Impact of Cluster Frontline Demonstrations on Pulses in Maharashtra: An Empirical Analysis

भाकृअनुप
ICAR

ICAR-Agricultural Technology Application Research Institute

Zone-VIII, Pune, Maharashtra

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Dr. A.K. Singh
Deputy Director General
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Message

Pulses play an important role in sustaining food and nutritional security as well as environmental sustainability in India. These crops provide quality and cheap protein to humans, improve soil fertility and can be cultivated under stress conditions with minimum use of resources. India is the world's largest producer and consumer of pulses constituting 25 per cent and 27 per cent share in total pulses production and consumption in the World, respectively.

Considering the significance of pulses, Cluster Frontline Demonstrations of Pulses under NFSM was started in 2015-16 by the Ministry of Agriculture and Farmers Welfare, Government of India with an aim to enhance the pulses production in the country. ICAR-ATARI, Pune implemented the project on major pulse crops viz. pigeon pea, chickpea, lentil, urdbean and mung bean in selected districts through respective KVKs in the states of Maharashtra and Gujarat since 2017-18.

This publication on CFLD Pulses has included the fruitful information on impact of CFLD on pulses programme on area, production and yield and successful cases of Maharashtra. I hope this publication will be of interest to scientists, policy makers and extension functionaries.

I congratulate ICAR-ATARI, Pune for their efforts to bring out the publication on Impact Assessment of CFLD Pulses in Maharashtra.

(A.K. Singh)
Deputy Director General (AE)

Dated: 29th June 2022

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Dr. Lakhan Singh
Director

Preface

Krishi Vigyan Kendras of Maharasthra and Gujarat of ICAR-ATARI, Pune conducted Cluster Frontline Demonstrations (CFLDs) to demonstrate and popularize the newly released technologies i.e. seed, micro-nutrients, soil amendments, weed management, micro irrigation devices along with capacity building of farmers.

A total of 24776 CFLDs on Pulses in 9910.4 ha area between the period 2017-18 and 2021-22 were organised by 44 KVKs of Maharashtra. Comparative regional analysis was done in the present study to suggest the region specific interventions, which will be helpful in achieving self-sufficiency in pulses production in the country.

I express my sincere gratitude to Dr. Trilochan Mohapatra, Secretary, DARE and DG, ICAR; Dr. A.K. Singh, DDG (Agril Extension); ADGs Dr. V.P. Chahal and Dr. Randhir Singh for their guidance and support for execution of this programme. I appreciate all the participating KVKs for their efforts in implementing and monitoring of the programme. Scientists Dr. Rajesh T, Shri Tushar Athare and associated Senior Research Fellow Shri Sainath Kharat of ICAR-ATARI, Pune are acknowledged for their help in implementing the programme and preparing this publication. Special appreciation is extended to Smt Priyanka Kumari, AAO (ATARI, Pune); Shri Munish Ganti (FAO of ATARI, Pune and NRCG, Pune) for extending their support on regular basis. A valuable support received from SRFs of ATARI, Pune: Mr Mahesh Jadhav and Ms Supriya Patil is highly recognized. Other SRFs (Dr. Anita Deshmukh, Mr Ganesh Chaware, Ms Aarti Patole) and Ms Sumayya Bano, YP-I helped a lot whenever required, are acknowledged.

I hope this publication will be helpful for the scientists, policy makers, extension workers and farmers.

Dated: 2nd July 2022

(Lakhan Singh)

Contents

Chapter 1

Introduction

The growth in Indian agriculture over last few decades has helped the country in achieving food security at National level. The next big challenge faced by the country in general and Indian agriculture in particular is to sustain this growth and achieve nutritional security as well. On the consumption side, pulses will continue to form a major source of protein for a huge section of India, particularly for the poor, backward classes and most of the traditionally vegetarian population. Pulses are major sources of proteins and also sources of vitamins and minerals and are popularly known as “Poor man's meat” and “Rich man's vegetable”, which contribute significantly to the nutritional security of the country. Pulses provide high quality protein complementing cereal proteins for pre-dominantly substantial vegetarian population of the country. Although, being the largest pulse crop cultivating country in the World, India's pulse production is relatively lower in comparison to cereal production. The cultivation of pulses builds-up a mechanism to fix atmospheric nitrogen in their root nodules and thus meet their nitrogen requirements to a great extent. In India, pulses can be produced with a minimum use of resources and hence, it becomes less costly even than animal protein. In comparison to other vegetables, pulses are rich in protein which are less expensive and can be cultivated as an inter-crop and also as a mixed crop. Pulses are mostly cultivated under rainfed conditions and do not require intensive irrigation facility. This is the reason why pulses are grown in areas left after satisfying the demand for cereals/cash crops. Even in such conditions, pulses give better returns. Apart from this, pulses possess several other qualities such as they improve soil fertility and physical structure, control soil and water erosion acting as cover crop, fit in mixed/inter- cropping system, crop rotations and dry farming and provide green pods for vegetable and nutritious fodder for cattle as well.

India is the world’s largest producer (25%) of world's production and consumer (27%) of total pulses. The frequency of pulses consumption in the country is much higher than any other source of protein, which indicates the importance of pulses in daily food habits. As per third advance estimates of 2021-22 of Directorate of Agricultural and Statistics Research, pulses

were cultivated in an area of 28.14 million hectares with an overall production of 27.75 million tons, Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka, Gujarat and Andhra Pradesh accounted for more than 80 percent of total area under pulses, contributing nearly 83 percent of total production.

The targeted area, production and productivity in new cultivation area is possible by way of harnessing pulses in new niches, precision farming, quality inputs, soil test based INM, timely weed management and mechanized method of pulse cultivation complemented with generous governmental policies and appropriate funding support to implementing states/stake holders (Tiwari and Shivhare, 2017). According to the Vision-2030 document of ICAR-Indian Institute of Pulses Research (IIPR), Kanpur, a growth rate of 4.2% in pulse production has to be ensured in order to meet the projected demand of 32 million tons of pulses by 2030. This will, however, require a paradigm shift in research, technology generation and dissemination, popularization of improved crop management practices and commercialization along with capacity building of the stakeholders in frontier areas of research (Tiwari and Shivhare, 2017).

Addressing this concern of significance, the Ministry of Agriculture and Farmers Welfare, Govt. of India had initiated a nation-wide Cluster Frontline Demonstration (CFLD) programme on pulses under National Food Security Mission-Pulses (NFSM- Pulses). The basic strategy of the Mission is to popularize improved technologies, i.e., seed, micro-nutrients, soil amendments, weed management, Integrated Pest Management, farm machinery and implements, micro irrigation devices along with capacity building of farmers. The ICAR through its Krishi Vigyan Kendras (KVKs) across the country has been implementing this CFLD programme on different pulse crops to boost the production and productivity of pulses with improved varieties and location specific technologies.

In ICAR-ATARI Pune, CFLD programme is being conducted in major pulse growing regions of Maharashtra and Gujarat, and major crops grown under this programme includes green gram (*Vigna radiata*), black gram (*Vigna mungo*), pigeon pea (*Cajanus cajan*), chickpea (*Cicer*

arietinum), lentil (*Lence culinaris*), cow pea (*Vigna unguiculata*), horse gram (*Macrotyloma uniflorum*) and dolichous bean (*Lablab purpureus*).

In Maharashtra, CFLD pulses program was implemented by 44 KVKs on 1640 ha area of 4100 farmers in the year 2021. Major technologies demonstrated were improved variety, IPM, INM, seed treatment and use of bio fertilizers. In kharif season, Pigeon pea was conducted on 460 ha area with yield of 14.23 q/ha, Green gram on 160 ha with yield of 4.64 q/ha, Black gram on 70 ha area with 4.02 q/ha of yield. In rabi season, Chickpea was taken on an area of 760 ha area with yield of 18.27 q/ha, cowpea on 20 ha with 8.58 q/ha of yield, horsegram on 40 ha with yield of 11.50 q/ha and dolichous bean on 30 ha area with 10.10 q/ha of yield.

Chapter 2

Process and Methodology

The programme 'Cluster Frontline Demonstrations on Pulses' was initiated under National Food Security Mission (NFSM) with financial assistance of Ministry of Agriculture and Farmers Welfare, Govt. of India in 2015-16. The major objective of the mission was to increase production and productivity of pulse crops under different agro-ecological conditions and undertake mitigating activities in case of natural calamities in pulses sector. The outcomes of the programme envisaged demonstrations of production potentiality of newly developed technologies and varieties of pulse crops at farmers' fields through KVKs towards increasing profitability of pulse crops in the country.

The present study is based on the secondary data (2009-10 to 2019-20) on land area statistics published by Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India. The crops group considered for the study includes cereals and millets, pulses, oilseeds and commercial crops. The Simpson Index of Diversification (Sd) is estimated for the entire crop sector and crop sub-sectors for the period 2010-11 to 2019-20. Simpson Index of crop diversification (Sd) is used to assess the degree of crop diversification. The index is estimated using the following formula,

$$sd = 1 - \sum_{i=1}^{n} p_i^2$$

where, P_i is the proportion of i^{th} crop/crop sector in the gross cropped area. The diversification index ranges between 0 and 1. Higher values indicate high degree of crop diversification.

Data on number of demonstrations and area covered under CFLD Pulses was obtained from 44 KVKs of Maharashtra. Further, information related to local yield, demonstration yield, cost and returns was compiled from various annual reports of ICAR-ATARI, Pune. Observations recorded during front line demonstrations were considered while studying the impact.

Chapter 3

Scenario of Crop Diversification in Maharashtra

Crop diversification refers to a shift from the regional dominance of one crop to the regional production of several crops. Diversification in cropping choice decreases the overall production risk by selecting a mix of crops that have a low or negative correlation in their productivity. The direction of crop diversification is also a matter of research interest. Diversification of crops enhances cropping intensity and productivity growth (Bobojonov et al., 2012). In India, the degree of diversification exhibits huge variations among different regions (Radhakrishna and Panda, 2006). Identifying pattern and degree of crop diversification are imperative in formulating region-specific agriculture development strategies. With this background, an attempt has been made to examine the status of crop diversification in Maharashtra.

As the Ministry of Agriculture and Farmers Welfare, Govt. of India had initiated a nation-wide CFLD programme on pulses under NFSM- Pulses during 2015-16, two time periods i.e. 2010-11 and 2019-20 have been selected with the objective of analysing the impact of the programme on pattern of crop diversification, especially on area coverage under pulses in the state of Maharashtra. Table 1 describes the region wise Simpson indices of Maharashtra for the period 2010-11 and 2019-20. The Simpson Index of Diversification (Sd) is estimated for the major crop sector and crop sub-sectors for the period 2010-11 and 2019-20. The diversification index ranges between 0 and 1. Higher values indicate high degree of

Table 1: Region wise Simpson Indices of Maharashtra

Regions	2010-11	2019-20
Marathwada	0.69	0.74
Vidarbha	0.75	0.75
Konkan	0.20	0.16
Western Maharashtra	0.42	0.60
Khandesh	0.55	0.66
Overall	**0.65**	**0.74**

crop diversification. In case of Maharashtra, Simpson Index has increased from 0.65 to 0.74 between 2010-11 and 2019-20, which indicates that degree of crop diversification has increased significantly during the same period.

The Simpson Index of Western Maharashtra region has increased significantly between the period 2010-11 (0.42) to 2019-20 (0.66), whereas Konkan region has shown decline in degree of crop diversification during the study period. The Simpson Indices for Marathwada and Khandesh regions have increased from 0.69 and 0.55 to 0.74 and 0.66 during the 2010-11 and 2019-20, respectively. Vidarbha region has shown stagnant degree of crop diversification during the same period.

Chapter 4

An Overview of Area, Production and Yield of Pulses in Maharashtra

Region-wise area coverage under pulses in Maharashtra during the period 2009-10 to 2019-20 is shown in Figure 1. Marathwada and Vidarbha regions have the higher area coverage under pulses in Maharashtra during the same period. Whereas being the major rice producing area, Konkan region has the least area coverage under pulses in Maharashtra. Highest area coverage was achieved by Marathwada region with 17.33 lakh hectares under pulses during 2017-18. Western Maharashtra and Khandesh regions have shown increasing trend in pulses area. In Khandesh region, area under pulses has increased from 4.32 lakh hectares in 2009-10 to 5.76 lakh ha in 2019-20, whereas it has increased from 10.34 lakh ha to 15.07 lakh ha during the same period in Marathwada region.

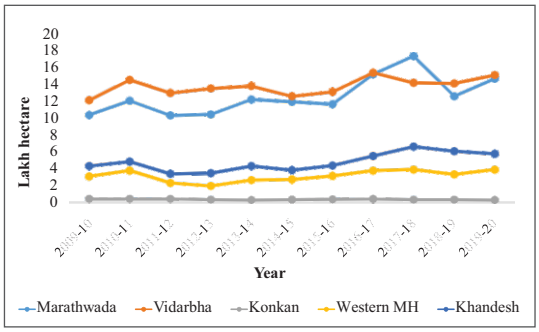


Figure 1: Area under Pulses in Maharashtra (lakh hectare)

The pulses production in Maharashtra during the period 2009-10 to 2019-20 has shown increasing trend across the regions (Figure 2). Vidarbha region has the highst pulses production followed by Marathwada, Khandesh and Western Maharashtra regions during the period. Being the major pulse producing regions, Marathwada (18.22 lakh tons) and Vidarbha (17.70 lakh tons) regions have shown a significant increase in production in the year 2016-17, which may be due to the impact of implementation of the programme CFLD Pulses under NFSM during 2015-16. In Marathwada region, production under pulses has increased from 7.11 lakh tons in 2009-10 to 14.11 lakh tons in 2019-20, whereas it has increased from 10.22 lakh tons to 15.42 lakh tons during the same period in Vidarbha region.

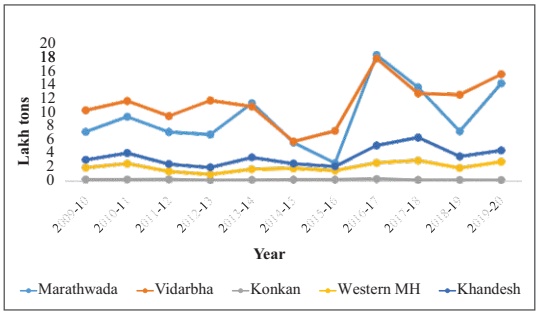


Figure 2: Pulses Production in Maharashtra (Lakh tons)

Figure 3. clearly shows the impact of pulses demonstrations on productivity of pulses across all the regions of Maharashtra. The productivity of pulses has increased significantly between 2015-16 and 2016-17, which may be due to the adoption of high yielding varieties, following advanced farming practices under CFLD Pulses programme in the state. Pulses productivity has increased between 2009-10 and 2019-20 across the regions. Highest productivity of 1.20 tons per hectare was experienced by Marathwada region followed by Vidarbha region (1.15 tons per hectare) during 2016-17. In Vidarbha region, productivity under pulses has increased from 0.84 tons per hectare in 2009-10 to 1.02 tons per hectare in 2019-20, whereas it has increased from 0.69 to 0.96 tons per hectare during the same period in Marathwada region.

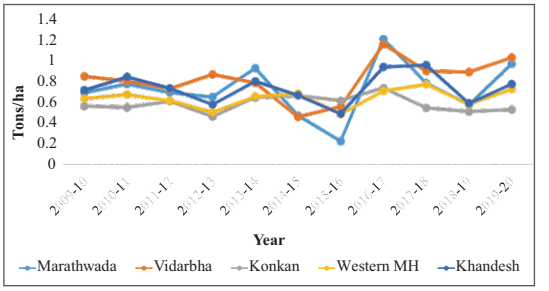


Figure 3: Productivity of Pulses in Maharashtra (tons/ha)

Chapter 5

Status of Demonstrations under CFLD on Pulses in Maharashtra

From the regional analysis it was found that Vidarbha region has the major share in total number of demonstrations in Maharashtra, followed by Marathwada and Khandesh regions between 2017-18 and 2021-22. During 2017-18, 2050 demonstrations were conducted in Marathwada region, whereas 1975, 1175 and 718 demonstrations were conducted in Vidarbha, Khandesh and Western Maharashtra regions, respectively. Between 2017-18 and 2021-22,

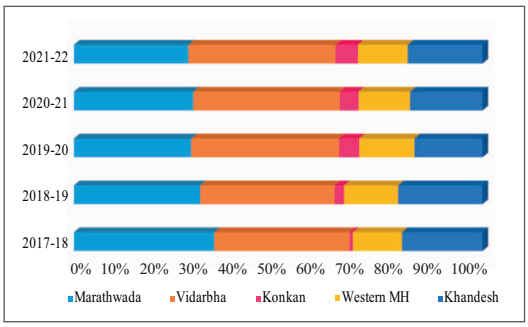


Figure 4: Share of different regions in Demonstrations under CFLD Pulses in Maharashtra

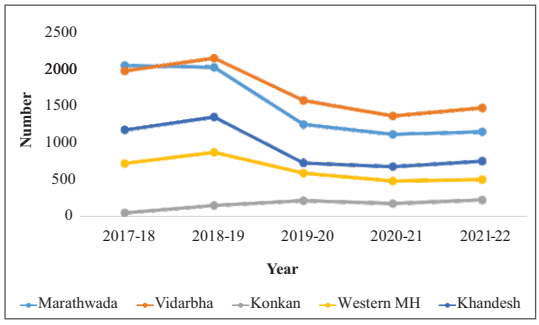


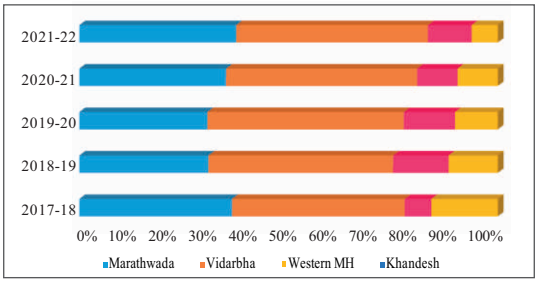
Figure 5: Number of Demonstrations under CFLD Pulses in Maharashtra

Western Maharashtra region conducted less than fifteen percent of the total demonstrations under CFLD on pulses in Maharashtra. During 2021-22, 1475 demonstrations were laid out in Vidarbha region, whereas 1150, 750 and 500 demonstrations were conducted in Marathwada, Khandesh and Western Maharashtra regions, respectively.

Pigeon pea

Vidarbha region has the major share in total number of pigeon pea demonstrations in Maharashtra (>40%) followed by Marathwada (>30%) region between 2017-18 and 2021-22 (Figure 6). 650 demonstrations were conducted in Vidarbha region, whereas 575, 250 and 100 demonstrations were organized in Marathwada, Khandesh and

Western Maharashtra regions, respectively during 2017-18 (Figure 7). Between 2017-18 and 2021-22, Western Maharashtra region conducted less than 15% of the total pigeon pea demonstrations under CFLD on pulses in Maharashtra. During 2021-22, a total of 1200 demonstrations were organized on farmers' fields, out of which 550 demonstrations were conducted in Vidarbha region, whereas 450 and 125 demonstrations conducted in Marathwada and Western Maharashtra regions, respectively.



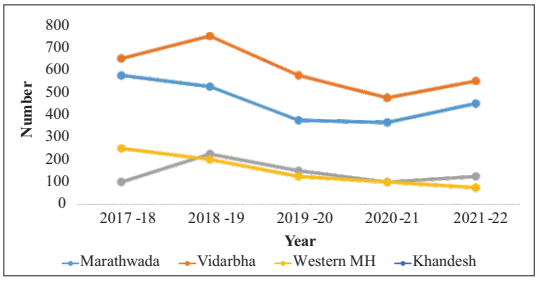


Figure 6: Share of different regions in Pigeon pea Demonstrations under CFLD Pulses in Maharashtra

Figure 7: Number of Demonstrations on Pigeon pea under CFLD Pulses in Maharashtra

Chick pea

Chickpea demonstrations under CFLD on pulses in Maharashtra were conducted between 2017-18 and 2021-22. The Figure 8 indicates that Vidarbha region has the major share in total

number of demonstrations in Maharashtra, followed by Marathwada and Khandesh regions. During 2017-18, 950 demonstrations were conducted in Marathwada region, whereas 775, 625 and 561 demonstrations were laid out in Vidarbha, Khandesh and Western Maharashtra regions, respectively. Between the years 2017-18 and 2021-22, Konkan region conducted less than five percent of the total chickpea demonstrations under CFLD on pulses in Maharashtra due to low cropped area under the crop. During 2021-22, 625 demonstrations have been conducted in Vidarbha region, whereas 450, 425 and 375 demonstrations were organized in Khandesh, Marathwada and Western Maharashtra regions, respectively.

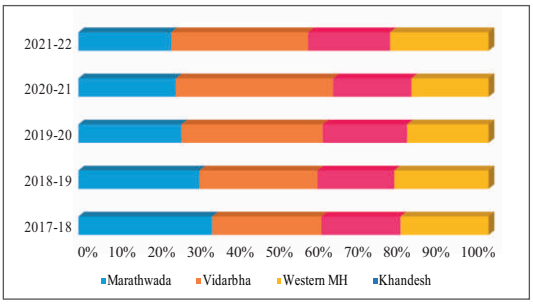


Figure 8: Share of various regions in Chick pea Demonstrations under CFLD Pulses

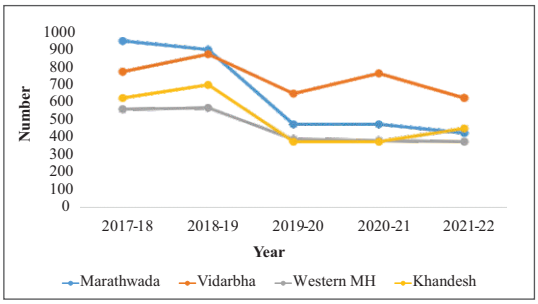


Figure 9: Number of Demonstrations on Chick pea under CFLD Pulses in Maharashtra

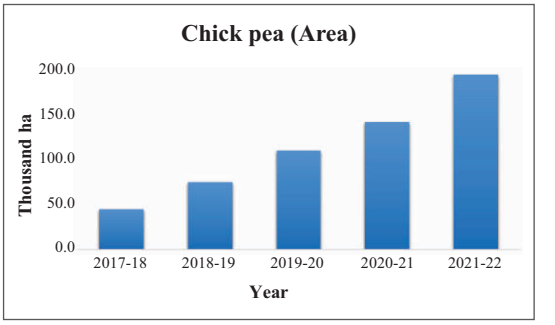
Chapter 6

Horizontal Expansion of Technologies under Pulses in Maharashtra

Vidarbha Region

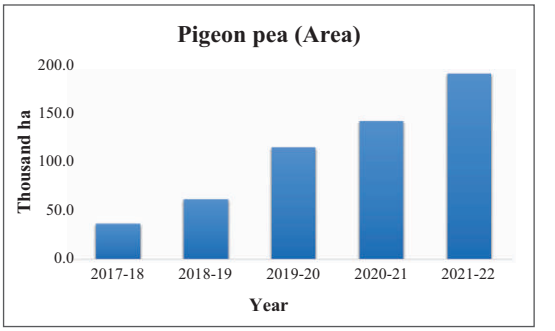
Chick pea

- Intervention of new variety of Chickpea viz. JAKI 9218, Digvijay, PDKV Kanchan and Phule Vikram.
- Use of High Yielding variety (RVJ-202).
- Use of bio-fertilizers and seed treatment with bio-mix culture.
- Adoption of recommended package of practices in ICM.



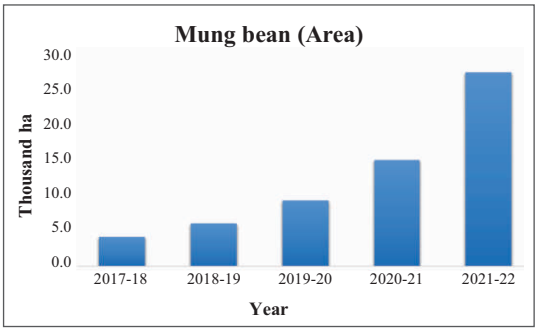
Pigeon pea

- Intervention of new variety PKV TARA and BDN 716.
- Seed treatment with bio-fertilizers and bio-mix, use of bio-fungicides for disease control.
- Sowing on BBF method.



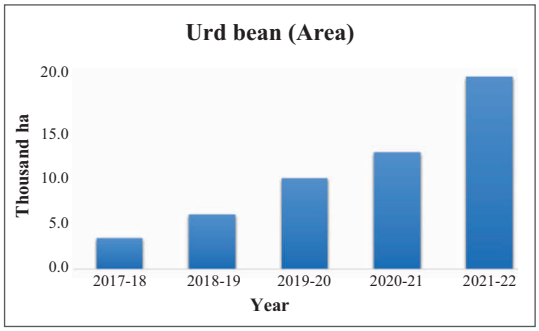
Mung bean

- Intervention of new variety of mung bean (BM 2003-2).
- Use of bio fertilizers.
- Use of high yielding variety.



Urd bean

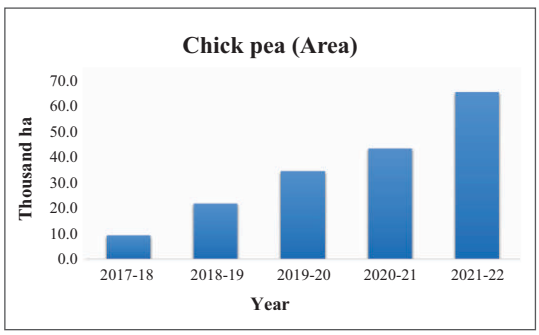
- Intervention of new variety of black gram AKU- 15, PDKV –Black Gold and Raj Vijay-203.
- Integrated crop management.



Marathwada region

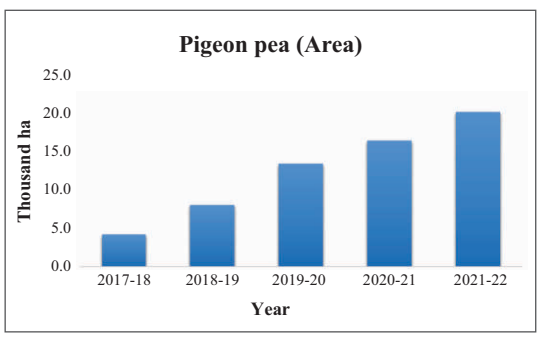
Chick pea

- Use of University recommended improved varieties BDNG-797.
- Use of Chick pea variety of Phule Vikram and JAKI-9218.
- Use of high yielding variety Akash / JAKI 9218.
- Seed treatment with trichoderma and NPK-2 @10 ml per kg of seed.
- Use of BBF techniques for sowing.



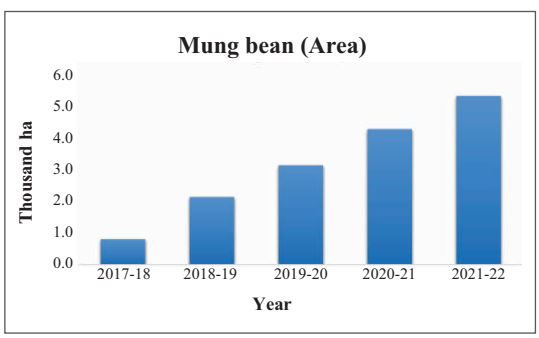
Pigeon pea

- Improved Varieties introduction BDN-711 and BDN-716.
- Seed treatment, INM, IPM & management of stress.
- Opening of ridges furrow 60 and 90 DAS for soil and water conservation.
- To demonstrate potential yield of Pigeon pea variety of BDN-711 as compared to Khadki.



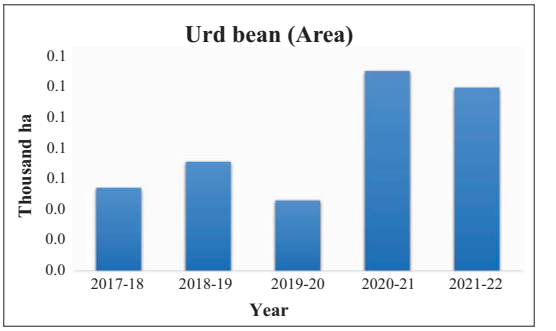
Mung bean

- Varietal replacement with high yielder variety Utkarsh and INM.
- Use of improved variety BM-2003-2.



Urd bean

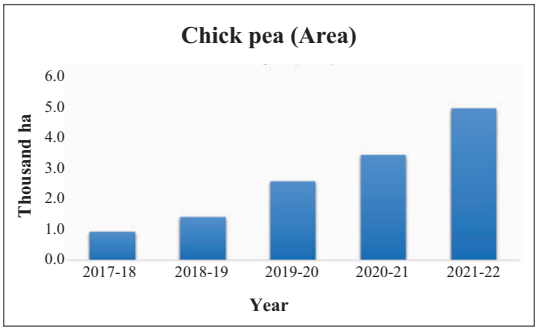
- To demonstrate potential yield of Black gram variety of AKU-15 as compared to TAU-1.
- Seed treatment, INM, IPM and BBF techniques for sowing.



Western Maharashtra

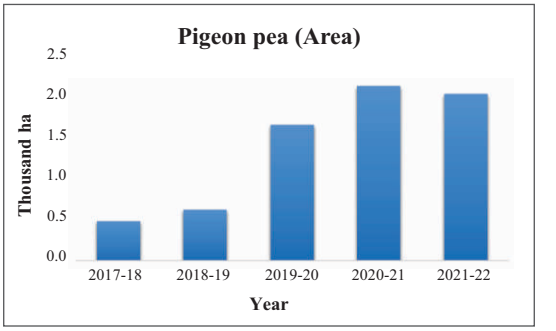
Chick pea

- Introduction of new variety RVG-202 and Phule Vikram and use of IPM technique for pest control.
- Use of gram variety- Digvijay with IPM, INM and ICM.
- Use of improved variety JAKI 9218 with IPM practices.
- Ridge and furrow method of sowing.



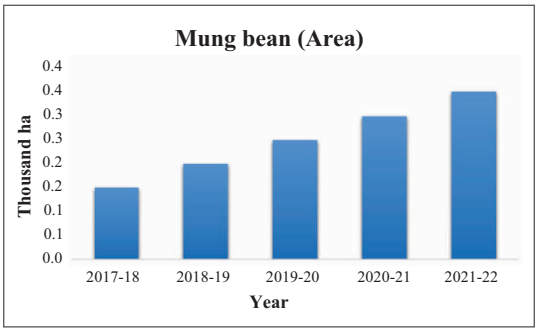
Pigeon pea

- Introduction of new variety BDN- 711.
- Use of IPM, nipping and ICM techniques.
- Seed treatment and soil test based fertilizer application.
- Drip irrigation and IPM in Pigeon pea.



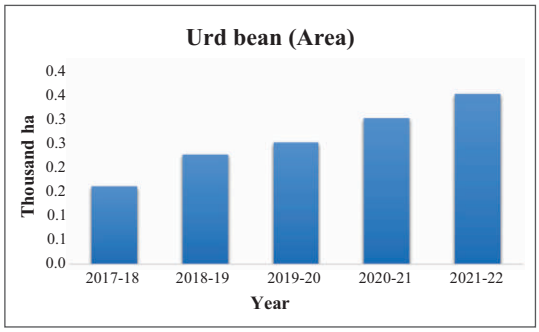
Mung bean

- IDM and ICM.
- Seed treatment, INM and IPM.



Urd bean

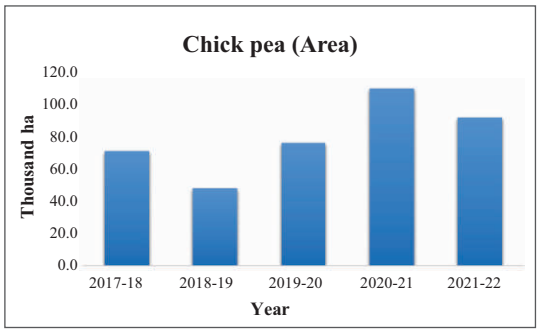
- Use of Var-TAU-1.
- Improved practices like BBF and INM.
- IDM and ICM.



Khandesh Region

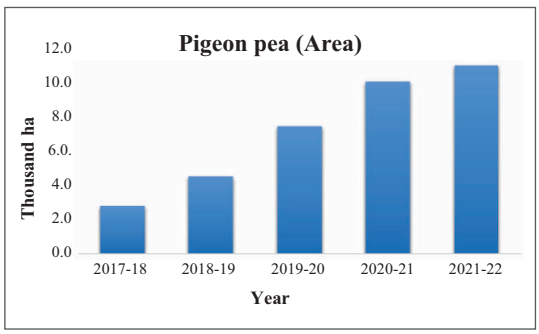
Chick pea

- Varietal intervention includes Digvijay, Phule Vikram and variety-RVG-202.
- Seed treatment with bio fertilizers
- FYM and Trichoderma application in soil
- Sowing technique-BBF (broad bed furrow)
- New technological tool consists of IPM, IDM, and ICM



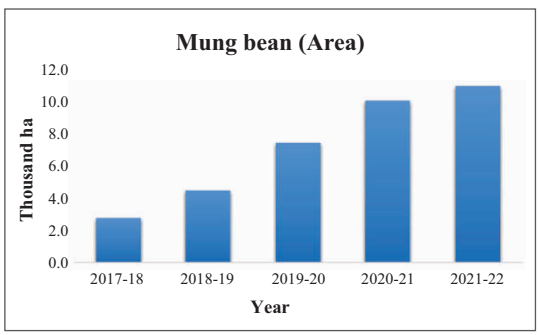
Pigeon pea

- Varietal Intervention include Phule Rajeshwari and BDN-711.
- Trichoderma application.
- Sowing technique-BBF (broad bed furrow).
- Weed control, IPM, IDM and ICM techniques.



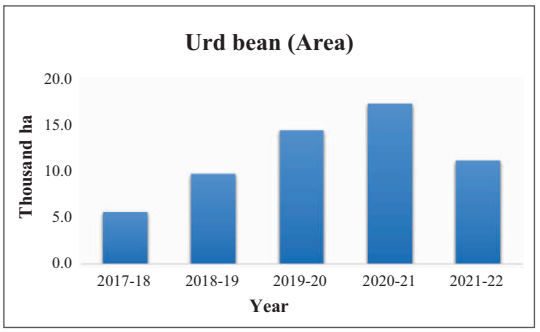
Mung bean

- Varietal Intervention with BM2003-2 and Utkarsh.
- Seed treatment with Thiomethoxam.
- Sowing technique-BBF (broad bed furrow).
- Improved Cultivation Practices with ICM, weed control and IPM.



Urd bean

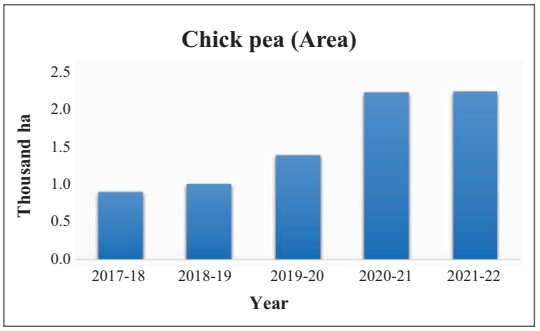
- Varietal Intervention (variety-AKU-15).
- Seed treatment with thiomethoxam.
- Improved cultivation practices includes sowing technique-BBF, weed control and IPM practices.
- Integrated crop management.



Konkan Region

Chick pea

- Varietal replacement and IPM.



Chapter 7

An Economic Analysis of CFLD Pulses in Maharashtra

In Marathwada region, average demonstration yield in case of pigeon pea was increased from 14.07 q/ha (2017-18) to 16.42 q/ha (2021-22) with the net income of Rs.39009/ha and Rs. 62105/ha in 2017-18 and 2021-22, respectively. From the analysis it was found that B:C Ratio has increased from 1.71 to 2.12 between the same period. Highest demonstration yield of 16.98 q/ha was obtained in year 2020-21 with net gain of Rs. 70659/ha. In case of chickpea, demonstration yield was more than 25% higher than the local yield between 2017-18 and 2021-22. B:C Ratio has increased from 1.50 in 2017-18 to 1.92 in 2021-22, whereas cost of cultivation has not increased significantly during the same period (Table 2).

Table 2: Economics of pulses in Marathwada Region of Maharashtra

Marathwada Region						
Crop		**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Pigeon Pea	Demo yield (q/ha)	14.07	10.41	14.63	16.98	16.42
	Local yield (q/ha)	9.50	7.61	12.37	13.52	12.69
	Cost of cultivation (Rs/ha)	22866	21509	25316	27702	29233
	Net income (Rs/ha)	39009	28310	51800	70659	62105
	B:C Ratio	1.71	1.32	2.05	2.55	2.12
Chickpea	Demo yield (q/ha)	16.00	12.94	16.16	17.69	17.52
	Local yield (q/ha)	12.34	9.60	12.51	13.30	13.95
	Cost of cultivation (Rs/ha)	23132	21326	23187	26620	25627
	Net income (Rs/ha)	34687	32826	41091	49588	49140
	B:C Ratio	1.50	1.54	1.77	1.86	1.92

Cost and net income related information of pigeon pea and chickpea of Vidarbha are given in Table 3. In pigeon pea, highest net return of Rs. 58113 per hectare was realized by participating farmers in the year 2020-21. The average demonstration yield was 14.75 q/ha as against the average local yield of 11.87 q/ha. B:C Ratio ranged from 1.58 to 2.31 between 2017-18 and 2021-22. In case of chickpea, the average demonstration yield of 18.98 q/ha was achieved as against the average local yield of 15.70 q/ha in 2019-20. In chickpea, the percent increase in demonstration yield over local yield was increased from 18% to 25% between 2017-18 and 2020-21.

Table 3: Economics of pulses in Vidarbha Region of Maharashtra

Vidarbha Region						
Crop		**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Pigeon Pea	Demo yield (q/ha)	10.76	11.05	13.03	14.75	12.13
	Local yield (q/ha)	8.72	8.94	10.43	11.87	10.02
	Cost of cultivation (Rs/ha)	20725	21330	23062	25196	24682
	Net income (Rs/ha)	32838	36473	43868	58113	46810
	B:C Ratio	1.58	1.71	1.90	2.31	1.90
Chickpea	Demo yield (q/ha)	14.95	16.11	18.98	18.90	18.62
	Local yield (q/ha)	12.65	12.91	15.70	15.14	15.69
	Cost of cultivation (Rs/ha)	24100	24236	28630	31047	28782
	Net income (Rs/ha)	36749	43548	52943	58426	51183
	B:C Ratio	1.52	1.80	1.85	1.88	1.78

During 2021-22, net income and cost of cultivation was recorded Rs. 76715 per hectare and Rs. 25975 per hectare with the B:C Ratio of 2.95 in Western Maharashtra region. Highest demonstration yield (23.47 q/ha) was obtained in year 2017-18, followed by 18.58 and 17.33 q/ha in 2020-21 and 2019-20, respectively. From the analysis it was found that B:C Ratio has increased from 2.17 to 2.95 between 2017-18 and 2021-22. In case of chickpea, the average demonstration yield was more than twenty-five percent higher than the local yield during the same period. The highest average yield (17.65 q/ha) and highest net income of Rs. 62309 per hectare was observed in the years 2018-19 and 2021-22 respectively (Table 4).

Table 4: Economics of pulses in Western Maharashtra Region

Western Maharashtra Region						
Crop		**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Pigeon Pea	Demo yield (q/ha)	23.47	15.60	17.33	18.58	17.15
	Local yield (q/ha)	14.23	11.92	11.90	13.03	13.55
	Cost of cultivation (Rs/ha)	28580	25189	27417	36581	25975
	Net income (Rs/ha)	61972	52170	70606	73029	76715
	B:C Ratio	2.17	2.07	2.58	2.00	2.95
Chickpea	Demo yield (q/ha)	18.59	22.10	19.48	18.64	20.53
	Local yield (q/ha)	12.68	17.65	13.91	14.07	15.43
	Cost of cultivation (Rs/ha)	32937	35491	35722	40370	45387
	Net income (Rs/ha)	43334	59039	59012	54353	62309
	B:C Ratio	1.32	1.66	1.65	1.35	1.37

Cost and income related information of pigeon pea and chickpea of Khandesh region of Maharashtra is given in Table 5. In Khandesh region, average demonstration yield in case of pigeon pea has increased from 15.96 q/ha (2017-18) to 16.11 q/ha (2021-22) with the net income of Rs. 54097/ha and Rs. 64966/ha in 2017-18 and 2021-22, respectively. From the analysis it was found that B:C Ratio has increased from 2.49 to 3.72 between 2017-18 and 2020-21. Highest chickpea demo yield of 18.73 q/ha was obtained with highest net gain of Rs. 100506/ha (B:C ratio 3.72) in 2020-21. In case of chickpea, B:C Ratio has increased from 1.54 in 2017-18 to 2.50 in

Table 5: Economics of pulses in Khandesh Region of Maharashtra

Khandesh Region						
Crop		**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Pigeon Pea	Demo yield (q/ha)	15.96	15.65	16.61	18.73	16.11
	Local yield (q/ha)	11.38	10.44	12.68	14.62	12.67
	Cost of cultivation (Rs/ha)	21731	21330	22996	26997	27740
	Net income (Rs/ha)	54097	52751	56106	100506	64966
	B:C Ratio	2.49	2.47	2.44	3.72	2.34
Chickpea	Demo yield (q/ha)	18.31	19.60	19.01	17.88	18.53
	Local yield (q/ha)	14.26	14.10	15.91	13.22	14.45
	Cost of cultivation (Rs/ha)	27329	29534	32140	30905	27583
	Net income (Rs/ha)	41994	40442	50106	56621	69070
	B:C Ratio	1.54	1.37	1.56	1.83	2.50

2021-22, whereas cost of cultivation has not increased significantly during the same period. Highest yield was obtained in tune of 19.60 q/ha in 2018-19 and highest net economic gain of Rs. 69070/ha (B:C ratio 2.50) in 2021-22.

Chapter 8

Success Stories

1. Chick pea: Ahmednagar-I

Name of KVK:	Ahmednagar-I
Crop and Variety:	Chickpea and Phule Vikram
Name of farmer:	Shivaji Nivruti Chaudhari Village: Shingve Tal: Rahata
Basic information:	• Farmer has 4 ha land and having partial irrigation facilities with well. • Major crops are soybean, maize, cotton during kharif, wheat, gram, onion, fodder during rabi. • Dairy is also allied enterprise with 4 cows.
Technology Demonstrated	Demonstrated new high yielding variety Phule Vikram of chickpea with Integrated Pest Management under CFLD programme
Institutional Involvement	• Provided seeds of new high yielding variety under demonstrations. • Provided Rhizobium, PSB, Trichoderma for seed treatment and pheromone traps, Insecticide Emamectin benzoate for Helicoverpa management
Success Points	• Introduction of variety with seed treatment and using bio-fertilizers/ Bio-fungicide. • IPM technology helped in timely pest management and reduced crop damage
Farmer's Feedback	• Variety is suitable for irrigated condition. • Variety is semi spreading, pod setting is at top of the branches hence mechanical harvesting is possible.

Performance of Technology

Particulars	Yield (q/ha)	Gross cost (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)
Farmer's practice: Used conventional variety Vijay without seed treatment	12.5	40375	60375	20000
Demonstration: Use of new HYV Phule Vikram, seed treatment with bio fertilizers and IPM	20.0	44775	99600	51825
% Increase	**60**			

2. Chick pea: Kolhapur-II

Name of KVK	KVK Kolhapur-II
Crop and Variety	Chickpea and Digvijay
Name of farmer & Address	Mr. Balu Bajirang Bodake At/post- Daryache Wadgaon, Tal- Karveer, Dist- Kolhapur
Technology Demonstrated	Provided gram variety Digvijay and other inputs
Institutional Involvement	• Shri Siddhagiri KVK initially trained farmer about improved production technology in gram by using integrated crop management technology. • KVK provided improved seed, bio fertilizer, bio pesticide, pheromone trap with lure etc.
Success Point	• Chemical fertilizer dose of 25:50:30 NPK kg/ha. • Spraying of Neem-oil as first spray, other bio pesticide and spray of insecticide.
Farmer's Feedback	This variety is bold seeded, high potential yield & good response to late sowing
Outcome Yield (q/ha)	
Demonstration	17.3
Potential yield of variety/technology	21
District average	9.6
State average	7.96

Performance of Technology

Specific Technology	Yield (q/ha)	Gross cost (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)
Farmer practices	12	39000	58500	25882
Demonstration	17.3	43640	88230	48230
% Increase	44.16			

3. Chick pea: Nandurbar

Name of KVK	KVK Nandurbar
Crop and Variety	Black Gram and Vishwas
Name of farmer & Address	Mr.Sonya MotyaPawara, Tal: Dhadgaon, Dist.: Nandurbar
Technology Demonstrated	**Integrated Crop Management :-** • Demonstration of Improved variety (Vishwas) of Black gram seed @ 5kg/acre. • Biofertilizers and Trichoderma as a seed tratment • Trichoderma @ 5 gm/kg seed • Rhizobium @ 25gm/kg of seed • PSB @ 25gm/kg of seed • Correction of Zinc deficiency. Application of micronutrients i.e ZnSo4 @ 25 kg/ha at sowing time in soil. • Use of IPM package:- ▪ Neemark @ 2ml/acre ▪ Beveria bassiana : @1kg/Acre. ▪ Use of Pheromone traps+Lures @2/acre. ▪ Potassium Nitrate (13:00:45) 1% spraying ▪ Spraying of insecticides: Quinolphos20 EC @½ lit/Acr. • Storage of seed :- Grain storage bags (Grain pro bags)@4 bags/demo.
Institutional Involvement	• Identified the Green gram growers in villages Dhadgaon, Shelkui and Shivanipada • Two times farmers meetings organised and discussed the Black gram cultivation practices. • The cluster approach of block sowing of Black gram crop was followed. • Meeting organized to analyze the technology gap and to get information on farmers practice regarding Black gram cultivation.
Success Point	• Maintained plant population • Timely pest disease management and harvesting • Timely intercultural operations
Farmer's Feedback	• Bold seeded variety and ICM Package found effective for increasing yield (56 %) • Bio fertilizer seed treatment found effective for germination and wilt disease. • Variety found resistant against PM and leaf spot diseases. • Yellow mosaic was observed in variety.

Performance of Technology

Particulars	Yield (q/ha)	Gross cost (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)
Farmer's practice	3.92	10700	26852	16152
Demonstration	6.13	12350	41991	29641
% Increase	56			

4. Pigeon pea: KVK, Pune -I

Name of KVK	Pune -I
Crop and Variety	Pigeon pea and BDN-711
Name of farmer & Address	Mr. Sunil Jagatap At/post- Jalgaon K.P. Tal- Baramati Dist Pune M.S.
Technology Demonstrated	• Demonstrated Improved variety (BDN-711) of Red gram. • Conducted IPM for pod borer complex • Use of pheromone traps for monitoring of pest population • Use of alternate spray of HaNPV and 5%NSKE at the time of 50% flowering • Spray 50% Chloropyriphos at pod filling stage • INM • Seed treatment of Rhizobium and PSB @ 25 gm /kg seed • Use of fertilizers as per soil test report • Use of 20 kg sulphur/ha as secondary nutrient • During dry spell foliar application of 13:00:45@ 0.5%
Institutional Involvement	• One times farmers meeting was conducted to analyse the technology gap and to get information. • Farmers training were conducted before demonstration. • Field day was conducted on farmer's field just before harvesting of Red gram and got feedback from farmers.
Success Point	• Pigeon pea variety BDN-711 gives 26.9% increased yield against Var. Vipula. • Use of IPM to control Pod borer complex by using Pheromone traps, NSKE 5% Andchloropyriphos 20EC effectively controlled the pod borer complex.
Farmer Feedback	• Variety BDN-711 having maximum 2128 pods per plant with 6384 seeds/plant which is well suited for Baramati tahsil of Pune district • Increased pollination and yield by saving honeybees (use of bio pesticides).

Performance of Technology

Practice used	Yield (q/ha)	Gross cost (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)
Farmer practices	16.84	31240	62308	31068
Demonstration	21.38	32410	79106	46696
% Increase	27			

5. Pigeon pea: KVK, Solapur-I

Name of KVK	KVK, Solapur-I (Maharashtra)
Crop and Variety	Pigeon pea and BDN-711
Name of farmer & Address	Mr. DhanajiKashinathShelke, A/P : Surdi, Ta; Barshi, Solapur(Maharashtra)
Technology Demonstrated	• Seeds of Improved variety BDN-711 of Pigeon pea was introduced. • Wide row planting at distance of 6 X 1.25 ft by dibbling with drip irrigation. • In situ soil moisture conservation by preparation of Dead Furrow 45 DAS. • Correction of deficiency of micronutrients (Zn, S, Fe) by application of micronutrients i.e ZnSo4 and FeSO4 @ 12.5 kg/ha at sowing time through soil. • Foliar application of micronutrients during flowering and pod filling stage @ 2.5 liter/ha. • Monitoring and control of pod borer pest by the use of IPM technology.
Institutional Involvement	• Two trainings conducted on Integrated crop management and integrated pest management in Pigeon pea to improve skill and understanding of FLD farmer. • Conducted massive extension activities for creation of awareness & field day at crop maturity stage. Also given prompt advisories during crop growth stage.
Success Points	• Improved variety BDN-711 is resistant to sterility mosaic and wilt disease and highly suitable under existing farming system. • Synchronised flowering and highly responsive to irrigation and fertilizer application. • Sowing at wide row spacing of 6 X 1.25 ft and topping helped for vigorous branching. • Soil test based fertilizer application with in situ soil moisture conservation by preparation of Dead Furrow helped to improve yield and overcome stress.

Farmer Feedback	• Average No. of pods /plant observed in demonstration plot were more than 2400-2700 per plant. • Topping at interval of 45 DAS and 75 DAS helps in profuse branching. • Improved variety BDN-711 found resistant to sterility mosaic and wilt disease.			
Yield (q/ha)	Demonstration	Potential yield	District average	State average
	35.50	30	6.57	8.50

Performance of technology

Practice used	Yield (q/ha)	Gross cost (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B:C ratio
Farmer practices	12.50	17857	50,000	32143	2.80
Demonstration	35.50	32597	1,42,000	109403	4.35
% Increase	184				

6. Black gram: KVK, Washim

Name of KVK	KVK Washim
Crop and Variety	Black gram; AKU 10-1 variety (PDKV BLACK GOLD VARIETY)
Name of farmer & Address	ShriTulshiram Shankar Nitnaware At NawaliTqRisodDistWashim
Technology Demonstrated	• Demonstration of Improved variety AKU 10-1 was given. This is the new improved variety demonstrated first time on selected farmers field • Correction of deficiency of micronutrients (Zn, S, Fe) by application of micronutrients i.e ZnSo4 @ 20-25 kg/ha at sowing time in soil. • Use of 5% NSKE and CIB registered pesticide as measures for management of leaf eating caterpillars in crop and powdery mildew tolerance of demonstrated variety also helps to manage powdery mildew. • Monitoring and control of sucking pest by the use of Yellow Sticky trap carried out.
Institutional Involvement	• Two times farmers meetings conducted to analyze the technology gap and to get information on soil, water and other conditions. • Farmers training were conducted before conducting demonstration. • Field day was conducted on farmer's field just before harvesting of green gram and got feedback from farmers.
Success Point	• Installation of yellow sticky trap at the time of flowering helps to monitor and to check the population of sucking pests effectively. • Use of 5% NSKE at the time of flowering and Pod formation stage helped to manage incidence of Spodoptera, semilopper and spingid moth.
Farmer Feedback	• Higher yield of demonstration was due to high yielding variety i.e. PDKV BLACK GOLD var and use of INM and IPM component in demonstration • Demonstrated technology gave additional net return of. Rs 8388/- per acre as compared to traditional farmers practice.
Yield (q/ha)	
Demonstration	9.70 q/ ha
Potential yield of variety/technology	12 to 14 q/ ha
District average	5.14 q/ ha
State average	6.50 q/ ha

Performance of Technology

Practice used	Yield (q/ha)	Gross cost (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)
Farmer practices	6.50	25700	37700	12000
Demonstration	9.70	23970	56260	32970
% Increase	49			

7. Pigeon pea: KVK Nandurbar

Name of KVK	KVK Nandurbar
Crop and Variety	Pigeon pea and BDN 711
Name of farmer & Address	Mr. Manesh Mansu Lokani Village Shravani Tal. Navapur Dist.-Nandurbar
Technology Demonstrated	**Integrated Crop Management :-** • Demonstrated Improved variety (BDN 711) • Biofertilizers and Trichoderma as a seed tratment • Trichoderma @ 5 gm/kg seed • Rhizobium @ 25gm/kg of seed • PSB @ 25gm/kg of seed • Correction of Zinc deficiency. Application ZnSo4 @ 25 kg/ha at sowing time in soil. • Use of IPM package - Neemark(10000ppm)500ml/acre - Use of Pheromentraps+Lures @2/acre. - T bird purchase • Potassium Nitrate (13:00:45) 1% spraying • Spraying of insecticides: Quinolphos20 EC @½ lit/Acr. • Storage of seed :-Grain storage bags (Grain pro bags)@2 bags/demo.

Institutional Involvement	• Identify the Pigeon pea growers in Taluka:Navapur, village: Savrat • Farmers meetings organised. • The cluster approach block sowing of red gram crop. • Meetings organized to analyze the technology gap and also to discuss soil testing and other conditions. • 4 Demonstrations and 1 field day was conducted in ICM.
Success Point	• Maintained plant population • Timely pest disease management and harvesting • Timely inter-cultural operations • Collection of folded leaf
Farmer Feedback	• Bold white seeded variety- BDN 711. • Bio fertilizer seed treatment found effective for germination and wilt disease • Variety BDN 711 found resistant to water stress & sterility mosaic disease. • Seed treatment of trichoderma found effective for the control of fusarium wilt • ICM Package found effective for increasing yield (45%)

Performance of Technology

Practice used	Yield (q/ha)	Gross cost (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)
Farmer practices	14.01	18950	85461	66511
Demonstration	20.43	20300	124623	104323
% Increase	45.80			

8. Chick pea: KVK Beed-I

Name of KVK	Beed-I
Crop and Variety	Chick pea and PhuleVikram
Name of farmer & Address	Ram Pandurang Lakhe, At Khodas, Post Aadas, Tq. Dharur, Dist Beed
Basic information about farmer field	• Soil: pH- 7.89, Ec-0.863, OC-0.44%. • The soils are moderately fertile in nature. • Well drained soil with good moisture retention capacity.

Technology Demonstrated	• **Varietal replacement**: - Variety JAKI-9218 with new mechanical harvesting variety i.e. Phule Vikram. • **Seed treatment** – Seed treatment of chick pea with Vitavax 2 gm/kg of seed with 5ml of Rhizobieum + 5 ml of PSB and 5 gm of Trichoderma per kg of seed. • **Sowing method**: Drilling & dibbling method • **Soil test based nutrient management** – On the basis of test, nutrient managements were advised as follows (i) Application of 10kg sulphur and (ii) 8 kg zinc sulphate (iii) Chileted micronutrients (iv) 12:61:00 was advised to spray during flowering stage and 00:52:34 during pod filling stage. • **Integrated pest management**: Use of pheromone traps with heli lures and bird perchers saved cost of insecticide. Use of *flubendamide* and *Emamectin benzoate & neemark* for heliothis armigera. Trichoderma and Carbendizum + Mancozeb used to control wilt.
Institutional Involvement	Line department were involve under Field Days.
Success Points	• Replacement of variety • Good quality seed with high yielding variety • Resistance to pest and diseases • Bold seeded variety having more number of pods and good vegetative growth
Farmer's Feedback	• Variety suitable for mechanical harvesting, which reduces risk of labour problem. • Variety is having lodging resistance. • Bold seeded quality seed • Remunerative prices. • Seed production gives good monetary returns.

Performance of Technology

Particulars	Yield (q/ha)	Gross cost (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)
Farmer practices	18.60	26250	97650	71400
Demonstration	29.75	34200	156185	121985
% Increase	60			

9. Pigeon pea: KVK Nagpur

Name of KVK	KVK Nagpur
Crop and Variety	Pigeon pea and BDN-716
Name of farmer & Address	Santosh Kumbhare, Village –Saleghat , Block-Parsioni, District-Nagpur
Background Information	• Field is leveled and pre-dominantly deep black soil with good water holding capacity. • Nutrient analysis conducted by KVK showed deficiency in Zinc and ferrous content.
Technology Demonstrated	• Demonstrated Improved variety BDN-716. • Intercrop with cotton 8:2 pigeonpea rows. • In situ moisture conservation practices. • Correction of deficiency of micronutrients (Zn,S,Fe), by application of micronutrients i.e. ZnSo4 and FeSo4 @ 12.5 kg/ha at sowing time. • Foliar application of micronutrients during flowering and pod filling stage @ 2.5lit/ha. • Monitoring and control of pod borer pest by use of IPM technology
Institutional Involvement	• Four trainings on ICM and IPM in pigeonpea to improve skill and understanding of CFLD farmers. • Conducted extension activities for creation of awareness and field day at crop maturity stage. • Also provided prompt advisories during crop growth stage.
Success Point	• Improved Variety BDN-716 is wilt resistant and highly suitable for rainfed farming system. • Synchronised flowering and responsive to fertilizer application • Soil test based fertilizer application with in situ moisture conservation practice helps to improve yield and overcome stress.

Farmer Feedback	• Average number of pods/plant in demonstration plot were more 800-1000 per plant as compare to farmer practice plot. • Topping at interval of 45 DAS and 75 DAS helps in profuse branching. • Improved variety BDN-716 found resistant to wilt disease.			
Outcome Yield (q/ha)	Demonstration	Potential yield of variety/technology	District average	State average
	21.95	25	7.24	8.5

Performance of Technology

Specific Technology	Yield (q/ha)	Gross cost (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)
Farmer practices	12.60	26500	75600	49100
Demonstration	16.20	27200	97200	70000
% Increase	29			

10. Chickpea (JAKI-9218): KVK, Buldhana

Mr. Prakash Gumanrao Sapkal aged 41, is one of the contact farmer of Buldhana residing at Umala village of Buldhana district. He has 3 acres of land under the cultivation of *Kharif* crop Soybean, Black gram, Green gram and under Rabi season bengal gram regularly. He used to cultivate Chickpea variety Digvijay which is available locally with conventional practices. Continuous use of local varieties (Digvijay) leads to an enormous reduction in the yield and income.

In this condition, the KVK has selected him as one of the beneficiary farmers for the demonstration of Chickpea variety JAKI-9218 under the cluster front line demonstration on Pulses programme during 2016-17. The KVK introduced him the improved Chickpea variety JAKI-9218 with detailed package of practices. Consecutive field visits made by the team of Scientists to train him about technologies in chickpea.

He has adopted the new technologies like seed treatment with bio fertilizers, integrated nutrient management, proper weed management, integrated disease and pest management to harvest higher yield and more income.

Chapter 9

Reflections

- The impact of CFLD Pulses programme was reflected through the increase in degree of crop diversification across different regions of Maharashtra.
- The Simpson index, which measures the degree of crop diversification has increased from 0.65 during 2010-11 to 0.74 during 2019-20. This indicates that the farmers of Maharashtra are following more diversified cropping pattern in 2019-20 as compared to the year 2010-11.
- Western Maharashtra showed significant increase in Simpson index between the period 2010-11 (0.42) and 2019-20 (0.60), whereas the degree of crop diversification has declined in Konkan region during the same period.
- Regional analysis revealed that area under pulse crops is increasing between 2009-10 and 2019-20 across the regions in Maharashtra.
- Marathwada and Vidarbha regions together contributes more than 75 and 80 per cent of total area and production, respectively under pulses during 2019-20.
- Number of CFLDs reduced between the period 2017-18 and 2021-22, but due to the impact of CFLD Pulses programme, farmers adopted technologies and also expanded the area under pulses.
- Extent of technology adoption measured through horizontal expansion of agricultural technologies indicated a positive sign across the crops and regions in Maharashtra.
- In case of Urdbean, more than 45 percent increase in area coverage under new technologies was observed in Marathwada, Khandesh and Western Maharashtra regions between the period 2017-18 and 2021-22.
- Regional analysis helped in identifying the priority areas, where we can encash the opportunity of expanding the pulses area under non-conventional pulse growing regions.
- Successful cases farmers should be used as resource persons in the district for facilitating field extension system.
- Technical feedback on demonstrated technology should be recorded and informed to the concerned institution for further information.
- For fast technology transfer, cluster

approach for pulses demonstrations found very effective and useful in the villages.

- Technologies developed by ICAR institutes/ SAUs and suitable under climatic vulnerability situation should be identified for CFLD action plan.
- Many cases were found where farmers got higher yield under demonstrations as compared to potential yield in pulse crop cultivars. Such cases should be studied in-depth for investigating their factors responsible for the results.

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