

Transforming tribal farming

from subsistence to sustainable

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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 1,174 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.

Key words: Dry spells, Integrated farming system, Net income, On farm reservoir, Water productivity

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 limited to 20 cm, below which stones are predominant in the sub-surface layers with sandy loam texture. The infiltration capacity of soils in the region ranges from 50 to 70 mm/hr with low organic matter.

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 Petrallachenu village. The association

included 15 members, and chaired by the head of the 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 Yellaiah with 3 acres agricultural land having sandy loam red soil with 20 cm soil depth. 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. Three training-cum-meeting of tribal farmers on the advice of IRWMS were organized for providing know how on rainwater harvesting and management.



OFR with capacity of 600 m³

Research in the tribal farmers field

A watershed of 47 km² area (4,700 ha) in the lower Krishna basin under Nagarkurnool district covering four tribal dominant villages (Petrallachenu, Udimala, Padara, Chitlam Kunta) was selected for action research 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% of seasonal rainfall.

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 ICAR-CRIDA 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. The soils were low in nitrogen (123 kg/ha) and organic carbon (0.2%); very low in phosphorus (12 kg/ha) and medium in potash (163 kg/ha) 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 village namely sorghum, cotton, maize, chillies, red gram, green gram, black gram and forage crops.

On farm reservoir (OFR)

The design and construction of



Portable raingun irrigation system (PRIS)

OFR for small farmer having 3 acres of agricultural land was done 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 20 m × 10 m × 3.5 m having 600 m³ 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. It is lined with 500 micron geo membrane HDPE black film for controlling seepage losses and can provide two critical irrigation of 30 mm to the crops grown by the farmer.

Portable raingun irrigation system (PRIS)

For efficient water application to the crops from the OFR, a PRIS was designed and implemented through the IRWMA in the farmers' field. It was operated by 5 hp diesel engine mono-block pump set along with 40 HDPE sprinkler pipes. The raingun had the specifications of 240 lpm discharge at 2.5 kg/cm operating pressure with 48 m spraying diameter covering an area of 1,089 m² (given in figure). 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 hence 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.

Pulse based integrated farming system (2016-17)

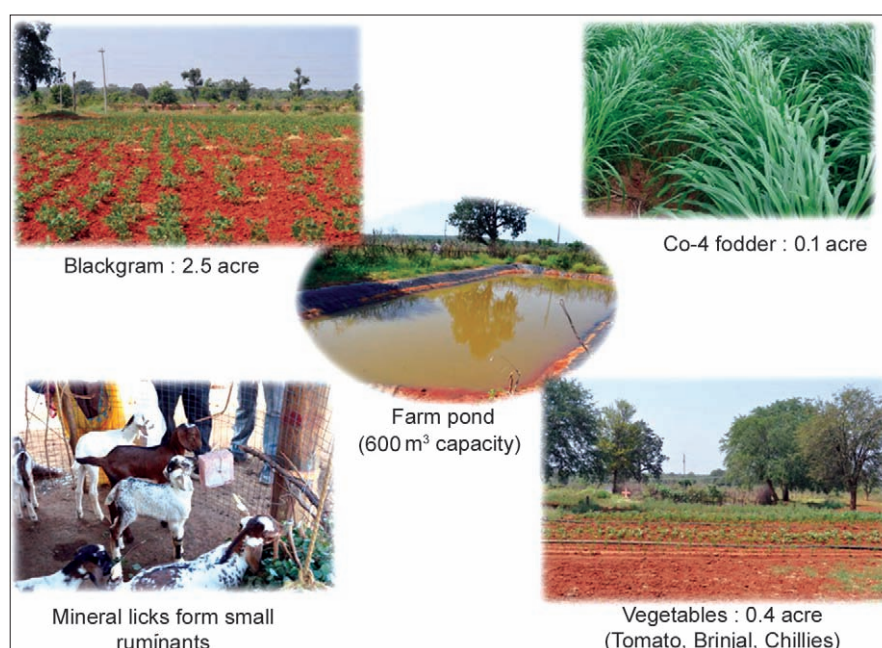
Before the project intervention, farmers' were doing monocropping with sorghum and cotton, grown alternatively leading to chronic losses. After convincing them about the potential benefits of diversification through capacity building and FFS, the IRWMA suggested to go for crop diversification with pulses, 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 June and continued to July with long dry spell and low rainfall events.

During such moisture deficit conditions, pulse based (black gram (2.5 acres) + vegetables (0.4 acre) + fodder (0.1 acre) cropping system was adopted by farmers with critical irrigation strategy using OFR water through efficient rainwater application system (PRIS). 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 farmers earned ₹ 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 m² helped them 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/m³ as compared to rainfed (0.13 kg/m³). The water productivity for chillies, tomato, brinjal and fodder was 0.5, 4.6, 9.2 and 27.52 kg/m³, which were not grown by the farmers before the project.

Cotton based integrated farming system (2017-19)

During 2017-19, cotton based integrated farming system was adopted by the farmers. During 2017-18, the seasonal rainfall during crop growing period was 344 mm as compared to 113 mm received (-75% deviation from normal) during 2018-19 and severe drought conditions prevailed in the area (Table 1). In



Pulse based IFS module (2016-17)

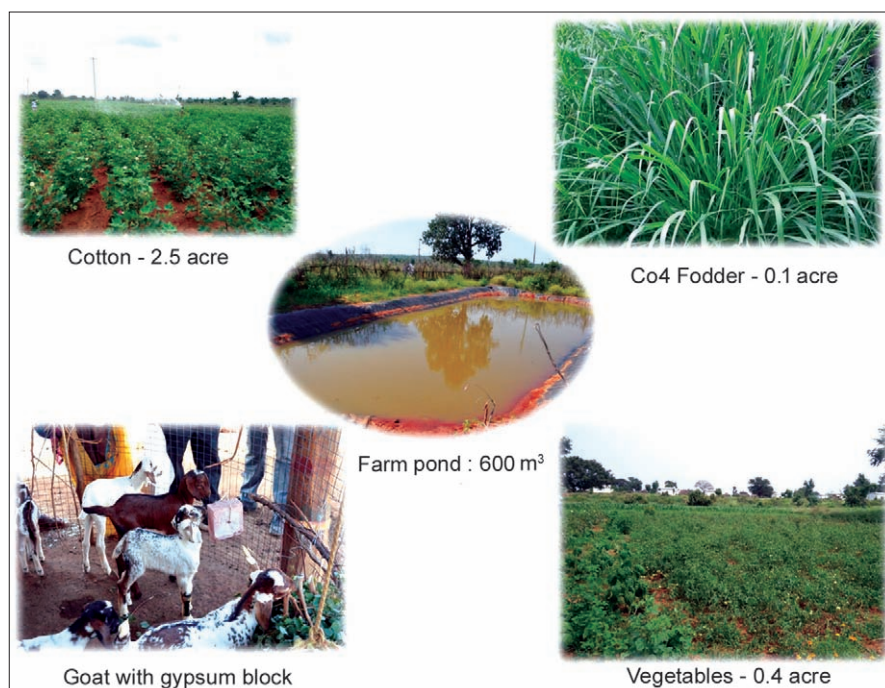
2017-18, a high intense rainfall of 50 mm in April filled the OFR. There was good onset rainfall for sowing the crop by the farmers. The adopted cotton based (cotton (2.5 acres) + vegetables (0.4 acre) + fodder (0.1 acre)) IFS model with 10 local goats in 3 acres of land using OFR (600 m³ capacity) water for addressing the dry spells with critical irrigation of 30 mm depth using PRIS.

The main crop cotton was sown on 10 June 2017. Immediately after germination, there was a long dry spell of 4 weeks (24 to 27) with the filling of on farm reservoir due to pre monsoon rainfall. Since water was available for managing dry spell in

the field, cotton was given 2 critical irrigations of 30 mm during its vegetative and boll formation and development stages in the farmers' field. On farm reservoir was filled 2 times creating storage of 1,200 m³ during the rainfall season. The rainfall during the growth period of cotton was 343 mm out of which 120.4 mm was effective rainfall and 30 mm deficit supplemental irrigation to cotton substantially increased the yield (30 q/ha) as compared to rainfed (10 q/ha). The water productivity in the SI cotton was 3.41 kg/m³ as compared to rainfed of 1.92 kg/m³. The green and blue water foot prints were

Table 1. Outcome of the on-farm reservoir based integrated farming systems

	2016-17	2017-18	2018-19
Cropping system adopted by the farmer	Pulse based	Cotton based	Cotton based
Date of sowing	2 August 2016	10 June 2017	16 July 2018
No of dry spells	2	2	3
Maximum dry spell (days)	32	33	35
No. of days of dry spell	60	46	57
Type of rainfall	Medium drought	Normal	Severe drought
Seasonal rainfall (mm)	211.2	344	113
Effective rainfall (mm)	73.92	120.4	39.55
Deviation of seasonal rainfall from normal (%)	-53%	-24%	-75%
Amount of water harvested (m ³)	1000	1200	600
Amount of water used (m ³)	973.9	1020.4	539.5
No. of critical irrigations applied (Main crop)	2	2	2
No. of critical irrigations applied (Vegetables)	5	5	5
Irrigation depth (Main crop), (mm)	60	60	40
Irrigation depth (Vegetables), (mm)	30	30	10
System water productivity, (kg/m ³)	1.96	3.45	1.86
Net income to the farmer, (₹)	17225	51365	10090
B:C ratio	1.4	1.74	1.14



Pulse based IFS module (2016-17 and 2018-19)

521 m³ and 360 m³, respectively, for the cotton and virtual water content of cotton was 294 litre/kg over the rainfed of 521 litre/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/m³ with VWC of 272 litre/kg.

During 2018-19 when a severe drought happened, the cropping system adopted included cotton (2.5 acres), vegetables (0.5 acre) along with small ruminants. The main crop cotton was sown on 16 July 2018. The seasonal rainfall from June to September was 113 mm which was 75% less from the normal rainfall of 450 mm. However, the total rainfall during the crop growing period (29 to 45 SW) was 105 mm with long dry spells in between the rainfall events happening throughout the season.

Owing the drought situation prevailing in the region and less runoff producing rainfall events that happened during the season, both the main crop of cotton and vegetables grown (38th SW), the irrigation was scheduled with two critical irrigations of 10 mm during the vegetative stage of the main crop and 10 mm depth of water application in the vegetables at 10 days frequency. Though the

water could be managed with available water in farm pond, the yield levels of cotton and tomato were, 8 q/ha and 2.86 t/ha, respectively. The effective rainfall calculated for the two different crops during their growing period were 40 mm and 7 mm for cotton and tomato respectively. The vegetables consumed 57 mm and cotton consumed 60 mm water during their growing period. The water productivity of cotton was 1.23 kg/m³ as compared to 0.75 kg/m³ of rainfed and 5.02 kg/m³ in tomato. The cropping system water productivity (SWP) was 1.86 kg/m³. There was 40% increase in the cotton productivity with two critical irrigations during vegetative stage over the rainfed and gave maximum resilience in terms of sustaining cotton crop with acute drought conditions.

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. These results were compared with rainfed system

with crops of sorghum and cotton, which were generally grown by the farmers before the project. Maximum net benefits were obtained in the cotton based IFS module varying from ₹ 10,000 to ₹ 50,000 for 3 acres land holding when system of on-farm reservoir and PRIS costs were considered with no incentive of subsidy and varying drought severity. However, these benefits will get doubled if 50% subsidy is offered as incentive to a farmer. The pulse based IFS yielded net benefits varying from ₹ 17,000 to ₹ 35,000 for various levels of subsidy incentives (50-100%). In the rainfed system of mono cropping with sorghum and cotton in 3 acres land, the net benefits were negative in the cotton and positive in sorghum with ₹ 12,000. The OFR for dry spell management in the rainfed regions provided water to meet the 2 critical irrigations of main crop and 5-6 irrigations with 30 mm at 10 days interval for vegetables over small acreage of 0.4 acres. Growing fodder in small area helped the farmer to feed the animals and the small ruminants. The OFR could be promoted as technology for water resource development in farm for alleviating the drought conditions with farmers. The B:C ratios were better than the rainfed system in spite of the expenditure for additional investments for irrigation system etc.

Conclusion

SAT regions with tribal habitants are prone to land degradation with loss of resource base from farmers' fields. These lands could be made productive by adopting rainwater harvesting through OFR structures with *in situ* SWC interventions. Rainwater harvesting through on farm reservoirs with proper design and construction within farmers' field integrated with crop diversification can boost the rainfed yields by 60 to 80% by conserving the soil, water and nutrients within farm with enhanced water productivity and profitability (increased net benefits and benefit cost ratio). Women has maximum say in scheduling water usage from OFR particularly when vegetables were introduced though

grown in small area of 0.4 acres but, contributing ₹ 20,000 to ₹ 40,000 per season by selling them within the local 60 households of tribal colony. The present investigations in the tribal farmers' fields clearly showed that there is a potential for doubling the income of the farmers 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 semi-arid tropics as a technology package can bring green growth, resilience, improved nutrition and water security with more profits for sustaining the livelihoods in tribal regions of SAT.

On farm reservoir (OFR) was designed for storing surface runoff based on the catchment area and runoff coefficient determined through SWAT modelling approach. OFR (20 m × 10 m × 3.5 m) with 600 m³ capacity was constructed with inclusion of SWC measures of contour bunds and field channels for

effectively collecting water into the structure. A portable raingun irrigation system was designed for water application in the critical stages of the crops during dryspells. Experiment in tribal farmer field during 2016-19 with two integrated farming system models (pulse and cotton based systems) with OFR for 2 critical irrigations to main crop during dry spells and 5 irrigations with 10-30 mm depth of water application at 10 day interval in vegetable and fodder, were conducted. Intensity of droughts in the study area with seasonal rainfall deviation from the normal (450 mm) were -53% (2016-17), -24% (2017-18) and -75% (2018-19) respectively. In the first year of medium drought, a pulse based cropping system was taken which resulted into a net income of ₹ 17,225, in the normal rainfall year (2017-18), cotton based cropping system resulted into net income of ₹ 51,365 and in the third year with severe drought the net income in the same cotton based

system was ₹ 10,090 in 3 acres of farmland with ratio of 2.5 acres of main crop, 0.5 acre of vegetables along with small ruminants. The system water productivity was 1.96 kg/m³ in the pulse based system (2016-17), 3.45 kg/m³ in cotton based system (2017-18) and 1.86 kg/m³ in cotton based system (2018-19). However, the net income from rainfed cultivation of cotton was negative in the region with cotton yield varying from 3-10 q/ha from normal to drought. Therefore, the on farm rainwater harvesting through small reservoirs of capacity varying from 250-1,000 m³ could be promoted by the government for sustaining the productivity along with profitability among the farmers. This approach provides nutritional security in the tribal areas who are mostly anemic in nature.

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Innovation in tribal farms

Plug nursery: An on-farm training-cum-demonstration on nursery preparation for vegetable crops was organized at Mailot in Kwanu cluster of Jaunsar tribal area of the district Dehradun on 22nd February, 2018. In the training, the farmers were given a demonstration on scientific method of nursery bed preparation. Information on nutrient and disease management in the nursery was also shared with the farmers. In order to acquaint farmers with the modern nursery techniques, the farmers were given demonstration and hands-on training on use of plug-trays for nursery raising. Seeds of tomato and capsicum hybrids, plug-trays, cocopeat and fungicides were also distributed to the farmers. A total of 14 leading vegetable growing farmers of the cluster participated in the programme.

Training: Farmers were given training under TSP on—Quality seed production of French bean at Farmer field; *Uchya Parvatiya Phaslon Ki Unnat Utpadan Takniki* evam *Ekikrat Nashi Jeev Prabhandan* (organized at Malari (3,300 amsl) in Niti Valley; *Sabji Matar ki Vigyanik Kheti* and *Sabjiyon Ki Unnat Takniki*.

Introduction of maize sheller: Shelling of maize in Jaunsar area is an activity that mainly involves female members of the family, and is done manually. A small maize sheller, therefore, got specially designed and manufactured, and introduced in the cluster as an easy means of shelling maize to mitigate this drudgery. Introduction of the maize sheller reduced the time 8–10-fold and has resulted in significant reduction in drudgery. Compared to manual shelling, maize sheller saves 21.4 days per ha which @ ₹ 250/day wage adds another ₹ 2,675 (considering engagement as manual labour for half of the saved time) to the farmer's income

Income generation of women through non-farm activities: A 15-day skill development training program on 'Income generation of women through non-farm activities' was organized at ICAR-VPKAS, Hawalbagh, under Tribal Sub-Plan. The participants were imparted training on tailoring and beauty culture so that they can become self-dependent and contribute to their family income monetarily. The participants were taught the basics of stitching and were provided hands-on training so that they practice it in their respective villages as an income generating activity.

Source: DARE-ICAR Annual Report 2018-19



Plug nursery: Seeds of tomato and capsicum hybrids, plug-trays, cocopeat and fungicides were also distributed to the farmers.



Income generation by women through non-farm activities