Pulses Production Scenario: Policy and Technological Options

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Introduction

Historically, India is the largest producer, consumer and importer of pulses. Although it is the world's largest pulses producer, there is still a huge shortage of pulses and also, the prices are not affordable to a large section of consumers. An immediate need is the development and dissemination of low-cost technologies in pulses production, so that they can be affordable to the common man. Even though pulses production increased by 3.35% per annum during the last decade, the cost of production and consequent prices are too high to be affordable to the common man; to increase production at lower cost is a bigger challenge. The earlier experience shows that technological efforts need to be supported by the right policy environment to harvest fruits of R&D in agriculture (Reddy 2009). Still, the productivity of pulses in India is low at 694 kg/ha, and to make pulses production internationally competitive, the average yield levels need to be increased to at least 1ton/ha.

Some of the policy suggestions that emerged from the studies at ICRISAT to increase pulses production are (i) Maintain a stable price band, which will give stable profits to farmers for a reasonably longer-period through innovative market interventions for all pulse crops, (ii) Strengthen government programs like National Food Security Mission (NFSM) to reduce yield gaps between farmers and research stations, (iii) Develop low cost innovative seed systems and select farmers' preferred varieties through farmers' participatory varietal selection (FPVS) to replace old varieties, (iv) Focus on abiotic and biotic stress management to increase stability in production through integrated approach, (v) Provide incentives for adoption of low-cost technologies such as application of micronutrients to reduce cost of production and increase yield, (vi) Increase awareness about the utility of wider adoption of farm machinery, herbicides and micro-irrigation facilities to cope with labor and water shortages in rural areas, and (vii) Develop market infrastructure and information systems and enhance credit availability in districts growing pulses. On the R&D front, development of short duration, photo-thermo insensitive varieties for different agro-ecologies, use of biotechnology tools for the development of new varieties with required traits, and development of bio-intensive low-cost integrated pest management (IPM) modules need to be given priority.

Daily item in food basket – poor man's meat

Pulses are good sources of proteins and commonly called the poor man's meat (Reddy 2010). The frequency of pulses consumption is much higher than any other source of protein; about 89 percent consume pulses at least once a week, while only 35.4 percent of persons consume fish or chicken/ meat at least once a week in India (IIPS, ORC Macro, 2007). Further, any reduction in prices of pulses will increase consumption by the poor more than the rich consumers (Mittal 2006). Further, pulses provide healthy proteins compared to other protein rich sources like meat and meat products. Lastly, pulses meet tastes of different sections of society across India. The major chickpea consuming states are Punjab, Haryana, Rajasthan and Madhya Pradesh. The major pigeonpea consuming states are Karnataka,

Maharashtra, Andhra Pradesh and Madhya Pradesh. Some pulses, like chickpea, are used in multiple ways – dal, wholegrain, flour and preparation of snacks – while pigeonpea is used in preparation of dal and sambhar (Reddy 2004; Reddy and Bantilan 2012; Reddy 2013).

Contribution to sustainability and profitability of cropping systems

Pulses are usually cultivated as mixed crops along with crops such as cotton, mustard, or as catch crops between two cereal crops. A comparison of the economics of pulse-based cropping systems with non-pulse-based cropping systems was done by Materne and Reddy (2007). The input utilization (fertilizers, pesticides, labor and water) was less for the pulse-based cropping systems. The benefit-cost ratio was almost the same (1.8) for both the cropping systems. Overall, pulse-based cropping systems are more suitable for resource-poor farmers and water-scarce regions. The pulse-based cropping systems are environmentally sustainable also, as they require lower use of fertilizers, pesticides and irrigation in addition to enhancing the productivity of cropping systems by increasing yield of subsequent crops (Reddy 2004, Reddy 2009a).

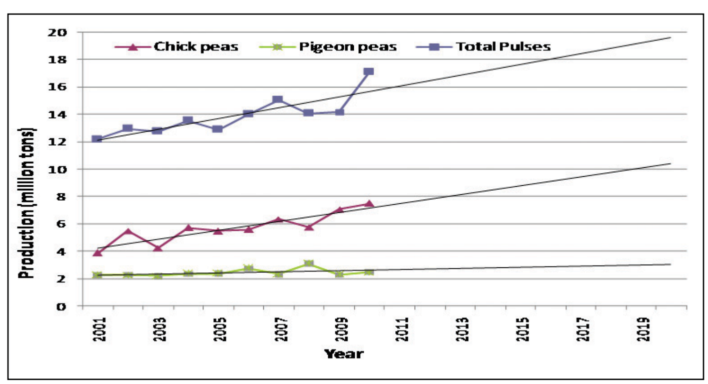
With this background, this policy brief tries to examine the reasons for the success of pulses production in recent years at the all-India level with special reference to chickpea and pigeonpea and suggest policy options to increase production and competitiveness. The study used secondary data collected from FAO and Directorate of Economics and Statistics, Ministry of Agriculture to depict trends in area, production and yield, and prices of pulse crops over a period. The cost of cultivation scheme data was used to examine the relative cost advantage of pulses in different states.

Production trends and geographical distribution

Pulses are grown in an area of 22-23 million hectares with an annual production of 13-18 million tons (MT). India accounts for 33% of the world area and 22% of the world production of pulses. About 90% of the global pigeonpea, 65% of chickpea and 37% of lentil area falls in India, corresponding to 93%, 68% and 32% of the global production, respectively (FAOSTAT 2011). There is a steep increase in the prices of pulses due to supply constraints to meet the growing demand due to population increase. The net availability of pulses has come down from 70.1g/day/person in 1951 to 31 g/day/person in 2008 (Indian Council of Medical Research recommends 65 g/day/capita). More recently, under the National Food Security Mission (NFSM), high priority has been given to increasing the production of pulses across the country to curtail growing imports, reduce protein malnutrition and make pulses affordable to the common man. Pulses are grown across the country with the highest share coming from Madhya Pradesh (24%), Uttar Pradesh (16%), Maharashtra (14%), Andhra Pradesh (10%), Karnataka (7%) and Rajasthan (6%), which together share about 77% of the total pulse production, while the remaining 23% is contributed by Gujarat, Chhattisgarh, Bihar, Orissa and Jharkhand. Among pulses, chickpea (45.1%) occupies the major share, followed by pigeonpea (15.7%), mungbean (9.9%), urdbean (9.6%) and lentil (7.3%), which together account for 87% of the total pulses production. Much of the pulses production has been slowly shifted from *kharif* to *rabi* and now the *rabi* share is increased to about 61.0% of the total pulses production. The research and development investments on each crop should be in proportion to the share of the crop in the respective category. More emphasis should be given to *rabi* pulse crops as their production share is much higher and increasing in recent years.

Evidence of growing mismatch between demand and supply

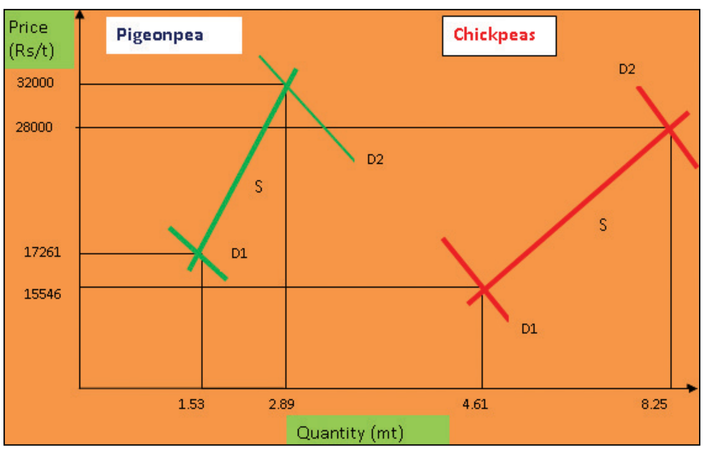
A study by Kumar (1998) projected pulses demand to be 30.9 MT, while Mittal (2006) projected 42.5 MT by 2020 and Indian Institute of Pulses Research (IIPR) in its vision 2030 projected pulses demand to be 32 MT by the year 2030. The projected domestic production from this study is 20.0 MT by 2020 (Graph 1). As per Mittal, the required growth in domestic



Graph 1. Trends in pulses production from 2001 to 2011 and projections for 2020.

production (supply) of pulses is 6.51% per annum, while IIPR estimated the required growth rate in production to be 4.2% per annum (IIPR 2011) to meet the growing demand. All these estimates indicate that, to bridge the gap between demand and supply, pulses production should grow at least between 4-6% per annum. However, the current growth rate is only 3.35% per annum.

To examine the general price trends in pigeonpea and chickpea, Graph 2 presents long run trends of prices of pigeonpea (as exemplar of inelastic supply) and chickpea (as exemplar of elastic supply). The long run price trend of pigeonpea increased faster than that of chickpea, which indicates that the supply of pigeonpeas is not able to meet the increase in demand due to supply side constraints such as biotic, abiotic stress and other socio-economic constraints. The prices of chickpea are less than that of pigeonpea due to technological change in chickpea, which have increased yields and reduced cost of production compared to pigeonpea.



Graph 2. Long run supply and demand trends of pigeonpea and chickpea between 1966 and 2012 (2012 constant prices).

Factors contributing to inelastic supply of pulses

Since 1966, pulse crops have been neglected with the agricultural policy environment favoring the spread of green revolution technology in a few crops such as paddy and wheat for food security reasons in India.

This input-intensive technology further enhanced the already existing yield gap between major cereals and pulses. Due to prolonged neglect for several decades, yield levels of pulse crops are stagnant (only 12.2% increase from 1966 to 2009 as against the 162.6% increase in yield of wheat). The real price steeply increased for pulses (by 85.4% for pigeonpea and 80.1% for chickpea) compared to a decline for wheat (-19.6%), maize (-9.6%) and millets (-2.3%), mainly due to the low supply response of pulse crops.

As a result of the widened gap between yields of pulses and major cereals, the relative profitability and competitiveness of pulse crops reduced even though prices increased due to shortage of supply to meet the rising demand. Another important reason for decreased preference of pulses by farmers is continued higher instability in yields of pulse crops than major cereal crops (Chand 2008). The main reasons for inelastic supply of pulses are (i) scattered and thin distribution of various types of pulse crops cultivated mostly in marginal and low productive lands, with each crop contributing a small share in total pulses area – the biggest hurdle for all stakeholders (researchers/extension/development/credit/market support agencies in both the public and private sectors) to provide input and output services and other institutional support; (ii) indeterminate plant type of many pulse crops with low yield potential; (iii) low response to input management; (iv) shifting of pulses to low-productive and marginal lands; (v) high frequency of crop failure and yield instability due to biotic and abiotic stresses; (vi) low priority by policy makers (Materne and Reddy 2007). 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 technology and low profitability, which need to be tackled. As a result, the area under paddy and wheat was increased in high-productive zones along with high doses of inputs like fertilizer and pesticides, and pulse crops were shifted to marginalized lands with no or little inputs and consequent low supply response even though prices are high. The recent increase in pulses production is attributed to the announcement of higher minimum support price (MSP), emphasis on improved seed production and distribution, the increased area in non-traditional areas for crops like chickpea, and higher market prices.

Short-run policy response

In response to shortage and higher prices, the Government of India reduced import duties on all pulses, banned exports (except *kabuli* chickpea), and enabled imposition of stock limit orders by state governments. The Government has also undertaken publicity campaigns to popularize the consumption of yellow peas, and measures have been taken by Public Sector Undertakings (PSUs) to distribute the same through the Public Distribution System (PDS) @1 kg per family per month at a subsidy of Rs 10 per kg. All these activities are effective in the short run to reduce prices. However, to reduce supply demand gap in the long run, there is a need for greater R&D efforts to reduce cost of production.

Long-run policy response

The low priority for pulses resulted in low investments in R4D and other drivers of production growth. If such policy support and investments were in place, they would have increased pulses productivity more rapidly, making them more affordable to the poor and expanding their environmental benefits (Planning Commission 2008). After experiencing a steep rise in prices and declining per capita availability of pulses, the government has encouraged pulses production through various programs with little success. The National Food Security Mission (NFSM)-Pulses is an ongoing program to increase pulses production in India. It is an integrated effort of the state extension system, National Agricultural Research Systems (NARS) and ICRISAT. NFSM-Pulses covers 16 major pulses producing states and covers about 97.5% of the pulses area in the country. This has resulted in some improvement in the production of major pulses, including chickpea and pigeonpea. It is only since 2001 that the growth rate of pulses production is significantly high due to supply response to rising prices; for example, the growth rate of chickpea is 6.32% per annum and pigeonpea is 2.05% per annum, while that of total pulses is 3.35% per annum, which is much ahead of the population growth but way below the growth in demand of about 4-6% per annum.

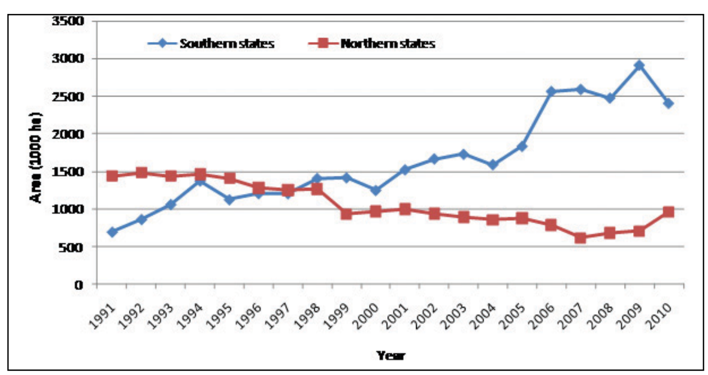
India has also launched the Accelerated Pulses Production Program (A3P) in 2010 as a part of NFSM-Pulses for demonstration of production and protection technologies in village level compact blocks. Assistance is also being provided to the farmers under other crop development programs, such as integrated development of 60,000 villages of Pulses under the Rashtriya Krishi Vikas Yojana (RKVY) program, Macro Management of Agriculture (MMA), Bringing Green Revolution to Eastern India (BGEI) in rain fed areas across the country for increasing crop productivity and strengthening market linkages.

The price of pulses in most years has been more than the MSP for all crops, which indicates that the R4D should focus on reducing cost of production. As a first step, efforts will have to be made to fill up productivity gaps of the existing technologies and their scaling up through proper extension mechanisms through supply of inputs, institutions and proper governance. In some regions, pulses are replacing other dryland crops, which needs to be promoted by providing improved seeds of pulses, availability of specific nutrients such as sulphur and phosphorous and better market linkages (Planning Commission 2008). The MSP needs to be linked to market prices, but there should be a mechanism to provide stable prices to protect farmers from high year-to-year price fluctuations and incentivise farmers to adopt new technology and increase area under pulses.

Adoption of improved varieties of chickpea in South India: A success story

Introduction of the chickpea crop into non-traditional areas such as South Indian states is an example of technological and institutional breakthrough that has the potential to be replicated in other areas and also in other crops. The area under chickpea is shifting from northern states to southern states (Graph-3). During the period 1991-93 to 2006-08, the highest increase in productivity of chickpea has been recorded in Andhra Pradesh (124%), followed by Karnataka (63%), Maharashtra (52%) and Gujarat (40%). There is still scope for productivity enhancement in the states to increase production to meet growing demand at the national level (AICRP on chickpea, 2012).

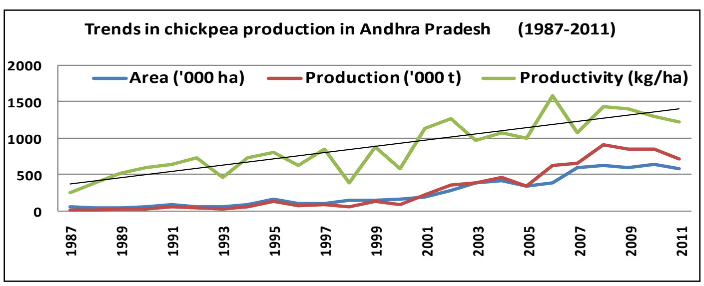
Many institutional and technological factors contributed to the expansion of area into South India. These include introduction of chickpea into black cotton soils, availability of plenty of rabi fallow lands, adoption of short duration and high yielding varieties



Graph 3. Shift in area from northern states to southern states (1991 to 2010).

(KAK-2, a Kabuli type with higher market demand; and short duration and wilt resistant varieties like JG-11), stable yield and prices, and well developed land lease market, which facilitated large scale mechanization. This large scale mechanization facilitated consolidation of operational holdings, contracting out of major labor demanding works such as harvesting and threshing to address the labor shortage, helped in scale economies in procurement of inputs as well as in production and marketing of output. Overall, even though investments increased in chickpea cultivation due to the adoption of technology, it helped in reducing costs of production due to steeper increase in yields and profitability. The wider availability of highly subsidized cold storage warehouses helped farmers to store chickpea during the peak harvest season to overcome lower market prices and to reap profits from higher prices during later periods. Importance of successful government programs like NFSM, subsidized seed distribution and mechanization, encouragement for cold storage structures and higher MSP helped in the chickpea revolution in South India.

In Andhra Pradesh, the yield of chickpea increased from 393 kg/ha to 1375 kg/ha from 1987 to 2011, while the area increased from 52.2 thousand ha to 542 thousand ha, which resulted in a production increase from 19.9 thousand tons to 730.7 thousand tons during the same period (Graph 4). The annual compound growth rate (ACGR) of area is 12.41% and that of yield is 5.80%, which resulted in a whopping 18.21% per annum growth in production from 1987 to 2008.



Graph 4. Trends in chickpea revolution in Andhra Pradesh, future thrust areas.

Technological options

Through integration of conventional breeding approaches with cutting edge technologies such as genomics, molecular marker-assisted breeding, transgenics, it is possible to develop suitable varieties that tolerate biotic and abiotic stress, have high input use efficiency and desired quality traits. Exploitation of heterosis and yield genes from wild relatives

Windows opened for technological breakthrough in pigeonpea

In 2012, ICRISAT scientists mapped the pigeonpea genome sequence; it is a breakthrough that helps in speeding up the development of improved varieties that can provide stable and also higher yields. The genome sequencing will enable the identification of the structure and function of more than 48,000 genes of pigeonpea. There are some unique genes that impart drought tolerance to pigeonpea. These can be exploited to develop high yielding varieties. This would also help cut down on the time taken to breed new varieties, from 10-12 years to just about 5-6 years. To break the yield barrier in pigeonpea, ICRISAT and partners have developed medium maturity hybrids, ICPH 2671 and ICPH 2740, which have produced 30-40% greater grain yields than the popular varieties across farmers' fields in India. However, there is not enough seed production and distribution of these hybrids either by the private or public sector due to the high cost of production and distribution and low ability of farmers to purchase at higher price. Hence, the adoption rate of these hybrids has not picked up.

Production and competitiveness of pigeonpea can be increased through (i) Popularization of an extra early and stable dwarf type suitable for multiple cropping and improved crop management in sequence with wheat under irrigated conditions in the states of Uttar Pradesh (UP), Haryana, Punjab and northern parts of Madhya Pradesh (MP), (ii) Replacement of other dryland crops like cotton in states with less water availability like Gujarat, Karnataka, Andhra Pradesh, Maharashtra and Tamil Nadu, (iii) Popularization of rabi pigeonpea in the states of Orissa, Gujarat, West Bengal, Bihar and eastern UP, (iv) Increasing area through inter-cropping of pigeonpea with soya bean in MP, Maharashtra and Rajasthan; and with cotton, sorghum, pearl millet and groundnut in the states of Andhra Pradesh, Maharashtra, Karnataka, Gujarat, MP and UP, which is expected to get additional coverage under pigeonpea by at least 1 million hectares by the turn of the century and (v) Pest management of pod borer, fusarium wilt and sterility mosaic.

have also been identified as promising avenues for breaking yield plateaus (IIPR 2011). The past breeding efforts have been concentrated on development of varieties suitable for rainfed cropping systems. There is a limit on productivity in rainfed agriculture. The proper management of rainwater to provide pulses with lifesaving irrigation is very important. In addition to developing varieties that are suitable for rainfed cropping, there is a need for developing varieties responsive to high input conditions. This will require substantial restructuring of plant types.

Low adoption of technology

There is a big gap between research station technology and farmers' technology, which has resulted in low yields. Yield gap I, which is the gap between research station and on-farm trial yields, is highest in the South Zone (30%) and lowest (17%) in the Northwest Zone. Yield gap II, which is the gap between on-farm trials and zone average yields, is large in all zones, ranging from 64% in the Northeast Zone to 148% in the Central Zone. Wider yield gap-II is an indication that there is a large gap between on-farm demonstration yield and zone average yield, which can be bridged by wider adoption of existing technology by farmers. The existing technology has the potential of doubling production at national level without increasing area under chickpea if farmers adopt the recommended package of practices (Reddy et al. 2007). A similar yield gap exists in pigeonpea also.

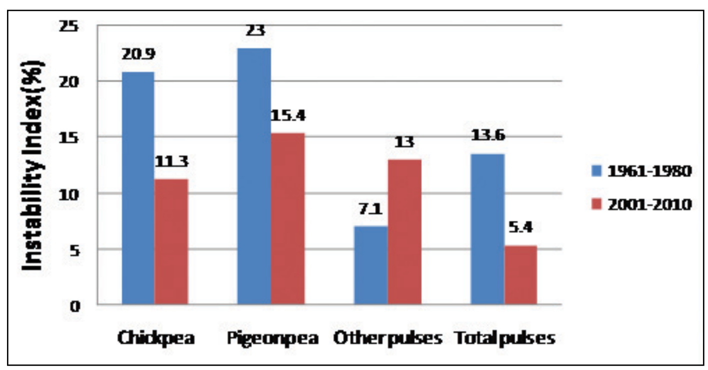
Abiotic and biotic stress management

Pulse crops reported huge losses due to biotic (pests and diseases) and abiotic (drought, high temperature, etc) stresses. Some of the studies estimated the losses in the range from 15% to 20% of normal production (IIPR 2011). This means, India can increase pulses availability by 15% to 20% with investments in appropriate crop protection R&D. As a strategy to cope with this situation, cultivars having combined resistance to most frequent and major biotic and abiotic stress factors need to be developed and adopted by the farmers. The scope for development of multiple resistant varieties has increased after recent advances in genomics and needs to be exploited further. The past success in management of biotic and abiotic stress is encouraging. Instability in yield decreased from 13.6% to 5.5% due to the adoption of biotic and abiotic stress resistant varieties and adoption of plant protection technologies (Graph 5).

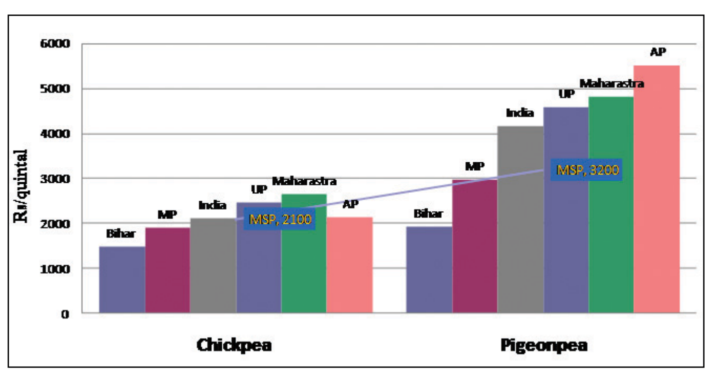
Instability for both chickpea and pigeonpea reduced significantly between1961-1980 and 2001-2010. However, instability in yield is lower in chickpea (11.3%) than pigeonpea (15.4%).

Focus on *kharif* pulses to reduce cost of production

For *kharif* pulse crops (pigeonpea, mungbean and urdbean), cost of production is far higher than for *rabi* pulse crops (chickpea and lentil) (Graph 6) due to cultivation under more uncertain conditions. In the recent years, the share of *kharif* pulses is decreasing in total pulses production. There is a need to focus on *kharif* pulse crops to evolve varieties that sustain uncertain environments. The cost of production is less than the MSP in Bihar and Madhya Pradesh for both chickpea and pigeonpea, which indicates the cost competitiveness of Bihar and Madhya Pradesh in pulses production. In the case of chickpea, cost of production is also less in Andhra Pradesh. This indicates the scope for expanding area under pulses in Bihar, Madhya Pradesh and Andhra Pradesh based on competitiveness and profitability. It is important to increase yield to reduce cost of production; for example, the cost could be reduced by 6% in pigeonpea if its yield levels increase by 10% (CACP 2012).



Graph 5. Reduction in yield instability of pulses in India.



Graph 6. Projected cost of production of chickpea and pigeonpea for the year 2011-12.

Overcoming socio-economic constraints

Awareness and access to new technology: Farmers' awareness on improved varieties and seed availability of improved varieties are the key factors in the spread of improved varieties. The television will be the most popular media for increasing awareness; FPVS trials and farmers' fairs/field days will also be helpful. The identified technology needs to be subsidized for wider adoption.

Semi-formal seed systems: Even though there is a good number of High Yielding Varieties (HYVs) released for all major pulses in India, and there is enough Breeder seed and Foundation seed produced, there is a shortage of Certified/Truthful seed at farmers' level. Both public and private agencies have not been able to meet the requirement of quality seed and the seed replacement ratio is very low. There has been some success in establishing semi-formal seed systems to produce Truthfully Labelled seed, in which linkages were established between the formal and informal seed sectors through supply of basic quality seed by the NARS, and quality of seed production is monitored by universities/non-governmental organizations/farmers' associations. If this system is continued, there will be enough quantity of seed production at the local level. It should also be coupled with FPVS, which gives farmers an opportunity to select from a range of improved varieties (Abate 2012).

Cash and Credit: Cash is a key element for enabling smallholder farmers to shift from low input-low-output to high-input-high-output agriculture. But access to credit by these farmers is low because of their low asset base, low risk bearing ability and high risk environments. This can be effectively tackled by the insurance-linked credit to pulse crops without any collateral security. The scale of finance should be sufficient enough to cover all the costs of the recommended practices (Reddy 2009).

Farm mechanization: One of the reasons for success of expansion of area under chickpea in Andhra Pradesh is the increased mechanization of farm operations. Farm mechanization can further be enhanced by developing varieties suitable for harvesting by combine harvesters. Hence, farm mechanization in peak season activities such as harvesting and threshing needs to be encouraged through the distribution of subsidized farm machinery to cope with labor shortage and higher wage rates.

Supplemental irrigation: With the expansion of irrigation facilities through groundwater and also through canal irrigation systems, there is a scope for expansion of irrigated area under pulse crops, especially summer, rabi and spring season crops, as yield response is higher. Harvesting and management of rainwater through watersheds rather than exploitation of costly groundwater needs to be emphasized.

Marketing: Markets for legumes are thin and fragmented due to scattered production and consumption across states. Farmers sell their marketed surplus immediately after harvest, while some large traders/wholesalers trade between major markets and hoard pulses to take advantage of speculative gains in the off-season. Due to this, farmers do not benefit from the higher market prices of pulses. Investments in market infrastructure, warehouses, market information systems both in public and private sectors through Public-Private Partnership (PPP) models and economic viability gap funding models need to be encouraged in SAT India.

Conclusion

In short, to increase area and production of pulse crops, we need crop specific and region specific approaches. Already ICAR and ICRISAT, with the support of state and central governments, are involved in the development of short duration, photo-thermo insensitive varieties for different agro-ecology, development of hybrids in pigeonpea, development of efficient plant architecture in major pulse crops, development of bio-intensive Integrated Pest Management modules, design of improved machines to cope with labor shortage, production of Breeder seed of the latest released varieties and in organizing frontline demonstrations in farmers' fields. The efforts under NFSM-Pulses and R&D under NARS needs to be further strengthened with the major thrust on (i) Diversifying of rice-wheat cropping systems by incorporating high yielding varieties of pulses in the cropping system, particularly promotion of pulses cultivation in rice-fallows, (ii) Including short-duration varieties of pulses as catch crop through introducing urdbean/mungbean (spring), which will utilize unutilized land and water in the spring/summer season with high returns, (iii) Encouraging

R&D on extra early maturity pigeonpea suited to multiple cropping and improved crop management, (iv) Developing pigeonpea genotype suitable for *rabi*/spring and summer seasons, (v) Developing varieties amenable to mechanical harvesting and tolerant to herbicides, (vi) Developing varieties tolerant to drought and heat stresses, (vii) Developing varieties responsive to high input conditions, (viii) Developing varieties with market-preferred seed traits, for example, large seed size in *kabuli* chickpea, (ix) Using biotechnology tools for developing multiple disease- and pest-resistant varieties to reduce yield loss of standing crop and to increase yields, (x) Coordinating research, extension and farmers through institutional innovations as technology dissemination and input delivery mechanisms are too weak for pulses, (xi) Reducing storage losses and improving market information and infrastructure and (xii) Linking MSP to market prices, with in-build mechanism to protect farmers from wide price fluctuations that will incentivize farmers to adopt new technology.

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