Enabling Pulse Revolution in India through Technology Adoption and Improved Market Access (Micro-level Evidences from Maharashtra)

Report Submitted to

International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India

By

Ronodweep Thakur

International Crops Research Institute for the Semi-Arid Tropics

Patancheru, 502 324, Andhra Pradesh, India, icrisat@cgiar.org

July 2012

DECLARATION

I do hereby declare that the dissertation entitled upon "**Enabling Pulse Revolution in India through Technology Adoption and Improved Market Access (Micro-level Evidences from Maharashtra)**" is an original and independent record of project work undertaken by me under the supervision of **Dr. MCS Bantilan and D. Kumara Charyulu**, at ICRISAT, Patancheru, India, during the period of my study as a part of curriculum of masters in agri-business economics.

HYDERABAD **By**

Date- 12th July 2012 **Ronodweep Thakur**

Title	**:**	**Enabling Pulse Revolution in India through Technology Adoption and Improved Market Access (Micro-level Evidences from Maharashtra)**
Name	**:**	**Ronodweep Thakur**
Institute	**:**	**Gokhale Institute of Politics and Economics, Pune**
Supervisor	**:**	**Dr. MCS Bantilan and Dr. D Kumara Charyulu**
Submitted	**:**	**12th July, 2012**

Abstract

Pulses have been traditionally recognized as an indispensable constituent of Indian diet. A major proportion of the population in India is highly dependent on pulse crops. Although India is the largest producer of pulses in the world, the nation has not been able to achieve self-sufficiency. This has been due to the presence of a number of impediments in terms of raising the pulse production in India, such as yield gaps, abrupt climatic changes, pests and diseases, lack of quality seeds, low adoption rates, etc. But there are ways to boost the production, namely adoption of improved cultivars, integrated pest and disease management, better access to improved seeds, reduction of yield gaps, and many more that have been discussed later in the report. Now, it is a known fact that the improved varieties of pulses have been gaining popularity amongst the farmers in Maharashtra due to their increased production and better yields, thereby favoring the farmers to a great extent. The paper deals with the pros and cons of the commonly used varieties of pigeonpea and chickpea by the farmers of Kanzara and Kinkheda, in Akola district of Maharashtra, as well as the market access in terms of the prices that the farmers receive and the producer's share in consumer's rupee, by undertaking a primary survey. In the process, an attempt has been made thereafter to bring out insights that could possibly enable a pulse revolution in the near future, which is of course, very much required.

Acknowledgement

I am extremely grateful to Dr MCS Bantilan for giving me an opportunity to work at ICRISAT, and for her constant support and encouragement during the course of the study. I am equally grateful to the LSU (Learning Systems Unit), ICRISAT. I am also thankful to Dr. D Kumara Charyulu for his inputs in the study. I wish to place my gratitude to Mr. VK Chopde for his support during the field visit. I extend my special thanks to Mr. Anand Dhumale for providing valuable inputs during the course of the entire study. It gives me pleasure in thanking Dr. Madhusudan Bhattarai for his encouragement and keen interest towards the study. I also wish to extent my gratitude to Dr. A Amarender Reddy and Dr. N Nagaraj for providing necessary inputs. I am greatly indebted to Mr. Surajit Haldar for providing me with requisite information. I am also grateful to Mr. Likhitkar for his support during the field visit. I am extremely grateful to Ajay and Sachin, for accompanying me during the field visit, and for their constant support. In fact, I thank all the scientists at ICRISAT for helping me out in the study. I am indebted to all my friends for their constant support and valuable inputs throughout the course of the study. I would also like to take this opportunity to thank my family for being there with me at all times.

Figures and Tables

Figures **Page nos.**

Tables **Page nos.**

Contents

1. Introduction

Pulses have gone a long way in benefitting the people of this country by ideally supplementing the cereal rich diet of predominantly vegetarian masses by virtue of their being rich in protein and several essential amino-acids. The finesse with which they fit into various cropping systems and cropping mixtures, their unique ability of biological nitrogen fixation which thereby facilitates soil fertility, their potential of yielding something even under adverse conditions and finally the high demand that they face from the consumers' side are precisely the reasons why pulses have become highly popular amongst the Indian farmers, thereby remaining an integral part of sustainable crop production system since time immemorial, especially in the dry areas. They also offer good scope for crop diversification and intensification. India is the largest producer, consumer, importer and processor of pulses in the world. Now unfortunately, although India is the largest producer of pulses, it has not been able to meet the demand of the growing population. Thus, there has been a rising trend in the Indian imports every year in order to bridge the ever-increasing gap between demand and supply. The per capita availability of pulses has also declined sharply in recent years. This shortfall has serious nutritional implications. In fact, it should be noted that India is home to around 40% of the world's malnourished children, and over 53% of children under the age of four are malnourished and under-weight, while 30% children of this group are stunted. About 17% of them have relatively low weight in relation to their height. Apart from that, India holds the largest area under pulses. But ironically, it ranks 118th in the world in terms of total pulse productivity (Sundaram). Therefore, both production and productivity needs to be stepped up to a great extent even though there exists quite a number of constraints in the way, which have been discussed later. The objectives of the study are:

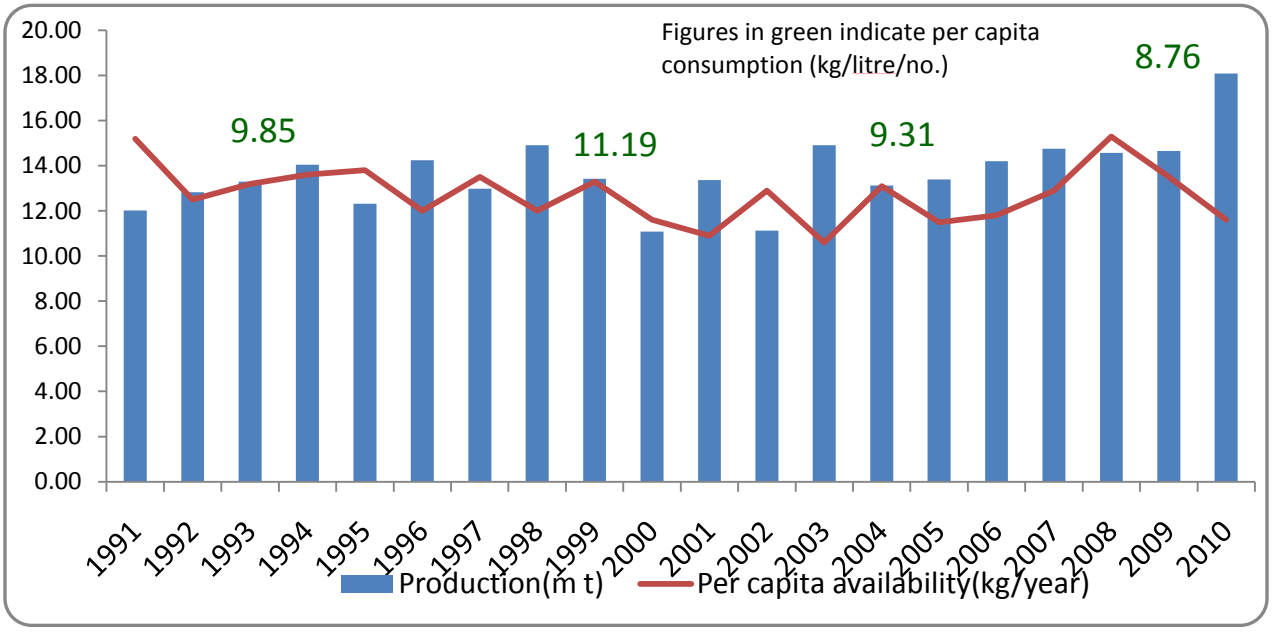
1. To review the scenario of pulse production in India
2. Development of strategy for enabling pulse revolution in India
3. To gain the micro-level evidences in pulse production from Maharashtra VLS villages

2. Scenario of Pulse Production in India

2.1 Total production, per capita availability and per capita consumption of pulses in India

From figure 1, it can be observed that the total production has been more or less rising for the last 20 years, except the years 2000 and 2002 when production fell to 11.08mt and 11.13mt respectively from 13.42mt and 13.37mt in 1999 and 2001 respectively. The per capita availability during this period has been lower than the total production, hovering around 12.5kg/year to 13 kg/year till 2007, before taking a leap to 15.3kg/year in 2008 and thereafter has been on a downward slide, eventually reaching 11.6kg/year in 2010. It should be noted that during the course of this period, the per capita consumption has always remained lower than the per capita availability. In 1993-94, the per capita consumption was 9.85kg/litre/no. while the per capita availability was somewhere around 13.4kg/year. Again in the years 1999-00 and 2004-05, the per capita consumption was lower than the per capita availability, and a similar trend has been seen in 2009-10 as well when the per capita consumption was 8.76kg/year as against the per capita availability which was 11.6kg/year. Therefore, these trends indicate the fact that the benefits of pulse production should be properly communicated to the urban as well as rural population.

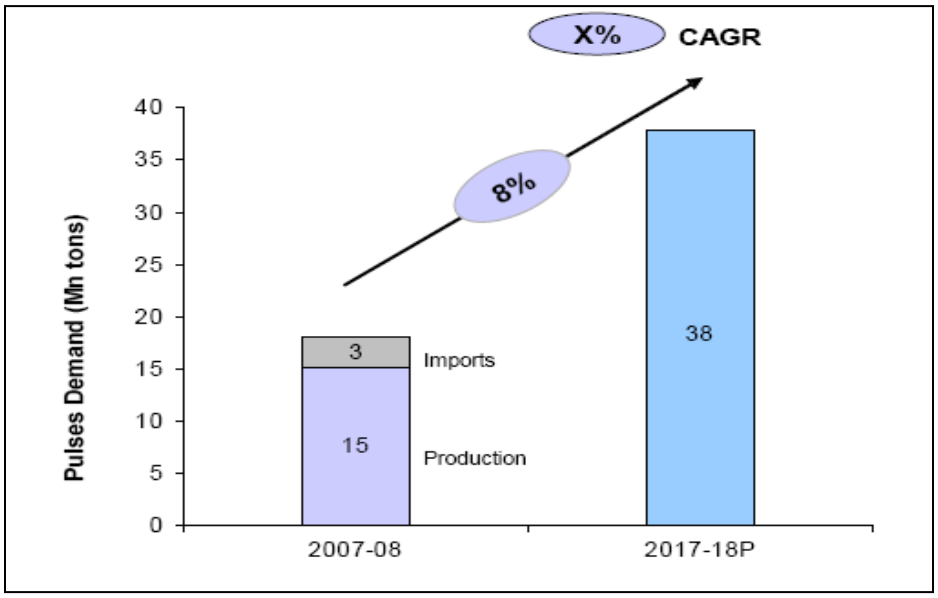
Figure 1: Total production, per capita availability and consumption of pulses in India



Huge demand-supply gap

India has been importing pulses on an increasing basis and these imports currently contribute to about 15-20% of total consumption. In 2007-08, the production of pulses in India was around 15 million tones, but the domestic consumption was in excess of 18 million tones. The additional requirement of nearly 3 million tones was imported. The World Health Organization recommends 80g/capita/day of pulses consumption for India. Based on this recommendation and expected population growth, India will require about 38 million tones of pulses by FY 2018. This is a huge demand-supply gap that needs to be filled. The figure given below shows the projected Indian pulse demand. (Why pulses)

Figure 2: Indian Pulses Projected Demand



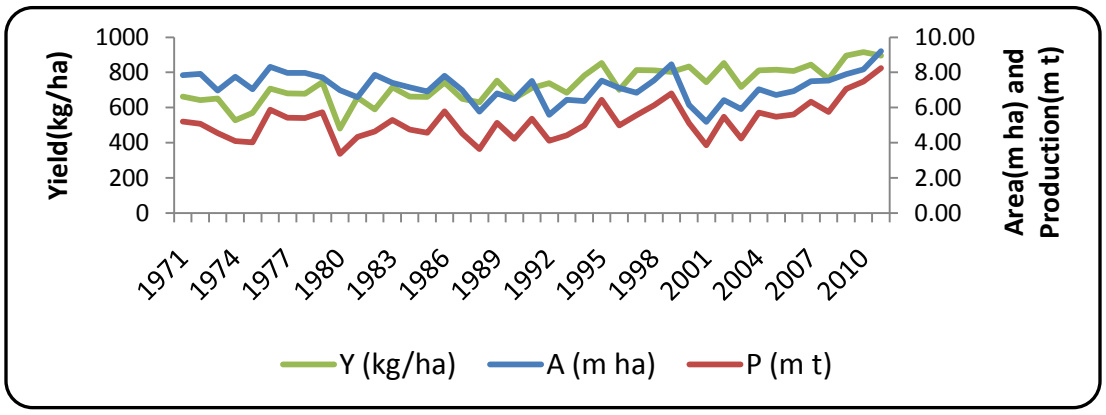
Source: www.growmorepulses.com

Figure 2 shows that the requirement of pulses in the year 2007-08 was about 18 million tones. Now in order to meet the projected demand of 38 million tones in 2017-18, it is necessary to have an 8% compounded annual growth rate. This could bridge the gap between demand and supply.

2.2 Trends observed in the All-India Area, Production and Yield

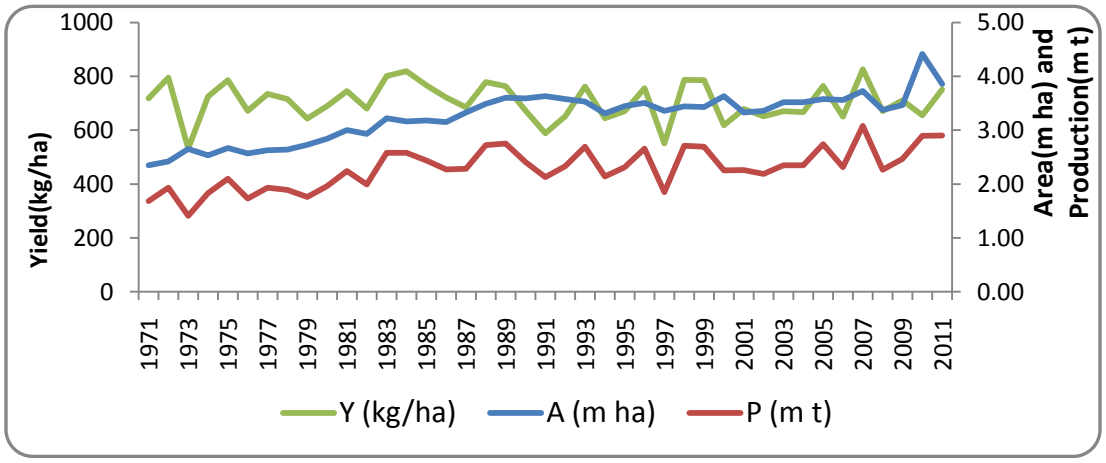
Figure 3 shows the area, production and yield of chickpea post green revolution period. (cooperation) During this period, that is, from 1971 to 2011, there has been an area expansion from 7.84 million hectares to 9.21 million hectares. Production has also risen from 5.20 million tones to 8.25 million tons. In fact, productivity has also shown a decent rise from 663kg/ha to 896kg/ha. In 2000, production had taken a dip due to a decrease in the area, productivity remaining constant. Again in 2007, production started increasing and has been rising thereafter. The reason behind it could possibly be the launch of the National Food Security Mission (NFSM) by the Government of India in that year, which aimed at increasing the pulse production by 2 million tons by 2011-12

Figure 3: All-India Area, Production and Yield of chickpea



Source: agricoop.nic.in

Figure 4: All-India Area, Production and Yield of pigeonpea



Source: agricoop.nic.in

From figure 4, it is observed that the area and production of pigeonpea has been very gradually increasing for the last 40 years, and when compared to that which existed during post green revolution period, both the area and production have only risen to a small extent. (cooperation) Area expanded from 2.35 million hectares to 3.86 million hectares during this period, while production rose from 1.68 million tons to 2.90 million tones. But production since 1971 has not shown any improvement and has mostly remained the same. It only rose to a mere 751kg/ha from 718kg/ha in 1971. For the last two years, production of pigeonpea has remained constant because although yields have been increasing in many parts of the country due to the adoption of improved varieties, yet area has declining due to change in the farmers' cropping systems, mostly preferring pigeonpea as an inter-crop.

2.3 Constraints in achieving Pulse Revolution

Yield Gaps

Yield gap analysis at a given location involves three components of yields, namely, potential, achievable and actual farmers' yields (De Datta 1981). Now, the experimental station yield is the maximum possible rainfed yield (observed rainfed potential yield) of an improved cultivar under the field conditions when the factors other than water availability are not limiting crop growth. On-Farm yield is the achievable yield obtained on-farm under rainfed conditions when the progressive farmers have adopted all the elements of improved technology. Again, yields obtained at the district level represent the average farmers' yields (actual yields). The reasons behind the low genetic yield potential are narrow genetic base, inefficient plant type, erosion of yield genes and the little scope of heterosis breeding, being a self-pollinated crop. The realized yield is also low due to the relegation of pulses from high productivity zone to low productivity zone and because of poor crop management. Apart from that, it is largely grown in rainfed areas (87%).

- ✓ The difference between potential (water-limiting in this case) and achievable yield is termed as yield gap 1 (YG 1). YG 1 is considered to be due factors that are non-transferable and cannot be narrowed (De Datta 1981).
- ✓ The difference between achievable yield and farmers' average yield is termed as yield gap 2 (YG 2). YG 2 mainly occurs due to the differences in the management practices

followed by the traditional farmer, such as use of sub-optimal doses of inputs and cultural practices, as compared to the improved practices followed by the progressive farmer. So YG 2 is manageable and can be narrowed down by deploying more efforts on research, extension services and appropriate government interventions. (VS Bhatia)

Abrupt climatic changes

The predicted changes in temperature and their associated impacts on rainfall and their consequent availability of water to crops and extreme weather events are likely to affect pulse production. High night temperature adversely affects the productivity of winter pulses. The reproductive physiology and grain filling are also adversely affected in most of the pulses due to unpredictable weather conditions and temperature extremities. In case of chickpea, terminal droughts and heat stresses are major constraints, particularly in the semi-arid tropics since it is grown in the post-rainy season on residual soil moisture without irrigation. In fact, the economic loss in pigeonpea production from abiotic constraints is higher than that from biotic constraints (Ryan 1995). Pigeonpea is very sensitive to abrupt fluctuations in temperature. Frequent droughts in the low-rainfall, semi-arid areas, and water logging in the high-rainfall areas cause heavy losses. Terminal droughts often take place due to the lack of moisture during the reproductive phase in case of pigeonpea. Now the most worrying part of the prediction is the estimated increase in the winter and summer temperatures by 3.2 and 2.2 degree celcius respectively, by 2050, which would reduce the total crop-cycle duration (Masood Ali and Sanjeev Gupta). Most of the pulses like murdbean and urdbean are short duration crops (65-75days). It would further reduce their yield per unit area (Gupta).

Complex Disease-Pest syndrome

It is clearly seen that the climate change is altering the distribution, incidence and intensity of pests and diseases. Fusarium wilt is an important disease that causes yield loss in both pigeonpea and chickpea. Sterility mosaic and Phythophthora blight are the other diseases of pigeonpea, while Botrytis grey mould and Ascochyta blight cause substantial losses in chickpea production. The gram pod borer, that is, Helicoverpa armigera, has been a major pest of pigeonpea and chickpea in most parts of the country. The spotted pod borer, that is, Maruca vitrata is now a major threat to short-duration pigenpea both in North and Central

India, causing storage/post-harvest losses. Now the pod fly, that is, Melanogromyza abtusa is emerging as a serious pest of pigeonpea in Central and South India. Thrips have become a major threat to mungbean and urdbean cultivation in India. Viral diseases are also on a rising trend in major pulse crops. So an appropriate Integrated Pest Management (IPM) strategy needs to be developed to manage new insect-pests. Proper forecasting modules can also help predict the incidence of these pests in advance (P Parthasarathy Rao, 2010).

Lack of supply of quality seeds and low seed replacement rate

The production potential of pulse crops is highly dependent on the quality of seeds, which creates a quick impact on the farmers. Farmers have a tendency to retain their own seeds, which are mostly of poor quality, having a mixture of many varieties and other crops too. Storage of these seeds under unfavorable conditions results in pest infection. It leads to poor germination, thereby reducing the yield. Besides, farmers are not much aware of the availability of new varieties and technologies. Considering the poor economic condition of the farmers, it is not possible for them to buy the seeds every year due to their high costs. Sometimes, seeds are not supplied in time, particularly through government agencies, which is very unfortunate for the farmers. Lack of organization of systematic seed multiplication is a major drawback because even though a large number of improved varieties of pulses have been developed, yet they do not reach the farmers. So these varieties remain confined to the research stations. A good quality seed can step up the production to a great extent. Apart from that, seed requirement has not been met mainly due to the poor conversion of breeder seeds into foundation and certified seeds. High market prices during harvesting affect the procurement of seed by seed corporations, as most of the seed agencies depend on the farmers for multiplication of foundation and certified seeds. Sometimes, seed growers sell the produce in local markets if they get better price, which ultimately affects the whole seed chain for the coming years. Presently, the total supply of quality seeds of pulse varieties is around half of the present requirement. (Gupta) Another major concern is the low seed rate. Farmers hardly use any recommended seed rate. In case of mixed cropping, the seed rate is never determined on the basis of the agronomic requirements, but is decided by the traditional practice. In case of pigeonpea, mungbean and urdbean, the plant population reported in the farmers' fields is

very poor. Farmers have been using a seed rate of 10-15 kg/ha as against the requirement of 20-25 kg/ha in case of mungbean, urdbean and pigeonpea (Yadav, 1992).

Flower drop

The rate of flower drop in pulses is high. In fact, flower drop in pigeonpea is more than 80%, thereby reducing yield (Reddy). This flower drop can be checked either by breeding lines which retain a large proportion of flowers producing pods or through physiological manipulations. Studies at ICRISAT involving removal of flowers and young pods of pigeonpea, have shown that plants compensate for the loss of flowers and young pods by setting pods from later formed owners, which otherwise would have dropped. This compensatory mechanism helps them to adapt to intermittent adverse conditions, which are common in warm rainfed areas of South India. The recent rise in pigeonpea yields is due to the release of long-duration varieties, which maximize utilization of assimilates in filling the available sink of a large number of flowers (Rego and Wani 2002).

Heterosis breeding in pulses

The quantum of yield advances made through breeding in pulses is much lower than that of cereals. This is mainly due to the lack of commercial exploitation of hybrid vigor in pulses due to lack of mass pollen transfer mechanism and non-availability of effective male-sterility system. The hybrid vigor for yield has not been exploited in all the pulse crops, except pigeonpea (ICPH-8). However, the adoption of these hybrids is limited due to seed production constraints posed by genetic nature of male sterility (Saxena et al 2000) even though ICPH-8 seemed more promising. It was released for cultivation in the central zone of India in 1981. Evaluation from 100 trials showed ICPH-8 to be superior to controls in productivity. Genetic improvement can be further enhanced in pulses through biotechnology. Mutation breeding has contributed about 10% of the total improved varieties of pulses and is facilitating the conventional breeding programme. There is good scope for development of ideal plant type, especially chickpea and pigeonpea. Special efforts are already being made in this regard by various organizations, national and international, with respect to chickpea (Reddy).

Provision for Irrigation

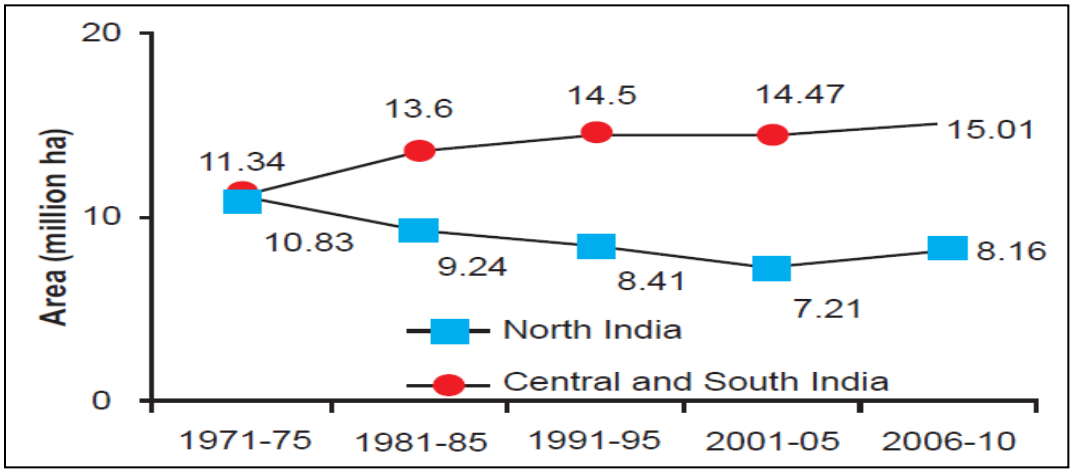
Irrigation is an important input in all the cropping systems. Pulses are generally cultivated as rainfed crops due to less irrigation response than competing crops like cereals. More than 87% of the area under pulses is presently rainfed. Pulse crops often fail due to moisture-stress, thereby sometimes resulting in low yields. Productivity can be increased to a great extent by the application of life-saving irrigation, especially in rabi pulses grown on residual moisture. Rain water harvesting is necessary in order to stabilize the yields and raise the productivity. This can be achieved by the creation of farm ponds and community reservoirs in every village of the pulse growing districts of the country. Provision of micro-irrigation through sprinklers or drips is also required at the Panchayat level (Gupta).

Other challenges in enabling pulse revolution

Geographical shift in Area

The Indo-Gangetic plains (IGP) of Northern India were once considered to be the pulse zone of India. But since 1971, the pulses area has shown a declining trend and has been quite heavily replaced by wheat, rice and maize due to better irrigation facilities. In the post green-revolution period, the area under pulses in the northern plains went below half compared to the area that existed under pulses about four decades ago. On the other hand, the area in South and Central India has been showing an upward trend on a continuous basis and has now almost doubled as shown in fig. 5.

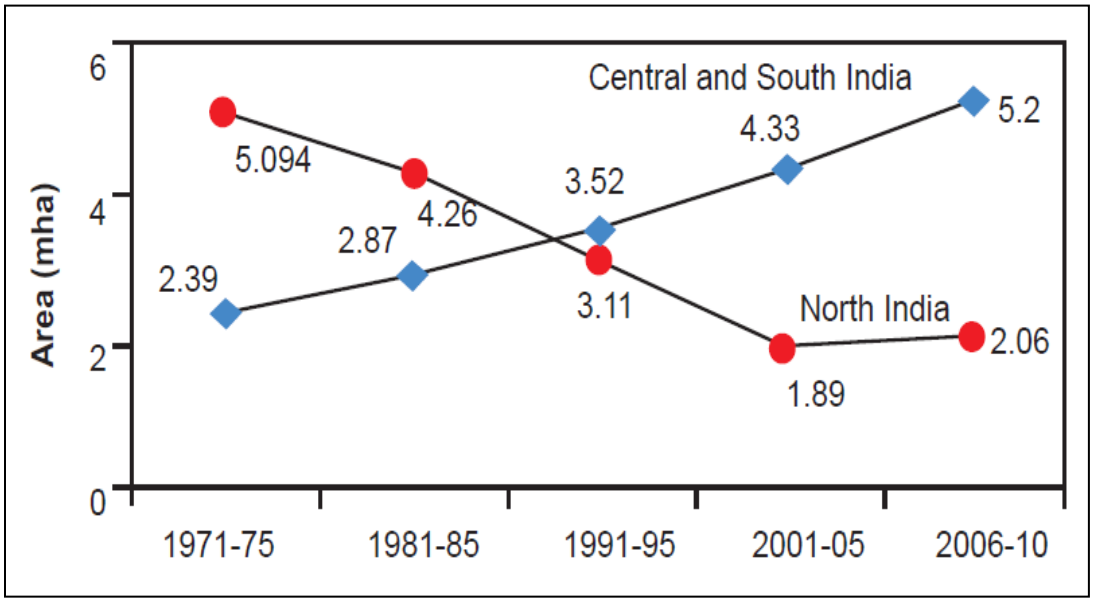
Figure 5: Geographical shift in total pulses area



Source: www.iipr.res.in (Vision 2030)

This scenario has definitely been more conspicuous in the case of chickpea. In fact, Andhra Pradesh leads in the total pulse productivity, especially in the case of chickpea and pigeonpea. The short-duration varieties developed through ICRISAT along with the NARS partnership have played a key role in expanding area and productivity of chickpea in South and Central India. Besides, in case of chickpea, the largest decline area took place in the Indo-Gangetic plains, mainly because of its declining competitiveness with respect to competing crops like wheat and rapeseed-mustard. The reasons behind this declining competitiveness were less profit, higher risk and lack of improved technologies. Apart from that, the high input technique of cultivation associated with modern wheat varieties was not compatible with the traditional mixed or sequential cropping of chickpea. Area of pigeonpea and lentil also showed a considerable rise in South India. Currently, in North India, rice-wheat crop rotation is predominant and there is not much scope for replacing wheat with rabi pulse crops, while in South India, there is huge potential for sowing rabi pulses by utilizing the vast rice fallows due to the absence of strong competitive crops in the rabi season. (research) Figure 6 shows the geographical shift in chickpea area:

Figure 6: Geographical shift in Chickpea area



Source: www.iipr.res.in (Vision 2030)

Deteriorating soil health

A major proportion of cultivated areas have started showing a decline in production along with soil health deterioration. A decrease in the total factor productivity combined with a fall in the organic matter content in soil and emergence of multi-nutrient deficiencies such as sulphur and zinc which help increase pulse production, have all contributed to the declining yields in recent times. It is a known fact that the yield of pulse crops can be stepped up by the use of proper rhizobium culture. But then, only about 40% of the pulse-growing nations have low-to-medium population of native rhizobium. In order to achieve sustained pulse production, soil health with diversification is necessary. Besides, balanced fertilization and use of bio-fertilizers are also required. (Gupta)

Socio-economic constraints

Pulses production in India is characterized by a high degree of diversity in terms of the number of crops and their spatial distribution into various agro-climatic conditions. Most of the crops are region-specific, and this diversity has several implications. First, it places serious restrictions on a single national policy to promote pulses production in the country, and to promote regional crop-specific strategies. But considering the socio-economic constraints, this diversified path could spread the resources too thinly, thereby making the efforts not worth it. This is partly the reason why there has been no major thrust on pulses research, which is again partly the reason behind their stagnation. (Reddy)Pulse production in India is dominated by chickpea and pigeonpea, which together account for more than one-half of the total pulse area in India. So if these two crops suffer from adverse climatic conditions, it reduces the total pulse production of the nation to a great extent. This fact is well supported by the geographical shift in area of pulses from the northern plains during the post-green revolution phase.

Poor marketing opportunities

Markets for pulses are thin and fragmented due to scattered production and consumption across states. Farmers usually sell their marketed surplus immediately after harvest, while some trade in the off-season in view of taking advantage of the speculative gains. This is why farmers do not benefit from the higher market of pulses. Apart from that, in case of certain pulses, the demand is region-specific and the markets are underdeveloped. Proper care needs to be taken in this regard.

Increasing population

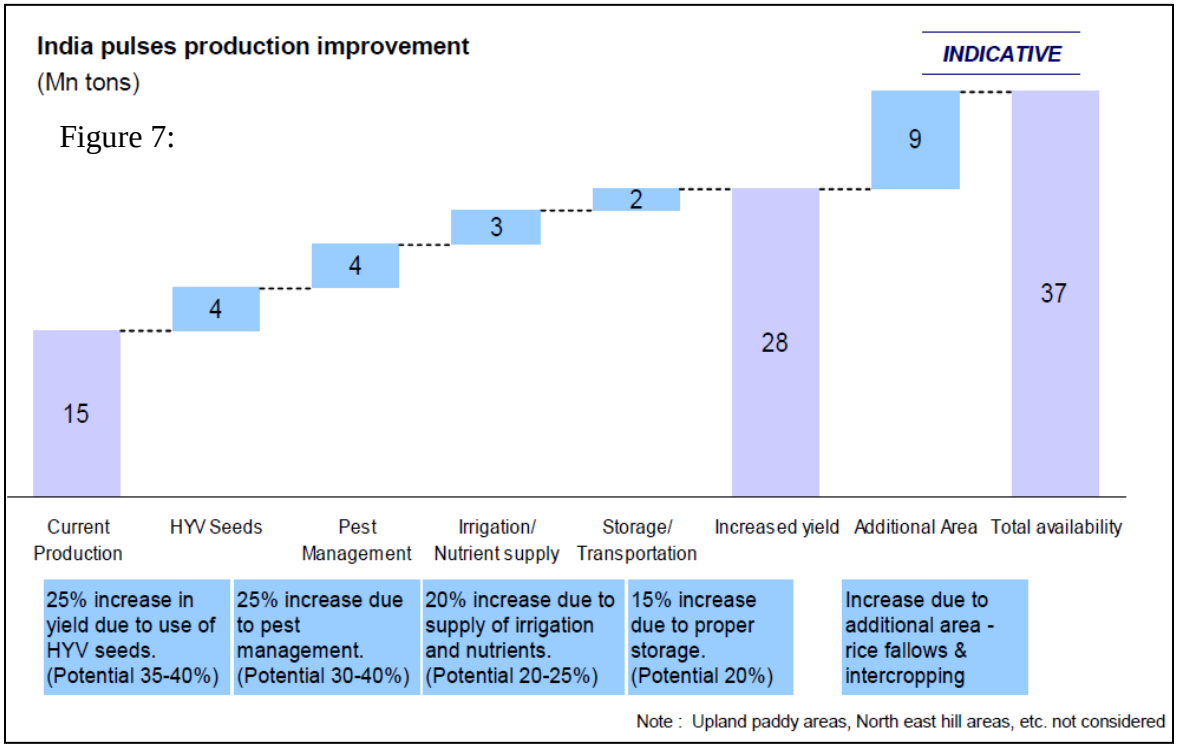
Although production of pulses has been following an upward trend, the rate of growth in population has always been higher than the rate of growth in pulse production. Consequently, the projected demand has been rising at a fast pace, which has made it increasingly difficult to bridge the demand-supply gap. Therefore, India has been importing pulses in increasing quantities in order to make ends meet. The ever-increasing population has been a serious issue for a long time and needs to be dealt with.

3. Development of strategy for enabling pulse revolution in India

3.1 Potential to improve Pulse Production in India

India has the potential to increase both production and yield by the adoption of some of the best practices across the world, as shown by the following diagram (Why pulses):

Figure 7:



Source: www.growmorepulses.com

From figure 7, it can be seen that there is a possibility of 25% increase in yield by the adoption of high-yielding variety of seeds, the potential being a significant 35-40% increase in yield. This could help increase the production by 4 million tons. The yield can be further increased by 25% by the development of an appropriate integrated pest management, which could again raise the production by 4 million tons. Another 20% improvement is possible by the provision of life-saving irrigation and proper use of nutrients such as sulphur and zinc, which could result in a production rise of 3 million tons. A further 15% rise in yield can be achieved through proper storage facilities since a significant proportion of post-harvest losses arise out of improper storage. This would again facilitate a production rise of 2 million tons, thereby helping the production reach 28 million tons from a mere 15 million tons. Apart from that, if additional area is brought under pulses by way of adoption of various cropping systems including pulses, then it would increase the production by another 9 million tons. This is how pulse production can be given a boost from 15 to 37 million tons. This would help attain self-sufficiency in pulses, thereby enabling a pulse revolution.

3.2 Possible avenues for increasing pulse production

Improved varieties/hybrids/transgenic

Although efforts in the past have been successful in terms of protection of pulse varieties against major diseases, reducing crop duration and improving the grain quality, yet yields have not been rewarding enough. In order to achieve a significant rise in yield, it is very necessary to broaden the genetic base by strengthening pre-breeding and developing core sets of germplasm. It is also required to make use of hybrid vigor through development of cytoplasmic male sterility (CMS) based hybrids in pigeonpea. Mapping and tagging of genes and marker-assisted selection for resistance to pests and diseases is vital too. Besides, gene pyramiding for stable resistance and the development of transgenic in chickpea and pigeonpea is very essential. Genomic research should also be carried out to study the structure and function of genes. High-yielding and input-responsive genes are yet to be searched and transgressed in common varieties. (Gupta)

Integrated Pest and Disease management

Protection of pulse crops against biotic stresses is highly essential. Fusarium wilt and many other diseases cause substantial loss in pulses. An integrated approach of wilt management is required

due to the non-availability of wilt-resistant seeds and existence of pathogenic variability. Helicoverpa armigera is a major pest that has been causing heavy losses in both pigeonpea and chickpea. So an integrated pest management is very critical in order to prevent the attack from various pests. Adoption of improved varieties, use of healthy seeds, modification of cultural practices and judicious use of fungicides can help stabilize yields. So the IPM modules need to be refined and modified according to the needs.

Better access to Improved seeds

It is very important for the farmers to get access to improved seeds. There should be an aim to double the national seed production while making seed readily available to the farmers by a decentralized approach. (Gupta) Advance and proper seed planning is required for each state, rolling out seed plans with emphasis to the newly released varieties. Seed buffer of improved cultivar should be maintained at the State Seed Corporation level. Promotion of public-private partnership is also necessary in seed business. Besides, farmers' participatory seed production needs to be encouraged for farmer-to-farmer seed spread. These measures would help increase the seed replacement rate. It is to be noted that, under NFSM, breeder and foundation seed production has been entrusted to Indian Institute of Pulses Research (IIPR), Kanpur, while production of certified seeds has been entrusted to National Seed Corporation and other state organizations for timely supply to farmers at affordable prices. (Reddy)

Reduction of Yield gaps

Yield gaps can be bridged by bringing additional area under pulses, and increasing their productivity. Now, pulses have a tremendous scope for area expansion. About 2.5 million hectares additional area can be brought under pulses through cropping system manipulation. This can be done by diversification of rice-wheat system in IGP through the popularization of short duration pigeonpea, kabuli chickpea, fieldpea and summer mungbean. The rice fallows can also be utilized through mungbean/urdbean, and the development and popularization of mungbean/urdbean can also help increase the area. Besides, intercropping of pulses like mungbean/urdbean with spring sugarcane and pre-rabi, chickpea with mustard/linseed, pigeonpea with groundnut/soyabean/millets, short-duration thermo-insensitive varieties can also help the cause to a great extent. There are also a numbers of ways to improve the productivity of

pulses. Some of them are the exploitation and utilization of gene pool from unexplored areas, development of new and efficient plant type, exploitation of hybrid vigor in pigeonpea, popularization of improved crop management practices, and development of high yield short-duration varieties that are disease resistant. (research)

Improved Mechanization for harvesting, threshing, processing and transportation

Currently, post-harvest processing of pulses is mainly handled by the private sector. Installation of efficient processing units in villages on subsidized rates would decrease the cost of processing and hence ensure their ready availability at cheaper rates. Distribution of seed-storage bins to the farmers at subsidized rates and mass awareness campaign for the adoption of scientific methods of storage of pulses at the village level could reduce losses from stored grain pests in pulses. (Gupta)

Minimizing Post-Harvest losses

Post-harvest losses in pulses during harvest, transport, threshing and storage are estimated to be 15-20%, out of storage losses alone account for 7.5%. Mass awareness programs to educate farmers about scientific storage and distribution of seed-storage bins reduce spoilage of grains to a considerable extent and ensure better quality grains. In fact, installation of efficient and modern dal mills is expected to increase dal recovery by 8-10%. Propagation of IIPR mini-dal mills through the formation of pulses producer and processor associations is one of the components of NFSM, which would not only decrease post-harvest losses, but also increase rural employment. (Gupta)

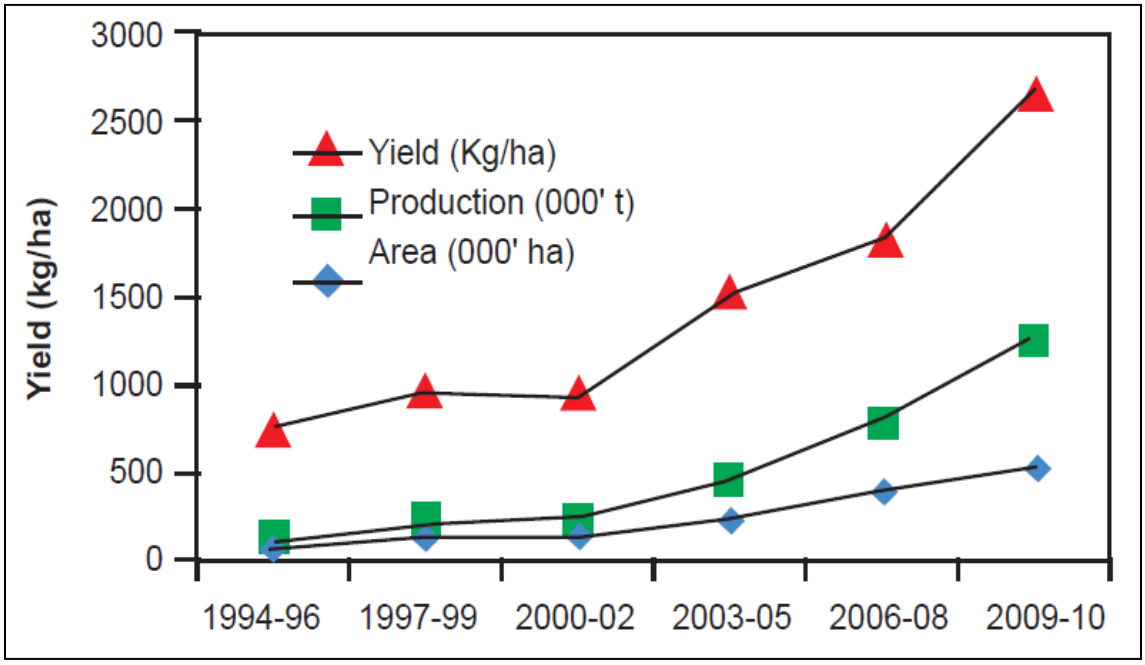
Public-Private partnership

The involvement of civilized societies and private entrepreneurs in promoting pulse production is very crucial in terms of transfer of technology, quality seed production, processing and value addition, and supply of critical inputs such as bio-fertilizers, bio-pesticides, sulphur, zinc, etc. Apart from that, provisions should be made for easy credit, insurance, attractive minimum support price (MSP) with procurement, and appropriate incentives.

Chickpea Success in Andhra Pradesh

Andhra Pradesh had not been the traditional chickpea growing area of the country till 1993. However, there has been a massive rise in area, production and productivity of chickpea in the state. The area has increased from 71000 hectares in 1991-93 to 619000 hectares in 2007-09, and productivity from 621kg/ha to 1264kg/ha. So the production increased more than eight times, while productivity got more than doubled. This was possible due to the development of appropriate varieties with shorter duration, availability of quality seeds of improved cultivars, government efforts in creating necessary infrastructure for cultivation and effective transfer of technologies. Presently, chickpea is regarded as a remunerative crop of Andhra Pradesh. These measures should be undertaken for other pulse crops too in different parts of the country. (Gupta)

Fig 8: Area, production and yield of chickpea in Andhra Pradesh



Source: www.iipr.res.in (Vision 2030)

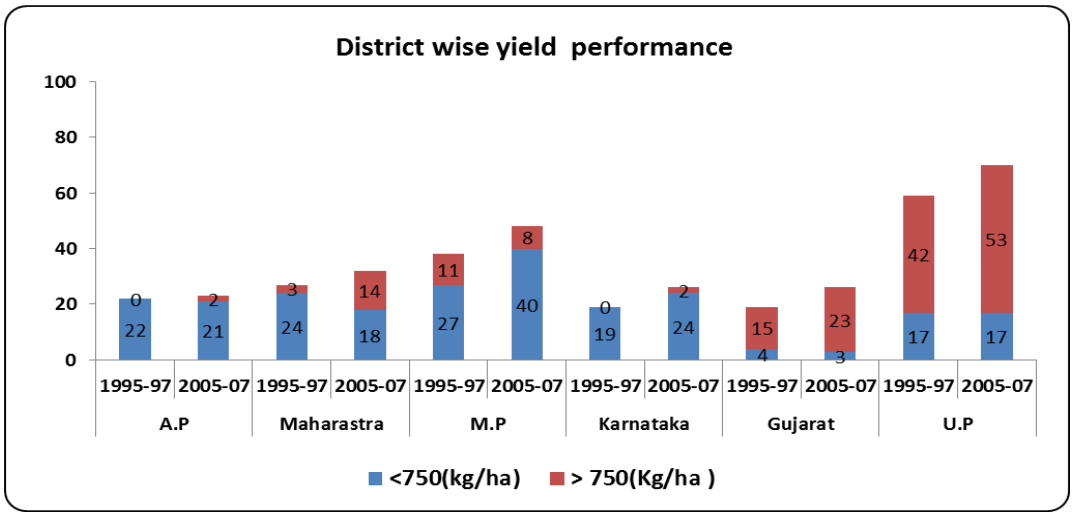
Reasons behind Pigeonpea not being as successful as Chickpea

- ✓ Highly sensitivity to heat, salinity, frost and water logging conditions
- ✓ It is mostly grown as an inter-crop
- ✓ Farmers prefer short-duration varieties since they fit well in almost all the existing cropping systems (proportion of area under long duration gone down except in Bihar, UP and MP)
- ✓ CMS – failed due to low stability of male sterile line
- ✓ GMS – succeeded but not commercial scale is lagging due to seed production problems
- ✓ Genetic purity of varieties is low (often cross pollinated)
- ✓ Vectors (honey bees) are needed for pollen transfer and good seed set

Potential of Hybrid Pigeonpea

A hybrid pigeonpea has the ability to produce higher yields than the commonly used varieties if proper package of practices is followed. It is characterized by increased plant vigor and reduced seed rates. It has greater drought tolerance, disease resistance and adaptability. Speedy growth rate, greater root and shoot biomass, and higher resilience to salinity are amongst the other features of hybrid pigeonpea. Hence, it is not much affected by climatic changes. In fact, under changed climatic conditions, a healthy hybrid crop will not only provide nutritive food and fodder, but also improve soil fertility and structure. (ICRISAT)

3.3 Yield gaps in Pigeonpea Production across different states in India



Source: TRIVSA Pigeonpea Report, 2012

Figure 9: Yield gaps in pigeonpea across states

Figure 9 shows the yield gaps across different states, namely Andhra Pradesh, Maharashtra, Madhya Pradesh, Karnataka, Gujarat and Uttar Pradesh from the years 1995-97 to 2005-07. The bars in blue show the number of districts in a particular state whose yield is below 750kg/ha, while those in red indicate the number of districts in a state whose yield is above 750kg/ha. In case of Maharashtra, it can be seen from the above figure that in 1995-97, there were 24 districts whose productivity were less than 750kg/ha, while there existed only 3 districts with a productivity higher than 750kg/ha. But in 2005-07, the numbers of districts showing a yield of more than 750kg/ha rose to 14, while that less than 750kg/ha came down to 18. So it can be stated that the yield gap in the state of Maharashtra decreased by a considerable extent. Again in the case of Madhya Pradesh, 27 districts had a productivity less than 750kg/ha as against 11 districts having a productivity more than 750kg/ha in 1995-97. In about a decade's time, a change was observed. The number of districts with productivity less than 750kg/ha went up to 40, whereas that above 750kg/ha came down to 8 in 2005-07. This indicates the fact that the yield gap increased in MP. Thus, the above figure illustrates the fact that the yield gap reduced in Maharashtra, Gujarat and Uttar Pradesh, while it increased in the case of Madhya Pradesh. In Andhra Pradesh and Karnataka, the yield gaps did not show much change. In fact, the gaps mostly increased.

3.4 Literature Review

- Carrying capacity of Indian agriculture : Pulse crops (Masood Ali and Sanjeev Gupta) – This article facilitated in a remarkable way in terms of getting a clear picture of the constraints in increasing pulse production and the technology drivers that could ensure self-sufficiency. It also showed a glimpse of the chickpea revolution in Andhra Pradesh
- Vision 2030, Indian Institute of Pulses Research – This article supported in a long way in terms of better understanding of the issues that pulse production faces, and the measures that can be taken in order to accomplish the vision of enabling a pulse revolution.
- Chickpea and Pigeonpea Economies in Asia, ICRISAT – This book provided all the facts and trends in terms of pulse production and productivity, along with the existing markets. It gave a clear idea about the present situation of pulses in India.
- Yield Gap Analysis of Soybean, Groundnut, Pigeonpea and Chickpea in India using Simulation modeling, VS Bhatia, Piara Singh, SP Wani, AVR Kesava Rao, K Srinavas –

This article helped in a long way in terms of understanding the different kinds of yield gaps.

- Pulses Production Technology : Status and Way Forward, A Amarender Reddy – This article provided valuable insights regarding a number of obstacles in the way of pulse production such as physiological constraints and exploitation of heterosis breeding.
- Pulse crops, DS Yadav – This book also helped in terms of understanding the potentialities in the pulse production in India.

Besides these articles, there were many others too that facilitated in a long way in terms of carrying out the study and formulating a proper set of objectives, that has been mentioned later.

4. Micro-Level evidences in Pulse Production from Maharashtra

4.1 An introduction to the micro-level study

A field survey was carried out in order to know both the advantages and disadvantages of using improved varieties of pigeonpea and chickpea, along with the aim of studying the consumption pattern of pulses over a period of time, and the market access of the farmers in the villages of Maharashtra. Information of 57 samples was collected from the villages of Kanzara and Kinkheda, Murtizapur taluka, in the district of Akola. All the farmers in the sample grew pigeonpea, while there were only 10 farmers growing chickpea out of the 57 samples taken. In case of pigeonpea, all the 28 farmers from Kanzara grew it, and all the 29 farmers from Kinkheda also cultivated it. But in case of chickpea, only 9 farmers from Kanzara grew it, while there was only a single farmer found in Kinkheda who had taken to chickpea cultivation. Thus, it was observed that there were 9 farmers in Kanzara grew both pigeonpea and chickpea, as against only one farmer in Kinkheda who cultivated both the crops. So apart from pigeonpea that was cultivated by all the farmers in the sample of 57, the other major crops grown in Kanzara and Kinkheda were soyabean, cotton and wheat, followed by chickpea, mungbean and sorghum, the others being grown in very small quantities were urdbean, cowpea and papaya.

4.2 Objectives of micro-level study

- Finding out the effectiveness of the improved varieties of chickpea and pigeon pea, and the extent to which new and improved technologies have benefitted the farmers in the VLS villages of Kanzara and Kinkheda.
- Finding out the drawbacks in the existing improved varieties and bringing out insights to enable pulse revolution
- To study the market access of the farmers
- To know the consumption pattern of pulses over a period of time

4.3 Methodology

- Collect the secondary information and analyze trends of chickpea and pigeonpea
- Collection of primary data from VLS villages regarding the perceived benefits in improved cultivars over local varieties as well as the drawbacks in the existing variety
- Analyze the primary data and suggest ways in order to improve the situation of the pulse growing farmers that would help bringing a pulse revolution

4.4 Basic Characters of the Sample

Table 1: Basic characters of the sample

	Kanzara	Kinkheda	Overall
Avg. land holding (acres)	9.875	8.687	9.272
Area under irrigation (acres)	3.393	4.672	4.044
Area under rainfed (acres)	6.482	4.017	5.228
Area under pulses (acres)	3.257	2.109	2.673
Avg yield of pigeonpea (kg/acre)	412.798	239.016	325.907
Avg yield of chickpea (kg/acre)	987.778	541.176	489.118

Commonly used varieties in Pigeonpea and Chickpea

The initial part of the study started with getting acquainted with the kind of varieties that the farmers generally use in the villages of Kanzara and Kinkheda. It was interesting to note that in case of pigeonpea, almost all the farmers in the two villages, that is, around 95% farmers out of

the sample used Maruti variety. Very few, that is, about 2 or 3 of them, used varieties like Nirmal-2, Asha and Nisha. In case of chickpea, the commonly used varieties were JAKI-9218 that accounted for around 60% out of the sample of 10, and Vijay comprised the rest.

Major sources of seed/new knowledge about pigeonpea/chickpea

The farmers in Kanzara and Kinkheda are aware to a certain extent about the kind of seeds available in the market, new technologies available, and the various cultivation practices involving pulses, especially pigeonpea and chickpea. The major source of knowledge in this regard comes from research centers, mainly ICRISAT. In fact, about 60% farmers out of the sample replied that their knowledge is enhanced by research centers. Various extension agents from a number of institutions also work in terms of providing knowledge about new seeds that help the farmers in going a long way. Apart from that, fellow farmers and neighbors also guide them in this regard in both pigeonpea and chickpea. Around 40 farmers stated that they receive information about improved varieties from fellow farmers and their neighbors. Around 25% replied that media and newspapers also facilitate to a small extent. Besides, private shops also contribute in the dissemination of information about pigeonpea and chickpea.

4.5 Adoption of improved varieties

When asked whether the farmers at Kanzara and Kinkheda have adopted improved varieties, all the farmers replied that they did use improved cultivars in case of both pigeonpea and chickpea. But this fact may not be fully true, the reason being many farmers in these villages do not buy seeds every year due to their high costs. So they retain their own seeds, whose quality drops due to a number of factors, improper storage being one of them. Thus, these seeds cannot be termed as improved ones. Nonetheless, it was seen that 94.74% out the sample of 57 were satisfied with the adoption of improved varieties, the rest stating that they were not satisfied due to a number of reasons that would be discussed later. This actually shows that improved varieties did make a big difference in these two villages, and facilitated the farmers in a number of ways.

4.6 Reasons behind the shift towards improved varieties

There a number of reasons why the farmers in the two villages have adopted the improved variety of Maruti in case of pigeonea and JAKI-9218 in chickpea, the first and foremost being high production. These improved varieties generate higher production on an average than any other variety like Nirmal-2, Asha and Nisha, which are pigeonpea varieties, or Vijay, a chickpea variety. In case of the pigeonpea variety, the average production of the sample came out to be 808.93 kg per farmer in Kanzara and 329.77 kg per farmer in Kinkheda, which is decent enough, although it shows that the pigeonpea farmers in Kanzara are better-off than those in Kinkheda. Again, when the chickpea variety was considered, the average production was 1055.56 kg per farmer in Kanzara and 4600 kg per farmer in Kinkheda. It is to be noted that this production of 4600 kg per farmer came from the lone chickpea farmer in Kinkheda, and so the figure might not be very conclusive. Nevertheless, the average production is quite high for both pigeonpea and chickpea in the two villages. In fact, the most important criterion for a farmer in the village to grow a certain variety is high production, since each and every farmer in the sample stated high production amongst others as the reason behind their shift to improved cultivars. The second factor why farmers prefer improve varieties is land suitability. Now pigeonpea is sensitive to abnormal changes in temperature and the consequent rainfall. But the variety that they use in pigeonpea, that is, Maruti, adjusts to uneven rainfall, thereby becoming highly suitable for the land that is prevalent in those villages. JAKI-9218 also shows land suitability, which is the second most important reason cited by the farmers. Around 33% out of the total sample pointed out the decent price that these varieties offer as the third factor behind the shift, although most of them feel that the prices are not remunerative. Another reason why the farmers prefer these improved cultivars is that the market demand for these varieties are quite good, which is probably because of their high quality and good taste.

Perceived benefits in improved cultivars of pigeonpea over local varieties

Almost all the farmers in the sample cited better quality and taste as the primary benefit that receive by using the improved variety of pigeonpea. It can be said that all the households in the villages depend on the consumption of pulses to a huge extent. Naturally, good quality dal along with great taste becomes a major factor why farmers prefer the improved cultivars over the local varieties that are available in the market. As long as the farmers' consumption needs are fully

met by a certain variety, it is obvious that the farmer would be satisfied with its adoption to a great extent. Fusarium wilt is a major disease that causes heavy losses in case of both pigeonpea and chickpea. Sterility mosaic and Phythopphthora blight are other important diseases of pigeonpea. The Maruti variety that the farmers use is wilt resistant and as such goes a long way in benefiting the farmers in terms of being disease resistant. Almost 50% of the farmers pointed out the variety to be disease resistant. In fact, close to 50% also stated that the Maruti variety that they use grows well on light and medium soils, thereby making the crop very soil-friendly. Drought resistance was another benefit that the farmers perceived in the improved cultivar. So the crop did not dry up very easily when the temperature rose to a great extent. About 25% farmers cited this beneficial property, amongst the many other advantages. Apart from that, pest resistance was another benefit observed in the variety. Pests such as Helicoverpa armigera and Maruca Vitrata greatly affect the production, and this particular variety of Maruti helped prevent the pest attack, as agreed by 22% farmers out of the sample of 57. The other perceived benefits observed were shorter duration than the local varieties, low mortality and animal feed.

Perceived benefits in improved cultivars of chickpea over local varieties

As observed earlier in case of pigeonpea, every chickpea farmer in the sample stated that better quality and taste is the prime reason why they use the improved variety, that is, Jaki-9218, since that is mainly what they are concerned about when it comes to family consumption. A very favorable characteristic of the improved variety in chickpea is that the grain size is large along with a high grain weight. This prevents grain damage from heavy machinery that becomes necessary to use during cultivation. This trait is mainly observed in chickpea only. Again, there are various diseases such as Fusarium wilt, Ascochyta blight and Botrytis grey mould that could harm the production and yield. 80% farmers cited disease resistance as a perceived benefit. So the variety does help in restricting major diseases. Some even said that the variety was pest resistant since pests such as Helicoverpa armigera can also damage the crop.

4.7 Reasons for not adopting other improved varieties

The sample of 57 farmers were taken and a question was put forward to them regarding the reasons why they are continuing to grow the improved Maruti variety in pigeonpea and mostly JAKI-9218 in chickpea, instead of going for some other varieties that are available in the

markets. The responses were ranked, right from the most important factor behind their growing the same variety time and again, to the reason that was not much significant relatively, yet made quite a difference at times in terms of adoption. Thus, based on the farmers' perceptions in the two villages, the reasons are ranked as follows:

1. **Lower yield than expected** – It is a common feeling amongst all the farmers at Kanzara and Kinkheda that by the adoption of other improved varieties, the yield level would definitely go down, both in case of pigeonpea and chickpea. Moreover, this fact is proved by their past experiences only. There would be a fall in area if some other variety is adopted because the farmers would not risk much in intercropping other varieties with sugarcane or cotton in case of pigeonpea, and they would not even go for sole-cropping of some other chickpea variety. Apart from that, the production would definitely fall to a considerable extent. Thus, the farmers' expectations would not be met in terms of yields and so they would not adopt any other cultivar.
2. **Absence of land suitability** – The varieties that the farmers currently use in case of pigeonpea and chickpea adjusts to unfavorable weather conditions and temperature changes that has an impact on rainfall. Even if there is not enough rainfall in a particular year and there is scarce water available to the crops, both the Maruti and Jaki-9218, and sometimes Vijay, another commonly used chickpea variety, generate decent production in comparison to the other varieties that do not provide such high quantities of production. So if different cultivars are adopted, the land would not be as suitable as it is for the existing varieties.
3. **Lower price** – It is quite obvious that a good quality seed promoting high production would provide a decent price. This is seen in the case of both Maruti and JAKI-9218, which help the farmers in the two villages get a good price during most of the times, if not remunerative. So an average farmer mostly relies on these varieties to a great extent in order to get a decent price, which is not obtained in case of the other cultivars that the farmers have adopted in the last five years.
4. **Lower pest and disease resistance** – It has been noticed earlier by the farmers that the other varieties of pigeonpea such as Nirmal-2, Asha and Nisha are susceptible to various pests and diseases which has already been a crucial threat to the crops in the past. In fact, other chickpea varieties such as Digvijay and Virat have not performed well in terms of insulation of crops against biotic stresses. Therefore, pests and diseases are a major concern if a farmer wants to

adopt these varieties, and so most of the farmers do not risk growing these varieties again. On the other hand, Maruti and JAKI-9218 have greatly reduced pest and disease attack.

5. **Unawareness** – Farmers' unawareness is a major issue that needs to be dealt with in a proper manner. Sometimes, the farmers are not aware of the new varieties available in the market and continue growing the same variety time and again, without even purchasing new seeds of the variety that they have been growing. This reduces the grain quality. Moreover, even if a certain cultivar with a significant potential exists in the market, the farmers remain unaware of it. This is another reason why farmers do not get to use other cultivars.
6. **No market** – The market demand of other cultivars is low, which is due to the fact that their quality is not as much as desirable as the varieties commonly used by the farmers of Kanzara and Kinkheda. Besides, dal made from other varieties does not even taste that good, though it can be used for animal feed at times. This is another reason why farmers do not generally opt for cultivars other than Maruti or Jaki-9218, in case of pigeonpea or chickpea respectively.

Area expansion under pigeonpea and chickpea

It is natural that if a farmer gets profit from a particular crop by the adoption of improved cultivars, then he would plan to increase the area under the crop in the subsequent year. Now in case of pigeonpea and chickpea, the advantages obtained in both the villages by the adoption of improved varieties definitely seem to outweigh the disadvantages. So it is obvious that the farmers would plan to increase the area under pigeonpea and chickpea in the next year in the two villages. But when asked whether they actually intended to go for an area expansion in the two crops, the responses were surprising.

Only 26.32% of the pigeonpea farmers replied that they would expand the area in the next year, while 73.68% of the farmers out of the sample of 57 stated that they did not have any intention to increase the area in the subsequent years. The reasons behind planning to increase the area, and not planning to go for an area expansion were then analyzed. Out of the 26.32% of the pigeonpea farmers who agreed to increase the area in the next year, 46.67% replied that they would increase the area due to the high production of pigeonpea that is obtained by using the improved cultivars, 26.67% stated that it was because of the fact that they receive decent prices for their produce, 20% pointed out that the intention to increase the area was due to the sufficient irrigation facilities available to them, though pigeonpea can be grown under moisture-stress environments,

and the remaining 6.67% cited less requirement of labor as the reason why they wanted to increase the area in the forthcoming year. Now out of the 73.68% respondents who did not want to go for an area expansion, a significant proportion, that is, 76.19% stated that it was majorly due to the land size constraint that they faced. It was not possible for them to increase the area since the rest of the land comprised other competing crops such as soyabean and cotton, which helped the farmers obtain relatively higher profits when compared to pigeonpea. Besides that, 14.29% replied that they do not get a decent price which is why they did not wish to go for an increase in the area, while each of 2.38% farmers cited long duration, increasing pest attacks, non-satisfactory production and risk averse as the reasons behind not increasing the area under pigeonpea in the subsequent year.

In terms of area expansion of chickpea in the two villages, 50% of the farmers replied that they would like to go for an area expansion in the next year, while the rest said they would not increase the area. It is to be noted that only 10 chickpea farmers were found in the survey from both the villages, thereby the size of the sample in this case being 10. Thus, the results might not be conclusive enough in terms of area expansion. Now out of the one-half who replied that they wanted to increase the area in the next year, 60% stated that it was due to the fact that they received a decent price by growing the improved cultivar, 20% pointed less requirement of labor to be a reason and the rest 20% said that it was due to good rainfall that they experienced that they planned to increase the area. Out of the other half who did not intend to increase the area, 60% replied that it was due to the lack of remunerative price, 20% pointed out land size constraint and the rest stated that it was due to non-satisfactory production.

4.8 Major constraints in pigeonpea and chickpea cultivation

There are number of constraints in the cultivation of pigeonpea and chickpea. The most important drawback in the cultivation of these pulse crops is animal attack. This is an issue which has been troubling almost each and every farmer in the two villages. In fact, 51 farmers out of the sample of 57 replied that their crops suffer from animal attack. Animals such as pigs, deer, rui and neelgay eat up the crops grown by the farmers and has harmed the cultivation of these pulses to a great extent. It is in a way surprising because out of all the major problems that a farmer can possibly face while cultivating the crop, animal attack ranks first in terms of constraints in cultivation, and even after following the right kind of practices, the animals

prevalent there might put the efforts of a farmer in vain. The other problem that ranks second in regard to the cultivation of pulse crops is uneven rainfall. Even though the improved varieties used by the farmers in the two villages has the potential to adjust to changing water availability, yet sometimes high or even low rainfall might damage the crops by causing water-logging or droughts. 36 farmers from the sample have pointed out uneven rainfall to be a serious threat, amongst the other issues while cultivating pulses. Again, 31 farmers stated that they do not get remunerative prices by cultivating pigeonpea and chickpea due to their relatively longer duration. This is probably why they take to soyabean or cotton cultivation, probably because they earn higher profits. This issue should be taken very seriously and proper measures should be undertaken to take care of it. There were even 21 farmers who said that they had to guard their crops at night. This again arises from the issue of animal attack in increasing numbers, which could, in the process, reduce labor hours. 18 farmers cited the absence of proper irrigation facilities as an obstacle to the cultivation of these pulse crops. Pigeonpea, mostly is a rainfed crop, and can adjust to changing conditions, but chickpea requires sufficient irrigation during cultivation. As such, sometimes its absence can really harm the production. Again, 16 respondents pointed out that abrupt climatic change was another important issue. Adverse weather conditions could cause heavy losses in production of the two pulse crops, especially pigeonpea. Timely availability of inputs such as labor as well as machinery also caused a lot of problems for the farmers in Kanzara and Kinkheda. 10 farmers agreed to it. One of the farmers also stated that non-availability of inputs was another constraint in the cultivation of these pulses.

Perceived drawbacks in the existing variety

Out of the total sample of 57, 45 farmers, that is, almost 80% stated that though the improved cultivars of Maruti and JAKI-9218 in case of pigeonpea and chickpea showed very impressive characteristics, yet there existed some drawbacks. The major issue was pests. In fact, a pest named aril has been causing massive problems in both the villages, and is greatly responsible for the decrease in production. 41 out of the 45 farmers stated that pest attack was a vital issue. Besides, the improved cultivars used by the farmers in the two villages are of relatively longer duration, especially in case of pigeonpea. So the crop gets affected at times due to post-November rains, thereby not providing them with a decent price. 24 farmers agreed to this fact. 22 farmers pointed out drought susceptibility as another drawback in the improved cultivar to a

certain extent. High temperatures result in droughts, which greatly affects the production and yields. Small and non-uniform grain size is another problem of the improved varieties. This is mainly applicable for pigeonpea, since its grain size is a matter of concern, but chickpea is more or less out of danger in this regard. 10 farmers mentioned this problem. Diseases also harm the crops to a certain extent, as pointed out by 9 respondents. The improved varieties are considerably effective in this regard, but 3 of the farmers believed that the varieties should be even more disease resistant. Apart from that, 2 farmers were concerned about flower drop. These were the perceived drawbacks in the existing varieties of pigeonpea and chickpea in the two villages.

4.9 Expected traits in future cultivars

It is very essential to take into account the farmers' needs and wants. No matter what steps are taken by the government or by any other research center or institution, it is highly necessary to know the requirements of the farmers in future cultivars, and deliver according to their needs, if the aim of increase in production of the pulse crops is to be achieved. Now the varieties used by the farmers in case of pigeonpea and chickpea generate high production. But all the farmers in the sample of 57 mentioned that they would not mind an even higher production from the future cultivars. In fact, this is the most crucial requirement in any future cultivar. 38 farmers replied that the future cultivars should have better resistance against pests, since pests damage a significant proportion of their crops. It is vital for the farmers to receive remunerative prices from the future cultivars, as cited by 36 of them, otherwise the farmers would continue giving more priority to the competing crops. Short duration varieties are very much required in order to fit the various cropping systems, as pointed out by 27 farmers. Besides, 23 farmers stated that drought resistant varieties should be introduced that would help increase the yields. Apart from that, better quality in future cultivars are always welcomed by the farmers of Kanzara and Kinkheda, and 13 farmers mentioned that it would increase the consumption of pulses to a significant extent. Another trait that should be present in the future cultivars, as stated by 11 out of the 57 farmers is large and uniform grain size, especially for pigeonpea. The weight of grains should also be higher. Amongst other expected future traits, some of the farmers cited disease resistance and lesser cooking time. These are the expected traits in the future cultivars of pigeonpea and chickpea.

4.10 Productivity comparison of pigeonpea and chickpea with past data

A comparison of both the current productivity of pigeonpea and chickpea was carried out against the average productivity that existed 10 years ago for both the pulse crops. This was done in order to observe the improvement in terms of productivity brought about by the improved varieties of pigeonpea and chickpea in Kanzara and Kinkheda. From secondary survey, in case of pigeonpea, it was found out that the average productivity that existed in these two villages 10 years ago was 100kg/acre. On undertaking a comparative study it was observed that currently almost all the farmers in the villages obtained a productivity of more than 100kg/acre, except only two farmers. This current information was obtained from the primary data itself. Apart from that, the current average productivity for pigeonpea was found out to be 325.907kg/acre, as against the average productivity of 100kg/acre that prevailed a decade ago. This clearly shows a massive rise in productivity of pigeonpea in the two villages by the adoption of improved cultivars in recent times.

Again, the average productivity of chickpea that existed a decade ago was found out to be 450kg/acre, as against 100kg/acre for pigeonpea. This huge difference is due to the fact that chickpea is grown as a sole crop, whereas pigeonpea is usually intercropped. From the primary data consisting of a sample of 10, it was observed that two farmers obtained a productivity of less than 450kg/acre, while the productivity of the rest 80% was more than 450kg/acre. The current average productivity was calculated to be 489.118kg/acre, which is higher than the productivity that existed 10 years ago. This again goes to show the productivity improvement in chickpea in the two villages by adopting improved varieties. Therefore, from the above study, it can be clearly stated that the overall productivity of both pigeonpea and chickpea has taken a huge leap by the adoption of improved cultivars.

4.11 Prices obtained by the farmers for their produce

In order to encourage the farmers to produce pigeonpea and chickpea in increasing quantities, it is vital to provide the farmers with remunerative prices. This has been a major obstacle in the path of pulse production in most of the pulse-growing areas. In fact, 91.23% of the farmers stated that they did get remunerative prices for their output, that is, 52 out of the 57 farmers were unhappy with the prices that they received. Only 5 farmers cited that the prices that they received were remunerative. Almost all the farmers at Kanzara and Kinkheda maintained the fact that

their expectations in terms of pulse prices were never met, and this issue needs to be dealt with in a serious manner. In fact, the gap between the previous year prices and expected prices were quite huge in both pigeonpea and chickpea, as shown in the figures given below:

Figure 10: The Pigeonpea Price Gap

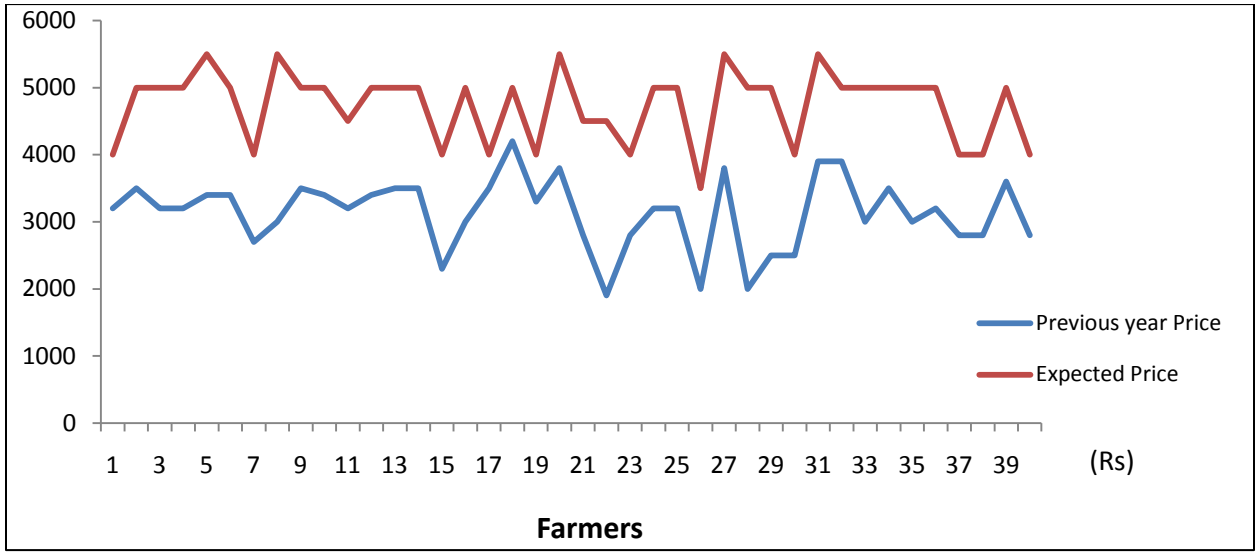


Figure 10 shows the gap that exists in the two villages in terms of pigeonpea prices that was prevalent in the last year and the prices that the farmers expect. Here, 40 farmers out of the sample of 57 pigeon growers are taken into account. The rest either find the prices remunerative or do not sell their produce at all in the market. From the above figure, in case of the 1st farmer, the previous year price was Rs.3200, while the expected price was Rs.4000. So there is a gap of Rs.800. In fact, the 18th farmer in the above case obtained a price of Rs.4200, and yet he does not consider it to be remunerative, probably because he earns higher profits by growing other competing crops. The expected price is Rs.5000, and so clearly there is a gap of Rs.800 again. Again, there are instances where the price gaps are extremely high such as in the case of the 4th farmer where the gap is Rs.1800 and even the 8th farmer where the gap is Rs.2500. From the study it has been seen that the average price gap in case of pigeonpea in both the villages is somewhat around Rs.1600, which is matter of concern.

Figure 11: The Chickpea Price Gap

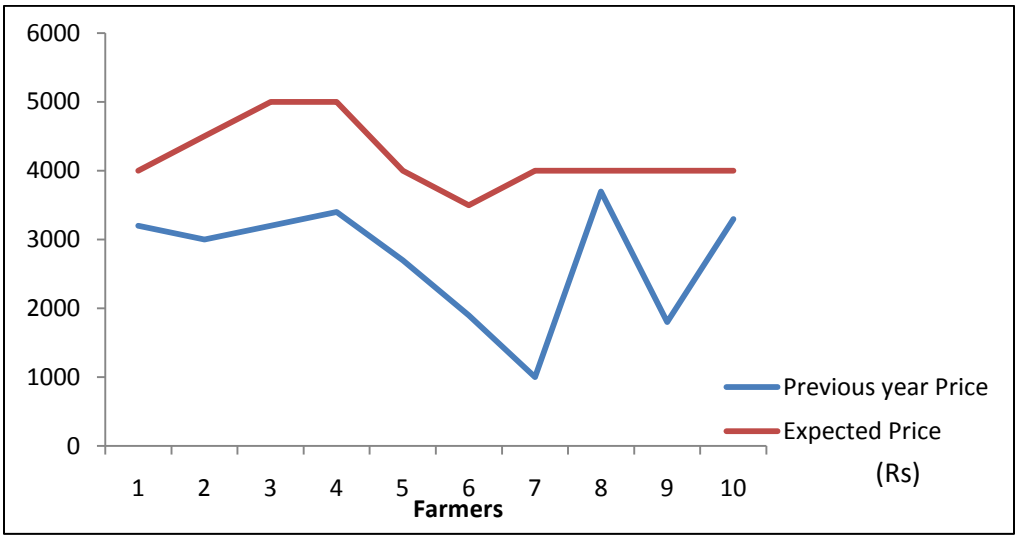


Figure 11 shows the case of all the 10 chickpea farmers in Kanzara and Kinkheda. All the chickpea growers stated that they did not receive remunerative prices. Considering the case of the 4th farmer in the above figure, it can be seen that he got a price of Rs.3400 in the previous year, but the expected price was Rs.5000, thereby showing a difference of Rs.1600. Again, the 7th farmer obtained a very less price of Rs.1000, and the expected price was Rs.4000, citing a gap of Rs.3000. The average price gap in chickpea turned out to be around Rs.1500. Therefore, proper measures have to be taken in order to reduce this existing price gap as much as possible.

Replacement of cultivars during the last 5 years

Now a question may arise that even if the farmers are provided with remunerative prices, would they actually use it in pulse cultivation only and thereby put their best foot forward in terms of raising production that could ensure self-sufficiency? The answer is yes. It has been seen from the primary survey that in the last 5 years, 59.65% of the pigeonpea farmers made a change in the cultivars that they had been using, whereas there was no cultivar change in the case of the remaining 40.35% of the farmers. Out of the 59.65% farmers who used other varieties, 21 stated that they adopted the pigeonpea hybrid, ICPH-2671, that was introduced by ICRISAT, but the hybrid did not satisfy them. Asha was also another pigeonpea variety that was used by 13 farmers, and 10 pigeonpea growers adopted Nirmal-2. The other varieties used by the farmers in Kanzara and Kinkheda were Ganesh, BSMR-786, Yeshoda and Durga. But in case of chickpea,

almost all the farmers in the sample of 10 replied that they mostly used Jaki-9218 or Vijay, except one who had tried the Nisha variety sometime ago. These facts show that farmers would not hesitate before going for pigeonpea or chickpea cultivation, if proper prices are provided to them.

Reasons why pigeonpea hybrid was not successful in Kanzara and Kinkheda:

- ✓ Flower drop
- ✓ No remunerative price
- ✓ Purchase of seeds every year is difficult for the farmers
- ✓ Relatively longer duration than the commonly used varieties
- ✓ Non-satisfactory yield
- ✓ Black in color

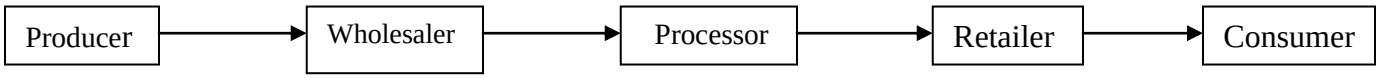
4.12 Producer's Share in the Consumer's Rupee

It is the price received by the farmer expressed as a percentage of the retail price, that is, the price paid by the consumer. If Pr is the retail price, the producer's share in the consumer's rupee (Ps) may be expressed as follows:

$Ps = (Pf/Pr) * 100$

Here, Pf is the producer's price, that is, the net price received by the farmer at the time of first sale. (Source: Agricultural marketing in India, Acharya)

The figure below shows a simple marketing channel of pulses:



(Rs 30/kg) (Rs 37/kg) (Rs 45/kg) (Rs 52/kg) (Rs 60/kg)

This shows that the produce that was worth Rs.30/kg when the farmer made his sale eventually rose to Rs.60/kg during consumer purchase. So the profits of the farmers get reduced due to the presence of the intermediaries. Thus, proper market access should be made.

The producer's share in the consumer's rupee of both pigeonpea and chickpea in the two villages was found out during the primary survey, assuming the consumer's price to be Rs.60/kg. It is shown below:

Table 2: Producer's Share in Consumer's Rupee

	Kanzara	Kinkheda	Overall
Pigeonpea	54%	51%	53%
Chickpea	44%	55%	45%

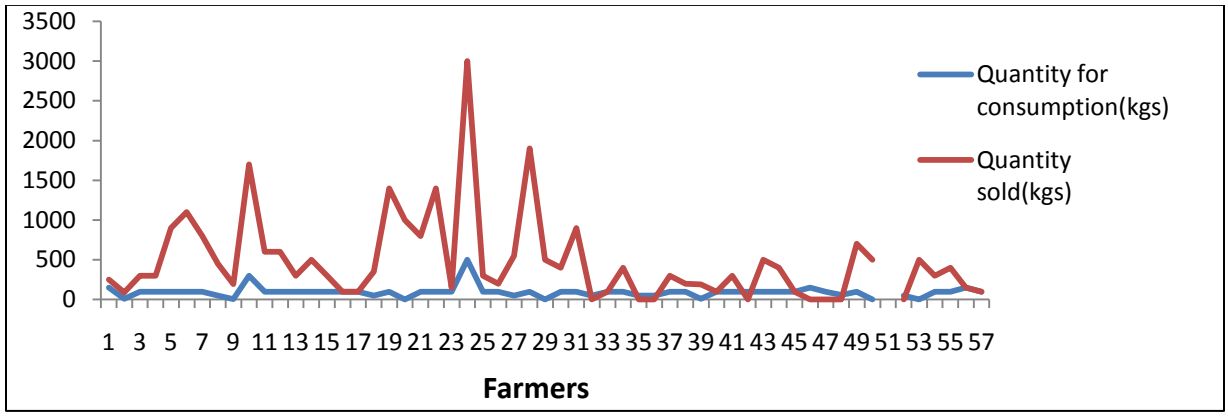
Therefore, considering all the advantages and disadvantages faced by the farmers in Kanzara and Kinkheda by the adoption of improved varieties, 91.23% farmers out of the sample of 57 were empowered or benefitted in some way or the other, when compared to the initial stages when they were not familiar with the improved cultivars. So definitely the new and varieties helped them go a long way in terms of improvement of their plight.

4.13 Change in consumption of pulses over a period of time

A part of the study involved knowing the consumption pattern of pigeonpea and chickpea in Kanzara and Kinkheda over a period of time. The reason behind the study was to found out the extent of dependency of the households on these pulse crops in terms of consumption of these varieties as dal in the last couple of years. According to the primary data collected from a sample of 57, 71.93% pointed out that they always kept a certain fixed quantity of pulses for home consumption and this trend had not changed in the last couple of years. 10.53% farmers mentioned that the quantity meant for consumption fluctuates as per need. Another 10.53% respondents cited that there was a decrease in the quantity of pulses that they consumed in the last few years, not because they did not want to consume it, but mainly due to low production, thereby forcing them to sell the entire quantity produced in order to get money. But then some replied that they purposively used to sell the total production in the market because the commonly used varieties such as Maruti fetched them a good price, and purchased the quantity required for household consumption from the nearby markets. Besides, 7.02% of the farmers even stated that the pulse consumption in their respective households had increased over a period of time.

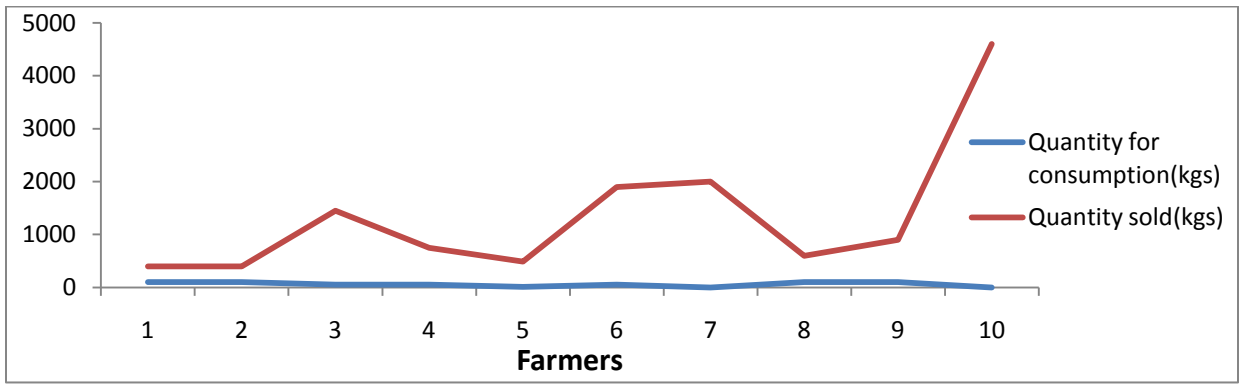
In fact, considering the picture of the change in consumption of pulses in the two villages in the last few years, it is not very surprising to know from the primary data itself that, a complete cent percent of the farmers maintained the fact that, no matter what the existing problems are in terms of the cultivation and marketing of pulses, they would never stop consuming pulses. This fact is definitely true at least in the forthcoming years.The following figures show the quantity consumed and sold in case of the 57 pigeonpea growers, and that consumed and sold in case of the 10 chickpea cultivators, in the villages of Kanzara and Kinkheda:

Figure 12: Quantity consumed and sold for Pigeonpea



The above figure shows that almost all the pigeonpea farmers always keep a certain quantity of pulses that is meant for home consumption. The discontinuous portion indicates the farmer whose crop got entirely damaged, and thus had no production. The portion where the consumption line touches the horizontal axis shows the farmers who sold the entire quantity, either due to low production or because of earning a remunerative price.

Figure 13: Quantity consumed and sold for Chickpea



From the above figure, it can be seen again that the 10 farmers cultivating chickpea also hold, even if it is a very small quantity, a certain part out of the total production for home consumption, except the 7^{th} and the 10^{th} farmer who sell the entire quantity.

5. Recommendations

The most notable feature that can be taken into account from the village surveys and consequent study of data is that, at the end of the day, all that a farmer is concerned about is high production and yields, and getting a remunerative price. It is very necessary to have horizontal expansion such as cropping system manipulation, as well as vertical expansion including institutional support and adoption of the new technologies, in order to raise the yields. A major problem in these villages is that farmers tend to prefer soyabean and cotton. Presently, soyabean is the major crop in the villages due to its short duration, making double cropping possible. Pigeonpea is usually grown as an intercrop and even if it is intercropped with soyabean, farmers face a problem since then double cropping is not possible. Again, cotton is preferred to pigeonpea due to its higher production. Apart from that, there is a significant gap between the expected and actual prices that the farmers receive. So even if farmers receive prices that are sometimes higher than the MSP, they are still not content in growing pulses since they obtain higher profits from the other competing crops. A major constraint in the cultivation of pigeonpea and chickpea at Kanzara and Kinkheda is that wild animals, mainly pigs, deer and rui, eat up the crops. It would be extremely beneficial for the farmers if the forest officials could devise a plan that could prevent animal attack. This is an issue that is overlooked by most of the people, and is not given much importance. But if there is any intention to improve the pulse situation in the villages of Maharashtra, especially Kanzara and Kinkheda, then the elimination of such animal attack should be given top priority. Efforts should also be taken to improve the irrigation facilities in these villages, particularly in case of pigeonpea. The commonly used varieties of pigeonpea and chickpea that are grown in Kanzara and Kinkheda are all disease-resistant, that is, wilt resistant cultivars, which is of course a good sign. But arli, a major pest, is a major drawback in the existing variety. So it is important to develop pest-resistant varieties that could help increase production by a long way. Nowadays, farmers prefer short-duration varieties since it fits well in various cropping systems, and moreover, the long-duration varieties might get damaged due to

post November rains. Also, it is a major reason why farmers do not get a remunerative price. So it is very necessary high yield short duration varieties should be developed in pulses. Some of the farmers also face problems due to droughts. As such, more drought-resistant varieties should be introduced. In the last 2 years, there has been grain damage in pigeonpea, by the use of harvesters, resulting in wastage. Consequently, the quality has come down to some extent. Thus, there should be uniformity in the grain size of pigeonpea and the size of the grains should preferably be larger along with higher grain weights. In case if marketing of produce, all the farmers in the two villages sell their produce in the regulated market. The average producer's share in consumer's rupee for the two villages is 53% for pigeonpea and 45% for chickpea, which is decent enough, yet most of the farmers are not satisfied with the existing price. This shows that there is not much involvement of intermediaries and the market access is good, but it can be made better. In order to encourage the adoption of better and even more improved varieties, mass awareness programs should be undertaken by the various extension services because a number of farmers are still unaware of the improved varieties and their advantages. Scientific production technology which can increase the yield to a great extent and that has been demonstrated by scientists has to reach the farmers. In addition to that, adequate facilities for the training of development officials and progressive farmers should also be available. Thus, the benefits of the new and improved cultivars should be properly communicated to the farmers in these villages. Know-how centers should also be developed that could provide correct and adequate information to the farmers. ICRISAT is of course doing there bit to help the farmers improve their plight. In fact, 32 farmers out of the sample of 57 stated that ICRISAT encouraged them to adopt the improved varieties of pigeonpea and chickpea Kanzara and Kinkheda, the other adoption encouragers being fellow farmers and Krushi Vigyan Kendra. In fact, it was found from the primary survey that ICRISAT was also the main provider of seeds in the two villages, providing new and improved varieties to 29 farmers out of the 57, the other providers being private shops, fellow farmers and Krushi Vigyan Kendra. Increasing efforts are needed in this regard by other institutions too. Sample testing should be carried out in these villages whenever a new variety is introduced because farmers do not usually grow other varieties without experience.

6. Conclusion

Therefore, the micro-level study illustrates the fact that pulses continue to be an essential part of the diet and as shown earlier, Indians would not stop consuming it, at least in the years to come. So the major thrust areas to be addressed are prevention of animal attack, development of high yield short-duration varieties that would be pest and drought resistant at the same time, proper irrigation facilities, reduction of the price gap where government support is definitely required, increasing the producer's share in the consumer's rupee by getting rid of intermediaries which would improve the market access, and the encouragement of farmer's participatory research. Despite the presence of a number of hindrances in the way of attaining self-sufficiency, a phenomenal change is required in the state of pulses. Massive emphasis needs to be given in boosting the production and yields, as well as providing remunerative prices.

7. Bibliography

cooperation, D. o. (n.d.). *Agriculture statistics at a glance 2011.* Retrieved from http://eands.dacnet.nic.in/latest_2006.htm

Gupta, M. A. (n.d.). *Carrying capacity of Indian agriculture.* Retrieved from http://www.currentscience.ac.in/Volumes/102/06/0874.pdf

ICRISAT. (n.d.). *Hybrid pigeonpea (Pushkal).* Retrieved from http://www.icrisat.org/impacts/impact-stories/icrisat-is-pushkal.pdf

P Parthasarathy Rao, P. B. (2010). Chickpea and pigeonpea economies in Asia. *ICRISAT*.

Reddy, A. A. (n.d.). *Pulses production technology : Status and way forward.* Retrieved from http://oar.icrisat.org/376/1/EPW44_52_73-80_2009.pdf

research, I. i. (n.d.). *Vision 2030.* Retrieved from http://www.iipr.res.in/iipr_vision1.pdf

Sundaram, D. I. (n.d.). *India needs a pulse revolution.* Retrieved from http://www.efymag.com/admin/issuepdf/pulses_dec10.pdf

VS Bhatia, P. S. (n.d.). *Global theme on agro-ecosystems.* Retrieved from http://www.icrisat.org/journal/volume5/aes/aes1.pdf

Why pulses. (n.d.). Retrieved from www.growmorepulses.com: http://www.growmorepulses.com/media_kit_pulses.pdf

Yadav, D. (1992). *Pulse crops.*

TRIVSA Pigeonpea Report, 2012 ; Agricultural marketing in India, Acharya

8. Appendix

Questionnaire for the Field Survey

Title: Enabling Pulse Revolution in India - Role of Technology Adoption and Markets

Name: _____Sex: _____ Age: _____

Village: _____ District: _____

1) Which pulse crop do you grow? Chickpea/Pigeon pea
2) What is the total owned area?
3) How much land has been leased out or leased in, if any? _____
   Which crop? Why? _____
4) Out of the total owned area, how much area is operated under the pulse crop?
5) What is the total area having irrigation facilities?
6) What are the varieties that you prefer? Name them. Traditional/Improved
   _____
7) Mention the area under traditional and improved varieties.
8) How has the area under traditional varieties and production changed in the last five years? Provide the figures.
   _____
   _____
9) Mention your source of knowledge about the variety that you use.
   - Extension agent
   - Research center
   - NGO
   - Neighbors
   - Media/Radio/Newspaper
   - Private shop
   - Others
10) If you prefer traditional varieties, then list the reasons why you have not adopted improved varieties. (Rank)
    - Not available at all
    - Available but not on time
    - Very expensive
    - Require large doses of other inputs
    - Lower yield than expected
    - Disease and pest resistance not adequate
    - No market
    - Poor price
    - Post harvest losses too much
    - Others
11) What are the solutions that you would suggest for the improved varieties? (Rank)
    - Subsidy
    - Cheaper availability of seeds
    - Timely availability of seeds

- Others (Specify)

12) If you have adopted improved varieties, then for how many years have you been growing it?
13) In which year did you first adopt the improved variety?
14) Why did you shift towards growing improved varieties from traditional varieties?
15) Who encouraged you its adoption?
    - Village head
    - Household head
    - Fellow farmers
    - Others
16) Who provided you with the improved seeds?
    - Owned seeds
    - Other farmers
    - Government
    - Research institutes
    - Cooperatives
17) Are you satisfied with the adoption of improved varieties? Yes/No
18) List the favorable characteristics of the improved varieties.

    _____

    _____
19) Do you sell the crop that you produce? Yes/No

    If yes
    - Which are the marketing channels through which you sell the produce?
        - Regulated market
        - Commission agent
        - Village market
        - Govt. agencies
        - Others
    - Who is the ultimate buyer?
        - Other farmers
        - Farmers' association
        - Local vendor
        - Middlemen
        - Exporter
        - Others
    - What is the price at which the produce is sold and the quantity?
    - Mention the transportation costs.
    - Do the govt. agencies procure their produce? Yes/No

    If no, why and where does the final consumption happen?

20) To what extent has the adoption of improved varieties helped you over the initial stages when you were not using the improved technologies?
21) Do you wish to continue on using improved technologies? Yes/No If yes, what would be the area under improved varieties next year?
22) Would you stop cultivating pulses if the existing problems continue?