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Drought mitigation interventions of Krishi Vigyan Kendra for enhancing chances of successful harvest in rainfed areas of Satna district of Madhya Pradesh

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Abstract : Drought is a major constraint to rain-fed crop production. Analysis of drought on the basis of rainfall pattern of Satna district revealed that the distirct experiences three types of drought in *Kharif* sown crops; early season drought, mid season drought and terminal drought resulting in seedling, pre-flowering and post-flowering drought stress. Post-flowering drought stress manifests in crop lodging, disease, reduced seed size, premature plant senescence and death of plants. In Satna district, rice, pigeonpea and soybean are the main crops grown during *Kharif*. Yield losses vary according to severity and the type of drought. Prolonged droughts at any stage results in crop failures. When crop fails farmer rely on relieve measures from governments and welfare organizations. Drought affects livelihoods of more than 1.46 lakhs families in the district. To minimise impact of drought, Krishi Vigyan Kendra have assessed and demonstrated drought mitigating technologies to increased chances of successful harvests. The technologies include varieties that escape/tolerate drought due to early maturity and drought management techniques. Short duration, drought tolerant, disease tolerant varieties of rice, pigeonpea and soybean have been demonstrated and promoted to address drought problem in the district particularly in areas receiving less rains and poorly distributed rainfall. The rice varieties IR-64 and IR-36 (maturing in 115-120 days) have been replaced by early maturing rice varieties JR-201, NDR-97 and Vandana; soybean varieties JS-335 replaced by JS-9305 and JS-9560: long duration pigeonpea varieties have been replaced by short duration ICPL-88039, TJT-501 and TJT-401 in rain fed drought prone areas. These varieties escape terminal drought because of early maturing. The early maturing crops like sesame, black gram, green gram and cowpea have also been introduced in drought prone areas. Further, the improved short duration, disease tolerant varieties are integrated with drought management techniques to reduce drought effects. Management techniques included water harvesting and moisture conservation techniques like ridge and furrow sowing, mulching, compost application, conservation tillage, planting time manipulation and use of cover crops to reduce drought effects. Weather advisory services were provided to farmers on daily basis through Kisan Mobile Advisory. KVK also organized technology demonstrations and trainings, celebrated technology weeks to educate the farmers on drought management About 921 extension programmes comprising meetings, field days, *goshthis*, farmers fairs, exhibitions and film shows were organized on drought-mitigation strategies with the participation of about 59660 farmers and extension personnel of the district that encountered drought. During the year, seeds of short-duration and drought tolerant varieties of crops were provided to the extent of 994.46 quintal sufficient to cover an area of 2920.5 ha benefiting 4505 farmers in these droughts hit areas. The technologies resulted in better moisture management, better crop establishment and growth, less frequent crop failures and raised crop yields.

Key Words : Climate change, Rainfall, Drought, Mitigation, Short duration varieties, Resource conservation technologies

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INTRODUCTION

Drought is a major constraint to rain-fed crop production. The frequency and severity of risks in agriculture particularly in last few decades has increased on account of climate variability and change. The principal evidence of climatic change has been rising temperatures, erratic rainfall

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pattern, and increase in the severity of droughts, floods and cyclones which have caused huge losses in agricultural production and the livestock population.Drought occurs in different parts of India for centuries. Out of 329 m ha geographical area of India, 108 m ha is severely affected by drought, which includes 39 per cent of cultivable land and it has been estimated that about 263 m population live in drought prone districts (Chaube, 2000). Seasonal variation in rainfall has a bearing on crop productivity. Under rainfed conditions, the period of water available for plant growth is of vital importance for crop planning (Sharma *et al.*, 1987). Therefore, resource conservation technologies play significant role for rainfed crop planning. In Satna district of Madhya Pradesh, farming is mostly rainfed.The occurence of frequent mild to moderate drought situation during the last 15 years has severely affected rain fed crop production .In years of deficient rainfall, most of the rain fed crops experiences moisture shortage and farmers find it difficult to grow crops successfully. Most of the time, a vast tract remain uncultivated during *Kharif* as well as during *Rabi* season due to lack of irrigation. To minimize impact of drought, series of drought adaptation and mitigation services were innitiated at different levles by Krishi Vigyan Kendra in the district with specific objective of miniizing drought risk and to increase chances of successful harvests.

MATERIAL AND METHODS

The rainfall data recorded at KVK for the period of 1996 to 2010 was analysed to determine rainfall deficit or surplus for evaluating a strategy for contingent crop planning and water management practices to promote crop production in rain fed areas. The field observations and interactions with farmers were made to assess the technology need of the district in order to mitigate the drought effects. Based on the rainfall pattern and assessment of technologies need of the district, the drought mitigation interventions and activities were planned and executed in the district. The data on interventions taken by Krishi Vigyan Kendra for addressing the drought in drought affected regions of district were analysed. Assessment in terms of technology dissemination, technology adoption and impact on productivity of crops etc., was done. Various methods of data collection like field observations, formal and informal groups interactions, feed back during field diagnostic services and extrainees meet, case study, district agricultural statisitical data etc., were used.

RESULTS AND DISCUSSION

As a part of the drought-mitigation efforts, Krishi Vigyan Kendra, Satna initiated very specific interventions for mitigating drought during the year 2001 to 2012. The drought mitigation activities included organization of awareness camps; organization of farmers *Gosthies*; preparation of contingent plan; providing technological backstopping and inputs mainly seed and planting materials; identification of relevant crops and varieties; organization of animal camps for creating awareness; conducting technology week at KVK for showing the performance of technologies under drought conditions, etc. The farmers were advised to follow specific intervention to increase water use efficiency and water productivity and to sustain rain fed agriculture. The interventions included soil and water conservation, rain water harvesting for ground water recharge, life saving irrigations during dry spell and recharging of wells, water saving methods,application of life saving irrigations at critical growth stages. For improving the water holding

Table 1: Frontline demonstrations on oilseeds

Crops	Varieties	No. of farmers	Area (ha)	Yield (q/ha)		Increase (%)
				Demonstration	Local	
Soybean	JS-9560, JS-9305	197	63.6	16.55	10.87	52.25
Sesame	TKG-22, TKG-55, JTS-08, Shekhar-1, TKG-306	192	87.0	4.83	2.56	88.67
Mustard	JM-1, JM-2, JM-3, Pusa Jai Kisan, Pusa Tarak, Arawali	227	72.5	10.63	7.74	37.34
Linseed	JLS-23, JLS-27, JLS-9, Shubhra	155	63	7.26	5.3	36.98
Total		771	286.1			

Table 2 : Frontline demonstrations on pulse crops

Crop	Varieties	No. of farmers	Area (ha)	Yield (q/ha)		Increase (%)
				Demonstration	Local	
Urdbean	WBU-108, PU-31, PU-19, LBG-20	171	50.6	8.3	4.35	90.80
Moongbean	TM-9837, TM-9938, Meha, Samrat, Pant Moong-5	62	21	9.29	6.65	39.70
Pigeonpea	ICPL-88039, JKM-189	158	52.5	10.83	6.79	59.50
Chickpea	JG-14, JG-16, JG-11, JG-14,	213	87.5	11.59	8.2	41.34
Lentil	JL-1, JL-3, DPL-62	87	21.5	8.9	4.83	84.27
Total		691	233.1			

capacity of soils and its resilence to dry spell the farmers were educated to improve soil fertility and productivity by growing green manuring crops and incorporating organic mannure.

Alternate crops/ varieties for adapting drought:

Introduction of short duration crops/ varieties tolerant to biotic and abiotic factors was one of the major intervention taken up by the KVK. The focus was mainly on laying out demonstrations on oilseeds, pulses, sorghum, short duration rice and vegetables. During 2001 to 2012, a total of 2487 frontline demonstrations, covering an area of 798.62 ha, were organized on oilseeds, pulses, cereals, fodder crops, horticultural crops, livestock, and other enterprises on farmers' fields. Under oilseeds the major crops demonstrated were sesame (87.0ha), soybean (63.6 ha), mustard (72.5ha) and linseeds (63.0 ha). A total of 771 demonstrations were conducted covering about 286.1 ha area (Table 1). Increase in yield varied from 36.98 % in linseed to 88.67 % in sesame, and on an average oilseed crops under improved technology demonstrations gave 46.52 % more yield than farmers' practice. The increase in yield was primarily owing to suitable early maturing varieties and better adoption of integrated crop management practices.

In pulse crops, varieties tolerant to biotic and abiotic factors were demonstrated. Pegionpea (52.5ha), urdbean (50.6 ha), moongbean (21.0 ha), Chickpea (87.5 ha) and lentil (21.5 ha). Thus an area of 233.1 ha was brought under alternate crops/ varieties benfiting 691 farmers (Table 2). The percentage increase in yield varied about 39.70 in moongbean to 90.80 in urdbean, and on an average pulse crops under various technology demonstrations gave 55.38 % more yield than farmers' practices.

In cereal crops, a total of 438 demonstrations in 169 ha in paddy, wheat and sorghum, were conducted during the year, achieving an average increase of about 51.04 % in paddy to 32.70 % in sorghum (Table 3). The increase in productivity in paddy and wheat was mainly due to use of short duration varieties and popularization of the drought management technologies, farm mechanization and nutrient management.

In horticultural crops comprising vegetables, fruits, spices and condiments, 587 demonstrations were conducted in 110.42 ha. The average yield increase recorded under demonstration compared to farmers' practices was 68.10 % in cowpea, 47.68 % in chillies, 47.56% in tomato and 25.78 % in onion (Table 4). The increase in yield in horticultural

Table 3: Frontline demonstrations on cereal crops

Crops	Varieties	No. of farmers	Area (ha)	Yield (q/ha)		Increase (%)
				Demonstration	Local	
Paddy	JR-201, NDR-97, Vandana, Pant dhan-10, Pant dhan-12	209	76.5	26.78	17.73	51.04
Wheat	Rainfed- HI-1500, Sujata, HW-2004, JW-17, C-306	182	76.7	27.89	18.62	49.79
	Limited Irrigation- JW-3020, MP-3211					
Sorghum	JJ-1041, JJ-1042	47	15.8	18.22	13.73	32.70
Totat		438	169			

Table 4: Frontline demonstrations on horticultural crops

Crops	Varieties	No. of farmers	Area (ha)	Yield (q/ha)		Increase (%)
				Demonstration	Local	
Tomato	Kashi Vishesh, Kashi Amrit, T-6, NDT-5 and 6	192	24.12	216.8	146.92	47.56
Chillies	Kashi Anmol	176	33.6	70.49	47.73	47.68
Onion	Agri Found Dark Red, Arka Kalyan, Arka Niketan	143	38.5	156.45	124.38	25.78
Cowpea	Kashi Kanchan, Kashi Gauri	76	14.2	98.37	58.52	68.10
Total		587	110.42			

Table 5 : Drought mitigation technologies assessed/ refined by KVK

Crops/ Enterprise	Varietals evaluation	Nutrient management	Cropping system /farming system	Resource conservation	Weed management	Insect/ disease management	Total
Cereals	3	-	-	3	2	-	8
Pulses	4	2	-	3	-	2	11
Oilseeds	3	2	-	2	2	2	11
Vegetables	4	-	-	-	1	1	6
Fruits	-	1	1	-	-	2	4
Spices	-	-	-	-	1	2	3
Livestock	2	2	-	-	-	1	5
Total	16	7	1	8	6	10	48

crops resulted due to manifold interventions like improved varieties, raised bed/ ridge and furrow sowing, micro irrigation and Integrated Pest and Disease Management practices.

Technology assessment and refinement:

48 technological interventions were assessed in 38 locations by laying out 249 trials on the farmers' fields on various crops under different thematic areas, namely, varietal evaluation, integrated nutrient management, cropping system, integrated pest management, integrated disease management, resource conservation technologies, weed management, integrated farming systems, and farm machinery in the KVK of districts. In case of livestock, 5 technological interventions in 9 locations covering 39 trials under the thematic areas, namely breed evaluation, nutrition management and disease management were assessed (Table 5).

Intercropping systems:

On farm trials on intercropping systems conducted in drought hit areas in the district, revealed that intercropping was effective intervention in increasing the total production as well as farm income besides making best use of limited resources. The data analysis showed (Table 6) an additional income of Rs 2232, 1874, 3785 and 2860/ ha, respectiviely from gram+ mustard, gram+ linseed, jowar + pegionpea and wheat + mustard over sole crops. Thus it is apparent from the analysis that intercropping technology in drought hit areas will certainly improve the economic conditions of farmers by enhancing the crop production.

Table 6 : Beneficial effects of intercropping over sole cropping

Main crop	Main + intercrop	Additional benefit over main crop (Rs./ha)
Gram	Gram+ Mustard (6:2)	2,232
Gram	Gram+ Linseed (3:1)	1,874
Jowar	Jowar + Pegionpea (4:2)	3,785
Wheat	Wheat + Mustard (6 :2)	2,860

Sowing time:

On farm testing to assess the effect of time of sowing on grain yield in *Rabi* sown crops were also conducted. Increase in yield by 23.45 % in wheat, 28.37 % in mustard and 15.84 % in chickpea was observed over farmers practice by advancing the time of sowing and use of suitable varieties (Table7).

Training programmes:

A total of 458 training programmes both on-campus and off-campus was organized benefiting 15258 farmers and 1382 extension functionaries. Farmers and farm women were imparted training on various aspects of drought

Table 7: Effect of time of sowing on crop yield

Crops	Farmers practice	Intervention	Increase in yield (%)
Mustard	Last week of Oct to 1st week of Nov.	1-15 Oct.	28.37
Wheat	15-20 Dec.	15-30 Nov.	23.45
Chick pea	Last week of Oct to 1st week of Nov.	1-15 Oct.	15.84

adaptation and mitigation technologies in crop production, horticulture and livestock production and management,. The details of training programmes organized by KVK are presented in Table 8. In the training programmes, farmers were acquainted with improved production technologies such as selection of short duration, drought, disease and insect pest tolerant varieties, seed treatment, sowing techniques, in-situ moisture conservation, irrigation scheduling, use of micro irrigation system, balanced fertilization, weed management, plant protection measures, vermiculture, livestock feed and fodder management.

Extension programmes:

921 extension programmes were organized covering 59660 farmers and 1589 extension personnel, to create awareness about drought mitigation technologies. The activities included advisory services, diagnostic visits, field-days, group discussions, *kisan goshthi*, film shows, self-help group conveners' meetings, *kisan melas*, exhibitions, scientists' visit to farmers' fields, ex-trainees *sammelan*, farmers' seminar/workshop, method demonstrations, exposure visits etc. Besides, 173 programmes were carried out through electronic and print media to have wider coverage in the district. These included electronic media, extension literature, newsletters, newspaper coverage, technical articles, technical bulletins, radio talks, TV talks, popular articles, leaflets and folders and lecture delivered.

Farmers–scientist interaction on livestock management:

Livestock were adversely affected due to drought and the problems like shortage of fodder , incidence of diseases and pests and deficiencies were observed. KVK conducted farmers- scientists interactions on rearing practices, fodder production, sensitlization about health related problems etc., 114 interactions were organized with the participation of 5008 stakeholders. 43 vaccination and health camps were organzed in the villages to solve the livestock related problems (Table 9).

Distribution of seed:

Quality seeds of improved short duration varieites of cereals, pulses, oilseeds, vegetables, spices and fodder crops were ditributed to the farmers. Total of 994.46 q seeds were

Table 8 : Training programmes organized on drought mitigation technologies

Sr. No.	Title of training	No. of training programmes	No. of beneficiaries	
			No. of farmers	Extension functionaries
1.	Rain water harvesting and *in-situ* moisture conservation techniques	39	1234	219
2.	Resouurce conservation technologies for rain fed farming	68	1938	246
3.	Seed production	43	1346	216
4.	Weed management in *Kharif* crops	43	2097	164
5.	Integrated farming system models for drought prone areas.	26	992	104
6.	Drought mitigation and management technologies for *Kharif* crops.	42	1186	92
7.	Improved technologies for orchard establishmnet and *in situ* moisture conservation on wastelands.	36	1263	67
8.	Nuresry management of horticultural crops	19	438	37
9.	*Kharif* cultivation of onion, tomato and chillies	34	789	118
10.	Organic manure preparation techniques	39	1484	94
11.	Integrated pest management in pulses and oilseed crops	61	1816	116
12.	Livestock feed and fodder management during drought	47	1909	128
	Total	458	15258	1382

Table 9: Farmers scientist interaction and animal health camps organized by KVK

Sr. No.	Intervention	No. of interventions	No. of farmers
A	Farmers scientist interaction		
1.	Feed and fodder management	37	1668
2.	Livestock managment in drought situation	15	754
3.	Animal health care during drought	23	803
4.	Care and management of milch animal during drought	39	1783
B	Animal health camps	43	7458

distributed by KVK (Table 10).

Planting materials:

532421 numbers of quality planting materials of vegetables, fruits, MPTs, spices, and forest species were produced and provided to 2839 farmers (Table 11).

Adoption of resource conservation technologies:

Different types of resorce conservation technologies with the help of district allied departments were introduced in the drought hit parts of the district. An area of 97867 ha with the participation of 39133 farmers was brought under demonstrations on resource conservation technologies (Table 12). Direct seeded rice, system of rice intensification, mulching, rainwater harvesting, drip and sprinkler irrigation, in-situ moisture conservation, sowing of low water requiring crops, water saving methods were major interventions initiated by KVK and allied departments. Major emphasis was laid out on technologies like integrated watershed development and soil and water conservation technologies. intercropping oilseed crops with cereals and pulse crops along with *in situ* moisture conservation, direct seeding, summer ploughing, and zero tillage. The resource conservation technologies were widely adopted by the farmers of the district.

Organizing technology week:

For educating the farmers on drought mitigation

Table 10 : Seed distributed by KVK

Crop	Seed (q)	Provided to no. of farmers
Cereals	665.17	1199
Oil seeds	118.081	2151
Pulses	114.2	607
Vegetables	15.96	312
Spices	25.05	202
Mushroom spawn	56	34
Total	994.461	4505

Table 11: Planting material produced and distributed by KVK

Crop	Number	Provided to no. of farmers
Fruits	24955	790
Vegetables	438141	1256
Spices	51455	414
Forest species	17160	241
Ornamental plants	345	118
Bio fuel	365	20
Total	532421	2839

technologies, 5 Technology weeks, were organized by Krishi Vigyan Kendra. The major activities undertaken during technology weeks were training for farmers, farm women and rural youths (18); seminars (9), exhibition (26), scientists-extension personnel-farmers interactive sessions (11), farmers gosthies (14), visit to crop cafeteria and technology demonstration plots (25); distribution of seed (6485 kg), planting materials (23780) and literature on drought management (20868), etc., benefiting 3478 farmers, farmwomen, rural youths and extension personnel.

Kisan mobile advisory:

KVK initiated the Kisan Mobile Advisory Service in 2008 to provide need based information to farmers. Regular mobile advisory services with regard to information on weather, disease and insect pest infestation on crops and plant protection measures to be adopted, market and farm operations, are provided to farmers to more than 3200 farmers of the districts. The Kisan Mobile Advisory has made access to the information easier and cost effective to the farmers. During the years, about 3221 registered farmers

Table 12 : Adoption of resource conservation technologies

Sr. No.	Technology	No. of villages	Area (ha)	Number of beneficiareis
1.	Summer ploughing	163	14374	3273
2.	Zero tillage	87	998	614
3.	Ridge and furrow	179	1769	1538
4.	Water harvesting- farm ponds	683	21346	9240
5.	Recharging of open and tube wells	629	3526	2046
6.	Micro iirigation	793	46782	14275
7.	System of rice intensification	248	9072	8147
	Total	2782	97867	39133

Table 13: Diagnosis of problems

Sr. No.	Diagnosed problem	No. of visits	No. of villages covered	No. of beneficiaries
1.	Bacterial blight, stem borer and leaf roller in paddy	167	124	398
2.	MYMV in soybean, moong and urd	339	211	742
3.	Girdle and blister beetle in soybean	173	135	527
4.	Root rot and wilt disease in pegionpea and chickpea	95	82	472
5.	Physiological disorders in vegetables	238	128	769
6.	Leaf curl virus in tomato and chillies; YVM in Okra	172	143	520
7.	FMD in cattle	148	141	1560
	Total	1332	964	4988

Table 14 : Impact of activities on area and productivity of cereal, pulse and oilseed crops in Satna district

Crops	Area (000,ha)			Productivity (q/ha)		
	2002-03	2011-12	Growth rate	2002-03	2010-11	Growth rate
Cereals						
Rice	101.9	80.0	(-) 3.79	6.60	25.90	5.62
Wheat	160.28	135.0	(-) 2.47	12.32	22.33	2.52
Pulses						
Urd	13.65	20.0	1.46	2.42	5.80	5.33
Greengram	2.11	5.50	7.68	1.94	4.60	3.91
Pigeonpea	12.90	30.0	11.41	3.57	10.74	4.30
Chickpea	95.35	103.5	0.32	6.48	13.00	0.80
Lentil	31.42	39.0	0.64	3.08	10.00	7.50
Oilseeds						
Sesame	2.0	4.20	9.71	1.29	2.00	1.10
Soybean	5.99	57.00	27.73	3.71	11.95	8.53
Linseed	6.92	6.00	(-) 4.06	2.37	4.50	2.83
Mustard	2.47	3.40	2.31	3.01	7.00	4.83

have been sent 197 messages on various aspects of agriculture, horticulture and animal husbandry, besides weather forecast, and pest and disease control.

Diagnostic visit to farmers field:

KVK made 1332 diagnostic visist to the villages for identification of problems and spot advice. During the visits farmers were provided neccessary skill on identification of insect and diseases, nutritional deficiencies symptoms and their control measures were suggested (Table 13).

Contingent plan development:

Farmers were advised to grow blackgram, greengram, soybean, sesame, cowpea and short duration early maturing varieties of paddy and pegionpea to escape the terminal drought situation. Intercropping of blackgram, greengram and sesame, soybean in between the rows of sorghum and pegionpea was also advocated for proper use of moisture/ rain water. Farmers were also suggested to grow arkel variety vegetable pea and Bhawani variety of toria during first fortnight of September for minimizing drought risk.The farmers were advised to harvest rain water and utilize stored water for life saving irrigation during moisture stress conditions.Resource conservation technologies (sytem of rice intensification, direct seeded rice, sowing on raised bed and ridges, zero tillage and dry seeding) soil and water conservation technologies, sub merged pitcher and pit depression system of planting fruit trees and cucurbits, and mulching in low volume high value horticultural crops were advocated and promoted for avoiding risk of crop failure due to moisture stress. Low water requiring crops like lentil, linseed, gram, toria, mustard and durum wheat were suggested in *Rabi* in drought situation. Foliar application of DAP/ urea 2% on standing crops of pegionpea and chickpea was also suggested.

Imapct of drought mitigation interventions on growth rate of area and productivity of crops in the district:

It is apparent from the analysis that drought mitigation interventions carried out by KVK with the support of allied departments have been quite effective in enhancing chances of succeful harvest despite of frequent drought situation in the district. The positive growth rate in productivity of various crops grwon in the district shows that the farmers of the district have adopted the drought mitigation technologies suggested by tht KVK over the years. Promising growht rate in area (27.73 %) and productivity (8.53%) in soybean has been quite encouraging (Table 14). This has been possible due to crop planning based on moisture availabilty. Under rainfed conditions, the period of water available for plant growth is of vital importance for crop planning (Higgins and Kassam, 1981). Increased growth rate in productivity of various crops in the district despite of frequent droughts in the district can be attributed to the integration of various interventions awareness activities and convergence of various programmes by Krishi Vigyan Kendra. Kokate *et al.* (2010) also suggested the integration of technological interventions and advisory services for minimizing risk of drought.

Thus it can be concluded that the Krishi Vigyan Kendra, Satna took up very specific interventions for mitigating drought in the district by undertaking drought mitigation activities like organization of awareness camps, organization of farmers gosthies, preparation of contingent plan, providing technological backstopping and inputs mainly seed and planting materials, identification of relevant crops and varieties, organization of animal camps for creating awareness, conducting technology week at KVK for showing the performance of technologies under drought conditions, etc. The farmers were advised to follow specific intervention like soil and water conservation,rainwater harvesting for ground water recharge, life saving irrigations during dry spell and recharging of wells,water saving methods,application of life saving irrigations at critical growth stages to increase water use efficiency and water productivity and to sustain rain fed agriculture. For creating mass awareness and have wider coverage in the district, print electronic media, compaign extension literature, newsletters, newspaper coverage, technical articles, technical bulletins, radio talks, TV talks, popular articles, leaflets and folders were extensively used. Krishi Vigyan Kendra played a significant role in mitigating the drought and increasing the chances of successful harvest in drought hit areas of the district.

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