Doubling Farmers Income Through On Farm Reservoirs (OFR) Based IFS Models for Small Landholders of SAT Regions : A Success Story in Tribal Region of Telangana, India

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Preface

The authors are enthusiastic about sharing the success story of transforming forest hunters to agrarian culture with low cost scientific interventions like improved soil and water management, diversification, livestock interventions, knowledge sharing, etc leading to a debt free Chenchu.

The inspiration behind writing this success story lies with the unprecedented response and profitability potential of the venture carried out at farmer's field. The people of Petrallachenu village were suffering from mal-nutrition, debt trap, lack of water resources and low income. When the research team of Agri-consortium Research Platform on Water (ACRP-W) visited the village, we were surprised to see the tribes living away from modern technologies, engaged in hard labour during extreme heat, children and women looking emaciated. This was a real challenge before us to deliver them a successful life ahead with our scientific technologies. During PRA, we came across the poor status of farmer and thought of working in the region in a participatory way. We begin our intervention by convincing Shri M Pedda Ellaiah garu to spare some land for farm pond so as to exhibit our low cost easily adaptable technology which can later be upscaled by converging with ongoing government schemes.

The whole story of success which was achieved in two years from 2016-18 have been narrated systematically in order to use similar models in similar agro-ecologies for small and marginal tribal farmers of rainfed agriculture in semi arid tropics.

The authors are grateful to ICAR and GOI for funding this project under the theme "Development and Management of Integrated Water Resources in different Agro Ecological Regions of India" under ACRP-Water. The authors are also grateful to the PI , ACRP-Water, ICAR-IIWM, Bhubaneswar and Director, ICAR-CRIDA, Hyderabad for their co operation in doing this project in the farmers field.

Authors

Introduction

The tribal regions in Telangana are endowed with land degradation, acute shortage of water for both agriculture and drinking, low income, subsistence farming and malnutrition covering almost 1174 villages with a total population of 31.78 lakh accounting for 9.08% of the total state population. In these areas, rain dependent agriculture is extensively followed by the tribal farmers with productivity levels far less than state average of 0.8-1.0 t/ha. The weather aberration in terms of increased dry spells immediately after germination of the crops during rainy season, changed pattern of rainfall with high intensity for short durations, shift in the occurrence of monsoon rainfall, decrease in rainy days etc. are very common due to the climate change impacts in the region. The resource base including soil is very poor in the tribal regions. The tribal farmers have the land holding varying from 1 to 5 acres with both patta and assigned lands distributed by the government. The soil depth is very limited to 20 cm, below which stones are predominant in the sub-surface layers with sandy loam texture. The infiltration capacity of the soils in the region is ranging from 50 to 70 mm/hr with low organic matter.

Basic Information of Chenchu Tribes and Selection of Interventions

Chenchus are Hindu aboriginal tribes in Telangana, Andhra Pradesh, Odisha and Tamil Nadu. They prefer hunting rather than farming and sell meat, jungle products, gum, beedi leaves, mahua flower and honey for their livelihood. Their staple food is maize, jowar and tubers. They take the boiled form of different roots, tubers and leaves. The flesh of hunted animals is taken in roasted form. They take boiled rice along with gruel once or twice a day to satiate their hunger. Most of them especially women exhibited the symptoms of mal-nutrition. A little amount of salt and green chillies add flavour to their routine diet. Hand-made breads are sometimes prepared from millets. Dietary intake of foods barring cereals, as compared to balanced diets is generally poor and less than the recommended levels. The present project is also a support to government initiatives for Chenchus to adapt agriculture as they prefer to live in harmony with forest life.

They use very little implements required in cultivation. These may be owned or procured or even hired. The project area tribal farmers were totally dependent on rains with no idea of fetching better productivity and profitability from their limited agricultural lands. Through the project, it was identified that if water availability at the farm level is enhanced, the interventions would be instrumental in triggering prosperity among Chenchus.

The Chenchus have the habit of domesticating sheep, goat and poultry birds besides the dog. Some of the well-to-do cultivators rear cattle even. They purchase young cattle, sheep, goat and rear them at home. The grown-up animals are then sold in the market to get better return either to their original masters or to outsiders. Sometimes, simple rearing of animals fetches them fifty per cent share of the value of the grown-up animals from the persons who engage them in such a vocation. They mostly keep their animals on forest residues and grazing. In the present intervention, it was postulated that fodder cultivation and mineral supplementation for animals can bring better growth rates with reduced morbidity and mortality. Apart from this, planning a diversification using enhanced water availability through OFR and water management system using multi-disciplinary team can help them in getting nutrient garden at

household level which can thrash the mal-nutrition in the area.

Institutional Mechanism

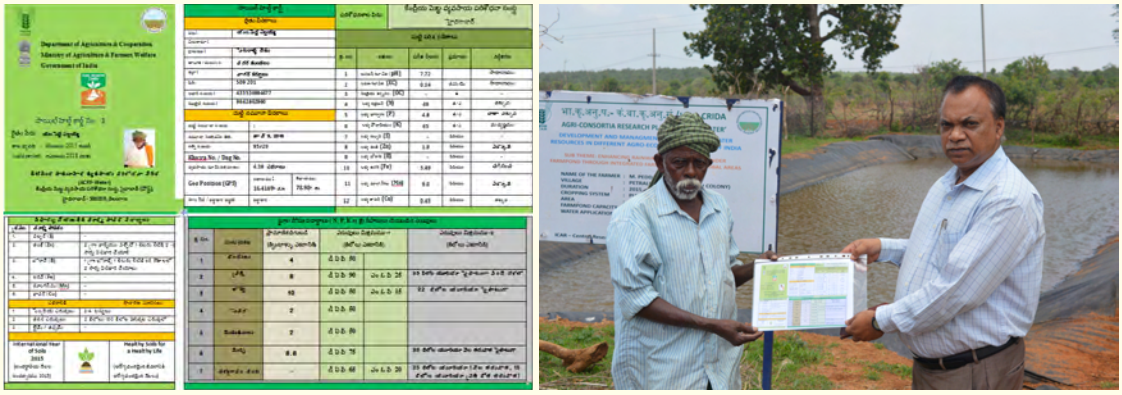
A systematic approach was followed to improve the water resources and its management through capacity building measures (CBMs) and FFS for awareness among 60 local households of Chenchu primitive tribes in the watershed for adoption of technology. A village level institution, namely Integrated Rainwater Management Association (IRWMS) was formed for taking the decisions in the village towards planning water resources development and management of water in the village, Petrallachenu. The association has 15 members group chaired by the head of the village.

Community meeting at Petrallachenu village

During initial stage of the project implementation (2016-17), the association decided to implement the construction of On Farm Reservoir (OFR) in the Chenchu farmer field, Shri M Pedda Ellaiah with 3 acres agricultural land having sandy loam red soil with 20 cm soil depth. He has 4 family members with 2 school going children. Traditionally before the project, the farmer used to grow sorghum and cotton alternatively under rainfed conditions with debt in his hands for agriculture and education of children.

Soil Health Management

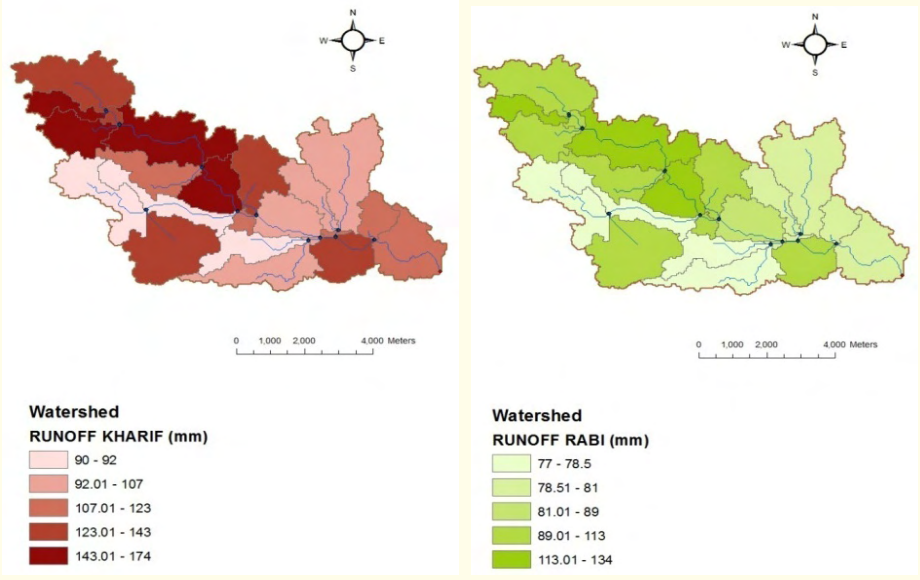
Soil samples from the agricultural fields of 10 Chenchu farmers were collected in participatory mode with the help of IRWMA and tested in the ICAR-CRIDA soil science laboratory for major nutrients like NPK and micro-nutrients. Soil health cards were prepared and distributed to the farmers along with recommendations for major nutrient deficiencies in the soil. Based on the test results, the soils were found low in Nitrogen (49 kg/acre) and organic carbon (0.2%); very low in phosphorous (4.8 kg/acre) and medium in potash (65 kg/acre) with insufficient micro-nutrient except zinc and manganese. The farmers were advised during the crop season to apply the required quantities of fertilizer for the crops grown by them in the village namely, sorghum, cotton, maize, chillies, red gram, green gram, black gram and forage crops.

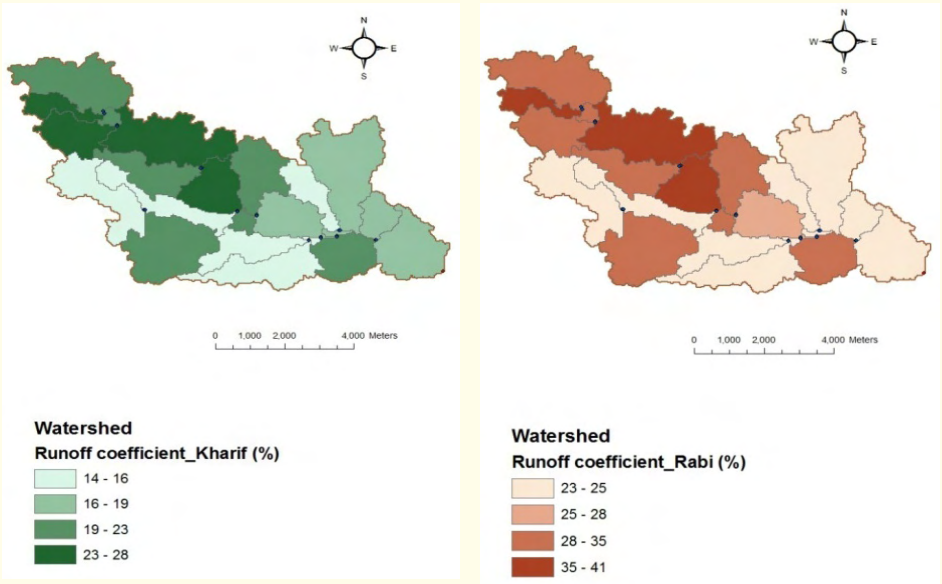


Soil Health Card and its distribution to the farmer

Action Research in the Tribal Farmers Field

A watershed of 47 km^2 area (4700 ha) in the lower Krishna basin under Nagarkurnool district covering four tribal dominant villages (Petrallachenu, Udimala, Padara, Chitlam Kunta) was selected for the present study in order to enhance their water availability through rainwater harvesting, water productivity through efficient irrigation system, nutritional productivity through crop diversification and OFR based integrated farming system modules at small landholder field (3.0 acres). In this area, for planning rainwater harvesting structures like OFR and check dam, rainwater harvesting potential was estimated using SWAT model. Annual total runoff was estimated to be 573 ha m with an average annual runoff depth of 122 mm out of an average annual rainfall of 734 mm giving a scope for harvesting 401 ha m through OFR in the watershed. The seasonal runoff for both *kharif* and *rabi* varied from 90-174 mm and 77-134 mm, respectively in the watershed. The runoff coefficient during *kharif* varied from 14-28 % and during *rabi* varied from 23-41 %.





Watershed runoff potential and runoff coefficients

On Farm Reservoir (OFR)

The design and construction of OFR for small farmer having 3 acres of agricultural land was based on the run off coefficient values and catchment area. The IRWMA implemented the construction of OFR at the lowest corner of the field with dimensions of 20x10x3.5 m having 600 m^3 capacity storage. The OFR was constructed under the project "Agri Consortia Research Platform on Water (ACRP-W)". The farm of 3 acres catchment was remodeled with soil and water conservation measures like contour bunds and field channels connecting to inlet of the OFR. In order to minimize the seepage losses, an HDPE geo-membrane film of 500µ thickness was used as a lining material.

OFR with a capacity of 600 m^3

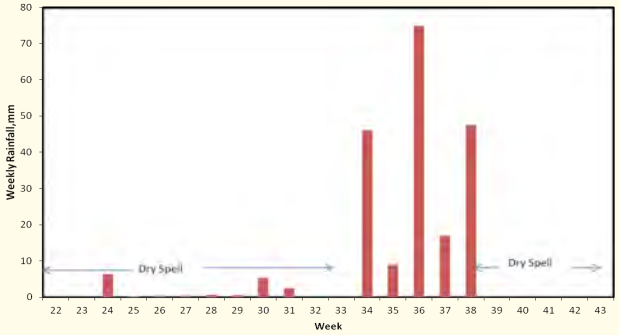
Portable Raingun Irrigation System (PRIS)

For efficient water application to the crops from the OFR, a 5 hp diesel engine mono-block pump set along with 40 HDPE sprinkler pipes and a PRIS was designed and implemented through the IRWMA in the farmers' field. The raingun had the specifications of 240 lpm discharge at 2.5 kg cm^{-2} operating pressure with 48 m spraying diameter covering an area of 1089 m^2. This system was implemented looking into the silt load in the surface water harvested through OFR and the filtration requirements. Since, raingun has larger orifice, the filtration requirements are minimum reducing the cost. The PRIS was used by group of farmers under the bore well system also due to its portability and acceptability of the farmer in terms of ease of operation, reduction in the irrigation time and wetting of the soil.

PRIS under field operation in the vegetables

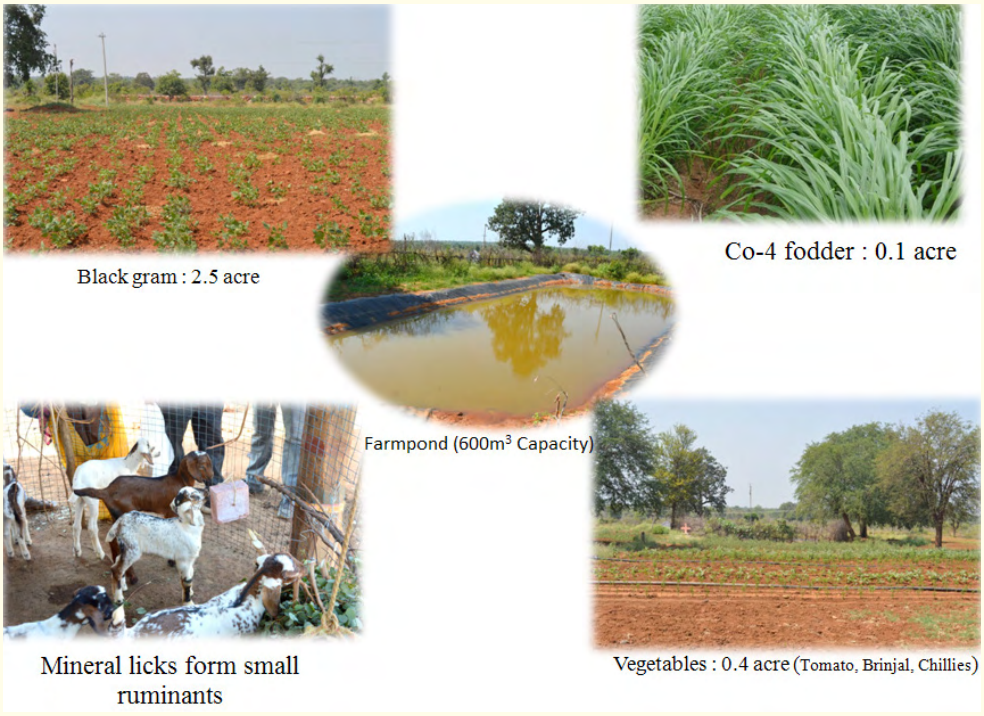
Pulse Based Integrated Farming System (2016-17)

Before the project intervention, farmer was adopting mono-cropping with sorghum and cotton grown alternatively leading to chronic economic losses. After convincing the farmer about the potential benefits of diversification through capacity building and FFS, the IRWMA suggested to go for crop diversification with pulses, vegetables, fodder, small ruminants, etc. with OFR as water source. During 2016-17, a pre-monsoon rainfall event of 60 mm in one spell filled the OFR. Onset of monsoon failed in the month of June and continued to July with long dry spell and sparse rainfall events.



Rainfall distribution at Petrallachenu during Kharif 2016

During such moisture deficit conditions, Pulse based (Black gram (2.5 acres) + vegetables (0.4 acre) + fodder (0.1 acre) were implemented in the farmers field with critical irrigation strategy using OFR water through efficient rainwater application system (PRIS).

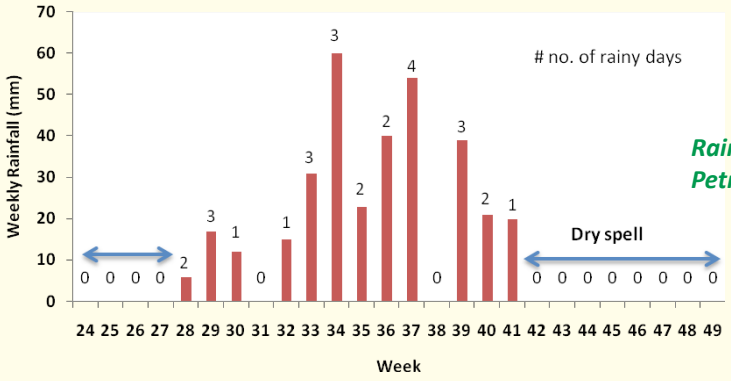


Pulse based IFS module

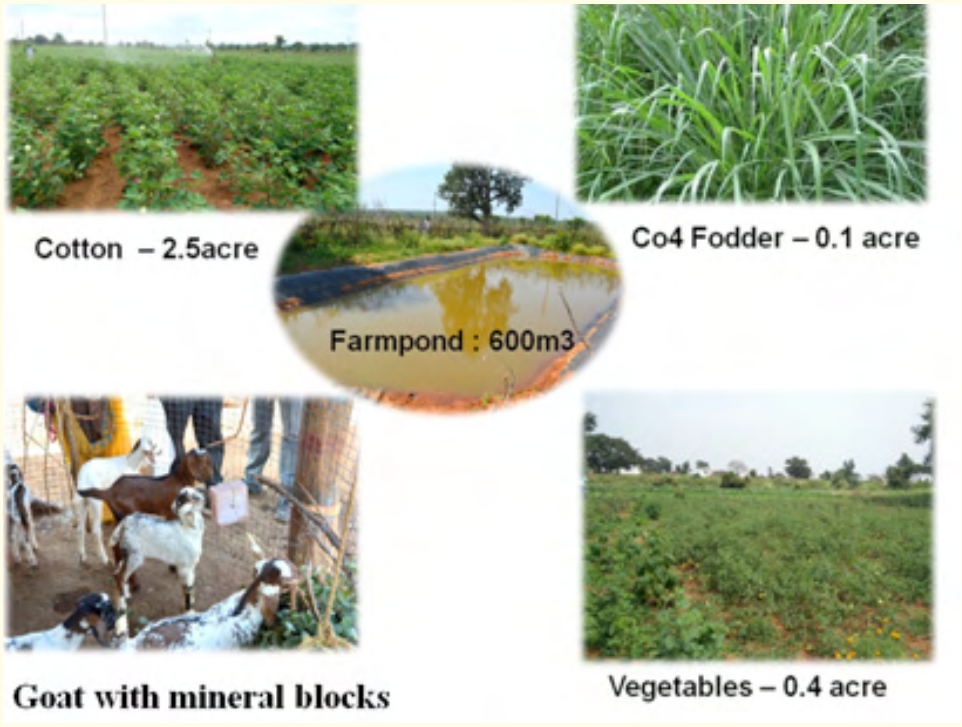
During the first year, introduction of vegetables was initiated which contributed to supplement the nutrient basket of all 60 Chenchu households in the colony. The farmer earned Rs.10,000/ net income by selling within the community with food and nutritional security among the community and reduced migration to forests. Growing fodder in small area of 400 m^2 helped the farmer to feed animals and small ruminants which added to the benefits further. Critical irrigation of 30 mm depth was ensured from OFR at critical stages of black gram through PRIS and irrigation for vegetables were planned at weekly intervals for 3 months period using water conjunctively. In 2016-17, with 2 times filling of OFR, water productivity of black gram with 3 q/ha yield was 0.21 kg/m^3 as compared to rainfed as 0.13 kg/m^3. The water productivity for chillies was 0.5 kg/m^3, tomato - 4.6kg/m^3, brinjal - 9.2 kg/m^3 and fodder 27.52 kg/m^3.

Cotton Based Integrated Farming System (2017-18)

During 2017-18, a high intense rainfall of 50 mm in the month of April filled the OFR. There was good onset rainfall for sowing the crop by the farmer. The farmer adopted cotton based (Cotton (2.5 acres) + vegetables (0.4 acre) + fodder (0.1 acre) IFS model with 10 local goats in 3 acres of land using OFR (600 m^3 capacity) water for addressing the dry spells with critical irrigation of 30 mm depth using PRIS.



Rainfall distribution at Petrallachenu during Kharif 2017



Cotton based IFS module

The main crop cotton was sown on June10th, 2017. Immediately after germination, there was a long dry spell of 4 weeks (24 to 27). Since, the OFR was filled during pre-monsoon rainfall, available water was used for managing dry spell in the field. Cotton was given 2 critical irrigations of 30 mm each during its vegetative and boll formation and development stages at Petrallachenu village in the farmers field.

OFR was filled 2 times creating a storage of 1200 m^3 during the rainfall season. The rainfall during the growth period of Cotton was 343 mm out of which 130.3 mm was effective rainfall. The analysis indicated that with 30 mm deficit supplemental irrigation during critical growth

stages to cotton substantially increased the yield (30 q/ha) as compared to rainfed (10 q/ha). The water productivity in the SI cotton was 3.41kg/m^3 as compared to rainfed of 1.92 kg/m^3. The green and blue water foot prints were 521 m^3 and 360 m^3 for the cotton, however, virtual water content (VWC) of cotton was 294 l/kg over the rainfed of 521 l/kg. VWC of cotton with supplemental irrigation was reduced by 43.63% over the rainfed with the increase in productivity by 77%. The water productivity of tomato was 3.67 kg/m^3 with VWC of 272 l/kg. These vegetables were sold within community enhancing the nutrient availability within 60 households of Chenchu colony.

Economic Impact

The cost economic analysis for IFS modules with OFR construction, irrigation system and its operation and maintenance, interest rate at 7% per annum, cost of cultivation, yield and market prices were considered for both pulse based and cotton based IFS modules for small holders in the tribal region (Table 1). These results were compared with existing rainfed system with mono-crops as sorghum and cotton, which were generally grown by the same farmer before the project. The analysis indicated that the maximum net benefits were obtained in the cotton based IFS module varying from Rs 16,500 to 23,500 per acre as compared to pulse based IFS where the net benefits varied from Rs 6,000 to 11,500 per acre for various cost considerations. In the rainfed system of mono cropping with sorghum and cotton in 3 acres land, the net benefits were found negative in the cotton and positive in case of sorghum with Rs. 4000/ per acre. In this case as adopted by the farmer, the advantage of having OFR for dry spell management in the rainfed regions provided enough water to meet 2 critical irrigations of main crop and 5-6 irrigations with 30 mm at weekly or 10 days interval for vegetables over small landholding of 0.4 acre. Growing fodder in small area helped the farmer to feed the animals and small ruminants. The OFR could be promoted as technology for water resource development and enhancing water productivity at the field level to alleviate the drought. The B:C ratios were also found to be better than the rainfed system in spite of the expenditure for additional investments towards irrigation system besides OFR construction and lining. The present investigations in the tribal farmers fields (Box 1) clearly showed that there is a potential for doubling the income of the small farmers of semi-arid tropics (SAT) through the implementation of OFR technology with irrigation systems as a total package for the farmers with subsidy incentive.

Therefore, replication of such modules in the SAT regions of Telangana as a technology package can bring green growth, resilience, improved nutrition and water security with more profits for sustaining the livelihoods.

Table 1: Economic analysis of OFR based IFS modules for small farm holdings in tribal area

Pulse based IFS module (Green gram - 2.5 acre + Vegetables - 0.4 acre + fodder - 0.1 acre and 10 small ruminants) during 2016-17

	Cost details	Full Cost (Rs.)	50% subsidy (Rs.)	100% subsidy (Rs.)
A	Capital Cost			
	OFR construction & Lining (20 years life)	95000	47500	0
	Irrigation systems (15 years life)	83300	41650	0
	Total capital cost	**178300**	**89150**	**0**
b	Annualised cost @ 7% interest	18100	9050	0
c	Variable cost (irrigation + Maintenance) per year	8300	8300	8300
d	Cost of cultivation per year	16000	16000	16000
	Total Expenditure (b+c+d)	**42400**	**33350**	**24300**
e	Gross benefits based on prevailing market rate	59625	59625	59625
f	Net Benefits	17225	26275	35325
g	**B:C ratio**	**1.40**	**1.79**	**2.45**

Cotton based IFS module (Cotton - 2.5 acre + Vegetables - 0.4 acre + fodder - 0.1 acre and 10 small ruminants) during 2017-18

	Cost details	Full Cost (Rs.)	50% subsidy (Rs.)	100% subsidy (Rs.)
a	Capital Cost			
	OFR construction & Lining (20 years life)	95000	47500	0
	Irrigation system (15 years life)	83300	41650	0
	Total capital cost	**178300**	**89150**	**0**
b	Annualised cost @ 7% interest	18100	9050	0
c	Variable cost (irrigation + Maintenance) per year	8300	8300	8300
d	Cost of cultivation per year	43000	43000	43000
	Total Expenditure (b+c+d)	**69400**	**60350**	**51300**
e	Gross benefits based on prevailing market rate	120765	120765	120765
f	Net Benefits	51365	60415	69465
g	**B:C ratio**	**1.74**	**2.0**	**2.35**
	Rainfed System	**Cotton**	**Sorghum**	
a	Gross benefits per year	44400	30000	
b	Cost of cultivation per year	48000	18000	
c	Net Benefits	-3600	12000	
d	**B:C ratio**	**0.925**	**1.67**	

BOX-1

Name of the farmer : **Shri M Pedda Ellaiah**

Village : Petrallachenu, Chenchu colony

Mandal : Padara

District : Nagar Kurnool

Geo Coordinates: $16^0$27'N and $79^0$01'E

The farmer was selected for the implementation of the project interventions based on the decisions of IRWMA of the village. Traditionally the soils are sandy loam with limited depth of 20 cms with low organic C content (less than 0.2%), Nitrogen (49 kg/acre), very low phosphorous (4.8 kg/acre) and medium in potash (65 kg/acre) with insufficient micro-nutrient except zinc and manganese.

In order to maintain soil health and quality, the soil health card was prepared and recommended the dosage of correct fertilizers, FYM and micro-nutrients. The farmer adopted two IFS modules during 2016-18. Before that the farmer was provided with an OFR structure of 600 m^3 capacity with dimensions of 20x10x3.5 m along with 500µ HDPE geo-membrane film as lining material. The farmer was also provided 5 hp diesel pumpset with 40 sprinkler pipes and portable raingun system as a combined package. During 2016-17, due to late onset of monsoon rainfall, the farmer adopted pulse based system with green gram as main crop in 2.5 acres, vegetables in 0.47 acre and fodder in 0.1 acre. There were two dry spells which was managed by providing critical irrigation of 30 mm through portable raingun irrigation system (PRIS) and vegetables and fodder with 5-6 irrigations at weekly intervals for supporting his family as well as 10 goats. The farmer says he got net benefit of Rs. 40,000/ excluding the cost of the infrastructure which otherwise was provided by the project.

During 2017-18, the farmer adopted cotton based farming system with OFR in the same area proportion under the vegetables and fodder and 10 small ruminants. Immediately after germination of the cotton, farmer could manage the long dry spell of 4 weeks during vegetative stage itself by providing irrigation through PRIS from the OFR which was already filled with sufficient runoff generated during pre-monsoon rains. Mr. Ellaiah earned a net system benefit of Rs. 96,000/ and was able to clear all his debts and liabilities.

The overall impact of the interventions, like OFR, PRIS, crop diversification (cropping system, vegetables and fodder with small ruminants) combined with social engineering through capacity building measures and participatory institutional mechanism resulted into not only doubling the farmers' net income through technological package, but also improved the overall water productivity of crops by 77%, improved nutrient availability in terms of protein (pulses and goat meat) and micro-nutrients (vegetables and goat meat), reduction in forest migration, reduction in mortality and morbidity of livestock, improved biomass for animals and small ruminants, etc.

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A way forward

Convergence of such modules along with OFR/ farm pond technology as package intervention in the government schemes for upscaling in the SAT regions of the country at farmers field will enable prosperity among rural rainfed farmers.

Formulation of mission mode projects on development module under the theme of doubling farmer's income and PMKSY for realizing on farm water, food and nutritional security particularly in the down-trodden tribal regions where malnutrition is very common among the children and women.

Convergence of the state Agriculture/ Horticulture departments with research organization like ICAR-CRIDA, ICAR-IIWM and ICAR-IISWC for providing technical back up with scientific planning in water resource development in the farmers field in rainfed or SAT regions.

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