

Technological interventions to enhance productivity and income in Arid Zones:

A compilation of successful cases under the Farmer FIRST Programme

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Agriculture in arid western Rajasthan is very challenging due to low, erratic rainfall and limited irrigation facilities. Under the prevailing climatic conditions, farmers are practising subsistence farming with low farm income and profitability. As a consequence, distress land sale, diversion of land for mining, urban migration, etc. are the common phenomenon observed in rural areas. Present article was formulated to document the successful technological interventions in terms of varietal intervention, inter cropping, crop diversification, nutrient management and production of critical farm inputs coupled with capacity building and awareness generation practiced among the farming community in arid region to make farming more profitable and reduce livelihood risk. Most of the technological interventions were conducted through participatory mode in selected locale under ICAR - Farmer FIRST programme. The successful performances of narrated technologies at farmers' field revealed that the technological interventions coupled with technical backstopping could definitely enhance the income of farmers and ensure livelihood security in arid region in general and Jodhpur in particular.

Key words: Arid regions, Crop production, Income enhancement, Vegetables, Vermicompost

CROP production in arid region is challenging due to low, erratic rainfall and limited irrigation facilities. Majority of the farmers dwelling in these region practice rainfed farming for their livelihood sustenance. To make farming more profitable, it is always advised to farmers to adopt low cost techniques like use of certified seed of improved varieties, intercropping of arable crops and trees, timely sowing, seed treatment and optimum seed rate for maintaining adequate plant population combined with proper plant protection measures. The ICAR-Central Arid Zone Research Institute under ICAR- Farmer FIRST Programme (FFP) designed interventions in farmers' participatory mode by providing them suitable

technological inputs along with technical backstopping and capacity building.

Technical interventions maximize the output of intercropping in agri-horti system, which combines arable crops and fruit trees on the same piece of land with the available resources. This alternative land management system, besides producing fruits and arable crops reduces the risk of crop failure in case of severe drought and harsh environmental conditions. The practice of growing ber trees in between crops is considered to be highly beneficial. Further the crops used in combination are useful in many ways. They serve as an additional income, if the intercrops grown are legumes they can add

nitrogen and other nutrients into the soil, apart from improving the soil and physical properties and hydrological behaviour. The competition for various resources like space, water and nutrients by the intercrops limits the weed infestation. At the same time, cultivation of drought hardy legumes such as moong bean, moth bean and cluster bean are undertaken in the arid region to stabilize crop production. The paper here discuss the successful story of farmers' field under Farmer FIRST Programme.

Case-1: Intercropping of moong and wheat in ber orchard

Technology implementation and support
Shri Khengara Ram, s/o Shri Raju Ram, 52 years old belongs to

Table 1. Net returns of traditional sole cropping and intercropping of crop + fruit

Years	Traditional cultivation (0.16 ha.)			Improved practices (0.16 ha.)			Total	Increase & decrease	% Increase & decrease
	Wheat	Total	Moong	Wheat	Ber				
2017	5,250	8,400	13,650	4,850	7,600	0	12,450	-1,200	-8.79
2018	5,400	9,200	14,600	3,800	7,050	0	10,850	-3,750	-25.68
2019	6,360	9,100	15,460	2,500	5,200	12,600	20,300	4,840	31.31
2020	7,200	10,000	17,200	1,000	4,000	21,000	26,000	8,800	51.16
Average	6,053	9,175	15,228	3,037.50	5,963	8,400	17,400	2,172.50	14.27

village Sirodi of Popawas Panchayat in Mandore block of Jodhpur district. He usually practices moong-wheat cropping system. Due to traditional crop production practices coupled with low rainfall and drought, he was left with meagre or less income per bigha. Further, his ignorance about the benefits of intercropping makes him lag behind other progressive farmers of the district. As a participatory farmer under the FFP, Shri Khengara Ram was encouraged for the intervention of intercropping in moong-wheat cropping system. Under this intervention, he was provided with 40 saplings of improved ber variety 'Gola' to plant in the field. The ber plants were planted in 6 × 6 m geometry in 0.16 ha (1,620 m²) land. He was advised to grow crop in interspace area of ber rows. He was also advised to follow proper pest and disease control measures.

Technology Uptake, Benefit and Spread

Under this crop + fruit

intercropping, the farmer received no returns from ber for initial 2 years. Whereas in the 3rd and 4th year, there was enhancement in income due to ber to the tune of ₹ 4,840 and ₹ 8,800 respectively as compare to the traditional moong-wheat cropping system in 0.16 ha area, besides the normal yield of moong and wheat.

Intercropping as new intervention pays rich dividends to Shri Khengara Ram in terms of additional income from same piece of land. The results in his field encouraged other farmers living in his vicinity to opt this intervention. Table 1 supplements in details about the importance of intercropping.

Case-2: Enhancement of farm income through vegetable cultivation

Technology Implementation and Support

Shri Sumera Ram s/o Shri Shree Purkha Ram, 45 years old belongs to village Popawas in Mandore block of Jodhpur district. The farmer has been growing grain crops such as pearl

millet, moong, moth, guar, etc. as an age-old practice but could not reap more income out of this farming to sustain his family. The farmer was also chosen as one of the beneficiaries under the FFP project and a farm plan was made for him according to the available resources. In this plan, a part of his land was put under some vegetables namely, brinjal, bhindi, chilli and some cucurbitaceous vegetables. Since his soil is less fertile, he was advised to go for vermicomposting to enrich the soil fertility and enhance the water retention capacity. Under the horticulture module, he was supplied with improved variety of chilli hybrid, Farm Sona – 1090 along with other required critical inputs (Fig. 1, Table 2). Besides attending as a participant in National Workshop on Methodologies for Doubling Farmers Income at ICAR-National Academy of Agricultural Research Management (NAARM), Hyderabad he was also one among the other beneficiaries, who were sent to ICAR-Central Institute for Arid Horticulture (CIAH), Bikaner to get acquainted with the recent developments in vegetable cultivation under capacity building programme of FFP.

Technology Uptake, Benefit and Spread

Considering the potential and demand for chilli cultivation in the agroclimate and agro-economic condition of Rajasthan in general and Jodhpur district in particular, he found it as a viable and remunerative option to grow chillies in his farm. Since the FFP project is already in operational in his panchayat, he expressed his desire to be as one of the beneficiary under the project. He was provided with the seeds of improved hybrid of chilli along with the technology support. The effort initiated by him yielded rich dividend



Fig. 1. Chilli Farm Sona-1090, a success story under ICAR-CAZRI, Farmer FIRST Programme.

Table 2. Production Statistics of Chillies/Bigha (1,618.7 Sq.Metres)

Particular	Details
Cost of cultivation for one Bigha (₹)	5,813
Marketing Expenses for one Bigha (₹)	2,000
Total Expenses incurred (₹)	7,813
Yield Obtained / Bigha	422 kg Green Chillies + 107 kg Red chillies
Returns @ ₹ 24 / kg green chillies	422 X 24 = ₹ 10,128
Returns @ ₹ 100 / kg red chillies	107 X 100 = ₹ 10,700
Net Profit / Bigha	₹ 20,828 – ₹ 7,813 = ₹ 13,015/bigha

Table 3. Technology of vermicompost preparation

Particular	Price (₹)	Quantity
Plastic vermi bed (Dimension 6' × 4' × 1.5')	₹ 2000/bed	
Quantity of earthworms/ bed	2 kg	
Price of earthworms	₹ 200/kg	
Moisture to be maintained in the vermin beds	45-50%	
Optimum temperature of vermi beds	20-30°C	

Table 4. Comparison of vermicompost and FYM

Particular	Vermicompost	FYM
Nitrogen (content %)	1.00 – 1.60	0.40 – 0.75
Phosphorus (content %)	0.50 – 5.04	0.17 – 0.30
Potash (content %)	0.80 – 1.50	0.20 – 0.55
Carbon: Nitrogen ratio	15.5	31.3
Duration of preparation (months)	1.5-2.0	12

from the sale of green and red chillies with a net returns of ₹ 13,015 bigha. After seeing the successful venture of Shri Sumera Ram, the neighbouring farmers and uneducated youths have been motivated to take up similar initiative in chilli and other vegetables by joining the FFP.

Case-3: Vermicomposting: Sustainable technology for restoring soil fertility

Shri Hukma Ram s/o Shri Ganesa Ram, belongs to village Rajwa in Mandor block of Jodhpur district. Sh. Hukma Ram grows crops like pearl millet, mungbean, clusterbean, wheat, cumin and vegetables like chilli. Even after putting his best efforts he always ended up with meagre farm income due to low soil fertility status. Further the soils in arid regions are sandy as well as coarse textured coupled with low organic carbon. Application of conventional FYM without proper decomposition leads to more termite incidences in the field. In the quest to increase crop productivity, he applied chemical fertilizers but due to the fertilizer inefficient use in coarse sandy texture soil, it only increases his cost of production without commensurate proper returns.

Technology Implementation, Uptake, Benefit and Spread

Under FFP, Shri Hukma Ram along with another 25 farmers were imparted training on vermicompost preparation using cowdung and organic waste from his farm through participatory technology development (Fig. 2). Under this participatory approach the selected

partner farmers were provided with plastic vermi-beds and *Eisenia foetida* species of earth worms along with technical know-how of vermicompost preparation (Table 3). After learning the process of vermicomposting, the trained farmers were producing vermicompost by using part of cow dung and crop residues produced at their farm and converted the cowdung and crop wastes into nutrient rich manure (Table 4). Normally, the vermicompost in vermin beds becomes ready in 45-60 days except in peak summer months of arid regions. Therefore, it becomes possible for them to take 4-5 batches of vermicompost from the vermibed. Shri Hukma Ram is also one among the trained farmer who applies vermicompost in his chilli field, ber plants and remaining amount in field crops like wheat, cumin, etc. (Table

Table 5. Recommended quantity of vermicompost for different crops

Crop	Quantity
Food grain crops	5.0-6.0 tonne/ ha
Vegetables	10-12 tonne/ha
Fruit trees	1.0-10.0 kg/ tree
Pots of kitchen garden	100 g/ pot

5). Finally, as the application of vermicompost in soil not only provides sufficient quantities of major and micro-nutrients to the crops but also make the soil environment favourable for plant growth by adding beneficial micro-flora. Hence not only Shri Hukma Ram but all the trained farmers were happy with this technology along with income enhancement by saving the cost of chemical fertilizers and increase in crop productivity and soil fertility (Table 6).

Conclusion

It is certain that the farmers of arid region faced innumerable challenges to sustain their livelihood in agriculture and allied activities. Specific area focussed technical interventions were critically assessed and chosen to conduct in farmer's participatory mode under the FFP in which the farmers were provided critical technological inputs and capacity building as institutional interventions. Ber intercropping in moong-wheat cropping system was found to be more beneficial in improving productivity with

**Fig. 2.** Vermicompost preparation at farmer's field.

Table 6. Estimates of fertilizer equivalence of vermicompost production from one unit of vermi-bed per annum

Particulars	Quantification
Quantity of vermicompost produced in vermi-bed /batch	0.5 tonnes
Total vermicompost preparation/year/bed	0.5 tonnes x 5 = 2.5 tonnes
Amount of nutrients (NPK) in total vermicompost	N (1.5%) – 37.5 kg, P ₂ O ₅ (2.5%) - 62.5 kg, K ₂ O (1.2%) – 30.0 kg
Fertilizer equivalence of nutrients made available through vermicompost preparation	Urea (46% N) –28 kg; DAP (18% N and 46% P ₂ O ₅)–136 kg MoP (60% K ₂ O)- 50 kg
Returns of vermicompost in terms of fertilizer equivalence considering price of fertilizers (Urea @6.0/kg, DAP @27.0/kg and MOP @19.0/kg)	Urea- 28 kg x ₹ 5.9/kg = ₹ 167 DAP-136 kg x ₹ 27/kg = ₹ 3668 MOP- 50 kg x ₹ 19/kg = ₹ 950
Total returns of vermicompost in terms of fertilizer equivalence/annum	₹ 4785

enhanced income per unit area. The results shows that integration of annual crops with fruit trees yields multiple outputs that ensure

production and income generation. Growing of vegetables, i.e. improved variety of chilli hybrid Farm Sona - 1090 along with other required

critical inputs yielded rich dividend to partner farmers with net returns of ₹ 13,015 / bigha in arid cropping system through crop diversification for improving nutrition and health standards to family besides stabilizing family income. Further the vermicompost preparation in plastic vermi beds at farm was able to produce compost of equivalent to N, P and K fertilizer worth of ₹ 4,785 per annum from single verminbed. Subsequently, it not only reduces cost of inorganic fertilizer but also decreases the dependency of fertilizers from outside sources.

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HANDBOOK OF INTEGRATED PEST MANAGEMENT

To reverse the loss of environmental resources and also to reduce biodiversity loss, the Government of India has Integrated Pest Management (IPM) as part of the National Agricultural Policy. Integrated Pest Management emphasizes the growth of a health crop with the least possible disruption to agro-ecosystems and encourages natural pest control



mechanisms. IPM is not new – mechanical, cultural and biological tactics were used by farmers for hundreds of years before chemical pesticides became available. Besides, there are IPM techniques that have been developed more recently and are effective in suppressing pests without adversely affecting the environment.

The task of spreading the message of IPM across is tough due to poor awareness about the subject among people in line-departments as also among the farmers. The information on integrated pest management as a whole is scattered. This *Handbook* comprehensively deals with all the aspects of integrated pest management in field crops, horticultural crops under traditional, protected systems. Information on basic strategies and tactics of different methods of management including mass production of biocontrol agents, IPM policy and pesticide registration is provided in comprehensive form.

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