdery mildew and rust diseases in field pea cause significant crop losses in the region.

Among insect-pest, gram pod borer *(Helicoverpa armigera)* cause significant crop losses in pigeon pea and chickpea in the region. Pod sucking bugs and pod fly (*Melanogromyza abtusa*) also pose threat to pigeon pea production in the region. Mungbean and urdbean crops suffer from spotted pod borer, whitefly, aphids and thrips. A change in incidences and severity of insect pest is frequent in the region, with minor pest like pod fly and thrips emerging as major ones in the recent past.

Weeds pose a serious threat in pulse crops due to the slow initial growth (Kumar *et al*., 2013) and they also hinder in intercultural operations and harvesting. Some weeds also act as alternate host of insect-pest and diseases of pulse crops.

Appropriate pest management strategy with inclusion of forewarning programs is desired for sustaining the yield levels in pulse crops in the region, especially with reference to the array of insect pest, diseases and weeds infesting these crops.

Kharif fallows

Approximately 69 % of the gross cropped area is under *Rabi* cultivation with only about 31 % under *Kharif* season (Singh and Joshi, 2011) indicating a large *Kharif* fallow area in the region. Pulse and oilseed crops occupy a major cropped area in *Kharif* season. A major challenge for bringing addition *Kharif* areas under cultivation in the region is the practice of letting loose cattle for unrestricted grazing (*Anapratha)*, during *Kharif* season. The practice is followed as a coping mechanism to reduced availability of fodder for cattle during summers. About 10 percent (550 thousand ha) of gross cropped area in Bundelkhand region is classified as the fallow land, that could be brought under pulses. Interventions focused on area expansion of pulses in *Kharif f*allows need to stress uptake of recommended varieties of urdbean, mungbean and short duration pigeon pea along with suitable production technologies.

Poor uptake of production technologies

High technological and extension gap exist with respect to pulse production technologies in UP Bundelkhand region (Mishra *et al*., 2017; Rajiv and Singh, 2014). Low uptake of improved varieties, production inputs like fertilizers and pesticides coupled with rainfed conditions converges in poor production and productivity figures in the region. Adoption of improved varieties has the capacity to enhance productivity by 20 to 25% (Singh and Joshi, 2011) however availability of quality seed of pulses is an important issue (Purushottam 2011; Mishra, 2014). Use of farm saved seeds is widely prevalent practice in Bundelkhand region (Sah *et al*., 2014). Affordability is a constraining factor for farmers in purchasing quality seeds of high yielding varieties. Fertilizer use in Bundelkhand region was observed to be lowest (56.6 kg/ha) among all the zones of UP state as well as state average (152 kg/ha) (Pandey and Reddy, 2012). Since large area in Bundelkhand is under oilseeds and pulses, use of sulphur as basic dose can increase crop productivity. Affordability of fertilizers by majority of farmers for usage in pulse crops is also an issue (Kumar *et al*., 2017). Inadequate adoption of crop protection measure coupled with heavy infestation of insect pest and diseases adversely affects the pulse productivity in the region. Farmers in general lack awareness on usage of pesticides. Timely availability and affordability of the plant protection chemicals by farmers also pose a challenge.

Other challenges

Farmers in the region generally resort to manual operations for pulse cultivation and there is low use of agricultural machinery for the tillage and inter-cultivation. This not only increases cost of cultivation and drudgery but also leads to higher crop losses (Singh and Kumar, 2014). Low level of farm mechanization along with small land holding size in the region also contributes to low productivity level. Limited availability of the technological inputs related to pulse cultivation (Purushottam *et al*., 2012) is also an issue. Farmers fail to realize better market margins as local traders purchase pulses at very low prices (Anonymous, 2012) is also a challenge that farmers in the region face. In addition, menace of blue bulls and stray animals also pose a serious challenge for pulse production in the region.

Technological interventions for enhancing pulse production

Improved production technologies

Adoption of disease resistant high yielding varieties of pulses with appropriate production and protection technologies can contribute to significant yield enhancement in the region and reduction in technological and extension gap (Mishra *et al*., 2017; Sah *et al.,* 2018). Dwivedi *et al.* (2018) assessed that the yield enhancement in pulses by 80-167 per cent with use of improved varieties and agro techniques in the region. Improved pulse production techniques can contribute to yield advantage of 75.2% to 113.8% in Bundelkhand region (Rajeev and Singh, 2014). Use of recommended herbicides and weedicides offer alternative to overcome the challenge of high weed infestation in crops especially in *Kharif* season (Kumar *et al.,* 2017). Promotion of use of foliar spray of 2% urea may be promoted in rainfed production situations. Production technologies like mulching, weeding, broad beds and furrows, ridge and furrow system of sowing especially in black heavy clayed soils, can be useful during excessive or deficit rainfall conditions, needs extensive promotion (Kumar *et al.,* 2015). Ridge planting of pigeon pea and raised-bed planting of urdbean crops is recommended for reduced disease incidence and recharging of rainwater for subsequent crop cultivation. This also reduces the adverse effects of temporary water logging by rains in heavy textured

black soils. Sowing on ridges or raised beds especially in black soils can enhance productivity by 15-20% with reduced risks (Samra, 2008). Fertilizers outlets in the region ought to be well prepared for meeting the fertilizers demands at crop sowing season. This must be supported with mass awareness programs on balanced application of fertilizer along with secondary micronutrients. Similarly, application of bio-fertilizers, seed priming and seed treatment need to be extensively promoted.

Strengthening the seed system of pulses

Enhancing the availability of quality seed of improved varieties and ensuring farmers' access to it are important means for overall improvement in pulse production in Bundelkhand region (Sah *et al.,* 2014). Efforts are needed for infusion the seeds of improved varieties for strengthening of pulse seed system in the region (Table 4). Interventions related to quality seed especially in *Kharif* season are needed for enhanced pulse production in Bundelkhand region (Kumar *et al*., 2017). Public-Private partnership in production of pulse crops need to be promoted in the regard (Singh *et al*., 2014). Establishment of "farmer managed seed hubs" at village level seed production and processing with essential certification and buyback system in pulse producing pockets of the regions can contribute towards better seed replacement rate at farm level in efficient manner. Large scale capacity enhancement programs for farmers on maintaining quality of the farm-saved seeds need to be initiated. A major initiative of establishment of ten pulse seed hubs in Bundelkhand region with a mandate of production of 100 thousand kg of quality seeds annually have been taken by Government of India (Singh *et al.,* 2019).

Ensuring availability of critical inputs

Pulse crops are though less water demanding, they respond well to applied irrigation. More than 70 per cent of the pulse area in Bundelkhand region is rainfed. Irrigation facilities in the region are limited leading to low consumption of fertilizer (Shakeel *et al.,* 2012). Moisture stress during crop growth translates in poor crop productivity. *Rabi* pulse crops in the region are primarily grown under mono cropped conditions on residual soil moisture and are least preferred for application of other production inputs including irrigation. Promotion of micro-irrigation systems like drip and sprinkler system for pulse cultivation may be instrumental in saving irrigation water in this water scarce region (Praharaj *et al.,* 2018). The provisions for subsidies on these systems need to be continued with extensive awareness campaigns on their benefits (Sandhu *et al.,* 2016). Promotion of site-specific rainwater harvesting systems in farm ponds and community reservoirs could be the potential options for ensured life-saving irrigation for pulse crops. Canal infrastructure need to be made compatible to sprinkler and drip irrigation. Rejuvenation of traditional water harvesting structures could be may also contribute to overcome the water scare conditions in the region. Availability of technological inputs plays a dominant role in determining productivity and stability in pulse production in Bundelkhand region (Purushottam *et al.,* 2012). Ensuring availability and accessibility to critical inputs like bio fertilizers, sulphur, zinc, micronutrients and bio-pesticides is important for enhanced crop production levels. Special efforts for strengthening the bio-fertilizer and bio-control production units and maintaining their quality are required in the region. Development of pulse crop varieties to mitigate the impacts of climate change and regular monitoring of diseases and pest population build up in pulse crops is important for ensuring sustainable yields (Basu *et al.,* 2016).

Mechanization for pulses production

Agricultural machinery for farm operations is essential for reducing the cost of cultivation, drudgery and ensures higher farm profits. Use of farm machinery also lead to greater efficiency and reduced crop loss (Mehta *et al*., 2019 and Yadav *et al*., 2019). Specialized farm machinery is needed for uptake of improved sowing techniques of ridge and furrow, raised bed and furrow method of crop sowing, harvesting and threshing. Availability of seed drills, zero-till machine, rotavator, reapers, threshers, graders and others would give impetus to pulse growers in the region. Ownership of expensive farm machinery is restricted in the region. Majority of the farmers in the region are marginal and usually hire the machinery for various farm operations.

Table 4: Recommended pulses varieties for Bundelkhand region of India.

Crop	Varieties
Pigeon pea	IPA 203, Narendra Arhar 1, Bahar
Chickpea	***Desi***
	RSG 888, RSG 963, Pusa 547, Phule G 9425-9, GNG 1581, GNG 558, GNG 2144, CSJ 515, RVG 202, RVG 203, Phule vikram, RVG 204, Pusa parvati
	Kabuli
	IPCK 2002-29, BDG 128, IPCK 2004-29, Jawahar Kabuli Chana-1, GLK 26155, GLK 28127, GNG 1969, Vallabh Kabuli Chana 1
Lentil	IPL 406, IPL 316, LL 699, KLS 218, PL 5, PL 7, PL 8, DPL 62, RVL 31, Shekhar Masur 3, Shekhar Masur 2
Field pea	Pant P 74, Pant P 125, Aman, HUDP 15, IPFD 99-12, IPFD 1-10
Mung bean	IPM 410-3(Shikha), IPM 205-7(Virat), IPM 99-125(Meha), TJM 3
Urd bean	Uttara, Pant Urd 30, Vallabh Urd 1, KU 96-3, NUL 7, KU 309, AKU 15

Strength	Weakness
• Predominance of pulse based cropping system. • Pulses cultivated in *Kharif*, summer and spring/summer season. • Well recognition as a pulse growing zone of the country. • Presence of 26 Agriculture produce markets in the region for marketing of pulses	• High yield gap in pulse crops. • Poor resource allocation to pulse crops. • Poor uptake of pulse production technologies. • Rainfed conditions • Heavy disease and pest incidence in pulse crops. • Poor risk bearing capacity of majority of the farmers.
Opportunity	**Threat**
• Area expansion of pulses under *Kharif* fallow • Organic pulse production • Availability of wide range of on shelf recommended varieties of pulses for the region along with matching production technologies	• Enhanced competition for area owing to increasing irrigation facilities. • Climatic variations • Menace of stray animals due prevalence of " Anapratha" • Instability in area and productivity of pulses.

Fig 2: SWOT analysis of pulse production in Bundelkhand region of India.

Farm implements like bed makers, zero till drills and mechanization on custom hiring basis are lacking in the region (Samra, 2008). Establishment of custom hiring facilities at block level for farm machinery through SHGs or private entrepreneurship or cooperative system need to be promoted on large scale. Online mobile applications may be leveraged for hiring the needed machinery.

Delivery mechanisms for technologies transfer

Timeliness in sharing of information and forecasting coupled with services and input support for farmers at farm level translates in higher farm return. This is especially important during extreme events like droughts, untimely rains, sudden rise in temperature *etc*. for ensuring better coping mechanisms. Benefits of modern information technologies need to be leveraged for speedier extension of information on improved pulse production technologies among the farmers of the region. Information regarding availability production inputs, plant protection chemicals, farm machinery and market price need to be made available to farmers through user friendly use on-line as well as offline platforms. Promotion of farmer led extension of pulse production technologies could contribute towards better uptake of technologies in the region (Sah *et al*., 2018). Large scale demonstrations on recommended varieties with good agronomic practices on farmers' fields along with extensive capacity enhancement programs need to be undertaken in the region to increase production and productivity of smallholder farmers.

Exploring the new production niches

Bundelkhand region has potential for horizontal expansion of pulses through bringing additional area under urdbean and mungbean in *Kharif* fallows with appropriate varietal interventions. About 1.2 m ha *Kharif* fallow area is available in the region (Anonymous, 2019). Pulses are suitable candidate crops for intensification of cropping sequences. These crops may be promoted as sequential and inter-cropping system as an insurance against climatic aberrations. In addition, popularization of inter-cropping of sorghum/pearl millet/soybean with pigeon pea and promotion of spring mungbean in irrigated areas could be carried out for additional farm returns.

Extra short duration varieties of pulse crops may be developed for Bundelkhand region with extensive root system. This would enable to utilize the limited soil moisture and help in reducing risks and vulnerability in this region. Short duration and drought tolerant *Kharif* pulses like moth bean, urd bean, mungbean and pigeon pea that require less water may be preferred for cultivation, in case of delayed onset of monsoon.

Policy support

Several efforts have been made by Government of India for promotion of pulses in the region. Establishment of seed hubs, cluster front line demonstrations (CFLD) on improved production technologies including newly released varieties, promotion of the critical inputs like bio-fertilizers, bio-pesticides and micro irrigation units were undertaken in pulse component of 'National Food Security Mission'. Besides, Bundelkhand Drought Mitigation Package was implemented for reducing the adverse impacts of drought to the communities in the region.

In this line, attractive minimum support price (MSP) with assured procurement after harvest through procurement centers at village or block level and declaration of support prices at the sowing are needed. Provisions like initiating rolling plans to ensure quality seed supply of newly released varieties along with maintenance of buffer stock of improved varieties at state level would contribute towards improving the seed replacement rates of pulses in the region. Support provisions for fencing of fields for protection of crop against stray cattle /wild animals; support for establishment of processing and value addition units could be supported for encouraging farmers for pulse production. Promotion of processing, value addition of pulses along with innovative institutional models of marketing like, Parag and Amul along with developing organized marketing arrangements for pulses in the region would ensure higher farm income among farmers. Suitable provision may be created for assisting small farm holders in availing the credit facilities and linking them with producer organization. Promotion of organic pulse production in the region may be carried out to cater to the niche market (Fig 2).

CONCLUSION

Bundelkhand region of India represents a fragile agro-ecological production situation. Pulses are important components of cropping sequences practiced in the region. Field pea, lentil, chickpea, urd bean, pigeon pea and mungbean are the major pulses cultivated in the region. These crops are cultivated under climate sensitive rainfed conditions with minimum external inputs. Pulses are cultivated under constrained production conditions that include limited irrigation facilities, low uptake of pulse production technologies, low mechanization level, climatic aberration, crop losses due to stray and wild animals and large fallow. However, the region offers tremendous potential for enhanced area coverage under pulses by way of vertical as well as horizontal expansion. Promotion of improved varieties of crops, efficient use of nutrients, judicious use of water resources and integrated crop management through enhanced awareness among farming communities can help improve the productivity level in the region. Cultivation of disease resistant and short duration varieties for existing production situation and related improved crop production technologies have opened new niches for cultivation of pulses in the Bundelkhand zones of India. Ensuring effective delivery mechanisms for transfer of pulse technologies to pulse growers, establishment of custom hiring facilities at block level for farm machinery, strengthening the bio-fertilizer and bio-control production units and promotion of farmer managed seed hubs need to be stressed on. Appropriate technological interventions like micro- irrigation systems like drip and sprinkler system for irrigation with conservation and judicious use of available agri resource coupled with supportive policy environments can work towards achieving the higher pulse production in the region and thereby bringing the sustainability in the production system. Promotion of processing and value addition of pulses in production zones and development of innovative institutional models of marketing can ensure higher farm income among farmers.

Conflict of interest

All authors declared that there is no conflict of interest.

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