Indian Journal of Extension Education
Vol. 54, No. 2, 2018 (153-161)

Impact of KVK Activities on Dynamics of the Adoption of Climate resilient Agricultural Technologies In Bundelkhand Region of M.P.

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ABSTRACT

Krishi Vigyan Kendras are conducting various programmes with the felt needs of the farmers as per the resources available to enrich knowledge and skill competency of the farmers to adopt the changed practices for more production and income for their sustainable livelihood. Climate change threatens to derail the lives and livelihoods of farmers if appropriate adaptation measures are not put in place. Technology adoption is seen as an important tool for increasing agricultural efficiency and struggle food insecurity. The present study conducted at KVK in the districts of Datia and Tikamgarh. The information was collected through personal interview schedule. The study revealed that there was increase in productivity of farmers was observed due to adoption of various smart practices as suggested by KVKs. Programme was found to be useful in imparting knowledge and adoption level of farmers in various aspects of climate resilient agricultural technologies. Practices created greater awareness and motivated the other farmers to adopt appropriate production technologies.

Keywords: Adoption, agricultural technology, climate change, climate resilient agricultural technologies, Krishi Vigyan Kendra,

INTRODUCTION

Krishi Vigyan Kendra (KVK), an innovative science based institution plays an important role in bringing the research scientists face to face with farmers. The main aim of KVK is to reduce the time lag between generation of technology at the research institution and transfer technology to the farmers for increasing productivity and income from the agriculture and allied sectors on sustained basis. KVKs are grass root level organizations meant for application of technology through assessment, refinement and demonstration of proven technologies under different micro farming situation at district (Das, 2007).

Farmers in India are still producing crops based on the knowledge transmitted to them by their forefathers leading to a grossly unscientific agronomic, nutrient management and pest management practices. As a result of these, they often fail to achieve the desired potential yield of various crops and new varieties. Potential yield is determined by solar radiation, temperature, photoperiod, atmospheric concentration of carbon dioxide and genotype characteristics assuming water, nutrients, pests, and diseases are not limiting the crop growth. Under rainfed situation, where the water supply for crop production is not fully under the control of the grower, water-limiting yield may be considered as the maximum attainable yield for yield gap analysis assuming other factors are not limiting crop production. However, there may be season-to-season variability in potential yield caused by weather

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variability, particularly rainfall. Water-limiting potential yield for a site could be determined by growing crops without any growth constraints, except water availability (Singh et al. 2001).

Technology is assumed to mean a new, scientifically derived, often complex input supplied to farmers by organizations with deep technical expertise. Neill and Lee point out that the majority of existing literature on agricultural technology adoption is focused on Green Revolution (GR) technologies such as irrigation, fertil-izer use, and the adoption patterns of high-yield variety (HYV) seeds.

The state of Madhya Pradesh has reason to be concerned about Climate Change, as we have a large population dependent on agriculture and forests for livelihood. The state's economy is also dependent on natural resources and any adverse impact on these and allied sectors will negate our efforts to alleviate poverty and ensure sustainable livelihood for the population. This is an opportune time to integrate the concerns of Climate Change into our policies and ensure ultimate objective of sustainable development with inclusive growth.

Agriculture in Bundelkhand is rainfed, diverse, complex, under-invested, risky and vulnerable. In addition, extreme weather conditions, like droughts, short-term rain and flooding in fields add to the uncertainties and seasonal migrations. The scarcity of water in the semi-arid region, with poor soil and low productivity further aggravates the problem of food security. Total population of Bundelkhand is 18.3 million, and 79.1% of population lives in rural areas (Census 2011) and more than one third of the households in these areas are considered to be Below the Poverty Line (BPL). The poverty situation in the region has also become extremely critical in the recent years. This is because of lack of employment and lack of opportunities. The insecurity of livelihoods and lack of supportive governance have led to forced large-scale migration of the local population.

Agriculture production is mainly dependent on climatic conditions. Climate plays a vital role in agriculture and allied activities. Prime decision making of these sectors is based on predicted weather parameters of a region. Seasonal nature of crops shows how climate affects fate of crop. Each crop, even varieties are highly specific to climate parameters, which are reflected in their yield. Specific temperature range is required for each stage of growth and development. Annual rainfall, maximum and minimum temperature, light intensity, relative humidity, wind velocity, soil moisture content, soil temperature, and atmospheric gaseous composition are the most critical factors determining crop growth. Climate can be a boon for production; at times it can also wreck the whole. Rise in the mean temperature above a threshold level will cause a reduction in agricultural yields. A change in the minimum temperature is more crucial than a change in the maximum temperature. Grain yield of rice, for example, declined by 10 per cent for each 1°C increase in the growing season minimum temperature above 32°C in growing season (Pathak et al., 2003).

Climate change impacts on agriculture are being witnessed all over the world, but countries like India are more vulnerable in view of the high population depending on agriculture and excessive pressure on natural resources. The warming trend in India over the past 100 years (1901 to 2007) was observed to be 0.51oC with accelerated warming of 0.21oC per every10 years since 1970 (Kumar 2009). Water requirement of crops is also likely to go up with projected warming and extreme events are likely to increase. Hence, there is a need to address the whole issue of climate change and its impacts on Indian agriculture in totality so as to cope with it through adaptation and mitigation. Climate change impacts on agriculture are being witnessed all over the world but country like India is more vulnerable in view of the high population depending on agriculture, excessive pressure on natural resources and poor coping mechanism.

METHODOLOGY

The present study is conducted at Datia and Tikamgarh district of M.P. Datia district is located in the northern part of Madhya Pradesh. The district has been suffering from drought since the last 10 years. Recently, the rainfall pattern has also changed with long dry spells and less number of rainy days. The Tikamgarh district has been suffering from drought since last five years. Recently, the rainfall pattern has also changed with long dry spells and early withdrawal of monsoon. More than 90% of cultivated area in the districts is rainfed and black gram, soybean, sesame, groundnut and paddy crop in kharif and wheat, mustard and gram is a major crop in rabi. The districts fall under Bundelkhand region as one agro climatic zone.

The technology demonstration components envisaged identifying climate vulnerabilities to agriculture in selected village in the district based on climate related problem, farmers experience, perceptions and preparing and implementing, adaptation and mitigation strategies following a bottom to top approach. The activities of KVKs are not only to demonstrate the climate resilient agriculture technologies but also to continued adoption of such practices in sustainable manner. The village from district was selected on basis of concerned KVK of district. The major climate challenges encounters are prolong dry spell like situation (drought). Total No. of 150 farmers were surveyed under the study. The numbers of respondents were randomly selected from each of the villages, while each KVK is a case by itself and focus of study, they also represent KVKs under different systems. Interview schedule was administered to generate data and the collected data was statistically analyzed through frequency and percentages. The findings were presented as per the expressed responses of the farmers/ farmwomen.

The rank correlation was calculated through formula suggested by Spearman as follows:

$$P = 1 - \frac{6 \sum d_i^2}{n\,(n^2 - 1)}$$

Where,

di = difference in rank

n = No. of observations

di = $xi - yi$ between the ranks of each observation on the two variables are calculated.

RESULTS AND DISCUSSION

The adoption gain after adopting the different adaptation strategies to climate change, as identified by the surveyed farmers, the following climate resilient agricultural interventions were considered for demonstration in farmers' fields during the study period are presented in Table 1.

Selection and use of drought tolerant varieties

Out of 16 adaptation strategies, selection and use of drought tolerant varieties, 90.00 per cent of farmers were adopting it after KVKs interventions in the selected village with rank as first, The highest adoption was found in use of drought tolerant varieties because farmers a drought tolerant variety was considered to have greater rooting density with depth in the soil profile for greater access and extraction of soil water. Combined drought & heat stress tolerance has greater benefit than either of the traits under climate change. Drought is the most common plant stress factor on the planet and over time plants have developed adaptation strategies that allow them to mitigate the negative effects of water deficits. Further, non adoption of the drought tolerant varieties might be due to the non availability of recommended variety in required quantity at sowing time. Another reason was that cost of the variety seed was rarely 40-60 per cent more than the local variety. After drought, farmers may feel the need to compensate for crop loss due to drought by cultivating more crops after the season. We found this benefit only in areas where farmers can cultivate crops after kharif, in areas where it is possible to produce double crops. The findings are in line with Kumawat (2008).

Cultivating short duration crops

Cultivating short duration crops mainly soybean, mustard and sesame was adopted by 45.33 farmers before KVK interventions and 84.67 per cent after

Table 1: Ranked order of the different adaptation strategies to climate change, as identified

(*n* = 150)

Improved technologies	Adaptation Strategies				
	Before		After		Rank
	No.	%	No.	%	
Selection and use of drought tolerant varieties	77	51.33	135	90.00	I
Cultivating short duration crops	68	45.33	127	84.67	II
Integrated farming system	59	39.33	125	83.33	III
Judicious use of available water	54	36.00	120	80.00	IV
Practicing crop rotation	47	31.33	116	77.33	V
Practicing intercropping	45	30.00	113	75.33	VI
Use of salinity tolerant varieties	39	26.00	109	72.67	VII
Practicing crop diversification	37	24.67	105	70.00	VIII
SRI: Water saving paddy cultivation	32	21.33	99	66.00	IX
Early planting of Rabi crops	29	19.33	95	63.33	X
In-situ soil moisture conservation	27	18.00	88	58.67	XI
Deep ploughing	25	16.67	78	52.00	XII
Zero tillage	23	15.33	77	51.33	XIII
Crop insurance	22	14.67	74	49.33	XIV
Agro forestry	19	12.67	73	48.67	XV
Soil conservations techniques	16	10.67	72	48.00	XVI

Data in table 1 presented the dynamic performance of most adopted technologies by the farmers recommended by KVK in adopted villages / clusters.

KVK interventions respectively as ranking at second place. This might be due to the short duration of crop variety helps farmers to cultivate crops after the main agricultural season (kharif). After drought, farmers may feel the need to compensate for crop loss due to drought by cultivating more crops after the season. We found this benefit only in areas where farmers can cultivate crops after kharif, in areas where it is possible to produce double crops. Furthermore, most of the transplanting is done during the month of July-August and harvest the crop by December only, which creates problem for cultivation of crops in fields. In order to gain time for winter crop cultivation, short duration varieties were introduced to farmers, among the different varieties. The crops sown during July could be harvested by mid October. By promoting short duration varieties the farmers could now cultivate winter crops and fetched additional income. Short-duration and temperature tolerant varieties of Rabi crops were promoted by KVK for cultivation. The varieties gave higher yields than local varieties.

Integrated farming system

The third most important adaptation strategy was the "integrated farming system" (being engaged in two or more enterprises which act symbiotically with one-another) as rank III. This farming system is becoming more popular throughout the region because of its economic returns. Practicing integrated farming system farmers were encouraged to take up cattle to tide over the losses due to drought. The adopted farmers were establishing the cattle units. These systems are gradually creating awareness among other farmers and many of them are approaching the KVK to help them set up the integrated farming system on their farms.

Judicious use of available water

Judicious use of available water was adopted by 36 per cent farmers before and 80 per cent after KVK interventions as ranked four. Thus important, among farmers' adaptive strategies to climate change. Use of available water increases the yield of production, improving nutrient availability to the plants but also leading to increased soil salinity. Water is an important factor in crop production system. Water shortage due to weather variability causes constraint to produce more crop to meet increasing demand. In spite of providing assured irrigation, use of pest-resistant high-yielding varieties, and high inputs of fertilizers and pesticides, crops yields are plateauing. Hence, to invest on improving water productivity and produce more crops was promoted through the KVK.

Practicing crop rotation, intercropping

The Practicing crop rotation, intercropping were adopted by 31.33 and 30 per cent before and 77.33 and 75.33 per cent farmers after KVK intervention as rank fifth and sixth respectively. The "Practicing crop rotation" is becoming more popular throughout the region because of it's economically profit. Intercropping offers farmers the opportunity to engage nature's principle of diversity on their farms. Plant spatial arrangements, planting rates, and maturity dates must be considered when planning intercrops. Intercrops can be more productive than growing pure stands.

Adoption of salinity tolerant varieties

After KVK interventions 72.67 per cent farmers were adoption salinity tolerant varieties as rank seventh. This might be due to the irrigation increases the yield of production, improving nutrient availability to the plants but also leading to increased soil salinity.

Crop diversification

24.67 per cent farmers were habituated to rice-wheat system is predominant in the adopted village. Crop diversification was promoted by KVK inclusion of different short-duration pulses, oilseeds and vegetables for minimizing water requirement enhance soil fertility and increased farmers' income as rank eighth. Hence, all the cropping systems performed better and gave higher net returns compared to rice-wheat system.

Water saving paddy cultivation: practicing SRI

Water saving paddy cultivation: practicing SRI was identified as the ninth-ranked adaption strategy with adopted by 66 per cent after KVK intervention against the 21.33 per cent before KVK intervention. This might be due to the water is an important factor in rice production system especially in lowlands. Water shortage due to weather variability causes constraint to produce more rice to meet increasing demand. In spite of providing assured irrigation, use of pest-resistant high-yielding varieties, and high inputs of fertilizers and pesticides, rice yields are plateauing. Hence, to invest on improving water productivity and produce more rice, SRI was promoted through the KVK interventions.

Early planting of rabi crops

The tenth important adaptation strategy among farmers' to climate change was early planting of rabi crops, 63.33 per cent farmers were adopting it after KVK intervention as the tenth ranked long. The dry spell (4-5 months) during winter months coupled with no irrigation facilities leads to very low crop yield, especially winter vegetable crops. Under this situation, farmers are reluctant to cultivate crop with apprehension of crop loss. Therefore, to address this problem, advancement of planting time for rabi crops was encouraged in farmers fields, immediately after harvesting of kharif crops when there is still moisture in the soil.

In-situ soil moisture conservation

In-situ soil moisture conservation practices is the eleventh ranked important adaptation strategy by adopting 58.67 per cent farmers after KVK intervention. Soybean sowing through broadcasting is common in the village, resulting in poor soil moisture conservation and one of the major causes for low crop yields. Hence, demonstrations on broad bed and furrow method of soybean sowing were conducted on selected farmers' fields. This is Suitable land configuration helps in enhancing the time of concentration, absorption and storage of rainwater in soil. Demonstrations on ridge and furrow method of soybean sowing were gave higher yield and income per ha compared to farmers' practice.

Deep ploughing

Most of the farmers i.e. 83.33 per cent have discontinued the practice of deep ploughing during summer for various reasons. This is also one of the reasons for crop failure. Hence, 52 per cent farmers adopting this practice after KVK intervention were laid out to demonstrate the advantages of deep ploughing during summer reduction in weed infestation, diseases and insect-pests and increase in yield. In addition, deep ploughing during summer was encouraged among the farmers for efficient conservation of soil moisture.

Practicing zero tillage

Practicing zero tillage was identified thirteenth-ranked adaption strategy (before KVK intervention only 15.33 per cent farmers, after KVK intervention 51.33 per cent adopted this practice). Generally, 2-3 or even more tillage operations are required which cost both time and money for the farmers. Wheat sowing by conventional methods requires multiple tillage operations to prepare a fine seed bed after harvesting of paddy crop. Moreover, shortage of time after paddy harvest to sow wheat creates uncertainty and delay in sowings. This sometimes results in moisture stress during the initial stages of crop growth eventually leading to poor yields. Impeded drainage in low lying fields makes it difficult for carrying out normal tillage operations. In such fields, late planting of wheat exposes the crop at critical stages to heat stress leading to decline in productivity. Demonstrations of zero till drill sown wheat in farmers' fields were undertaken in several villages. The zero till drill not only saves tillage costs and energy but also eliminates the need for seedbed preparation. Zero till drilled wheat yields were on par with conventionally sown wheat.

Crop insurance

Crop insurance was ranked as fourteen the least important adaptation strategy. Crop insurance in general has not been so successful across the realm. Policy makers have unrolled various avatars of crop insurance in different times. Considering the unique nature of Indian agriculture and inequitable socio-economic status of Indian farmers, crop insurance has remained a failed attempt in general. Even after repeated revision of the schemes and huge support in the form of premium subsidies for the farmers, crop insurance has failed to produce the desired results. Even after more than decades of existence of crop insurance in some form or the other, it has only reached just a small percentage of the farmers. Pradhan Mantri Fasal Bima Yojana (PMFBY)-2016 has been the most recent version of crop insurance in the country. Pooling in the important learning from all the earlier schemes and taking into consideration of access to technology in the recent days, Pradhan Mantri Fasal Bima Yojana promises to take care of the loopholes of earlier schemes.

Agroforestry

Agroforestry was ranked as fifteen play an important role in global efforts to tackle climate change. In smallholder farming systems, trees and forests are often key to livelihoods. Increasing the resilience of farming and forest systems to maintain and enhance the flow of ecosystem services, mitigating emissions from the sector by reducing deforestation.

A soil conservations technique

A soil conservations technique was ranked as sixteenth. This is most effective means of soil & water conservation. Ridge/Furrow is for water conservation.

The findings of the investigation revealed that the adoption with respect to climate resilient smart technology was different from practice to practice. Similar finding was report by Singh et al (2014). The calculated value of *Spearman's rank correlation* is found to be positive and lies between 0 to +1, the correlation of rank is considered to positive significant.

Adoption and impact of climate resilient technology under crop production:

Data presented in table – 2 regarding performance of introduced short duration varieties reveal that the three varieties, JS-95 60 (Soybean), JGN-3 (Groundnut) and JTS-8 () appeared very promising with increase in yields 58, 47 and 58 per cent respectively. Soybean, Groundnut and Sesame variety of JS – 95 60, JGN-3 and JTS - 8 maturity period decrease in 27, 12 and 26 days respectively. Similar observations were found in short duration rice variety PR 115 by Sidhu et al (2014).

Table 2: Performance of introduced short duration varieties

Crop/variety	% increase in yield	Decrease in maturityover local (days)
Soybean (JS-95-60)	58	27
Groundnut (JGN-3)	47	12
Sesame (JTS-8)	58	26

Data concerning Performance of introduced varieties are shown in table -3. Data indicated that varieties of rabi crops mustard – pusa jai kisan suitable under limited irrigation conditions increase yield 29.5 per cent and additional income Rs. 9560/- per ha over local practices. Similarly, temperature tolerant varieties of rabi crops chick pea – JG-11 were promoted for cultivation, the varieties gave 23.6 % higher yields and Rs. 10509/- additional income over local varieties.

Data with respect to effect of supplemental irrigation on crop yield and economic are presented in table – 4 reveal that the supplemental irrigations to

Table 4: Effect of supplemental irrigation on crop yield and economic

Crop/variety	Yield (Kg./ha)	Net return (Rs./ha)
Mustard (Pusa Jai Kisan)	1273	27913/-
Chickpea (JG-11), (JG-130)	1546	33212/-

mustard crop was noted increased the yields where an average of about 12.73 qt/ha is possible over the existing rainfed yields and net return of about Rs. 27913/- per ha is possible over the rainfed yields.. Similarly, it was noted the net return increased Rs. 33212/- per ha over local practice under chickpea crop (var. JG-11 and JG-130) and yield gain 15.46 qt/ha proved the economic viability of the intervention made under demonstration and convinced the farmers with respect to realize the utility of intervention.

The Performance of soybean in ridge and furrow methods of sowings presented in Table 5. It reveals that higher net return of Rs 38805/- per ha with B: C ratio of 3.51 is recorded in ridge and furrow system whereas, the net return of Rs 18898/- per ha with and B: C ratio of 2.41 was recorded under farmer's practice of sowing. There are several systems of sowing soybean and it has been established that sowing in lines using drills is the most appropriate. Further there are several drills like conventional seed-cum fertilizer drill, zero till drill, raised bed planter, ridge and furrow planter and broad bed planter etc. that can be used for sowing of soybean. Similar results reported by Jain et al (1998); Jat et al (2003); Verma

Table 3: Performance of introduced varieties

Crop/variety	% increase in yield	Additional Income (Rs./ha)	Varietal character
Mustard (Pusa Jai Kisan)	29.5	9560/-	Suitable underlimited irrigation conditions
Chickpea (JG-11)	23.6	10509/-	Tolerant to high temperature
Chickpea (JG-130)	31.5	11417/-	Suitable for rainfed condition

Table 5: Performance of soybean in ridge and furrow method of sowing

Particular	Ridge and Furrow	Farmers' practice	% increase in yield/income
Grain yield (kg/ha)	1937	1152	40.5
Net Return (Rs/ha)	38805	18898	51.3
B:C ratio	3.51	2.41	-

(2008), Bhargav et al., (2013) and Dhakad et al., (2014 & 2015). They concluded that the higher gross as well as net monetary returns were recorded under ridge and furrow planting as compared conventional system.

CONCLUSION

The study has shown the KVK programmes was found useful of the impacts and enhancing of rainfed agriculture and comprehensive understanding of adaptation options across the full range of warming scenarios and regions would go a long way in preparing the nation for climate change. Impact of climate changes on intensity and frequency of drought situation was decided by the rainfall under drought prone areas. The Krishi Vigyan Kendras will have to play crucial role in adoption of climate ready technologies in rainfed agriculture too as in other sectors. On the basis of this study, the better results of consecutive years were found in ridge and furrow planting system on the yield characters of soybean as compared to conventional method of sowing i.e. farmers practice. Farmers need to be provided with cultivars. Their adaptation process could be strengthened with availability of new varieties having tolerance to drought, heat and salinity and thus, minimize the risks of climatic aberrations. Similarly, development of varieties is required to offset the emerging problems of shortening of growing season and other vagaries of production environment. Farmers could better stabilize their production system with basket of technological options. Further, it showed the changes of dry spell during kharif season which helps the management practices in agriculture viz., sowing time, inter cultivation, protective irrigation, fertilizer application time of harvesting etc. Most significant contribution of rain fall probability and viability analysis in it decide the crop planning in various months so as to how we can effectively se the moisture for sustainable crops production.

Paper received on : February 07, 2018
Accepted on : February 23, 2018

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