The Pharma Innovation Journal 2023; SP-12(9): 521-527

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(9): 521-527

www.thepharmajournal.com
Received: 15-07-2023
Accepted: 13-08-2023

Guduru Dhanalakshmi
SHE & CS Krishi Vigyan Kendra
Yagantipalle Nandhyal Dt,
Andhra Pradesh, India

M Sudhakar
SHE & CS Krishi Vigyan Kendra
Yagantipalle Nandhyal Dt,
Andhra Pradesh, India

A Krishnamoorthy
SHE & CS Krishi Vigyan Kendra
Yagantipalle Nandhyal Dt,
Andhra Pradesh, India

Corresponding Author:
SHE & CS Krishi Vigyan Kendra
Yagantipalle Nandhyal Dt,
Andhra Pradesh, India

Empirical evidences of climate smart agricultural practices in scarce rainfall zone of Andhra Pradesh

Guduru Dhanalakshmi, M Sudhakar and A Krishnamoorthy

Abstract
Climate smart agricultural technologies were proved to be the best adaptation strategies followed by farmers in scarce rainfall zone of Andhra Pradesh for sustainable crop yields. The study was taken up in Nandhyal and Anantapur Districts of Andhra Pradesh, India with 180 respondents with an objective to record the economic benefit by adoption of crop production technologies. Results revealed that with conservation furrows, the crop yields of Setaria, Castor, and Red gram were enhanced by 28, 32 and 29 per cent respectively. The additional net benefit recorded was Rs 11,955, Rs 13, 263a and Rs 21,153/ha for Setaria, Castor and Red gram respectively. With supplemental irrigation in critical stages from farm ponds the yields of Groundnut, Jowar and Red gram were enhanced by 35.93, 57 and 31.3 per cent respectively. Setaria+ Red gram intercropping (5:1) recorded Rs.21973/ha additional net returns. Intercropping of Ground nut +Red gram (7:1) yielded 1123 kg/ha which is higher by 29.52 per cent. Drought tolerant Castor, Bengal gram, Groundnut, Jowar and Red gram varieties recorded 25, 23, 50, 43 and 34.5 per cent more yield than control with economic advantage. Short duration varieties of Setaria, Red gram, Groundnut and Green gram recorded additional net returns of Rs 14,412, Rs. 12,250, Rs 14,900and Rs. 4920/ha. By following drought mitigation sprayings (KNo3) in Red gram, Ground nut the yields were sustained. By adoption of weather based agro advisories in Maize, Rice and Cotton the yields were enhanced by 23, 12.6 and 22.6 per cent respectively.

Keywords: Farm ponds, In-situ conservation, intercropping, drought tolerant varieties, short duration varieties, drought mitigation sprays, WBAAS

Introduction
Climate change and increasing climatic variability are likely to aggravate the problems of future food security by exerting pressure on agriculture. Countries like India are more vulnerable in view of the high population depending on agriculture, excessive pressure on natural resources and poor coping mechanisms. Management practices that enhance/ stabilize agricultural production under adverse climatic conditions tend to hold up climate change adaptation because they increase resilience and minimize yield variability under variable climate and extreme events

Identification and prioritization of climate smart agricultural technologies support climate change adaptation. While designing climate smart crop production technologies at the field level we have to consider the crops and varieties that go well with climatic conditions, preference of the farmers and marketability**.** Hussain *et al*., (2013) [3] concluded that Crop adaptation strategies *viz*., changes from long to short duration varieties (75%), number of irrigation and spacing were adopted by majority (73%) of the farmers. Jasna *et al*., (2015) [4] stated that technologies demonstrated, through NICRA imparted resilience in terms of mitigation and adaptation to climate vulnerability, in Gumla district of Jharkhand and Tumkur of Karnataka concluded that short duration finger millets, green gram, intercropping of millets with pulses, drought tolerant varieties proved economical.

Materials and Methods
The study was conducted in Nandyal and Anantapur districts of Andhra Pradesh during August 2022. Three villages from Nandyal and three villages from Anantapur district were purposively selected as NICRA project was being implemented in those villages. The districts comes under scarce rainfall zone of Andhra Pradesh with annual rainfall ranging from 470 to 700mm mostly dominated by South-West monsoon. The climate vulnerability of the districts are late on set of monsoon, frequent dry spells, heat stress, haze and terminal moisture stress in Kharif crops. A sample of thirty was drawn from each village thus making it 180 sample size.

The data was collected using a structured schedule and list of crop production technologies followed by farmers in the project in Nandhyal and Anantapur in six NICRA adopted villages was considered for the present study. Yield advantage and economic benefit by adoption of the crop production technology was studied by using t test.

Results and Discussion

1. Farm Ponds for supplementation irrigation

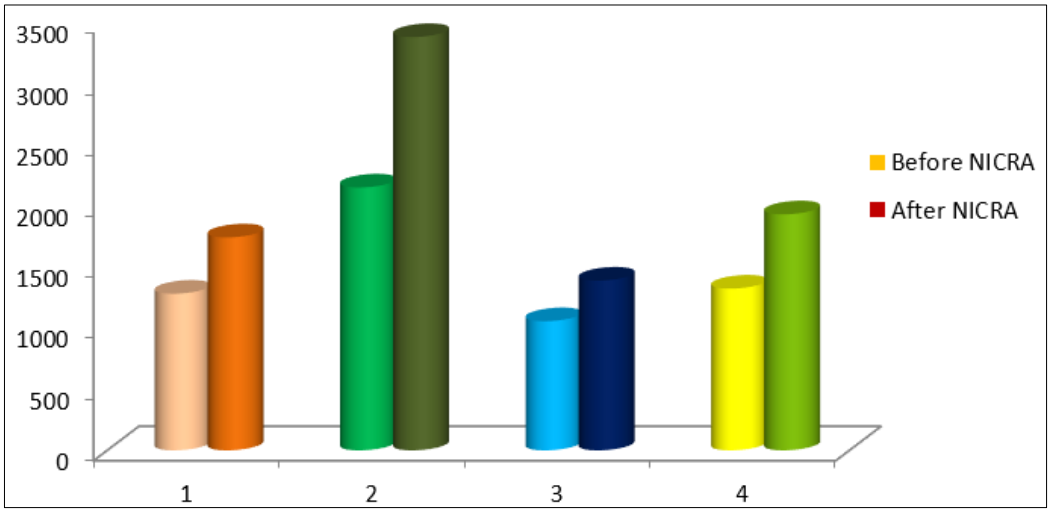
From the Table 1 and Figure 1 it is evident that supplemental irrigation was given during the critical stages of the ground nut crop. The yield obtained in groundnut was 1744 kg/ha which is 35.93 per cent more than the unirrigated crops. The yields are significant at five per cent level. Regarding jowar cultivation with supplemental irrigation the yield recorded was 3385 kg/ha which is 57 per cent higher than the control. With regard to red gram supplemental irrigation was given twice and the yield recorded was 1390 kg/ha which is 31.3 per cent higher than the control. The result is significant at 5 per cent level. Intercropping of red gram with groundnut the equivalent yield recorded was 1933 kg/ha which is 46 percent more than the control.

The results clearly state that supplementary irrigation during the critical stages will definitely bring out the potential yields of the crops. As the distribution of rainfall is not even in spatial and temporal dimensions, crops face moisture stress during different stages of the crops. If the moisture stress is in critical stage of the crop it has adverse effect on yield. All the crops which are shown in the table require less water requirement with one or two lifesaving irrigations the output was economical. The findings are tune with Srinivasa Rao Ch. *et al*. (2014) [11]

Table 1: Benefit of supplemental irrigation of harvested water through farm ponds

Crop	Crop yield (kg ha^{-1})	
	Before NICRA	After NICRA
Groundnut	1283	1744*
Jowar	2153	3385*
Redgram	1058	1390*
Groundnut equivalent yield (Redgram + Groundnut)	1325	1933*

* Impact of the intervention is significant 5 percent age level of significance



1. Groundnut 2. Jowar 3. Red gram 4. Red gram + ground nut

Fig 1: Yield advantage of supplemental irrigation with farm ponds

2. In-situ moisture conservation measures

From the Table 2 and Figure 2 it was concluded that conservation furrow was made for every six rows at 35 DAS with blade harrow helped in shortening the dry spell effect on the crop and the yield obtained was 1418 kg/ha. The yield advantage of the practice was twenty-eight per cent more and additional net returns were Rs. 11,955 /ha. The results are significant at one percentage level.

In castor formation of conservation furrows for every two rows planted at 90cm with blade harrow at 35 DAS. The adoption of the drought management practice resulted in 1332 kg/ha yield which is higher than the control by 32 per cent. The additional net returns obtained were Rs 13,263/ha. Regarding cotton cultivation with out in -situ conservation practice yield recorded was 960 kg/ha and minus net returns was recorded. With conservation furrows yield recorded was 1450 kg/ha which is 51 per cent more than control with net returns of Rs 13,150/ ha. Regarding conservation furrows in red gram, yield recorded was 1024 kg/ha which is 44 per cent higher than the control. The additional net returns obtained were Rs 21,153. The results are significant at one percent level of significance.

Since these practices do not involve much investment and small farmers prefer the no cost options, the technology is widely accepted by the farmers. As the technology is low cost and easily adaptable this can be scaled up by department of agriculture as it is the biggest extension unit prevailing across the country at the grass root level. Through custom hiring also RBKs can take up the activity. The findings are in tune with Srinivasarao *et al*. (2014) [11].

Table 2: Yield and economics of various crops as influenced by *In-situ* moisture conservation measures

Crop	No. of observations	Crop yield (kg ha^{-1})		Net returns (Rs.ha^{-1})	
		Before NICRA	After NICRA	Before NICRA	After NICRA
Setaria	63	1107	1418**	20260	32215**
Castor	11	1003	1332**	10430	23693**
Cotton	9	960	1450*	-5120	13150**
Red gram	20	709	1024*	22619	43772**

* Impact of the intervention is significant 5percent age level of significance ** Impact of the intervention is significant 1percent age level of significance

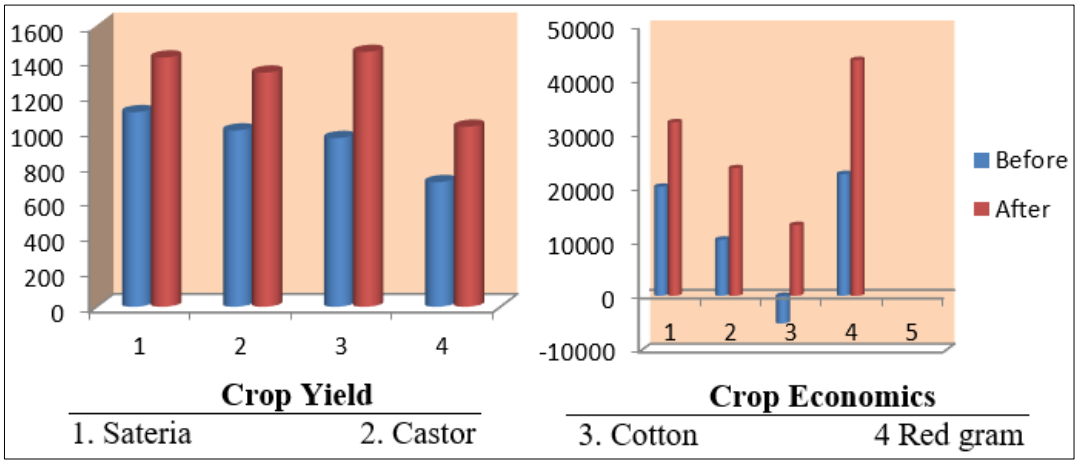


Fig 2: Yield and economics of in-situ moisture conservation in different crop
1. Sateria 2. Castor 3. Cotton 4. Red gram

3 Intercropping system

3.1. Setaria+ Red gram (5:1)

In this system after every five rows of setaria one row of red gram is sown (5:1). Sowing is done by bullock drawn seed drill. As setaria is main crop Setaria equivalent yield was considered for yield calculations. With the intervention the yield recorded was 1830 kg/ha which is 28 per cent higher than the control (Table 3 and Figure 3). The economic advantage of the system is Rs.21973/ha which is 42 per cent than the control. The higher rates are attributed for the price of red gram. The results are significant at one per cent level. The same was confirmed by Latha *et al*. (2012) [5]

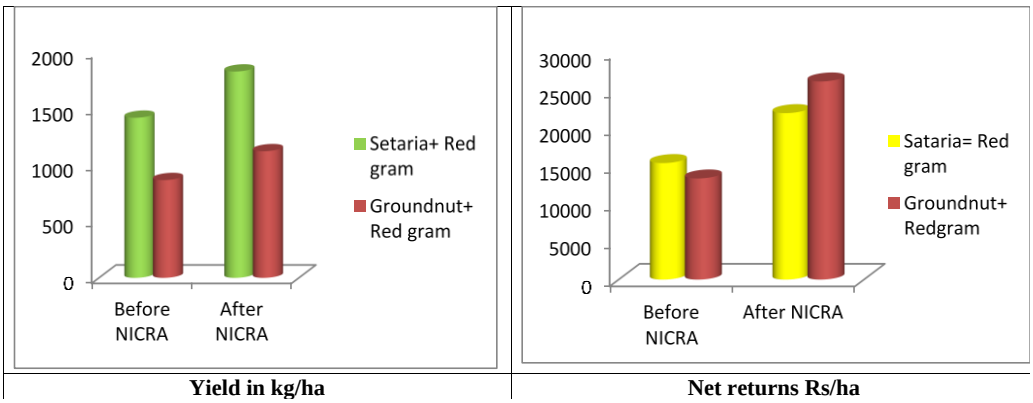


Fig 3: Yield and Economics of Setaria+ Red gram intercropping system

3.2 Groundnut + Red gram (7:1)

In this system after every seven rows of groundnut one row of red gram is sown by bullock drawn seed drill. As ground nut is main crop its equivalent yield was calculated for total crop yield. The yield recorded (Table 3 & Figure 3) in the intercropping system was 1123 kg/ha which is higher by 29.52 per cent than the control with additional net returns of Rs 12800/ha and the results are significant at one per cent level.

It was understood that majority of the rainfed farmers are adopting intercropping system. Farmers opined that pest incidence is less due to crop diversity, weed problem is lessened and soil nutrient status is enhanced with cultivation of legumes. It is like crop insurance and farmers of sure of reaping at least on crop. The system is holding good to dry land farmers as the cropping system is utilizing the bimodal distribution of rainfall and more efficient utilization of soil by combination of shallow rooted and deep-rooted crops. As the adoption is easy it has to be scaled up by the department by providing intercropping seed kits through government subsidy programme. The results are in tune with Rao (1988) Maddison (2006) [7], Deressa *et al*. (2009) [2] Srinivasa Rao Ch *et al*. (2014) [11], Jasna (2014) [4] and Sahil *et al*. (2022)

Table 3: Yield and economics of various crops as influenced by intercropping systems

Crop	No. of Observations	Crop yield (kg ha^{-1})		Net returns (Rs.ha^{-1})	
		Before NICRA	After NICRA	Before NICRA	After NICRA
Setaria equivalent yield (*Setaria* + Redgram)	34	1420	1830**	15380	21973**
Groundnut equivalent yield (Red gram + Groundnut)	26	867	1123**	13350	26150*

* Impact of the intervention is significant 5 Percent age level of significance ** Impact of the intervention is significant 1 Percent age level of significance

4. Drought tolerant varieties

From the Table 4 and Figure 4 it was evident that with the cultivation of drought tolerant varieties in castor the yield recorded was 1330 q /ha which is 25 per cent more than the control with additional net returns of Rs 10,082/ha. Some of the castor hybrids that are available in the research institutes like ICH-66, PCH-111, PCH222 are very good drought tolerant hybrids and suited to the rainfed ecology. With the availability of seed material, a greater number of farmers will be cultivating castor. Research institutes should identify proper nodal agencies at the district level and facilitate seed production by the farmers for horizontal spread of the technology.

With regard to Bengal gram cultivation the drought tolerant varieties gave 1513 kg /ha with 23.0 per cent more yield advantage. Additional net returns obtained was Rs 8720/ha. Bengal gram is cultivated in vast area in Kurnool and some parts of Ananthapur. With the availability of drought tolerant varieties of NBeG 49, NBeG 1, NBeG 452 at the research stations and KVK seed hubs farmers are able to cultivate. For reaching more number of farmers the drought tolerant varieties should be brought in to seed chain and supply to farmers on subsidy basis..

With respect to groundnut the drought tolerant varieties gave an yield of 1020 kg/ha which is 50 per cent more than the control with additional net returns of Rs 15,200/ha. Highest area is cultivated in Ananthapur and drought tolerant varieties play an important role in enhancing the district productivity. Drought tolerant varieties which can stand drought till 35 days are available like Dharani Kadiri lepakshi etc. Supply of seed material is the biggest challenge in seed replacement as ground nut seed rate is very high unlike other crops. As research stations are available within the district a comprehensive seed plan has to be developed by government for reaching to the needy farmers taking into cognizance of spatial and temporal dimensions. Involvement of NGOs FPOs may also help in spread of the technology.

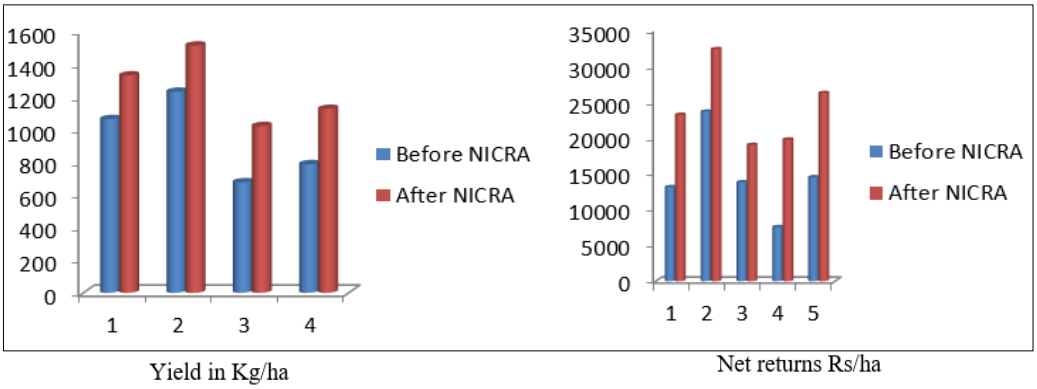
Jowar is an important dry land crop cultivated in rabi which is called as maagi jowar. From the results it was observed that jowar drought tolerant variety gave a yield of 1125 kg/ha which is 43 per cent higher than the control with additional net returns of Rs 11830/ha. The drought tolerant varieties available at research stations and KVKS are reaching more number of farmers. As seed rate is only 10 kg/ha seed multiplication can be taken at the village level under expert supervision by kvks, universities and department of agriculture so as to reach a greater number of farmers.

Regarding red gram the yield obtained for the drought tolerant varieties was 1095 kg/ha which is 34.5 per cent more than the control with additional returns of Rs 11,750/ha. Drought tolerant varieties are preferred by farmers as encountering of drought is a regular phenomenon in scarce rainfall zone. Farmers opined that it's a poor man crop and almost cultivated by small and marginal farmers in rainfed ecology. The gap in the adoption is due to unavailability of seed in time. The biggest challenge of seed supply can be faced by integrated efforts of government, universities, NGOs and FPOs' by forming a seed production consortium. The results follow Srinivasrao Ch (2014) [11].

Table 4: Impact of drought tolerant crop varieties on yield and economics

Crop	No. of observations	Crop yield (kg ha^{-1})		Net returns (Rs.ha^{-1})	
		Before NICRA	After NICRA	Before NICRA	After NICRA
Castor	6	1063	1330*	13125	23207**
Bengal gram	72	1230	1513**	23643	32363*
Groundnut	17	676	1020 **	13800	19,000**
Jowar	17	787	1125**	7545	19750**
Red gram	42	690	1025**	14500	26250**

* Impact of the intervention is significant 5percent age level of significance
** Impact of the intervention is significant 1percent age level of significance



1. Castor 2. Bengal gram 3. Groundnut 4.Jowar 5. Red gram

Fig 4: Yield and Economics of the drought tolerant varieties

5. Short duration varieties

The results from the Table 5 and Figure 5 indicates that the short duration varieties of fox tail millets yielded 1423 kg ha with additional net returns of Rs 14,412. Short duration Setaria like Garuda (55 to 60 days duration) Suryanandhi (75 to 80 days duration) are available for cultivation. The cultivation of these varieties is picking up as the perception of farmers regarding Setaria performance in climate variability is good. Farmers take decisions to choose the variety based on soil type. Some of the farmers prefer to take up these varieties so as to go for second crop with pulses in rabi season under rainfed situation. Short duration Setaria is very much suited for intercropping and doubles cropping systems. Promotion of setaria cultivation should be done by government by providing procurement centers and processing units at the ground level. As cost of cultivation is less, requires minimum fertilizers and pesticides with minimum external inputs, promotion of millets cultivation is very important as it is recommended in sustainable agriculture practices by FAO.

The results indicated that red gram gave yield of 1040 kg/ha which is 31. 8 per cent more than the long duration red gram. Additional net returns obtained was Rs 12550/ha. Most of the times cultivation of long duration varieties in scarce rainfall zone is leading to terminal moisture stress and occurrence of dry spell in the crop vegetative and reproductive period became a common phenomenon. Varieties like PRG176 with 135 days are escaping the terminal moisture stress and haze damage as the crop escapes flowering stage and reaches to pod formation at the time of haze incidence.

With regard to groundnut the yield recorded was 948 kg/ha which is fifty eight per cent more than the traditional variety with net additional income of Rs 14,900/ha. With the cultivation of short duration varieties farmers are able to get some economical benefit. These varieties can be multiplied and at the village level in coordination with department of agriculture and agriculture universities and FPOs

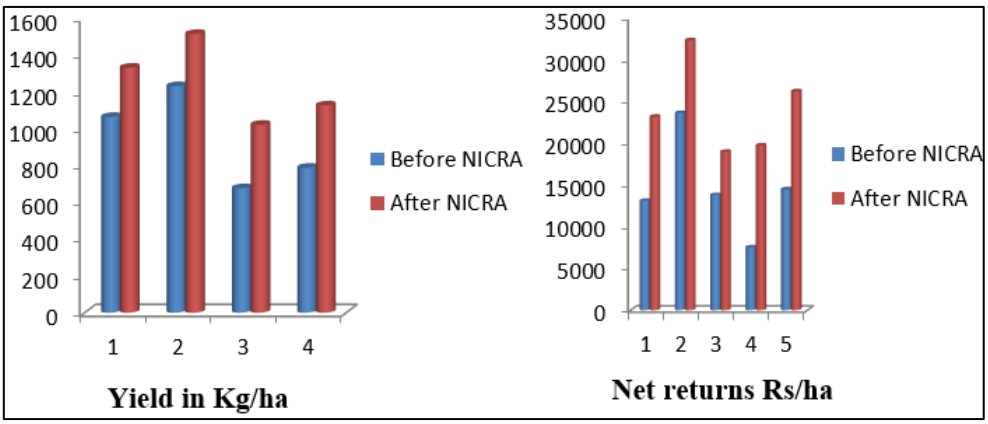
With respect to green gram the yield recorded was957 kg/ha which is 9.3 per cent more than the traditional variety. Short duration varieties like WGG 42 are preferred by farmers as the duration is 55 to 60 days and the crop is cultivated in all the cropping systems. Though the production is less, market is good for green gram and it also enriches the soil nutrient status.

Table 5: Yield and Economics of short duration varieties

Crop	No. of observations	Crop yield (kg ha^{-1})		Net returns (Rs. ha^{-1})	
		Before NICRA	After NICRA	Before NICRA	After NICRA
Setaria	66	1080**	1423**	22580**	36992**
Red gram	78	789	1040**	14450	27,000**
Groundnut	84	598	948**	-2650	14900**
Green gram	42	875	957*	17500	22420*

* Impact of the intervention is significant 5percent age level of significance

** Impact of the intervention is significant 1percent age level of significant.



1. Castor 2. Bengal gram 3. Groundnut 4. Jowar 5. Red gram

Fig 5: Yield and Economics of short duration varieties

6. Drought mitigation chemical sprayings

The results in the Table 6 and Figure 6 indicates that spraying of 0.5 per cent KNO_3 to red gram after 30 days of moisture stress twice with 3 days interval with 500 lit of water recorded 1023 kg/ha. The yield recorded was 20.0 per cent more than the control with additional net returns of Rs 8650/ha. In case of groundnut nut also spraying 0.5 percent of KNO_3 with three days interval twice after 35 to 40 days of dry spell recorded 1021 kg/ha which is 10.6 per cent more than the control with additional net return of Rs 4900/ha. Likewise spraying for intercrop of red gram + groundnut was done during the moisture stress period and the yield recorded was1047kg /ha of groundnut equivalent yield, which is 17.6 per cent more than the control with additional net returns of Rs 7850/ha.

Drought mitigation strategy with KNO3 spraying is a new technology in farmers point of view. Of late farmers are convinced with the technology and taking up spraying. As the drought situation will be similar across the villages, community sprayings can be taken by the farmers. Government can encourage these types of small interventions which create a huge difference in the crop yield.

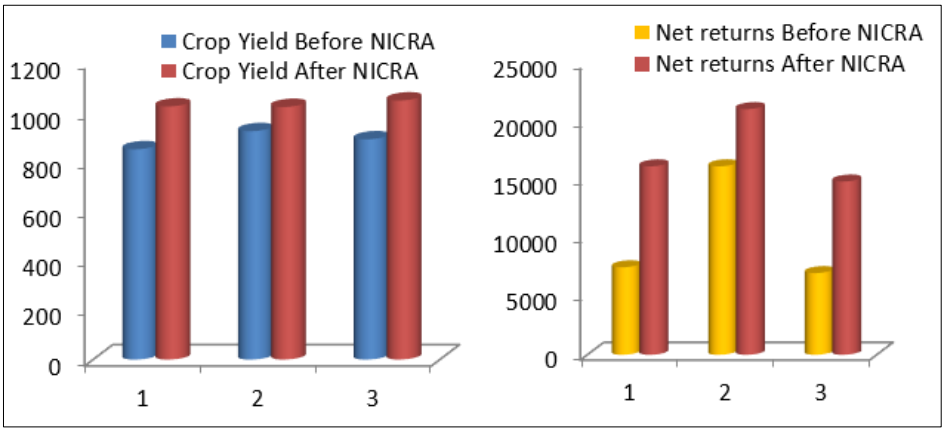


Fig 6: Yield and Economics of drought mitigation technologies

Table 6: Yield and economics of various crops as influenced spraying of Potassium Nitrate (KNO_3)

Crop	No. of Observations	Crop yield (kg ha^{-1})		Net returns (Rs.ha^{-1})	
		Before NICRA	After NICRA	Before NICRA	After NICRA
Red gram	36	850	1023* *	7500	16,150*
Groundnut	28	923	1021*	16150	21050*
Groundnut equivalent yield (Redgram+ Groundnut)	55	890	1047*	7000	14850*

***** Impact of the intervention is significant 5percent age level of significance
** Impact of the intervention is significant 1percent age level of significance

7. Weather based Agro advisory Services (WBAAS)

Table 7 and Figure 7 presents the results of weather based agro advisory services on the crop performance**.** Regarding the performance of maize by following weather-based crop advisories strictly the yield obtained was 5259 kg /ha, which is 23 per cent more than the control with additional net benefit of Rs 22,044/ha. In rice the yields obtained by following crop advisories was 6192kg/ha which is 12.6 per cent more than the control with additional net returns of Rs 15,360/ha. With respect to cotton also the yield obtained with the aid of weather based agro advisory services is 2707.5 kg /ha which is 22.6 per cent more than the control with net additional returns of Rs 42,500/-

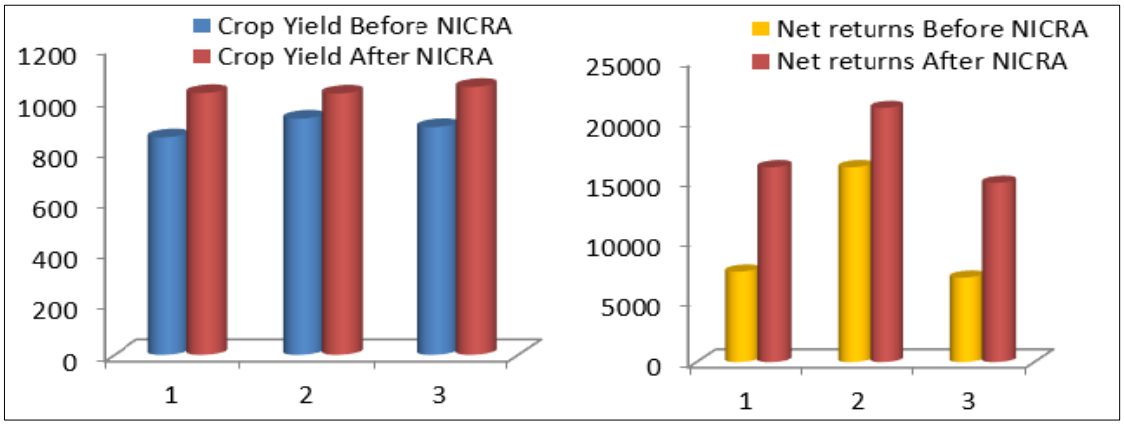
On the whole by following weather based agro advisory services farmers are able to curtail unnecessary expenditure in farm operations like pesticides sprayings, fertilizer application irrigation etc. Weather based agro advisory service is a very powerful tool to reach each and every farmer in the country. Localized agro advisories should be promoted by the government as it is the cheap mode of transfer of technology in reaching vast no of farmers in a single stroke. More focus is needed in expanding the services as this is going to be game changer if the messages are designed and sent meticulously in time.

The results are in compliance with Rajesh (2011) [8], Madan *et al*. (2015) [6] Rani saxena *et al*. (2015) [9].

Table 7: Yield and economics of various crops as influenced by weather based agro advisory services

Crop	No. of observations	Crop yield (kg ha^{-1})		Net returns (Rs.ha^{-1})	
		Before NICRA	After NICRA	Before NICRA	After NICRA
Maize	19	4257.5	5259.5*	48654	70698.00*
Rice	28	5498**	6192**	14390	29750**
Cotton	16	2207.5	2707.5**	112,595	155095**

* Impact of the intervention is significant 5 percent age level of significance
** Impact of the intervention is significant 1percent age level of significance



1. Maize. 2. Rice. 3.Cotton 1. Maize. 2. Rice. 3.Cotton

Fig 7: Yield and Economics of Weather based Agro-Advisory Services

Conclusion

On the whole it can be concluded that that by adopting climate resilient practices in rainfed situation optimum yields can be reaped. As rainfed agriculture occupies 51 percent of the country's net sown area and accounts for nearly 40 percent of the total food production. The productivity levels of the crops in rainfed situation is very low and it can be sustained with the adoption of climate smart technologies. Thus rainfed agriculture can be sustained with the adoption of climate smart technologies.

References

1. Ananta VR, Singh D, Das K, Baloda R. Weather based agromet advisories for enhancing the production and income of the farmers under changing climate scenario", International Journal of Agriculture and Food Science Technology. 2013;4(9):847-850.
2. Deressa T, Hassan R, Ringler C, Alemu T, Yesuf M. Analysis of the Determinants of Farmers' Choice of Adaptation Methods and Perceptions of Climate Change in the Nile Basin of Ethiopia", IFPRI Discussion Papers No. 798, International Food Policy Research Institute, Washington DC; c2008.
3. Hussain R, Dutta KK, Tamuly D, Deka RL, Khanikar PG. Farmers' perception of climate change impact and its mitigation in Golaghat district of Assam, Journal of Agrometeorology. 2013;15(2):203-208.
4. Jasna VK. "Impact of climate resilient technologies in rainfed agro-eco system, Unpublished M.Sc. (Ag.) Thesis submitted to. IARI. New Delhi; c2014.
5. Latha Asha KV, Gopinath M, Bhat ARS. Impact of climate change on rainfed agriculture in India: A case study of Dharwad, International journal of environmental science and development. 2012;3(4):366-370.
6. Madan Singh R, Roy Burman JP, Sharma VS, Iquebal MA. Effectiveness of Mobile based Agro-Advisory services In Addressing Information Need of the Stakeholders: A case study of m KRISHI^{R}", Indian Journal of Extension education. 2015;51(1 & 2):32-38.
7. Maddison D. The perception and adaptation to climate change in Africa, Discussion paper No.10. Centre for Environmental Economics and Policy in Africa (CEEPA). Pretoria, South Africa, University of Pretori; c2006.
8. Rajesh. Awareness and Perception of farmers towards weather forecasting advisory services in Haryana, Post-graduation thesis submitted to Haryana Agriculture University, Haryana, India; c2011.
9. Saxena R, Gupta KC, Mathur P. Economic impact analysis of weather based agromet advisories on crops under Climate Change scenario, Journal of Progressive Agriculture. 2015;6(1):100-102.
10. Boora S, Kaur B, Manisha TR, Rohit. Attitude of Farmers Toward Intercropping in Haryana. Indian Journal of Extension Education. 2022;58(4):91–95.
11. Rao S, Ravindra Chary CH, Mishra G, Subba Reddy PK, Maruthi G, *et al*. Rainfed Farming, A Compendium of Doable Technologies, All India Coordinated Research Project for Dry land Agriculture, Central Research Institute for Dryland Agriculture, Hyderabad, India; c2014.