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Crop diversification under moisture stress situations for sustainable intensification of small farms (Experience of KVK West Tripura under NICRA project)

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North Pulinpur (Fig. 1) with GPS location 23^{0}52.836^1 N, 91^{0}35.275^1 E and elevation 47m is one of the draught prone tribal inhabited ADC village of the district West Tripura under the state Tripura. The total geographical area of the village is 950 hectare with cultivable area of about 250 hectare only among 806 farm families. So, most of the families are holding either small or marginal farms. There were no perennial streams, rivers, ponds and other irrigation facilities in the village. Prevailing temperature ranges from 16^{0}C to 37^{0}C. Annual rainfall ranges from 2050 to 2550 mm, but almost whole amount goes out to neighbouring lower elevated village. Agriculture is the mainstay of the people, about 85 per cent of them engage in agriculture and its allied activities. Farmers earned their livelihood from only rainfed rice based monocropped cultivation and rearing of low profit making local pig and poultry before NICRA intervention. In this connection, KVK west Tripura identified the major three problems - a) moisture stress during *Kharif* dry spell and winter season which lead to rice based mono-cropping system, b) low fish production due to unavailability of water throughout the year, c) livelihood vulnerability in changing climate (Table 1) due to low income from small farm. So based on this, the present Climate Resilience Project entitled' 'National Initiative on Climate Resilient Agriculture (NICRA)' was started at village North Pulinpur to develop sustainable production system by protecting them from extreme climatic condition to raise overall profitability of farm household by crop diversification under such water stress village.

Fig. 1 : Yellow dot representing village N. Pulinpur

Fig. 2 : Blue pins representing water harvesting structures

Thrust areas of intervention on crop diversification for sustainable intensification of small farm at North Pulinpur

– Consideration of every house hold as small farm.

– Formulation of farming system models involving main and allied enter- prises for different farming situations.

– Creation of water harvesting structure as main component of farm as the village is under moisture stress like situation.

– Optional utilization and conservation of available resources and effective recycling of farm residues within system.

– Maintenance of sustainable production system by protecting them from extreme climatic condition to raise overall profitability of farm household by complementing main allied enterprises with each other.

Successful demonstration component for crop diversification:

Module I: Natural resource management **-** Rainwater harvesting structures, Vermicomposting, Bio-gas plant.

Module II: Crop production **-** Introducing short duration variety of paddy, Introducing potato/maize/lentil/pea/ bitter gourd as second crop, water saving paddy cultivation

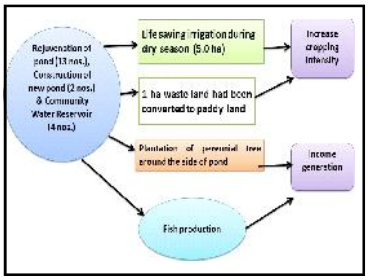
Table 1 : Climate variability challenges

Historical trends in rainfall		Decadal average		
		1980-90	1990-2000	2000-10
No. of rainy days		123.5	118.2	109.6
No. of dry spells during	>10days	1.1	1.5	2.6
Kharif season	>15days	-	-	0.1
	>20days	-	-	-
No. of intensive rain spells	>60 mm per day	9.2	8.5	7.3
Average annual rainfall (mm)		2675	2545	2235

Reorienting some interventions to climate variability challenges	
Interventions undertaken	Justification with climate resilient agriculture
Excavation of ponds/farm new pond, Community bunds	Meant for harvesting water in rainy season and utilizing it in *Rabi*-summer season to maximise water retention and economic utilization of its water during *Kharif* dry spell as well as growing next crop after *Kharif*
Jalkunds	To provide irrigation to kitchen garden
Vermicomposting	To enhance soil buffer system/fish feed
SRI Technology (paddy var. Ranjit)	Low water requirement with high return
Introduction of TPS potato/maize/ lentil/ pea /bitter gourd	To enhance cropping intensity
Mulching in bitter gourd	For moisture conservation
Kitchen garden	Providing nutrition to small farm family
Improvement in performance of Farm live stocks (Pig, poultry and fishery)	Meant as alternative livelihood strategies to sustain farm families when agricultural and horticultural crops may be damaged due to unexpected climatic effect

method (SRI), custom hiring centers for timely planting, Kitchen garden, Green manuring (Dhaincha).

Module III: Livestock and fisheries - Improved breed of poultry, Animal health camp and vaccination, improved shelters of pig, composite fish culture, Duck cum fish culture etc.



Module IV: Institutional - Custom hiring centre, Climate Literacy

Reorienting some interventions to climate variability challenges.


Fig. 3 : Potato var. HPSII/67

Some major outcomes on crop diversification through NICRA intervention:

Case I: Harvested rainwater based sustainable diversification

Before NICRA: Cropping system was mainly as *Kharif* Paddy – Fallow land.

After NICRA : The cropping system has been changed to *Kharif* paddy/Maize - Lentil/Pea/ Potato/ Maize/Bittergourd/ Winter vegetables /Boro paddy - Dhaincha as green manure.


Fig. 4 : Maize var. HQPM 1

Approximately, 175000 ft^3 rainwater is harvested every year by those above mentioned water harvesting structures, all of which can provide life saving irrigation for vegetables during *Kharif* dry spell as well as during *Rabi* summer season covering an area of about 5.0 ha. A total area of 1 ha waste land had been converted to paddy land using water from community water reservoirs. Now, KVK, West Tripura has successfully introduced TPS presently known as Hybrid Potato Seed (HPS) technology which was previously unknown to the farmers of North Pulinpur as comparatively less irrigated second crop after *Aman* paddy with the provision of irrigation from the rejuvenated pond or newly excavated pond under NRM intervention of NICRA. Similarly, after *Kharif* paddy fallow land is now successfully utilized by introduction of second crops like maize var. HQPM 1, vegetable pea var. Arkel 1 as short duration variety, lentil var. WBL 77 as relatively drought tolerant variety, bitter gourd with mulching practice to conserve soil moisture. Maize can also be grown as a contingent crop instead of *Kharif* paddy in some medium land situation in some cases when *Kharif* rainfall comes late about 25 – 30 days. These water reservoir structures are also using for table fish production. Adaptation of SRI in paddy by the farmers could minimize the losses due to water shortage in paddy cultivation. Keeping in mind a demonstration on SRI paddy cultivation using high yielding short duration variety MTU 1010 having 105 days duration was to overcome the problem of water scarcity due to less water requirement in SRI practices as well as shorter duration of the undertaken variety. Second crop for winter season after *Kharif* paddy could also be grown earlier or in time if short duration paddy MTU 1010 is grown instead


Fig. 5 : Lentil var. WBL 77


Fig. 6 : Bitter gourd with mulching


Fig. 7 : SRI paddy cultivation


Fig. 8 : Before NICRA

of long duration commonly grown variety Ranjit that takes about 140-150 days for harvesting. The detailed economics of all above mentioned diversified crop items along with their yield, area of successful demonstration etc. has been given in Table 2. Through all these successful interventions on crop diversification, the cropping intensity of the village has been increased from 115 to 135 % within three years only.


Fig. 9 : After NICRA

Scientific utilization of the side of pond was not practiced by the farmers earlier. After the KVK initiatives they have started Integrated farming approach. Pond embankment are utilizing for cultivation of colocassia, pumpkin, dolichos bean, banana, drum stick, coconut, beetle nut etc. for future income generation. Some of the farmers have also started duck cum fish rearing and composite fish culture.

Fig. 10 : Vemicomposting

Case II : Dairy based small sustainable diversification: Cycle of Jhum (2-3 years) leads to large scale loss of forest resources, loss of fertile top soil due to erosion and loss of carrying capacity of the soil and reducing agricultural area due to more area being utilized for rubber plantation. Rearing of cattle in North Pulinpur village was only for draught purpose and cow dung were used in the crop field. In this regard, to cope up with soil fertility deterioration in shifting climate for optimum utilization of dairy KVK, West Tripura has demonstrated Vermicompost production technology along with its application and benefits at adapted village and production of bio-gas using cow dung. After successful adoption of the technology, each beneficiary is now harvesting on an average of around three quintal Vermicompost along with fifteen litre vermiwash/ chamber (2m×1m×0.6m×2)/ cycle. The adopted farmers are regularly using the Vermicompost and Vermiwash in their agricultural land and also selling to other farmers. Intervention has also been taken on demonstration of use of vermicompost as fish pond manure to cope up with mortality and morbidity of fishes due to abiotic stress. Beneficiaries have successfully adopted the bio- gas plant using the cow dung and waste materials. Mostly they use cow dung for bio-gas production @ 20- 25 kg cow dung mixing with water at 1:1 ratio once or twice per day. It reduces their expenditure for fuel @ Rs 350/ month/ family. The byproduct of bio-gas plant are stored in a separate place and used in agriculture field as fertilizer,


Fig. 11 : Biogas plant


Fig. 12 : Improved poultry


Fig. 13 : Pigsty

Table 2 : Economics of different introduced diversified crops

Sr. No.	Crop/Technology	Area (ha)	Yield (Demo)	Yield (local)	Economics of demonstration (Rs./ha)				Economics of local (Rs./ha)			
					Gross cost	Gross return	Net return	BCR	Gross cost	Gross return	Net return	BCR
1.	Introduction of Short duration paddy var. MTU1010 with SRI	2.0	29.75 q/ha	33.00 q/ha (var. Ranjit)	35000	38610	3610	1.10	35000	39600	4600	1.13
2.	Introduction of bitter gourd with mulching practice	15.5	90 q/ha	NA	14500	112500	98000	7.76	NA	NA	NA	NA
3.	Introduction of potato var. HPS - II/67	3	24.8 t/ha	NA	82,000	2,55,000	173000	3.10	NA	NA	NA	NA
4.	Introduction of vegetable pea (var. Arkel 1)	1.5	11.5 q/ha	NA	25280	61250	35970	2.42	NA	NA	NA	NA
5.	Introduction of lentil var. WBL 77	1.45	16.75 q/ha	NA	32000	67000	35000	2.09	NA	NA	NA	NA
6.	Introduction of maize var.HQPM-1	2.0	30.23 q/ha	NA	55620	120920	17910	2.17	NA	NA	NA	NA
7.	Vegetable Kitchen garden	0.5	NA	NA	8998	43367	34369	4.81	NA	NA	NA	NA
8.	Table fish production	-	31.25 q/ha	20 q/ha	69758	160210	90452	2.29	61450	105000	43550	1.70

Table 3 : Economics of vermicomposting and vermicompost as fish feed

Technology	Area/ unit No.	Yield (Demo)	Yield (local)	Economics of demonstration (Rs.)				Economics of local (Rs.)			
				Gross cost	Gross return	Net return	BCR	Gross cost	Gross return	Net return	BCR
Vermicomposting	30	1.5 t/yr	NA	5600/unit	15000/ unit	9400/unit	2.68	NA	NA	NA	NA
Use of vermicompost in fish pond	0.08 ha	25 q/ha	20 q/ha	65000/ha	125000 /ha	60000 /ha	1.92	60000/ha	100000/ha	40000/ha	1.6

Table 4 : Economics of some livestock based diversification

Intervention	Measurable indicator		Economics of demonstration (Rs.)				Economics of local (Rs.)			
	Demo	local	Gross cost	Gross return	Net return	BCR	Gross cost	Gross return	Net return	BCR
Rearing of improved cross breed pig	Avg. weight at 6 month of age 70 kg	Avg. weight at 6 month of age 30 kg	5000/ pig	7000 /pig	2000/ pig	1.4	4000/ pig	5000/ pig	1000/ pig	1.25
Backyard rearing of improved poultry bird	Avg. weight at 6 month of age 1.70 kg/bird	Avg. weight at 6 month of age 0.800 kg/bird	100/ bird	340 /bird	240	3.4	70/ bird	160/ bird	90/ bird	2.29
Composite fish culture	Yield - 31.25 q/ha	Yield - 20q/ha	71825/ ha	156250 /ha	84375 /ha	2.17	62000 /ha	100000 /ha	40000 /ha	1.6

in pond as fish feed and in vermicompost. It creates great impact on other farmers of the adopted village and willing to adopt the technology in future. In this connection, the detailed economics has been furnished in Table 3.

Fig. 14 : Composite fish culture

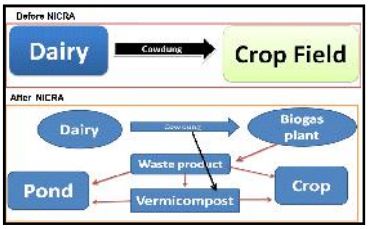
Case III: Other Live stock based sustainable diversification :

Major livestock rearing:

Before NICRA: Local piggery, local poultry and fishery with very poor management

After NICRA: Successful introduction of improved pig, poultry and composite fishery with scientific management

Scientific rearing of livestock and management of fishery were not practiced before NICRA intervention in the adopted village. There was no shelter for piggery. Animals were directly exposed to extreme climatic condition like direct rain fall, heat or cold stress etc which severely affect on their production. Considering this, intervention had taken on introduction of improved breed of poultry (Kuroiler and Gramapriya) under backyard rearing and rearing of improved cross breed pig (Yorkshire x Humpshire) with improved housing management (Pig sty), duck cum fish rearing and composite fish culture for nutritional security as well as alternative livelihood strategies to adjust with shifting climate. The detailed economics of these diversified interventions has been depicted in Table 4.



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