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Research Article

MORE CROP PER DROP OF RAIN WATER IN ANATAPURAMU DISTRICT OF ANDHRA PRADESH: AF ECOLOGY CENTRE EXPERIENCE

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Abstract: In Andhra Pradesh, out of 40 lakh ha rainfed area Anatapuramu district accounts for 22%. Rainfall analysis indicated that more than 50% droughts occur due to dry spell of 20 to 30 days. The technologies demonstrated for three years (*kharif* 2015 to 17) for lack of rains were: sowing with aqua planter, row water sowing and sowing of contingent crops and for drought were: water harvesting in lined farm ponds and protective irrigation. Supplemental irrigation was given through farm ponds to groundnut and mango. Mobile protective irrigation at the rate of 25000 l ha^{-1} given at flowering and pod formation stages gave 20 % more yield in pigeonpea. Protective irrigation in pigeonpea recorded seed yield of 875 kg ha^{-1} compared to 125 kg ha^{-1} under rainfed. Additional investment of Rs.5,000 ha^{-1} for row water sowing along with two protective irrigations for pigeonpea resulted an additional income of Rs 10,000 ha^{-1}.

Keywords: *Row water sowing, Aqua planter, Lining of farm ponds and protective irrigation*

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Introduction

India arid zone occupies an area of 32 million ha constituting about 10% of the country's geographical area. It forms a continuous stretch in the north-western states of Rajasthan (61%), Gujarat (20%), Punjab (5%), Haryana (4%) and scattered landmasses in the peninsular states namely Maharashtra, Karnataka and Andhra Pradesh (Scarce rainfall zone). Inadequacy in quantum and erratic distribution of rainfall (<150 mm to 400 mm, CV 36 to >65%) coupled with high evaporative demand (1600–1900 mm/year) and light textured soils (Aridisols) has made agriculture a difficult proposition [1]. In Andhra Pradesh out of 40.0 lakh ha of rainfed area, 45 % (16.0 lakh ha) is concentrated in scarce rainfall zone of Andhra Pradesh consisting Anatapuramu (546 mm normal rainfall per annum) and Kurnool (630 mm normal rainfall per annum) districts. About 25% of total rainfed area of Andhra Pradesh is in Anatapuramu district which is the rain shadow area of Andhra Pradesh and lowest rainfall receiving area next to Jaisalmer in India. Anatapuramu district is one of the most backward districts in India. Micro level climatic classification of Anatapuramu district was analysed using meteorological data for 25 years (1988-2012). This analysis has indicated that all the 63 mandals of Anatapuramu district are having arid climate with moisture index values -67.4 to-84.7[2]. In the last eighteen years, Anatapuramu has experienced three years of normal rain and fifteen years of drought. Rainfall was analysed for the last 25 years in 8 mandals and shown that more than 50% droughts occur due to loss of just one rain *i.e*., one dry spell of 20 to 30 days. Prolonged dry spells during crop season cause moisture stress and crops fail. About 80% of the crop failures (droughts) can be saved if one or two protective irrigations given during such dry spells, during critical stages. The actions sites of Anatapuramu district in Andhra Pradesh are witnessing growing uncertainty in onset of rainfall and posing challenges for cultivation of crops like groundnut, therefore it necessitates evaluating other suitable contingent crops to be grown as next best alternative to groundnut rather than leaving lands fallow. Drought mitigation technologies were developed at ARS, Acharya N.G. Ranga Agricultural University, Anatapuramu and there is necessity to test and refine these technologies for upscaling [3]. Over the last few years, Accion Fraterna (AF) has been developing and demonstrating practices and techniques to mitigate moisture stress in order to save the crops.

Materials and Methods

The project was implemented through sasya mitra groups of 25 members each in 8 mandals (Dharmavaram, Rapthadu, Kuderu, Atmakur, Beluguppa, Kalyanadurg, Settur and Kundurpi) in Anatapuramu districts. The soils were shallow red soils belonging to Alfisols and Aridisols. The technologies tried for lack of rains were: sowing with aqua planter, row water sowing. The practices for drought management during crop season were: water harvesting in lined farm ponds and protective irrigation, and sowing of contingent crops. These technologies were demonstrated for three years during *kharif* seasons of 2015 to 2017. Drought mitigation technologies were implemented through 870 farmer groups of 25 each which are known as sasya mitra groups in 8 mandals of Anatapuramu district. Farm ponds were lined with soil cement mixture in 6:1 ratio for storing rain water. Supplemental irrigation was given through farm ponds to groundnut and mango. Drought mitigation technologies were tested in farmers' fields. The plot size of experiment is field scale and in most of the cases it is 0.4 ha. The soils were shallow red soils belonging to Alfisols and Inceptisols. The technologies tested were row water sowing, sowing with aqua planter, lining of farm ponds, protective irrigation to different crops and sowing of contingent crops in case of delayed onset of monsoon.

Technology Description

Timely Sowing in the Absence of Timely Rain

Given the short span of 90 to 120 days of crop growing period, timely sowing becomes critical [4]. Further given low moisture, holding soils, sowing fast enough before moisture evaporates also becomes critical.

Aqua planter

It was developed by ARS, Anatapuramu to supplement water in while sowing groundnut or pigeonpea simultaneously to achieve timely sowing with optimum yields. It is designed to sow in time in the absence of timely rains in the sowing season *i.e*., June/ July. Once seed along with water is sown, the seed would germinate and survive for about two weeks to catch up with subsequent rains. It is made of Anantha Planter mounted with 2 drums of 200 litres capacity each on the frame. When the planter is in operation, it drills water and seed simultaneously and covers the furrows with blades attached to it. The amount of water required for sowing of crop depends on the soil moisture. For sowing in a dry soil, 20,000 l ha^{-1} are required for close growing crops like groundnut, sorghum and pearl millet *etc*. For castor or pigeonpea 10,000 l ha^{-1} is sufficient. The quantity of water can be reduced depending on the availability of soil moisture. An area of 1.5 ha can be sown in a day of 8 hours [3].

Planter + tractor tanker

The method comprises of a planter which is fitted to a tractor-drawn tanker, wherein water is released through pipes simultaneous to the sowing. This is particularly efficient for Pigeonpea and castor crops requiring wide space between rows like 5 to 6 feet and ensures healthy germination and growth.

Watering furrows

The technique involves the ploughing of furrows five to six feet apart, for castor or pigeonpea and watering the furrows followed by manual dibbling of seeds, and closing the furrows. The amount of water required is 12 500 to 20 000 l ha^{-1} depending in the soil moisture. Aqua Planter was used to sow pigeonpea without sowing rains. The amount of water used for sowing of was 25,000 l ha^{-1}.

Protective Irrigation

Protective irrigation to crops during dry spells can be provided from: 1) Farm ponds constructed on farmers' own fields. This is the easiest and most efficient source of irrigation; 2) Bore well water. This can be transported to the field by using a tractor drawn tanker or through pipes in case a bore well is available nearby; 3) Tanks in the village. When the water is available in the tank or at any public source, it can be transported to the fields by laying down pipes from the tank to nearby fields and pumping to provide protective irrigation. Water can also be transported by a tanker to too far away crops and protective irrigation can be given. Protective irrigation is application of small quantity of water during dry spell to protect the crop from drying and to maintain the crop in a diapause stage so as to use subsequent rain. Productivity of harvested water can be increased by applying small quantity of water to large areas than heavy irrigation to small area. Crops differ in responding to amount of irrigation water to supplemented irrigation during dry spell.

Accion Fraterna, has found that protective irrigation, implemented during a dry spell longer than 10 days, is a very effective drought mitigation measure. AF has very successfully demonstrated widely that crops can be protected with relatively low quantities of water through measured irrigation at crucial periods of moisture stress and is popularizing the practice with its partner farmers and convincing policy makers of its efficacy. However, given acute water scarcity, availability of water is the prime constraint. As a response, AF has developed easily manageable, low-cost mobile equipment and technologies for providing protective irrigation.

Cement-lining of farm Ponds

This is a practical and low-cost solution for ensuring protective irrigation, where farm ponds are lined with a cement and clay mixture to harvest and store rainwater on-farm. While testing the concept in Anantapur, AF has found that it can retain water for 30-45 days as opposed to farm ponds which are not lined, which only retain water for 8-10 days due to high seepage and evaporation. A typical size of farm pond was 10 X 10 X 2.5 m for red soils for 2.0 ha of cultivated field. Farm pond is lined with soil cement mixture in 6:1 ratio. Six parts red soil and one-part cement is mixed with water and all sides of the pond is lined with mixture. Curing is required for three days. Soil: cement lining is effective in red soils. Once it was filled with runoff, 2,50,000 liters of water will be available for supplemental irrigation. The cost of farm pond is about Rs.35400/. Once it was filled with runoff, 2,50,000 litres of water will be available for supplemental irrigation [3].

Row irrigation

Row irrigation was given to Pigeonpea at 25,000 l ha^{-1}. Water is applied in the furrow through a hose pipe from tractor-tanker or trough shallow furrow by the side of Pigeonpea row at flowering and or pod development stage. Protective irrigation was given to groundnut from farm ponds, streams and irrigation tanks through sprinkler irrigation and pumped by oil engines. Bore well water was also used to provide protective irrigation.

Mobile protective irrigation unit

Accion Fraterna has developed a working prototype of a lorry-drawn tanker with an attached mobile sprinkler and drip irrigation unit. The unit has a tanker capacity of 12,000 litres and is used regularly for field demonstrations of various protective irrigation methods. The units are feasible for a scale up considering the large number of tractors and trailers in Anantapur. Water is transported through tractor-tanker or any other tankers and crops are protected through row irrigation. It is mainly used for protective irrigation to widely spaced crops. Mobile irrigation is economical when the crop is drying due to drought or under terminal drought when entire crop is likely to be lost. Groundnut + pigeonpea is an important cropping system in rainfed areas and after harvest of groundnut, Pigeonpea come to flowering in the month of November. Most of the time monsoon recedes and terminal drought occurs to pigeonpea. Providing protective irrigation at flowering stage is highly economical even with the transported water.

Contingency crop planning

In the 2015 crop season, 40% of cultivable area could not be sown for want of timely rains in June and July. Accion Fraterna prepared the farmers for contingency crops with horsegram, jowar, green gram *etc*., which could be sown in August and September for late rains, and provided seed accordingly. With the rains finally arriving in August, the contingency crops were sown. With this, area that would have remained unfarmed and unproductive was brought down from 40% to 10% of total cultivable area. The year 2015 faced delayed rainfall scenario and most farmers could not sow groundnut and therefore contingents were sown.

Results and Discussion

Rainfall Analysis

The main reason for the distress in Anatapuramu district is low and erratic rainfall in the district [Table-1]. Rainfall of 25 years of 8 mandals (group of around 30 villages) was analyzed for 25 years [5]. The important trends of rainfall are as follows:

Year to year variation of annual rainfall is more than 30% and the amount of rainfall ranges from 280 to 750 mm. Timely rains adequate for sowing did not occur in July in 50% of the years. Amount of sowing rain ranged from 10 mm to 40 mm spread over in 1 to 3 days. The second sowing rain comes from 7 days to 35 days after the first sowing rain. Therefore, timely sowing could not be done by farmers in 50% of the years. Timely sowing under sufficient moisture condition is a critical factor for successful crop under rainfed condition. So, many droughts occurred due to lack of rains for timely sowings. Dry spells (rainless period of more than 7 days) occur every year. The numbers of dry spells range from 2 to 4 during the crop season (June to November). The duration of dry spells ranges from 10 to 45 days. The time of occurrence of dry spells is anytime during the entire cropping season. Generally, rainfed crops like groundnut, millets or pulses survive a dry spell of 15 days. If the dry spells are more than 15 days, either the yields are reduced or crops are failed. Thus, droughts were caused by the prolonged dry spells during the crop period. Wet spells (continuous rainfall more than 2 days) is occurring in September and October months. High rainfall events (more than 40 mm / day) are 2 to 6 during the crop season. Runoff events occur if the rainfall is more than 40 mm and water can be harvested in farm ponds with lining which can be used for protective irrigation.

Table-1 *Seasonal (SWM and NEM) Rainfall (mm) received in different mandals during different years*

SN	Name of the Mandal	Seasonal rainfall (mm) (22nd to 52nd Standard week) (28th May to 31st December)		
		2015	2016	2017
1	Dharmavaram	596.0	406.1	630.2
2	Rapthadu	502.4	237.7	497.8
3	Kuderu	331.6	363.4	562.2
4	Atmakur	471.2	345.5	507.0
5	Beluguppa	200.4	219.5	522.1
6	Kalyadurg	521.5	319.5	539.3
7	Settur	618.9	334.7	542.2
8	Kundurpi	532.0	286.1	458.2

Aqua Planter

AF tested this equipment with 5 farmers in 4.0 ha in Kuderu Mandal. The seed sown with this planter had 85% germination and survived for 20 days without any rain. Wherever there was inadequate moisture in the soil required for sowing, the Aqua Seed Drill added moisture and helped in better germination and a better growth of the plant. The farmers expressed their satisfaction. Pod yield noticed was 12.3 % more with developed planter compared to traditional method due to sowing of groundnut crop in the recommended time during *kharif* season [6].

Row Water Sowing

Accion Fraterna introduced a new technique during 2015 on a very small scale for sowing widely spaced crops like Pigeonpea and castor in the absence of timely rain. 10,000 litres of water would be required for sowing castor or pigeonpea on 0.4 ha of land. Water drawn from outside in a tanker was let in the furrows using pipes and the furrows were closed with a plank. Then the seed is sown or dibbled in the watered furrows. This helped the farmers timely sowing of crops in the absence of rains in time. Germination percentage ranged from 85 to 95 %. Success rate of establishing pigeonpea in the absence of rain was 95%. Demonstrations of row water sowing method were carried out on 176 ha of land belonging to 307 rain-fed farmers in the project area. More than 70% of the sown area registered yields like normal sowing and the farmers benefited ranging from Rs.6250 to Rs.12500 ha^{-1}. Pigeonpea and castor crops can be established by watering in the absence of rains [7].

Case study

Ms. Nagamani from Ipperu Village of Kudair Mandal has 2.8 ha of dry land. She could not sow as the village did not receive adequate rain during the sowing season *Kharif* 2017. Inspite of insufficient soil moisture, she took a bold decision of sowing Redgram using furrow watering and sowing method in 1.2 ha by lifting water from nearby canal. She hired the required equipment (Pipelines, oil engine) from Grama Saysa Mitra Samakhya. The same week, there was rainfall and the germination were good. Later she also provided two protective irrigations using the same equipment during the crop season to protect her crop during dry spells. She made additional investment of Rs.15000 ha^{-1} but made an additional income of Rs 25000 ha^{-1}. With this demonstration, 70 farmers in the village were inspired to follow the same.

Protective Irrigation

Crops which were sown before the July rains during 2016 were severely affected by the prolonged drought spells that followed between August and September. AF supported 3,206 farmers with protective irrigation of standing crops covering 1580 ha in the project area. Water for this purpose was accessed from cement lined farm ponds, bore wells tanks and canals. There was a clearly visible increase in yield and income compared to the control plots, and protective irrigation was found to be particularly cost effective for pigeonpea crop. Accion Fraterna had a major policy success when the Government of Andhra Pradesh launched a scheme called "Rakshaka Thadi" ("protective irrigation" in Telugu), which was implemented in Anantapur District. AF had been consistently lobbying for introduction of such a scheme to create a safety net against drought. Under the scheme, the Department of Agriculture provided one-time protective irrigation for the groundnut crop covering 1,23766 ha and for the pigeonpea crop covering 9897 ha. This initiative benefited more than one lakh farmers. More importantly, the policy in place would go a long way in mitigating drought in all the mandals of Anatapuramu in the years to come. Protective irrigation is provided when dry spell is more than 15 days. Castor is sensitive at seedling stage and flowering stage where as Pigeonpea is sensitive at flowering stage. Tractor tanker is used for providing water. The increase in grain yield was 12 to 25 %. Groundnut is sensitive to moisture stress particularly at pod development stage. Protective irrigation was given with sprinklers when the dry spell is more than 15 days. The amount irrigation was from 10 mm to 20 mm. 3166 farmers benefited from protective irrigation and protected from drought their rain-fed crops in 2652 ha of land [Table-2]. These farmers drew water from canals, reservoirs, groundwater and lined farm ponds. They also shared water with each other, during the critical stages of the crops. 43 ha was given protective irrigation using 45 lined farm ponds. This approach is found to be very cost effective and beneficial to farmers to mitigate the negative impacts of drought provided the farm pond is filled by early rains. Portable pump sets and pipes were provided to 138 Sasya Mitra Groups and Grama Sasysa Mitra Sanghas at 33% subsidized cost with guidelines and institutional agreements at the group for proper utilization of about 3500 members.

It has been proved that spending an additional Rs.5000 ha^{-1} on protective irrigation increases chance of registering a positive net income of Rs. 10000 to 15000 ha^{-1} [8]. Cost of in-action during dry spell could result in the crop wilt and total loss of crop investment.

Table-2 *Promoting protective irrigation (2017-18)*

Source of Water	Area under protective irrigation (ha)	Number of farmers
Tankers	330	549
Farm Ponds	43	45
Bore Wells	1255	1139
Reservoirs	65	100
Canals	194	136
Own & Mutual Cooperation	767	1143
Total	2654	3166

Case Study 1: Protective Irrigation in Srimajjanapalli village during 2016

Srimajjanapalli village in Kundurpi mandal stood as an example where the community was mobilized by AF to take up protective irrigation using the water from common village water tank. The success here inspired thousands of farmers and was noticed by government officials, who expressed interest in replicating it in nearby villages. Due to a perception that the village tank water was the right of farmers who possess their lands under the ayacut, small farmers in the village were initially sceptical of the idea. They thought the ayacutdars would resist their access to the water. Perhaps as an indication of AF's strong presence in the area, the drawing of water took place without any hurdles. The water was drawn using mobile diesel pumps and supplied to the fields using pipes and sprinklers. The initiative benefited 67 farmer families covering 53 ha, resulting in a profit ranging from Rs.7500 to 12500 ha^{-1}. AF incentivized the effort by providing the diesel pump, pipes and sprinklers to the SMGs, and these were in turn rented out to the farmers.

Nasa Obayya, a member of the local CBO, was extremely happy with the results. "I gave protective irrigation twice to 1.2 ha of groundnut tapping water from the village tank. Without it, my crop would not have survived. I sold my crop for Rs.36,000, which will certainly recover my investment and earn me some profit. My neighbour, who did not use protective irrigation for his groundnut crop lost his entire investment."

Case Study 2: Ms. Tulasamma demonstrates the benefits of protective irrigation

Ms.Tulasamma, a dry land farmer of Settur mandal, is a member of Sasya Mitra Group in the village. She had sown pigeonpea in 0.6 ha land in June 2017, but a dry spell followed for the entire July and Aug 2017. The crop started to wilt. She knew about the benefits of protective irrigation during dry spells and the support provided by AF for this purpose. Ms Tulasamma provided protective irrigation with support of AF team to her pigeonpea crop in Aug 2017. In the first round, she provided 8,000 litres of water by availing water from a bore well of another farmer. She paid Rs. 500 for water. And subsequently she provided one more irrigation in Sep 2017. Because of protective irrigation, she was able to harvest seed yield of 875 kg ha^{-1} in pigeonpea, whereas other farmers in the village who could not provide protective irrigation could harvest only 125 kg ha^{-1}. She earned Rs.16,000 from 0.6 ha from pigeonpea during 2017. She spent Rs. 1,800/- on protective irrigation, which is an additional expenditure. However, the net profit from her crop is Rs. 9,000/-. Ms Tulasamma stands as a testimonial for the benefits of protective irrigation during dry spells. Now many farmers are motivated to take up protective irrigation in the village. Critical stages for irrigation were branching and flowering in case of winter pigeonpea and enhanced the pigeonpea yields by 16% [9]. Further, it is also indicating from the experiment that if there is a provision for the single irrigation it is better to provide the irrigation at flowering with 20mm irrigation.

Lining of Farm Ponds

Accion Fraterna facilitated cement-lining for 29 farm ponds, increasing the number of such demo farm ponds to 171 during 2016. However, due to low rainfall, only 62 farm ponds harvested enough water to provide protective irrigation. In total, the farm ponds catered to the irrigation requirements of 66 ha for both annual crops and tree crops like mango. During 2015, out of 249 farm ponds, 95 % got filled and stored water for more than 30 days. Supplemental irrigation was mostly given to groundnut and mango. Accion Fraterna has been successful in drawing the attention of policy makers to the cement lining of farm ponds, and expects that the government has agreed to make it a policy to do lining of farm ponds. This drought-mitigation measure has significant potential, considering that more than 70,000 farm ponds have been constructed in the District as part of MGNREGS. Four runoff events were recorded during the crop season and crop yields were increased by 120 per cent by giving two supplemental irrigation of 10 mm each for breaking the dry spell of 43 and 37 days during vegetative and pod development stages, respectively [10] and [11]. The haulm yield increased by 50 per cent.

Case Study: Rain water stored for a non-rainy day

Mr. Lokanna from Vitlampalli of Beluguppa Mandal is a dry land farmer. He constructed a farm pond with the support of MGNREGS on his 4.0 ha land to harvest rain water and use for watering the fruit trees. But water in this farm pond was quickly percolating into the soil and not available during dry spells. With the support AF, he lined the farm pond with cement plaster. It prevented the seepage of harvested rainwater and helped him store it for more than 40 days. The water is now available for him, when the crops needed most. Apart from watering his mango trees, he also gave protective irrigation to groundnut and castor crops which saved them from wilting during dry spell of *Kharif* 2017. Both the mango plants and groundnut crop are saved. Inspired by this, eight more farmers came forward and constructed farm ponds under MGNREGS and AF supported for lining the farm pond, with cement plaster. A small additional investment (for cement lining) to the existing farm ponds made all the difference to rain-fed farming in the village.

Contingent Crop Planning

Mixed crop systems dilute the risk of failure due to drought since one crop is selected for its shorter duration with respect to the other. Millets and pulses are food crops, so add to the food and nutritional security of the farmer's household. Finally, at about Rs.12500 ha^{-1}, the cost of cultivation of millets and pulses is half the cost of cultivation of groundnut at Rs.25000 ha^{-1}. The Benefit to cost ratio from contingent crops were higher when compared groundnut [Table-3]. The yields of groundnut crop were reduced due delay in sowing. Cut-off date of groundnut sowing is 31st July.

Table-3 *Mean yield (kg ha^{-1}) of contingent crops sown in the month of August*

Crop	Seed yield (kg ha^{-1})	Net Returns (Rs ha^{-1})	B:C ratio
Jowar	538	13170	1.26
Horsegram	529	7544	1.11
Foxtail millet	642	17587	2.50
Groundnut (check)	796	19782	0.94

Case study: Lalithamma benefitted from contingency crop when the rains were delayed

Lalithamma and her husband Narayana Chowdary from Hulikallu village of Kalyanadurg mandal had been cultivating groundnut as mono crop until 2014 for over 15 years on their 1.2 ha dry land. The family could reap only two good crops in the last 15 years. For about 10 years they could not recover even the cost of cultivation from groundnut. This year there were no rains during June and July months. AF proposed in the Sasyamitra Groups meetings to test Shakti variety of green gram which is of short duration and virus resistant on the farmers' fields. Lalithamma was selected by the group for demonstrating improved variety of green gram. Lalithamma took a bold decision of sowing green gram on her entire 1.2 ha of land. She sowed the seed in the last week of August when there was enough rain for sowing a contingency crop. The crop was not affected by any disease or virus and gave a good yield. She harvested 450 kg ha^{-1} of greengram and sold @ Rs.55 kg^{-1} and earned a gross income of Rs.24,750 ha^{-1}.

"After losing investment on groundnut for several years, I found greengram a convenient crop with very little investment and less labour compared to ground nut. When AF staff told me about the virus resistant Shakthi variety of green gram, I thought of giving it a try as the investment is not very high. I spent less than Rs.10,000/- and earned over Rs.14,750/- net income. When the main crop could not be grown due to lack of rains in June-July, these contingency crops sown in August-September are good for the District like Anantapur ours as the crop life cycle is less than 90 days explained Lalithamma. Like Lalithamma all the 190 farmers who had sown Shakti variety of green gram benefitted with an average income of Rs.10000 ha^{-1} even in a worst drought year of 2016.

Conclusion

Water scarcity and dry spells in dryland agriculture pose a major challenge for bringing the desired impacts in the sector. Timely sowing of crops in drylands will be done with row watering technique in case of delayed onset of monsoon. Farm-ponds at the individual small holder level proved effective to cope with the long dry spells while empowering farmers to intensify and diversify production systems. This contributed not only to production resilience, but the economic resilience of the small holders. Low cost lined ponds were found effective in storing water in red soils with high percolation rates and so is a scalable technology. Protective irrigation at critical stages of crop growth doubles the yield in drylands.

Way Forward

Desired policies to promote such low cost but critical interventions are needed to benefit large numbers of smallholding farms, that may increase their abilities to put their farms on the growth trajectory. Similarly, farm mechanization sowing options proved beneficial in enhancing operational and economic efficiency, reducing drudgery and improving productivity through proper and timely sowing. However, small holders are not in a position to maintain machinery at the individual farm level, and therefore a farm machinery custom hiring business model with the provision of initial capital support is needed.

Application of Research: Drought mitigation in rainfed areas and also sustainable livelihood improvement in rural areas.

Research Category: Dryland Agriculture and Horticulture

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