E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(1): 168-172
Received: 07-10-2023
Accepted: 19-11-2023

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Adoption of technology interventions in maize (*Zea mays*) and Bengal gram (*Cicer arietinum*) by the beneficiary and non-beneficiary Respondents of NICRA project

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i1Sc.254

Abstract
National Innovations on Climate Resilient Agriculture (NICRA) project aims to enhance the resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration. In the present study, a total sample of 140 farmers (70 beneficiaries and 70 non-beneficiaries from the Ratnagiri district of Maharashtra state) were selected. The adoption of technology interventions by the respondents was measured with the help of a structured schedule. The schedule consisted of a total of 12 items each related to improved technology in maize and Bengal gram, respectively demonstrated under the Technology Demonstrations Component of NICRA in the year 2020-21. The beneficiary respondents showed a medium to high level of adoption of technology interventions about maize and Bengal gram crops than those of non-beneficiary respondents. Also, beneficiary respondents showed significantly high adoption of technology interventions as compared to non-beneficiary respondents. Interventions wise adoption revealed that beneficiary respondents have adopted relatively more interventions than non-beneficiary respondents in maize and Bengal gram cultivation.

Keywords: Adoption, technology, beneficiary, interview schedule, project

Introduction
National Innovations on Climate Resilient Agriculture (NICRA) is a network project of Indian Council of Agricultural Research (ICAR) implemented in various districts of the country since 2011. The project aims to enhance the resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration.

The technology demonstration component of the project deals with demonstrating proven technologies for adaptation of crop and livestock production systems to climate variability. This component was implemented in selected vulnerable districts of the country through location-specific interventions. These districts were selected based on the drought, cyclone, flood proneness, vulnerability to heat wave and cold wave, actual incidence of floods and droughts, etc. criteria besides the strength of the KVKs. The crop production module consists of introducing drought/temperature/flood tolerant varieties, advancement of planting dates of *rabi* crops in areas with terminal heat stress, water-saving paddy cultivation methods i.e. SRI, aerobic, direct seeding, etc., frost management in horticulture through trash burning, community nurseries for delayed monsoon, custom hiring centers for timely planting, location-specific inter-cropping systems with high sustainable yield index.

Adoption is a process by which an individual or other decision-making unit puts an intervention into use. The successful adoption of an intervention could be considered as a means to achieve increased productivity and thereby an improved standard of living for the farming community. In NICRA villages production technology interventions of maize and Bengal gram were selected on the basis of technologies recommended by Vasantrao Naik Marathwada Agricultural University for assessing their adoption level by respondents.

So, looking at the above facts the present study was undertaken to understand the adoption of technology interventions in maize and Bengal gram by the beneficiary and non-beneficiary respondents of NICRA Project.

Materials and Methods

The present study was conducted in the Aurangabad (*Chattrapati sambhajinagr*) district from Marathwada region of Maharashtra state. All the five operational villages of the NICRA project *viz*. Shekta, Vajanapur, Gopalwadi, Shankarpur and Shiresaygaon were selected. From these villages, 70 farmers (14 farmers from each village) were selected as beneficiaries. For this study, 70 farmers were taken from the nearby five villages (14 farmers from each village) as non-beneficiaries on a random basis for comparison. Thus, the total sample size was 140 respondents. The adoption of technology interventions by the respondents was measured with the help of a structured schedule, which was developed in consultation with the experts. The schedule consisted of a total of 12 items each related to improved technology in maize (*Zea mays*) and Bengal gram (*Cicer arietinum*), respectively demonstrated under the Technological Demonstrations Component of NICRA in the year 2020-21. Scores of 2, 1 and 0 were assigned to each item for full adoption, partial adoption and no adoption, respectively. The individual raw scores of the respondents were later converted into standardized scores to get the adoption index with the help of the following formula:

$$\text{Adoption index} = \frac{\text{Obtained adoption score}}{\text{Highest obtainable score}} \times 100$$

The categories of adoption were made by using the formula mean + S.D. The 'z' test was used to observe significant differences between adoption of beneficiary and non-beneficiary. Frequency and percentages were calculated for statement wise adoption.

Results and Discussion

Distribution of Respondents According to Crop-wise Adoption Level of Technology Interventions

The data presented in Table 1 with respect to maize crop technology interventions revealed that 12.86 percent beneficiary respondents showed high level of adoption, whereas, 77.14 percent showed medium level of adoption and 10.00 percent showed low level of adoption. In case of non-beneficiaries, only 8.57 percent respondents showed high level of adoption, 62.86 percent showed medium level of adoption and 28.57 percent showed low level of adoption of technology interventions of maize crop.

Table 1: Distribution of respondents according to crop-wise adoption level of technology interventions

Crops	Adoption level							
	Beneficiary (n=70)				Non-beneficiary (n=70)			
	Low	Medium	High	Mean/S.d.	Low	Medium	High	Mean/S.d.
Maize	7 (10.00)	54 (77.14)	9 (12.86)	63.45/7.65	20 (28.57)	44 (62.86)	6 (8.57)	34.70/5.79
Bengal gram	8 (11.43)	48 (68.57)	14 (20.00)	53.10/5.84	26 (37.14)	35 (50.00)	9 (12.86)	34.88/7.90

(Figures in the parenthesis indicates percentages)

As regards adoption of technology interventions of Bengal gram crop is concerned, Table 1 depicts that 20.00 percent beneficiary respondents showed high level of adoption, whereas, 68.57 percent showed medium level of adoption, and the remaining 11.43 percent showed low level of adoption. So far as non-beneficiaries are concerned, 12.86 percent respondents showed high level of adoption while 50.00 percent and 37.14 percent showed medium and low level of adoption, respectively.

Similar observations were also made by Yadav and Khan (2012) [9], Ranawat (2013) [5], Rekha Parmar *et al.* (2018) [6], Kalyan Babu (2019) [3], Anil Singh *et al.* (2021) [1] and Sangita Yadav *et al.* (2022) [8]

Difference in adoption of technology interventions by beneficiary and non-beneficiary respondents

Table 2: Difference in adoption of technology interventions of different crops

Crops	Mean score		'z' value
	Beneficiary (n =70)	Non-beneficiary (n =70)	
Maize	63.45	34.70	25.07**
Bengal gram	53.09	34.88	15.53**

** Significant at 0.01 level

The results in Table 2 indicate that, mean score pertaining to adoption of technology interventions on maize and Bengal gram by beneficiary respondents were 63.45 and 53.09, respectively. Whereas, the mean score of non-beneficiary respondents were 34.70 and 34.88 for the crop's maize and Bengal gram, respectively. The calculated 'z' value for adoption of technology for both the crops found highly significant at 0.01 level. This indicates that beneficiary respondents showed significantly high adoption of technology interventions as compared to non-beneficiary respondents.

Technology interventions wise adoption by beneficiary and non-beneficiary respondents

The National Innovations on Climate Resilient Agriculture project has a focused approach. Therefore, the important interventions of crop production technologies namely improved seed, cultivation techniques, fertilizer management and plant protection measure etc. were introduced under the Technology Demonstration Component of NICRA project. An effort was made to study adoption of these important technologies diffused in the study area. The intervention-wise results have been presented in Table 3 to 4.

Data presented in Table 3 about technology interventions in maize revealed that, use of stress tolerant hybrid variety P-3501 suggested by the organizing institute was adopted by 85.71 percent beneficiary respondents and 45.71 percent non-beneficiary respondents. This variety was not used by 14.29 percent beneficiary and 54.29 percent non-beneficiary respondents. The reason was that they preferred private hybrid varieties *viz*. P-333, Shahanshah, Dikalp 8101, Trimurthi 2608, Adventa, JK502, etc. With respect to recommended seed rate @20 kg/ha, it was observed that this intervention was fully adopted by cent percent beneficiary respondents and 92.86 percent non-beneficiary respondents. The intervention of seed treatment by Azospirillum @ 200 gm/10kg of seed was adopted by 45.71 percent and partially adopted by 51.43 percent

beneficiary respondents. However, this intervention was adopted by 48.57 percent non-beneficiary respondents as it was provided by line department and not adopted by 44.29 percent respondents. The reason expressed by respondents was unavailability at village level and lack of knowledge. Recommended sowing time 15th June to 15 July was the intervention adopted by majority of respondents i.e. 91.43 percent and 85.71 percent beneficiary and non-beneficiary, respectively.

The intervention of sowing of seed on ridges at 60cm x 30 cm by using Broad Bed Furrow (BBF) method was recommended in the study area. BBF method helps in conserving moisture and reducing water stress in the event of extreme as well as deficient conditions during the crop growth period. For this purpose, Broad Bed Furrow planter was used for sowing of maize seed. This intervention was followed by 52.86 percent beneficiary respondents and only 11.43 percent non-beneficiary respondents. The percentage of partial and not following this intervention was nearly half (47.14%) by beneficiary, whereas, 45.71 percent non-beneficiary respondents were partially following and 42.86 percent were not following this intervention. The reason was unavailability of skilled persons to do this job, high cost of machinery and a seed requirement by this method also more as compared to other methods. In case of weed control by spraying of Atrazine @1.5 kg/1000 lit water for 1 ha area immediately after sowing was partially adopted by 65.72 percent beneficiary respondents and only 17.14 percent adopted fully. However, 57.14 percent non-beneficiary respondents adopted partially this practice and 34.29 percent not adopted. The reason expressed behind this was no proper knowledge and time-consuming operation.

The intervention of opening of furrow after every sixth row for soil and water conservation was fully adopted by majority (62.86%) of beneficiary respondents and partially adopted beneficiary were 32.86 percent. Whereas, 17.14 percent non-beneficiary respondents fully adopted and 28.57 percent partially adopted this technology. However, more than fifty (54.28%) non-beneficiary respondents not adopted this technology. The reason given by non-beneficiary respondents was lack of knowledge. With respect to recommended fertilizer dose i.e.@120:60:40 NPK kg/ha, it was observed that 90.00 percent beneficiary and cent percent non-beneficiary respondents adopted partially. The reason expressed by both category of respondents was high cost of fertilizers and complexity in calculating individual nutrient requirement dose as per availability of fertilizers. Regarding foliar spray of 1% potassium nitrate @13:0:45 NPK after flowering, it was seen that 42.86 percent beneficiary respondents adopted this intervention fully and 28.57 percent partially. However, 90.00 percent non-beneficiary respondents not adopted this intervention due to lack of proper knowledge.

The intervention of spraying of 5% *limboli arc* (*Neem* product) for control of stem borer was fully adopted by 32.86 percent and partially adopted by 44.28 percent beneficiary respondents. However, 68.57 percent and 24.29 percent non-beneficiary respondents reported in the category of partial and non-adopters, respectively. The reason was chemical control measures were more effective than use of this organic product as expressed by respondents. Protective irrigation at the time of flowering and grain filling stage was fully adopted by all beneficiary respondents, whereas, 44.29 percent non-beneficiary respondents adopted fully and 55.71 percent partially adopted this practice. The intervention of intercropping maize crop with soybean and *Dhaincha* (2:1:2) was not adopted by majority (87.14%) of beneficiary and cent percent non-beneficiary respondents. The reason was highly complex procedure and improper growth of inter crop as the height of maize plant is more which suppressed the growth of other crops.

The data presented in Table 4 regarding technology interventions in Bengal gram indicates that majority (77.14%) of beneficiary respondents fully adopted improved variety i.e. BDNG-797 (Akash), whereas, 40.00 percent non-beneficiary respondents adopted fully and 60.00 percent not adopted this variety. The beneficiary respondents were given this variety seed under demonstrations. Non-beneficiary may have got this variety seed from line department as seed mini-kit. The intervention of recommended seed rate @ 60 kg/ha was fully followed by cent percent beneficiary respondents and 74.28 percent non-beneficiary respondents. Regarding seed treatment with Carbendazim @ 2gm/kg of seed, it was seen that majority (64.29%) of beneficiary respondents adopted partially followed by 27.14 percent respondents with full adoption. Also, this intervention was partially followed by 57.15 percent non-beneficiary respondents and fully followed by 17.14 percent non-beneficiary respondents. Majority of respondents of partial adoption category was found may be due to improper knowledge regarding proper dose of chemical. Recommended sowing time between 25th October to 7th November was fully adopted by majority of beneficiary respondents (87.14%), whereas, 34.29 percent non-beneficiary respondents only.

Recommended fertilizer dose @ 25:50:25 NPK kg/ha at sowing time was the intervention not adopted by majority of beneficiary respondents (77.14%) and non-beneficiary respondents (95.71%) due to unavailability and high cost of fertilizers. The intervention of weed control by spraying of pendimethalin @2.5 lit/750 lit water for 1 ha area immediately after sowing was adopted by only 11.43 percent and partially adopted by 58.57 percent beneficiary respondent. However, it was and not adopted by 30.00 percent beneficiary respondents. Further, it was observed that 45.71 percent non-beneficiary respondents adopted partially and 54.29 percent not adopted this intervention in their field. The reason was high cost of weedicide and lack of knowledge about dose of application. Foliar spray of 1% potassium nitrate @13:0:45 NPK after flowering was fully, partially and not adopted by 37.14 percent, 34.29 percent and 28.57 percent beneficiary respondents, respectively. However, 52.85 percent non-beneficiary respondents not adopted and 34.29 percent adopted partially. The reason was lack of knowledge of its application and also its effect on crop.

Technology intervention of irrigation by sprinkler method at the time of flowering and pod filling stage was adopted by majority i.e. 92.86 percent beneficiary respondents, while, 18.57 percent non-beneficiary fully adopted. Further, 57.15 percent non-beneficiary respondents partially adopted and not adopted by 24.58 percent non-beneficiary respondents. The reason was no sprinkler system available with some of the non-beneficiary respondents and lack of knowledge in handling of system. The intervention of spraying of 5% *Neem arc* when an infestation of pod borer observed was fully and partially adopted by 28.57 percent and 20.00 percent beneficiary respondents, respectively and 51.43 percent respondents not followed it because of non-infestation in the field and chemical measures more effective than application of this organic product as expressed by respondents. Similar observation was reported of this practice by non-beneficiary respondents where 35.71 percent reported partial adoption and 61.43 percent no adoption was found. Fixing at least 50 bird perch randomly in one hectare area was the intervention given to protect the crop from birds. The data

shows that only 8.57 percent respondents followed this practice and majority of beneficiary (68.57%) and non-beneficiary respondents (65.71%) followed it partially. Respondents from both categories expressed that they grow few seed of Jawar or Bajara crop randomly in the Bengal gram field which works as bird perch.

Installation of pheromone trap @ 5 per ha to control stem borer was the intervention given to respondents. Here, it was seen that 45.72 percent and 35.71 percent beneficiary respondents followed this practice fully and partially, respectively, whereas, it was not followed by 18.57 percent respondents. However, 82.86 percent non-beneficiary respondents not followed this practice. The reason was lack of proper knowledge of its application and also its effect. The intervention of intercropping Bengal gram with linseed crop (4:2) was only adopted by 7.14 percent beneficiary and partially adopted by 35.71 percent beneficiary respondents and not adopted by 57.15 percent respondents. Further, it was observed that majority (90.00%) of non-beneficiary respondents not adopted this intervention. This non-adoption was due to complex process, labourious method and time-consuming work.

Similar observations were recorded by Etwire *et al.* (2013) [2] Sharma and Choudhari (2014) [7].

Table 3: Distribution of respondents according to adoption of maize technological interventions

Sr. No.	Interventions	Adoption											
		Beneficiary (n=70)						Non-beneficiary (n=70)					
		Full		Partial		No		Full		Partial		No	
		f	%	f	%	f	%	f	%	f	%	f	%
1.	Use of stress tolerant hybrid variety (P-3501)	60	85.71	0	0.00	10	14.29	32	45.71	0	0.00	38	54.29
2.	Recommended seed rate (@20kg/ha)	70	100.00	0	0.00	0	0.00	65	92.86	0	0.00	5	7.14
3.	Seed treatment (Azospirillum @200 gm/10 kg of seed)	32	45.71	36	51.43	2	2.86	5	7.14	34	48.57	31	44.29
4.	Recommended sowing time (15th June to 15 July)	64	91.43	0	0.00	6	8.57	60	85.71	0	0.00	10	14.29
5.	Sowing on ridges (60cm x 30 cm by using BBF Technology)	37	52.86	17	24.28	16	22.86	8	11.43	32	45.71	30	42.86
6.	Weed control (spraying of Atrazine @ 1.5 kg/1000 lit water for 1 ha area immediately after sowing)	12	17.14	46	65.72	12	17.14	6	8.57	40	57.14	24	34.29
7.	Opening of furrow after every sixth row for soil and water conservation purpose	44	62.86	23	32.86	3	4.28	12	17.14	20	28.57	38	54.28
8.	Recommended fertilizer dose (@ 120:60:40 NPK kg/ha)	7	10.00	63	90.00	0	0.00	0	0.00	70	100.00	0	0.00
9.	Foliar spray (1% potassium nitrate @13:0:45 NPK after flowering)	30	42.86	20	28.57	20	28.57	7	10.00	0	0.00	63	90.00
10	Spraying of 5% *limboli arc* (*Neem* product) for control of stem borer	23	32.86	31	44.28	16	22.86	5	7.14	48	68.57	17	24.29
11.	Protective irrigation at the time of flowering and grain filling stage	70	100.00	0	0.00	0	0.00	31	44.29	39	55.71	0	0.00
12.	Intercropping maize crop with soybean and *dhaincha* (2:1:2)	2	2.86	7	10.00	61	87.14	0	0.00	0	0.00	70	100.00

Table 4: Distribution of respondents according to adoption of Bengal gram technological interventions

Sr. No.	Interventions	Adoption											
		Beneficiary (n=70)						Non-beneficiary (n=70)					
		Full		Partial		No		Full		Partial		No	
		f	%	f	%	f	%	f	%	f	%	f	%
1.	Use of improved variety (i.e.*BDNG-797* (Akash)	54	77.14	0	0.00	16	22.86	28	40.00	0	0.00	42	60.00
2.	Recommended seed rate (@60 kg/ha)	70	100.00	0	0.00	0	0.00	52	74.28	0	0.00	18	25.71
3.	Seed treatment (Carbendazim @2gm/kg of seed)	19	27.14	45	64.29	6	8.57	12	17.14	40	57.15	18	25.71
4.	Recommended sowing time (25th October to 7th November)	61	87.14	0	0.00	9	12.86	46	65.71	0	0.00	24	34.29
5.	Recommended fertilizer dose (@25:50:25 NPK kg/ha at the time of sowing)	13	18.57	3	4.29	54	77.14	0	0.00	3	4.29	67	95.71
6.	Weed control (spraying of Pendimethalin @2.5 lit /750 lit water for 1 ha area immediately after sowing)	8	11.43	41	58.57	21	30.00	0	0.00	32	45.71	38	54.29
7.	Foliar spray (1% potassium nitrate @13:0:45 NPK after flowering)	26	37.14	24	34.29	20	28.57	9	12.86	24	34.29	37	52.85
8.	Irrigation by sprinkler method at the time of flowering and pod filling stage	65	92.86	5	7.14	0	0.00	13	18.57	40	57.15	17	24.28
9.	Spraying of 5% *Neem arc* (*Neem* product) when an infestation of pod borer observed	20	28.57	14	20.00	36	51.43	2	2.86	25	35.71	43	61.43
10	Fixing at least 50 bird perch randomly in one hectare area	6	8.57	48	68.57	16	22.86	0	0.00	46	65.71	24	34.29
11.	Installation of pheromone trap (@ 5 trap per ha to control stem borer)	32	45.72	25	35.71	13	18.57	2	2.86	10	14.28	58	82.86
12.	Intercropping Bengal gram with linseed crop (4:2)	5	7.14	25	35.71	40	57.15	0	0.00	7	10.00	63	90.00

Conclusion

It can be concluded that, beneficiary respondents showed a medium to high level of adoption of technology interventions pertaining to both crops i.e. maize and Bengal gram than those of non-beneficiary respondents. Thus, beneficiary respondents showed an increasing trend in the use of improved technologies. Also, beneficiary respondents showed significantly high adoption of technology interventions as compared to non-beneficiary respondents. Interventions wise adoption revealed that beneficiary respondents have adopted relatively more interventions than non-beneficiary respondents in maize and Bengal gram cultivation. This could be due to use of extension teaching methods i. e. result demonstrations, trainings and exposure tours, etc. under the NICRA project. The non-beneficiary respondents lacked these opportunities, and hence showed a lower level of adoption in these technologies.

Acknowledgement
My deepest gratitude goes to the Professor and Head, Ex. Professors of Departments of Extension Education, RCA Udaipur, KVK Aurangabad (*Chattrapati Sambhajinagr*) from Maharashtra for their support in providing necessary documents and reports during the research process, insightful comments and supports. Next, the author would also like to express his heartfelt gratitude to MPUAT, Udaipur (Raj.) and Dr. BSKKV, Dapoli (M.S.) for the valuable assistance for successfully completion of the research works.

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