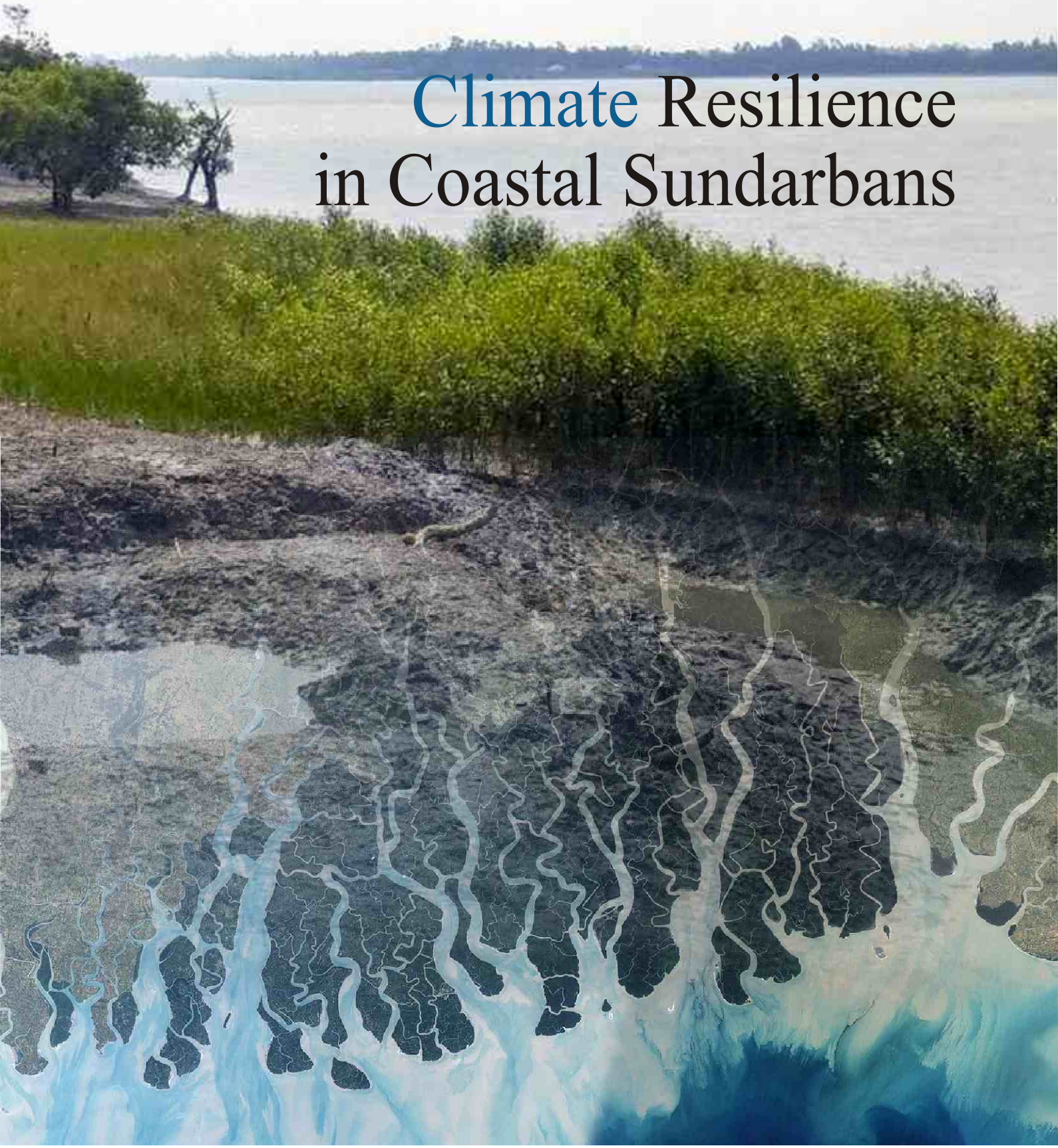
Climate Resilience in Coastal Sundarbans



hoffnungszeichen
sign of hope

German Federal Ministry
for Economic Cooperation
and Development

DRCSC

Climate Resilience in Coastal Sundarbans

Acknowledgement

Development Research Communication and Services Centre (DRCSC)along with DIW-Vision Indiagratefully acknowledges the contribution from Sign of Hope (SoH) and BMZ, Germany for implementing Sundarbans Climate Change Adaptation Project in 16 villages covering Ramganga & Patharpratima Gram Panchayats of Patharpratima Block, South 24 Parganas. The present study recognises the involvement of all project staffs and inputs from respective stakeholders. This study also admits the guidance and support from Team leader and senior members of DRCSC.

Abstract

Climate change is an inevitable part of world's existence. Due to human's indiscreet activities, a rapid change in climate has been observed. One of its devastating impact is rapid rise in temperature due to greenhouse effect. The temperature rise lead to polar ice cap melting and rise in global sea-level. The water has come from Himalayan glacial melt and added with the Bay of Bengal and the sea-level rise at a dangerous height. Sundarbans region, the home of Royal Bengal Tiger which contains arguably the world's largest remaining area of mangroves, and is well-known for its exceptional bio-diversity is facing a threat of existence due to this sea-level rise. Moreover, the dwellers of this area are constantly fighting for their existence due to high intense and frequent natural calamitiesforcing to insecure their lives & livelihoods.

The present study consists of the impact of a project which focused on finding out the ways which would be able to mitigate the causes of climate change and help people to adapt the situations created for the changing climate.

Agricultural activities take a major role in climate change. So, the project activities were mainly focused on sustainable agricultural techniques, conservation of existing floras& faunas and generation of new greeneries.

Before initiation of the project work, the vulnerabilities, problems etc. as well as the resources and capacities of the area are identified in a participatory way. The findings of these participatory exercises have been given in brief. Based on the identified vulnerabilities and capacities, some activities are formulated by the project personnel and the community. Most of the activities are in trial approach as both the funding and implementing agencies intended to explore what would be the strategies to adapt the changing climate in Sundarbans perspective.

The description of every activity has been given in brief. Along with that some case-studies and comparative studies have been attached to give clear understanding of the activity and also impact of the same. Every activity is evaluated by the project personnel and the core findings of it have been given in bullet points. There are some quantitative values which measured statistically and some qualitative values which are shared by the beneficiaries, community people and field workers of the project.

At last, but not the least, some points have been given to take forward some activities as the project work has left a considerable positive mark in the project area.

Key Findings:

Sustainable agricultural techniques and land shaping in agricultural land are mostly required in the project area to reduce the crop failure and adapt with the changing climate. The crop variety should be so chosen that it could tolerate high temperature, water-logging and high salinity. As good seeds are not available always in the market, farmer should conserve the good quality seeds by his/her own. Not only seed, optimum irrigation facilities and applying organic manure techniques are also crucial in this cultivation system. To reduce the risk, species diversity, genetic diversity and atmospheric diversity should be introduced in a single farm. Alternative energy sources should be used rather than fossil fuel and synthetic chemical fertilizer to mitigate the climate change. A huge no. of green vegetation should be introduced in the coastal region to save it from erosion& other natural calamities. Mangroves, the age-old guardian of Sundarbans region should be conserved. Alternative income sources should be generated to secure the livelihood of Sundarbans dwellers.

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Glossary of Acronyms:

SoH: Sign of Hope
BMZ: Federal Ministry for Economic Cooperation and Development, Germany
DRCSC: Development Research Communication and Services Centre
NG: Nutrition Garden
IFS: Integrated Farming System
SHG: Self Help Group
PRA: Participatory Rural Appraisal
PVCA: Participatory Vulnerability and Capacity Assessment
GP: Gram Panchayat
PMGSY: Pradhan MantriGraminSadakYojna
MGNREGS: Mahatma Gandhi National Rural Employment Guarantee Scheme
MCG: Mutual Cooperation Group
LPG: Liquid Petroleum Gas
NTFP: Non-Timber Forest Products
O_2: Oxygen
CO_2: Carbon-di-Oxide
CH_4: Methane

1. Project Background

Sundarbans area is full of extremities. There are several problems before the recent world-wide climate change such as mangrove species & other natural resources are declining to give shelter & livelihood to increasing no. of dwellers, supplying fuel wood, small timber for making houses, business by selling trees etc. Rising of river water (due to river bed siltation and polar-ice melting) is also a strong reason of declining mangroves. Over fishing in some areas are also found. As a result, the bio-diversity of Sundarbans is declining and a rapid river-bed siltation is found.

It became more vulnerable after the climate change. Every year, the loss of life, property and livelihoods in this area was increasing due to high frequency and intensity of cyclones, flash floods and breach of embankments, change in rainfall pattern, cloud burst, saline water ingression and coastal erosion due to accelerated sea level rise

People of Sundarbans are fighting continuously against this adverse climate to survive. Income opportunity of this people is very low. So, most of them migrate to different parts of the country to earn money. As the connectivity of the area become smooth, smuggling of woods, natural resources and trafficking are increased. The main livelihood of the dwellers is agriculture. But, their per capita land-holding is very small. The salinity of agricultural land become very high due to inundation after saline water flood. So, the land become mono-cropping (only cultivable during rainy season). On the other hand, input cost (chemical fertilizers, pesticides, farm machineries etc.) of cultivation is increasing day by day resulting to increase in crop failure due to erratic climate. Hence, they couldn't break the Vicious Cycle of Poverty. Malnutrition among people is very high, especially women and children. Their literacy rate is also low. So, they didn't even understand what to do in this changing climate. Some of them are engaged in collecting forest products which is harmful for existence of Sundarbans and also become a life-risk to the collectors.

In 1986, Sundarbans is considered as World Heritage Site due to the availability of 334 different plant species, 165 algae species, 59 reptile species, 48 mammal species, 210 fish species and 43 snail species. The total area of Sundarbans Island is 10 thousand square meters, out of which 4 thousand square meters is in West Bengal and 6 thousand square meters is in Bangladesh. It has total 102 nos. of Islands out of which 48 Islands are only forest lands and 54 are used for human dwelling. Within last 10 years, 5mm rise in sea-level was measured in Sundarbans. As an effect, we have lost two islands namely *Suparivanga & Lohachora*. Maximum part of *Ghoramara* Island which is a human-dwelling island has also been submerged into sea. The whole Sundarbans area is consisting of mainly three types of lands which are core forests area, fringe forest area and sub-urban area distant from the coastal region.

The project region was selected from a fringe forest area of Sundarbans in West Bengal, in such an area where the livelihood of residents was threatened by natural disasters, triggered by climate change and overall dependence on common

resources (climate, coastal protection and natural resources). An average of 44% of total population lived below the national poverty threshold of less than USD 0.5 per day, 33% didn't have any access to basic healthcare provisions and 60% did not have any access to clean drinking water. There was a lack of income-earning opportunities, trade and local industry. The most severely marginalised groups (landless and marginal land-holding fishermen and smallholders) were targeted. The landless proportion of the target group lived predominantly in mud or wooden houses located on public land in high-risk areas (near to unprotected coastal stretches and river sections). The smallholders and marginalised members of the target group also lived predominantly in high-risk areas, owning between 0.2 and 0.4 hectares of land on which rice was cultivated during the monsoon season and lentil & other pulses were cultivated during the dry winter months. In addition to this, they often own, a vegetable garden measuring approx. 0.005 to 0.01 hectares in size, a pond and natural pool, a small number of animals and various fruit trees and plantations. The livelihood of farmers was endangered by the natural disasters.

Most households had small nets and fish traps at their disposal to catch fish off the coast, in the small, fresh water channels and in the flooded paddy fields during the monsoon season. Fish was the most important source of protein to the target group. Most houses were single storied and made of mud. They were built on foundations, approx. 40 cm in height, to provide protection from flooding. The men regularly went to sea on trawlers for 8 to 10 days at a stretch and in 1-2 days interval again for same duration, between the middle of June and February. A significant reduction in the catch amount was recorded in the recent years. The causes were decline in stocks, resulting from destruction of habitats and over-fishing. The management of land, collection of natural resources and fishing were performed equally by all members who were capable of working. If a worker was absent (due to illness or an accident), or if there was a reduced yield as a consequence of natural disasters, food security was not ensured and the household forced to resort to negative management strategies like mangrove felling, gathering of fish spawn, hunting of rare species, fishing and crab collection in protected areas.

A drastic change in agricultural land of the project area was observed after the hit of *Aila* cyclone (on 25th May, 2009). A high tidal wave and cyclone were found. A vast portion of it was flooded with saline water and it entered into the cracks of the land. The land didn't gain its original properties even after 8 years. Even grasses could not grow in some parts. Moreover, soil of this area was clayey and compact. So, aeration and percolation of soil was disturbed and fertility declines considerably. During rainy season, the salts of surface land leached out and the lands became cultivable. But during summer season, salts came out from lower layer to surface land due to capillary action. Every year during summer, the land became so saline that grasses couldn't even grow and cultivation hampered.

Problem Tree

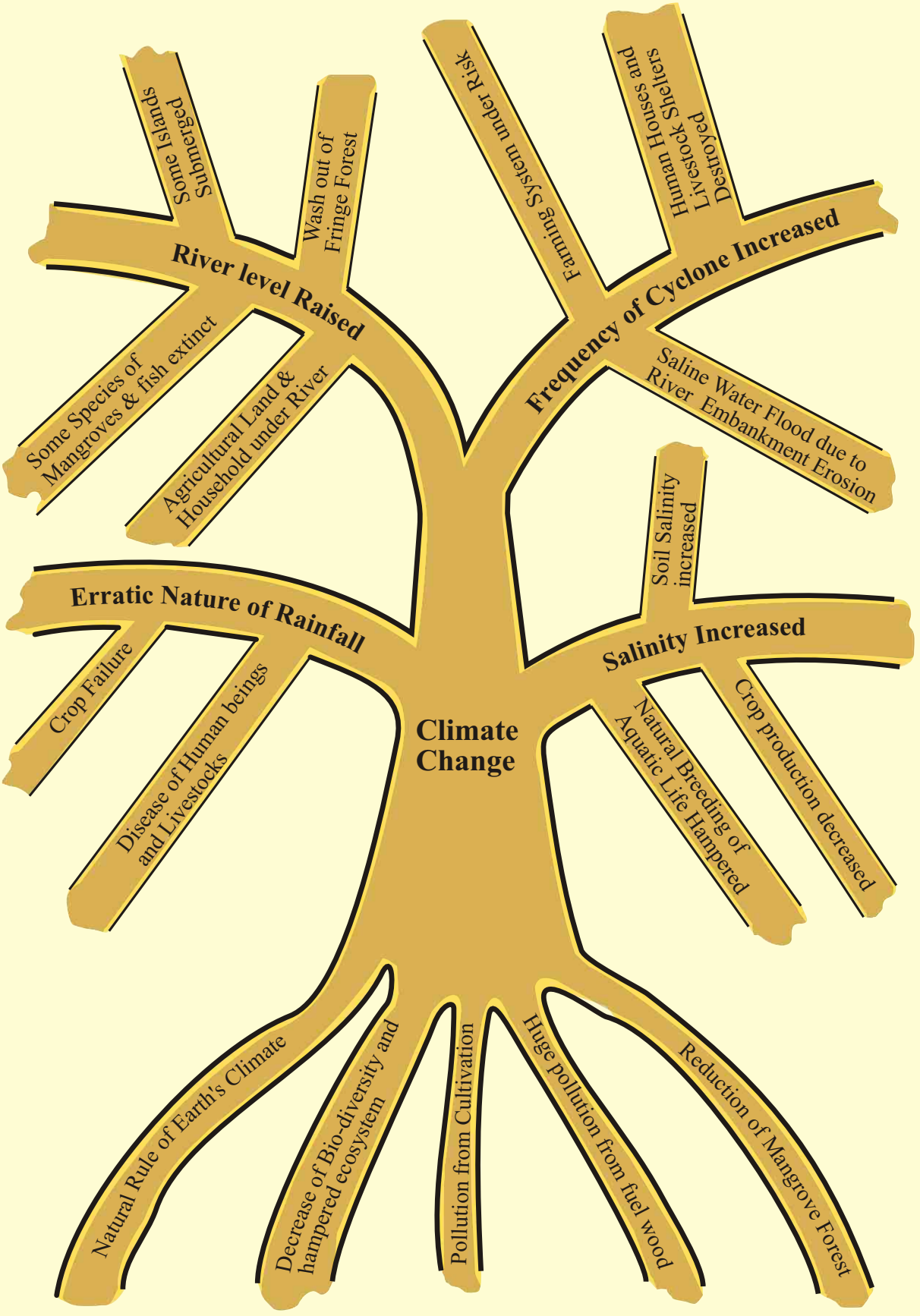


Figure 1 : Problem Tree on Climate Change.

2. Project Description in Brief & Its Objectives

Development Research Communication and Services Centre (DRCSC) has worked hard with the financial support of two German organizations, Sign of Hope (SoH) and BMZ for previous three years (2018-2020) to mitigate the climate change risks and to adapt this changing climate in a small patch of Sundarbans.

Marginalized and particularly vulnerable village communities in 16 villages located on Patharpratima block of the Sundarbansare the target group of the project. There are 8 villages from Ramganga GP and 8 villages from Patharpratima GP respectively. The targeted villages from Ramganga GP are namely Ramganga, Dakshin Mahendrapur, Dakshin Gobindapur, Debichak, Sagarmadhabpur, Dakshin Shibpur, Gayadham and Indraprastha. The targeted villages from Patharpratima GP are Baradapur, Bhagbatpur, Paschim Dwarikapur, Kishorinagar, Dakhin Laxminarayanpur, Madhabnagar, Dakshin Shibgaunj, Kshetramohanpur. Approx. 51345 residents (as per 2011 Census) lives in 16 villages within the project region, out of which 3288 individuals from 1644 households are directly involved in the project activities. All the beneficiaries are identified from the villages using the Participatory Rural Appraisal and Participatory Vulnerability and Capacity Assessment (PRA & PVCA) and assigned to the various activities, based on a number of pre-defined criteria such as disadvantaged households, vulnerability to natural disasters, livelihood, potential, willingness to participate etc. All the residents of both islands (approx. 111500 people) are indirect beneficiaries – primarily due to the reforestation measures as well as the measures to protect the eco-system and natural resources, i.e., towards increasing regional and global common resources.

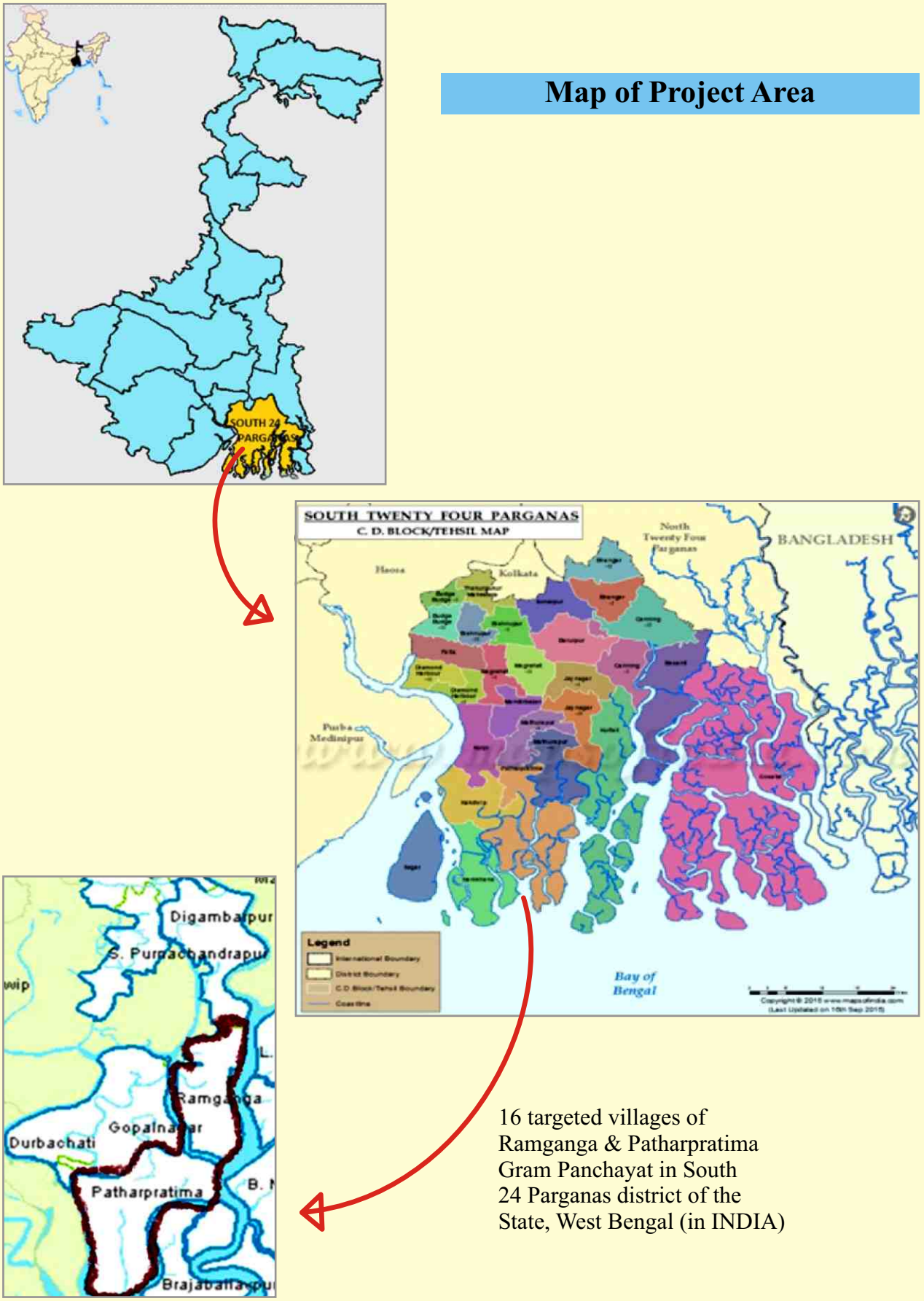
Under the project activity, some measures are taken to improve resilience and create alternatives like fertility and nutrient optimisation of household gardens, conversion of small farms into integrated farming systems; promotion of sustainable livestock farming, sustainable aquaculture, alternative income-earning opportunities; installation of tubewells for drinking water supply and installation of community seed banks. Some measures are also taken to reduce emissions and protect the eco-system, like reforestation for coastal protection purposes and generation of sustainable resources, establishment of alternative energy sources (like improved ovens, bio-gas, solar cookers, solar dryers). Another initiative of the project is skill development of the target group and reinforcement of environmental awareness by way of events on the subject of climate change and ecological sustainability in schools and within target group.

All the initiatives are taken to make people climate smart in their daily life and also for their each and every livelihood practices.

Project Objective:

The endangered flora and fauna of the Sundarbans is being regenerated and protected in a sustainable manner, thanks to reforestation and empowerment of the local population with regard to resource management and positive management strategies, thus contributing to the improved resilience of the target group in the face of natural disasters.

Map of Project Area



16 targeted villages of Ramganga & Patharpratima Gram Panchayat in South 24 Parganas district of the State, West Bengal (in INDIA)

Figure 2 : Map of Project Area

Assessment of Vulnerability and Transformed into Action

Assessment of Vulnerability and Capacity	Assessment of Climate Change Impacts, Trends, Vulnerabilities and Capacities
Selected Course of Action	Prioritization of issues and Defining Adaptation Goals Analysis and Selection of Adaptation Measures
Implementation of Adaptation Strategies	Actions taken to build capacity and avoid implementation barriers Implementation of Adaptive Interventions
Evaluation of Adaptive Measures	Evaluation work on Adaptive Interventions Taking forward Adaptive Actions for next phase of Implementation

Figure 3 : Flow of Project from Vulnerability Assessment to Activity Evaluation

3. Assessment of Vulnerability & Capacity

3.1 Assessment of Climate Change Impacts, Trends, Vulnerabilities and Capacities

3.1.1 Social Analysis:

Social analysis was done to understand the social composition and social cohesion within communities, and to assess the control and access to social/communal infrastructure in the villages. The information was collected from Social Map done with the community people.

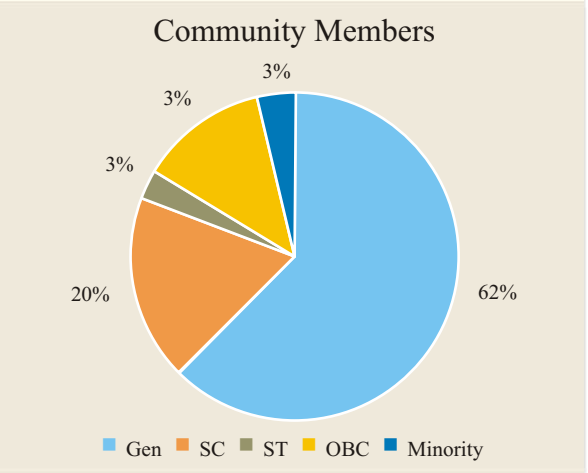


Figure 4 : Caste Distribution of Community

Community members:

Community members were mostly small and marginalized farmer families. Few of them were landless lab-ores. Nearly 1644 nos. of beneficiary. Families resided in the project villages where no. of General Caste population was more (62% general followed by 20% SC, 12% OBC and 3% each for ST & Minority community respectively). Out of total population approx. 51.4% were males and 48.6% were females.

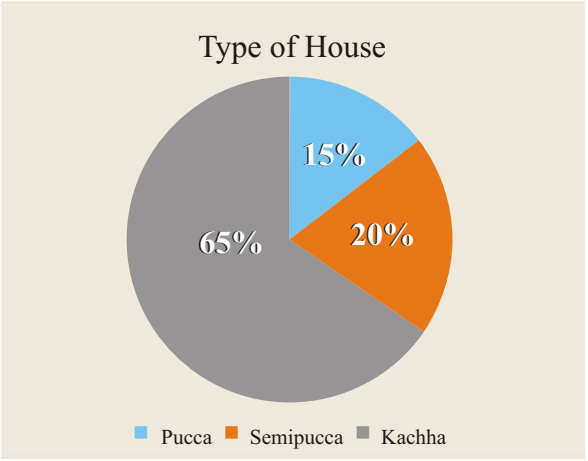


Figure 5 : Household Types of the Project Area

Vulnerable community members:

Vulnerable families were resided beside and alongside rivers. Various areas were there where river bank erosion happened every year and river water entered into the villages. There were nearly 60 – 70% families of the total families who were residing in the vulnerable areas having temporary house arrangements built with mud and straw thatch.

Among the total families in the villages, 65% families had (*kaccha)* temporary houses, 20% had semi-permanent and 15% had permanent well-built houses respectively. Particularly in vulnerable areas, more than 70% houses were temporary houses (*kaccha*) with mud built and straw thatched.

3.1.2 Social Infrastructure and its use:

Drinking water: There were on an average 340 tube-wells with an average 800-900 ft deep. Scarcity of water was observed in the end of March till July. During summer the water table went down and villagers had to keep on hand pumping for extracting the water from ground.

School: In the project area, there were 27 Free Primary Schools, 14 Sishu Siksha Kendras (SSKs), 3 Junior High Schools and 3 High Schools. Most of the schools were well built with concrete roof and classrooms. There were separate toilets for boys & girls, drinking water facility (tube-well), electricity connection, separate kitchen and Mid-day meal eating space and small playground. It is interesting to note that in few schools some differently able children came regularly for collecting Mid-Day-Meal from the schools.

Primary health care & ICDS: There were 3 sub-health centres which was 1 km – 3 km in radius from the villages where people used to visit for primary health care services. There were approx. 72 ICDS Centres.

Roads & transportation: Most of the intermediary connecting roads were Brick paved road in the villages. PMGSY roads (pitch road) were present in some areas and State Highway (*Sunderban Sadak*) was present in the eastern & western border of the villages. There were also few stretches of mud paved roads inside the villages.

Other Social Assets: In these villages, there were 70 temples, several churches, 12 crematorium ground and one Animal Health Centre.

3.1.3 Mobility of Male & Female

The mobility map of the female members of households depicted following information;

- Female members had to travel 3 – 5 km for attending local market/hat where they sold or bought essential items and also assisted others for selling of products.
- They sometimes travelled 3 to 15 km for vocational education training and also to Patharpratima College.
- They occasionally visited Hospital which was on an average 7 -10 km apart.
- The women members were also involved in MGNREGS work and for that they had to go 2.5 – 5 km for doing the work. Besides, they also travelled 1 -2 km for 3-4 months regularly in search of agricultural labour work.
- Most of them were also engaged in finger-ling/prawn spawn collection twice in a week from the nearby river.
- They occasionally visited BDO Office which was situated centrally. They also visited Ramganga & Patharpratima Gram Panchayat for 4 times a week.

The mobility mapping exercise was also done with all the male members of households of the village;

- The male members had to travel on an average 3 – 5 km for visiting nearby village market for selling of produces, purchasing of essential items etc. Sometimes they had to go Midnapore area for selling of produces and Gurudaspur for purchasing of daily household items. Some villagers also preferred to go Ganjer bazar, Dhruba bazar and Patharpratima bazar for shopping and purchasing of important daily items.
- Regarding education purpose, males used to go Patharpratima College and Kolkata for higher study.
- The villagers were involved in MGNREGS work and travelled different parts of their village and also to nearby villages for doing the work.
- Villagers had to migrate in north-east direction to Howrah, Hooghly, Burdwan, Nadia etc. for working in Cold stores and sometimes they went out of state like Delhi, Kerala, Bangalore etc. or even to Dubai & Kuwait in search of work.
- They were engaged in catching of fishes from sea and rivers. Most of them were also involved in crab collection from creeks and went to forests (*Dhanchi*) for collection of honey, fuel-wood etc.

3.1.4 Resources and Economic Analysis:

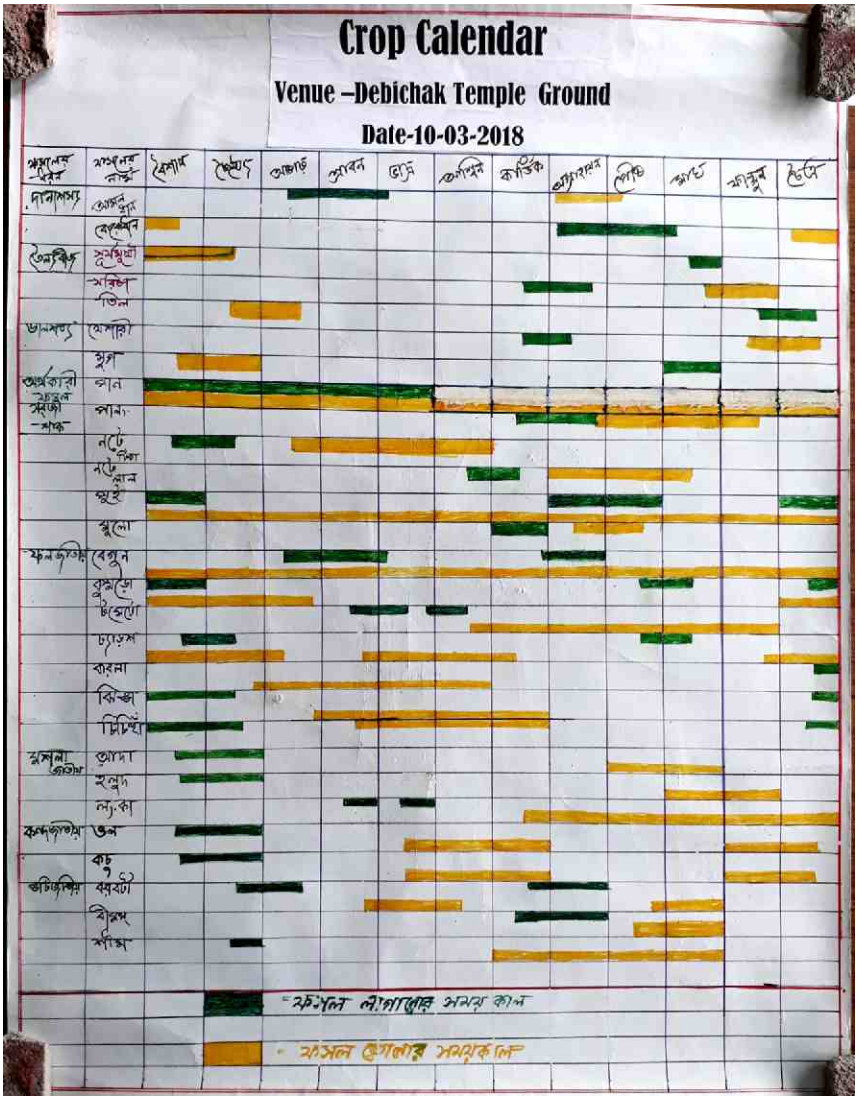
Different Economic Resources:

Cropping land – Total area of cropping land was 300 ha. There were single cropped and double cropped land in the villages. According to the resource map percentage of double cropping land was less (30-40%).

Water bodies (ponds/wells) – In these villages, 14 perennial ponds were present where villagers used the water for domestic purpose and fish cultivation. There were few canals by which excessive water of agricultural land was washed out and added with river during rainy season. There were 40 shallow pumps with personal ownership which helped in irrigating double cropped lands. Further there were 340 tube-wells for drinking water purpose inside the villages.

Streams/rivers – There were *Shuka* River, *Gobadia* River and *Mridangabhanga* River which passes through the project area. The villagers depended on this river for collecting fish fingerlings, crabs etc. for livelihood generation.

Crops – A crop calendar was made on the widely cultivated crops in the field area before implementation of the project. According to the crop calendar, *Aman* & *Boro* paddy were cultivated in both monsoon and winter season respectively. Oilseeds like sunflower, mustard; pulses like green gram and black gram; cash crops like betel leaves were cultivated in the villages. Further leafy vegetables like Indian spinach, Spinach, Green Amaranth etc.; fruit vegetables like eggplant, tomato, okra, ridge gourd, bitter gourd; spices like onion, chili; tubers (like potato, taro) were also found in the crop basket of the villages. According to voice of one villager, "Due to saline soil, monsoon paddy (*Aman*) is cultivated in the fields and in winter *Boro* paddy, potato, onion, sunflower, pulses etc. are cultivated using pond-water and water from swallow tube-wells."



It is observed that different varieties of fruit vegetables were cultivated in the monsoon season. But they were not cultivated at a single garden. Mainly single cropping and chemical farming practices were there.

3.1.4.1 Crop Calendar

Type of Crops	Name of Crops	Season	Pre-monsoon Season				Monsoon Season				Post-monsoon		
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Cereals	Paddy (*Aman*)												
	Paddy (*Boro*)												
Oilseeds	Sunflower												
	Mustard												
Pulses	Green gram												
	Black gram												
Cash Crop	Betel leaves												
Leafy Vegetables	Spinach												
	Green Amaranth												
	Indian Spinach												
	Water Spinach												
Fruit Vegetables	Egg plant												
	Tomato												
	Okra												
	Bitter gourd												
	Ridge gourd												
Legumes	Yard long bean												
Tuber	Potato												
	Taro												
Spices	Chili												
	Onion												

Planting Period **Harvest Period**

Figure 6 : Seasonal Calendar of Crop (Its Transplantation & Harvesting Periods)

3.1.4.2 Venn diagram:

According to the Venn diagram conducted with the community members, paddy varieties like Patnai, Dudheswar, Malabati, Marichshal, Palui etc. had characteristics of salinity resistant, good yield, beneficial by-products etc. and were popular among the farmers for cultivating those in their lands. Most of the local and indigenous paddy varieties became extinct and replaced with the high-yielding and hybrid varieties. Thus, the coping mechanism was lost.

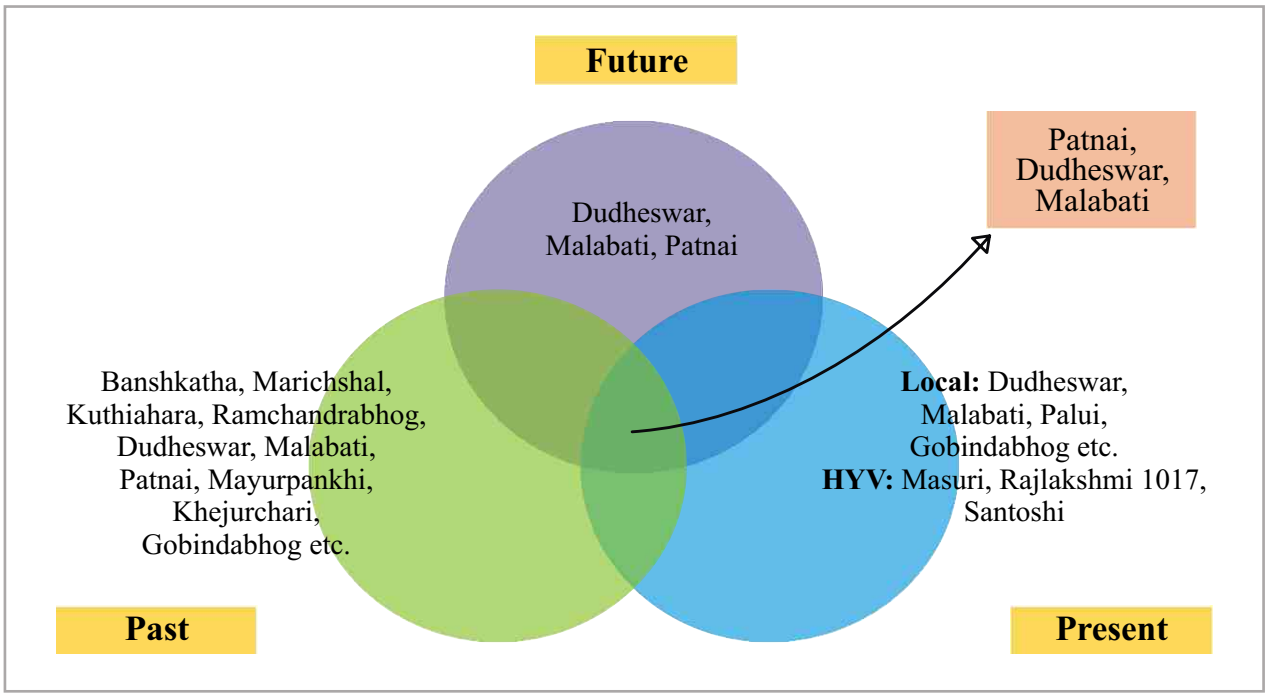


Figure 7 : Venn diagram on Paddy Varieties

Markets - People of this area depended on Ganjer Bazar, Dhrubo Bazar, Patharpratima bazar etc. Community people usually attended this market for selling of produces and also buying essential items for daily life.

Livelihood Assets - In the project areas most of the villagers were small & marginal farmers and depended on agriculture, mostly monsoon paddy (*Aman*) cultivation. Besides this, few of the farmer families cultivated winter paddy (*Boro*), vegetables, pulses etc. using pond and canal water and shallow pump. A participant said, "The use of chemical fertilizers & pesticides makes the soil unfertile and thus many local fish species are being extinct."

What kinds of livelihood tools/assets are available in the village: According to the villagers, besides cultivable lands, there were 14 perennial and large ponds present in the village which were denoted as livelihood asset where community people could engage in fish cultivation, crab cultivation, pond bank cultivation and management etc.

Women's livelihoods and income: Women were involved in MGNREGS work and travelled to north east in nearby villages like Sagarmadhabpur, Shibpur, Indraprastha, Jogindrapur etc. for doing the work. Besides they also travelled in other areas in search of agricultural labour work for 3-4 months regularly. Most of females were also engaged in fish-ling/prawn spawn collection twice in a week from nearby *Mridangabhanga* & *Gobadia* River. Some of the women were engaged in stitching, tailoring etc.

3.1.5 Analysis of the Seasonal Calendar:

According to the discussion with community members, seasonality of different scarcities as well as occurrence of multiple hazards was identified. Scarcity of food was observed during September to November months in the year. Scarcity of fuel-wood was there from mid of July till mid of

November. Villagers were facing shortage of drinking water from April to end of May. Scarcity of fodder was observed in monsoon season from July to mid of August and during harvesting season from mid of October to December. Work unavailability was seen from mid of August to mid of October. Villagers had to migrate to other states and neighbouring districts for livelihood generation from end of May till mid of December and mid of February to mid of April. Due to unavailability of work, shortage of food etc. villagers had to take loans from moneylenders, shops and relatives during mid of November to mid of January. In the village, diseases like diarrhoea, skin diseases, fever, cough & cold and stomach pain were seen from mid of June to mid of September. Animals were having diseases in the month of May to mid of July and November to mid of January. Further seasonality of occurrences of natural hazards was also noted. Flood was very common during the months of August and September and affected the cropping fields and hampered the daily life of the villagers. Heavy rain occurred during August and September. Storm occurred during April-May and October-November. Dry spells were seen in the month of mid-June to mid-August.

Sl. No.	Items	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
1	Food Scarcity												
2	Fuel-wood Scarcity												
3	Drinking Water Scarcity												
4	Fodder Scarcity												
5	Work unavailability												
6	Migration												
7	Debt												
8	Diseases of Human												
9	Diseases of livestock												
10	Flood												
11	Heavy Rain												
12	Storm												
13	Dry Spell												

Figure 8 : Seasonal Hazards Mapping

3.1.6 Vulnerability Analysis:

Climatic Hazard Mapping: There were 4 types of natural hazards that occurred in the villages.

- Heavy Rainfall
- Cyclone
- Storm
- Flood

3.1.6.1 Climatic Hazard Trend Analysis (History of Hazard):

Trend of climatic hazard was taken for last 30-40 years. During the year 1978 and 1982, devastating flood occurred in the village which created havoc loss and impacted in the lives of the local people. At that time people took shelter in the houses situated in higher places, school buildings etc. and necessary Govt. relief and supports were given. After that in 2007, excessive rainfall occurred and in 2009, Cyclone Aila demolished the village infrastructures, agricultural fields etc. Following that

heavy rainfall in 2014, drought in 2015 and again heavy rainfall in 2017 were faced by the villagers and therefore crops, vegetables, fishes etc. were destroyed. According to the comment of a villager, "After Aila, the frequency of natural hazards is increasing day by day".

Figure 9 : History of Hazards

Year	Hazard / Disaster	Vulnerability Ranking	Impact	Coping Strategies	Support taken
2014 & 2017	Heavy Rainfall	**3**	The event damaged the seedbed of *Aman* paddyand also matured paddy crops, kitchen garden, betel vines, fish etc. The villagers also faced trouble of preparing seedbed for monsoon paddy cultivation, loss of fish species, drinking water scarcity, diseases of livestock, diarrhoea and other related diseases of humans etc. and hampered the daily life of the villagers	Villagers tried for one stick paddy crop cultivation, rearranged the nutrition garden, reformed the betel-vines, collected medicines for livestock, cultivate fish in small ponds etc. As most of the houses get destroyed, so the affected families resided in the concrete/permanent build houses of other fellow villagers. Men and women worked hand in hand for draining the logged water from the fields, houses, gardens etc. In most of the cases people had to bring drinking water from far-flung areas, depended on stored food and collected necessary medicines from health centre or ORS from ICDS centres.	Community people get compensation from Government.
2015	Drought	**2**			
2009	Cyclone Aila	**5**	It created a huge impact in the life of the inhabitants. Initially the crops were damaged, the intrusion of saline water made the soil unfertile for next 2 years. Saline water entered into the fresh water ponds, canals and destroyed the living bodies. The cyclone affected the houses, trees, animals and other living bodies. Villagers faced drinking water shortages. Saline water also entered into the garden and damaged the crops, betel-vines were destroyed and people experienced huge economic instability.	People depended on stored food and collected necessary medicines from health centre or ORS from ICDS centres. Villagers collected edible leaves, fruits and fishes from rivers, riverbanks, forests etc. and met their hunger demand. They also rearranged the nutrition garden, reformed the betel-vines, collected medicines for livestock, cultivated fish in small ponds etc. The saline tolerant seeding materials were introduced in every cultivation.	Communities got food support from Govt. and were also provided with Grains. Local NGOs supported daily use things and Medicines.

Year	Hazard / Disaster	Vulnerability Ranking	Impact	Coping Strategies	Support taken
2007	Heavy Rainfall	**3**	Heavy rainfall occurred and seeds and crops were affected. Houses were damaged and villagers faced shortages of drinking water and became sick at that time	The affected families resided in the concrete/permanent build houses of other fellow villagers. They also prepared new temporary houses for staying. People had to bring drinking water from far-flung areas, depended on stored food and collected necessary medicines from health centre or ORS from ICDS centres.	Support of Mosquito net, Hurricane etc. from local NGO, ORS from ICDS centre.
1995	Cyclone	**3**	Heavy rainfall and cyclone occurred. Houses were damaged and villagers were facing shortage of food. Local Forest was damaged.	The affected families resided in the concrete/ permanent build houses of other fellow villagers.	Government support.
1988	Flood & water logging	**3**	It damaged the harvested paddy, livestock became lost. The feed, fodder of livestock became short, fishes died, houses got destroyed. Food scarcity observed for human also.	The villagers were able to cultivate fishes in saline water which ensured their food. People depended on uncultivated foods and weeds like different leafy vegetables (*girashak, bulgarshak*etc.). Villagers stranded on the high buildings. Even many people fed for only once in a day to cope up with the adverse situation.	Govt. supported Ration (rice, wheat etc.), Milo and other dry food items.
1983	Flood	**5**	It created massive loss and highly impacted the lives of common people. At that time, matured paddy crops, domestic animals, houses, trees, etc. were damaged. People were affected with diseases and they faced food, fuel and drinking water shortages.	The community people survived from the increasing natural hazards mainly by utilizing their own and local knowledge. Mutual cooperation was there among the community people. They depended on collected foods; even they ate maize, Milo, local herbs. People used to drink water from unhygienic water bodies at the time of water scarcity. At that time there were no doctors, physicians and people lived their life with lots of stresses and difficulties.	Govt. supported for drinking water, food and medicines.
1977	Flood	**5**			

Note: In the recent days, the frequency and devastating nature of climatic hazards has been found to be increased. Two simultaneous super-cyclones hit the project area in six months intervals which were on 11th November, 2019 and 20th May, 2020 respectively during the project period.

3.1.6.2 Climatic Hazard Impact Assessment:

During the flood which happened in the villages in 1978 and consecutively in 1982 created massive loss and highly impacted the lives of common people. At that time, matured paddy crops, domestic animals, houses, trees, etc. were damaged. People were affected with diseases and they faced food, fuel and drinking water shortages.

In 1988, flood and water logging happened in many villages. It damaged the harvested paddy, livestock became lost. The feed, fodder of livestock became short, fish died, houses got destroyed. Food scarcity observed for human also.

In the year 1995, heavy rainfall and cyclone occurred. Houses were damaged and villagers were facing shortage of food. Local Forest was damaged.

In the summer of 2007, heavy rainfall occurred and seeds and crops were affected. Houses were damaged and villagers faced shortages of drinking water and became sick at that time.

After that Cyclone Aila occurred in 2009. It created a huge impact in the life of the inhabitants. Initially the crops were damaged, the intrusion of saline water made the soil unfertile for next 2 years. Saline water entered into the fresh water ponds, canals and destroyed the living bodies. The cyclone affected the houses, trees, animals and other living bodies. Villagers faced drinking water shortages. Saline water entered into the garden and damaged the crops, betel-vines were destroyed and people experienced huge economic instability.

In the August of 2014, again heavy rainfall occurred in the village and affected *Aman* paddy cultivation coupled with destruction of betel-vines and vegetable gardens. Successively in 2017 once again heavy rainfall damaged the crops, livestock etc. and hampered the daily life of the villagers. In between these years in 2015, drought (no rainfall) was observed in this part of the Sundarbans for few months. At that time villagers faced trouble of preparing seedbed for monsoon paddy cultivation, loss of fish species, drinking water scarcity, diseases of livestock, diarrhoea and other related diseases of humans etc.

Climatic Hazard Ranking: According to the villagers, the impact of Cyclone and Flood was more dangerous and severe which affected the communities economically, socially and ecologically. Further heavy rainfall, drought, storm etc. were other hazards which had more frequencies and also affected the communities.

Vulnerability Assessment: In relation to the proneness of vulnerability there were few areas where river bank erosion happened every year and river water entered into the villages. Additionally, as few of the areas of the villages had downward slope, so water logging was common after heavy rainfall during the monsoon. There were nearly 70% of the total families who were residing in the vulnerable areas having temporary house arrangements built with mud and straw thatch. Further as most of the economically backward and marginal families lived in the river bank areas, so they were more likely to face initial damages from flood, cyclone etc.

3.1.7 Integrating Disaster Preparedness:

Vulnerable places: In the project area, most vulnerable areas were present in the middle, northern and north-western part. Approximately 5 – 10 sq. km area was vulnerable in respect to river bank erosion, flood and water-logging. The Rivers which were present in the villages had many areas

where frequent river bank erosion happened and therefore during heavy rainfall river water entered into the villages and damaged the agricultural fields. River water also entered through the canals. Further, the southern, eastern and middle part of the area having low land and during heavy downpour, water became stagnant and water-logging situation occurred. Nearly, 200 acres of land became water logged for 10-15 days during heavy rainfall.

Safe places: According to the participatory exercises and observation in the villages, there was some Cyclone/Flood Shelter situated in the villages. Besides, there were Primary School buildings, high school buildings, Junior High School buildings etc. for safeguarding the common people from natural hazards.

Coping and Adaptation Strategies Assessment: In the project area, the community people survived from the increasing natural hazards mainly by utilizing their own and local knowledge. Villagers tried for one stick paddy crop cultivation, rearranged the nutrition garden, reformed the betel-vines, collected medicines for livestock, cultivated fishes in small ponds etc. Mutual cooperation was there among the community people. As most of the houses got destroyed, so the affected families stayed in the concrete/permanent build houses of other fellow villagers. After flood and heavy rainfall, men and women worked hand in hand for draining the logged water from the fields, houses, gardens etc. In most of the cases people had to bring drinking water from far-flung areas, depended on stored food and collected necessary medicines & ORS from health centres or ICDS centres. In some cases, villagers collected edible leaves, fruits and fishes from rivers, riverbanks, forests etc. and met their hunger demand.

Government support was given to the villagers. They also got compensation for crop loss and house damage. After Aila the communities got food support and were also provided with mosquito net, ORS, medicines, drinking water packs etc. by Govt. and NGOs.

4. Selected Course of Action

4.1 Prioritization of Issues and Define Adaptation Goals

Some issues which were the main causes of their vulnerability were identified during field study and also prioritized by the villagers based on their intensity of damage and evil effect on dwellers.

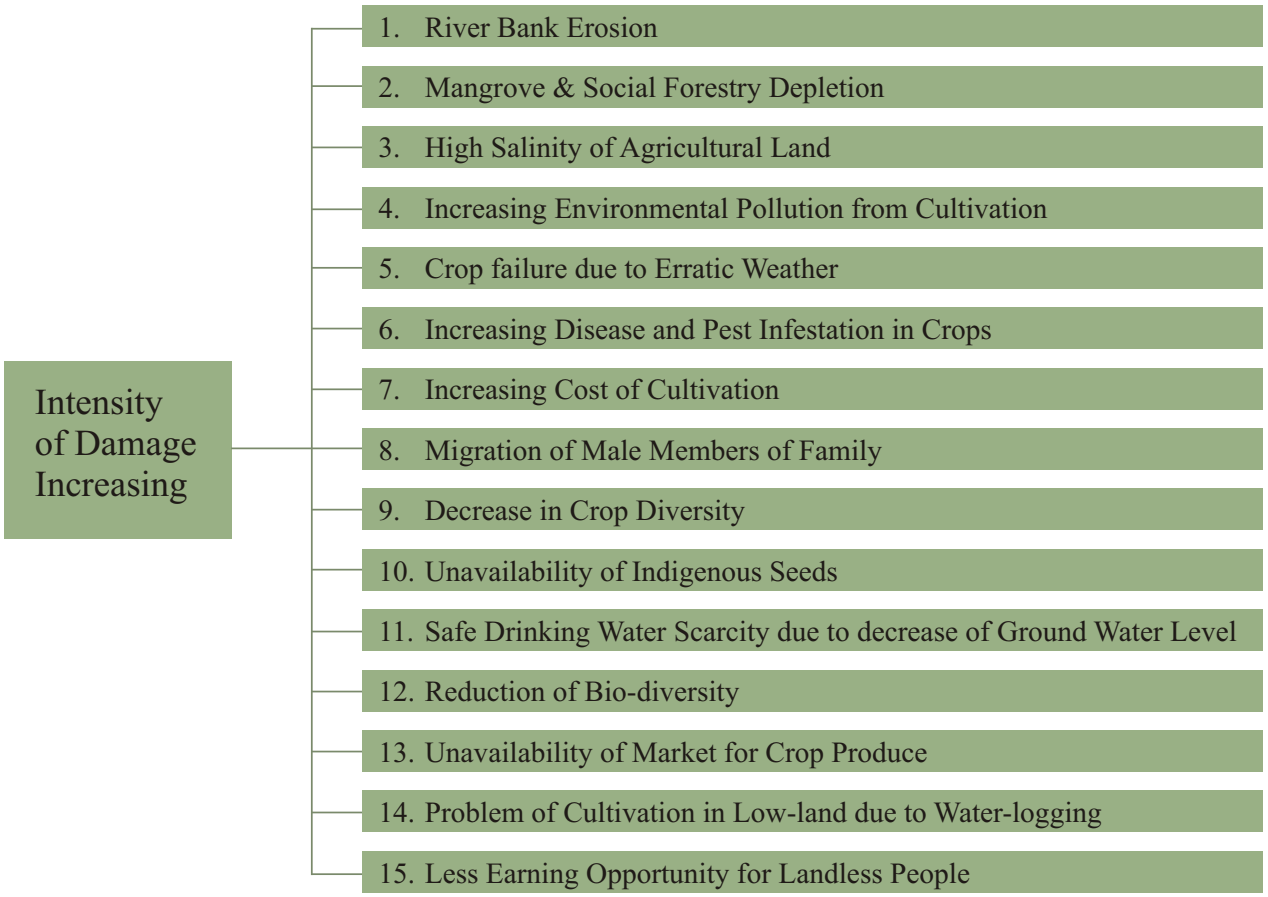


Figure 10 : Prioritization of Issues identified in the Project Area

Based on the previously mentioned issues, adaptation strategies are formed. The adaptation strategies suggested by community are as following:

- Knowledge support on nursery development for Mangroves and Multi-purpose Tree Saplings
- Plantation and Conservation of Mangrove and useful Multipurpose Local Trees
- Knowledge Support on Salt-tolerant Crops and their Cultivation
- Knowledge and Material Support on Alternative Energy Use
- Organic Inputs Support and handholding on Preparation of them at Household Level
- Knowhow on improved water management system and how to get integrated agricultural production
- Providing Support for Climate Adaptive Cultivation
- Knowhow & Handholding support for Preparation of Agricultural Pest and Disease Controlling Materials
- Providing Indigenous Seeds, Knowledge and Material for their Conservation
- Introducing Alternative Income Generation Programmes
- Knowledge on New Scientific Cultivation Techniques based on the Resource
- Preparation of Rain Water Harvesting Points
- Providing Knowledge of Less Irrigated Cultivation Techniques

- Knowledge on Livestock Rearing and also Support of Indigenous Breeds
- Linkage Establishment with Markets in Kolkata
- Introduction to Suitable Cultivation Techniques in Small Land

4.2 Analysis and Selection of Adaptation Measures

Table 1 : Defining Activities based on the identified issues

Problem	Desired Change	Detail Activities	Resource Require	
			Community	External
River Bank Erosion	Less Erosion	Mangrove Conservation and Plantation & Awareness Generation among neighbouring people	Taking charge of Plantation & Conservation	Resource Person, Seeds & Saplings Supply & Linkage with Govt. Departments
Decrease of Mangroves species & Socia Forests Decrease	Increase of Greenery	Mangrove and Multi-purpose Tree Plantation and Conservation	Taking charge of plantation, protection and maintenance of the trees	Seeds, Saplings, Fertilizers and Fence, Linkage with Govt. Department
High Salinity of Agricultural Land	Decreasing Lowering Salinity of Agricultural Land	Use of Organic Fertilizer, Year-round Cultivation, Salt-tolerant Material Use	Organic Fertilizer Preparation using Household Waste	Resource Person, Seeding Material
Increasing Environmental Pollution from Cultivation	Less Pollution from Cultivation	Use of Waste in Organic Fertilizer Preparation, Use of Alternative Energy	Preparation and Use of Organic Fertilizer and Alternative Energy	Delivery of Required Material
Crop failure due to Erratic Weather	Less Crop Failure	Use of Raised Bed, Sorjan Technique, Mixed Cropping, Inter-cropping, Water Harvesting and Using	Implementation of Local and Other Scientific Knowledge and Techniques	Knowledge & handholding Support
Increasing Disease and Pest Infestation in Crops	Less Disease and Pest Infestation	Cultivation of Trap and Pest-repellent Crops, Use of Organic Pest-Repellent and other Organic Inputs	Cultivation of Trap and Pest-repellent crops and Preparation of Organic Inputs	Knowledge and Required Material Support
Increasing Cost of Cultivation	Less Cost of Cultivation	Training on Home-made Organic Inputs Preparation	Preparation of Organic Inputs	Knowledge & handholding Support and Fixed Material Support
Migration of Male Members of Family	Getting Sufficient Income Locally	Finding out Alternative Income Generation Programme Locally and Proper Use of Existing Resources	Engagement in New Income Opportunities enthusiastically	Knowledge Support

Problem	Desired Change	Detail Activities	Resource Require	
			Community	External
Decrease in Crop Diversity	Crop Diversity Increased	Training on Multiple crop cultivation in a single patch of Land	Cultivation of Multiple Crops in their Land	Different Kinds of Seeds Support and Knowledge support for Cultivation
Unavailability of Indigenous Seeds	Plenty Availability of Indigenous Seeds	Training on Cultivation of Different types of Indigenous Seeds and their Preservation	Cultivation and Preservation of Indigenous Seeds	Knowledge Support & Seeds Support & Linkage with Govt. Departments
Safe Drinking Water Scarcity due to decrease of Ground Water Level	Plenty Availability of Safe Drinking Water	Training on Relay Crops' Cultivation, Techniques of Less Irrigated Cultivation and Drinking Water Tube-Well Installation	Cultivation of Relay Crops and Applying Less Irrigation Techniques	Drinking Water Tube-Well Installation
Reduction of Bio-diversity	Enriched Bio-diversity	Mangrove and Multi-purpose Tree Plantation and Conservation and Use of Organic Inputs in Cultivation	Plantation and Conservation of Mangrove and Multi-purpose Trees	Knowledge and Inputs Support
Unavailability of Market for Crop Produce	Market Linkage Established	Linkage Establishment with External Markets	Producing Quality Vegetables	Market Demand
Problem of Cultivation in Low-land due to Water-logging	Low-land Crops will also be survived	Use of Scientific Land Shaping Techniques and Proper Selection of Crops	Cultivation of Properly Selected Crops	Knowledge Support and Monetary Support for Land-shaping
Less Earning Opportunity for Landless People	Landless People were getting well Income	Implementation of New Cultivation Techniques and Training on Livestock Rearing	Applying New Cultivation Techniques	Knowledge Support

5. Implementation of Adaptation Strategy

5.1 Actions taken to Build Capacity and Avoid Implementation Barriers

Table 2 : Brief of Capacity Building Programmes

Sl. No.	Training Details	Participants	No. of Training Organized	Training Type
1.	Group Strengthening Training	1644 group members	169 nos.	One Day/ Two Day as per requirement
2.	Group Exchange Visit	290 beneficiaries	20 nos.	One Day
3.	Nutrition Gardening Training	1442 beneficiaries	81 nos.	Two Day
4.	Nutrition Gardening Refresher Training	1327 beneficiaries	62 nos.	One Day
5.	Nutrition Garden Exchange Visit	206 beneficiaries	13 nos.	One Day
6.	Training on Small Farm Improvement	1079 beneficiaries	65 nos.	Two Day
7.	Refresher Training on Small Farm Improvement	708 beneficiaries	40 nos.	One Day
8.	Small Farm Exchange Visit	205 beneficiaries	13 nos.	One Day
9.	Training on Sustainable Aquaculture	837 beneficiaries	43 nos.	One Day
10.	Livestock Rearing Training	207 beneficiaries	7 nos.	Two Day
11.	Training on Group based Income Generation Programme	144 beneficiaries	13 nos.	One Day/ Two Day as per requirement
12.	Training on Alternative Energy Use	40 Villagers	8 nos.	As per requirement
13.	School Seminars for Climate Change Awareness	6463 nos. of Students & Teachers	31 nos.	One Day
14.	Farmers Awareness on Climate Change	5878 Farmers	65 nos.	One Day

5.2 Implementation of Adaptive Interventions

5.2.1 Collective Effort for bringing Positive Attitude

People can learn more through mutual inter-action. All the 1644 beneficiaries were divided into 140 mutually co-operated groups to promote solidarity, co-operation and exchange of knowledge between the members. There are 16 community mobilizers in 16 villages to guide the group members. They mainly taught them about decision-making mechanisms, conflict resolution strategies and also provided them the aid of supporting materials for their capacity enhancement. They not only learned the interventions properly through group interactions, but they also saved some money for their future security.

Here are two case studies of group activities.

5.2.1.1 Case Study 1: Jyoti Swanirvar Dal

12 willing women of Sagarmadhabpur village made a Mutual Co-operation Group following all the norms of a Self-Help Groups and also helped each other mutually. They created members' savings of Rs. 3960/- till 31st March 2021.

All the members of this group established nutrition garden and took support of seeds for cultivation and saplings for developing living fence. Some of them also re-excavated their ponds with project support. With this support, they are harvesting rain-water, cultivating aquatic animals into it and using pond water for cultivation. 8 members took fish spawns and fish feed and 4 others took protective net for crab cultivation. Some of them constructed vermi-compost pit and other members took concrete bowls for vermi-composting. 6 members are provided with mud pitchers to produce organic matter. Some of them constructed smokeless ovens in their kitchen and other took improved oven to reduce the use of fire wood for cooking purpose. 7 of them took livestock support to enrich their livelihood. One of them got zero-energy cold-storage support to save perishable vegetables. They also took saline tolerant paddy seeds and sesbania seeds for small farm improvement. They took seeds of pulses and oil-seeds for relay cropping. They planted trees along the road-side of the river bank with the help of other neighbouring groups. They also started group-based income earning through poultry rearing.

Their rule is to give a pay-back of 25% on what they had taken from the project support and saved it as revolving fund. They saved Rs. 34289/- as Revolving Fund till 31st March, 2021 and earned Rs. 1234/- from bank interest.

The group have 2 nos. of Integrated Nutrition Garden farmers, 2 nos. of farmers having Integrated Farming System and 3 model Nutrition Garden farmers who become experts in organic farming. 6 women from them identified their leadership quality from group activity.

A group member shared, "My family got organic vegetables and our family income is increased. I also got help of other members in my difficult days after becoming a member of this group."

5.2.1.2 Case Study 2 : SagarMahila Dal

This group has 14 members. It started on 23rd April, 2018. They arranged meetings several times in a month due to smooth implementation of the project work. The presence of members in those meetings is 74%. The total member savings of this group till 31st March, 2021 was Rs. 8150/-.

12 members of this group constructed Smokeless Ovens and 2 members installed Bio-gas ovens with the project support to reduce wood consumption during cooking. 3 of them also took improved oven to trial it as an alternative of smokeless oven. Some of them dug ponds to harvest rainwater. One also constructed a tank for rain water harvesting. They also cultivated fish in it and use water for vegetable cultivation. They also took fish spawn support for sustainable aquaculture. One took protective net for crab cultivation. Some of them constructed vermi-composting pits and others took concrete bowls for worm composting. 4 of them also took mud-pitcher for organic manure preparation. Each member of this group established a nutrition garden at their homestead based on their capacity. They took seed supports for gardening and fruit tree saplings and mulberry cuttings for its fencing. 2 of them also took bamboo for fencing. Some of them took mushroom spawns to produce mushroom. Some of them took seeds of pulses, oil seeds, sesbania seeds and salt-tolerant paddy seeds to improve the health of their small farms. They also established a seed-bank to preserve, inter-lend and sell indigenous seeds. 5 of them took livestock support to take livestock rearing as their alternative income earning source. They also engaged in a group-based income generation programme on *Bori* (Lentil Dumplings) and Wood Apple Pickle preparation. The profit of their business shared among the group members and a part of it saved in their group account. They saved Rs 1632/- of the profit in the group account till 31st March, 2021. They also took 25% of project support from the members and saved it in their group account as revolving fund. They got a revolving fund of Rs 41052/- till 31st March'21.

They used the fund to meet their household emergencies. They took money as loan and repay it with interest. They gave loan to group members and earned interest from it. Total interest come from their inter-lending, was Rs 6400/-. They also earned Rs 295/- as Bank interest.

Figure 11 : Graphical Representation of Monetary Transaction (in Rupees) of two Sample Groups:

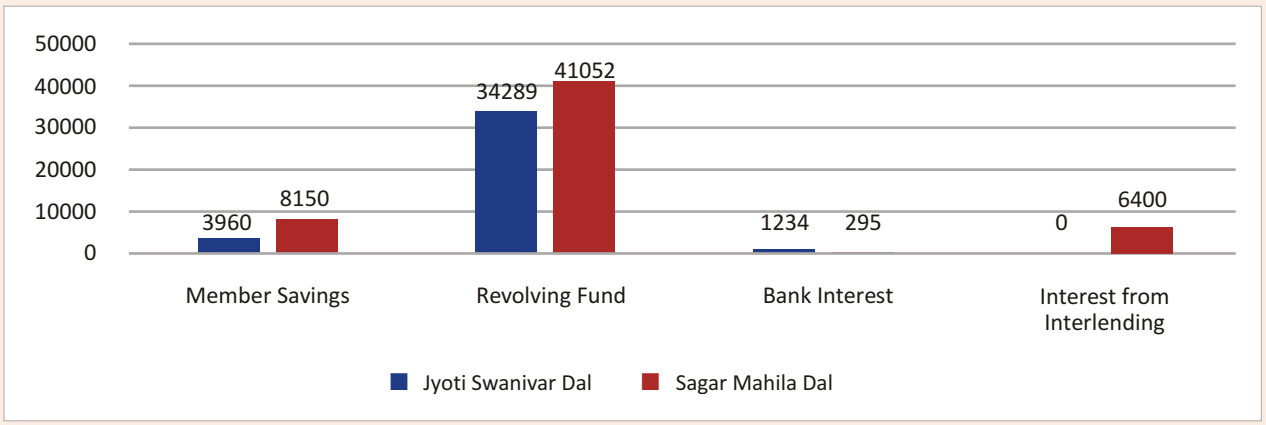
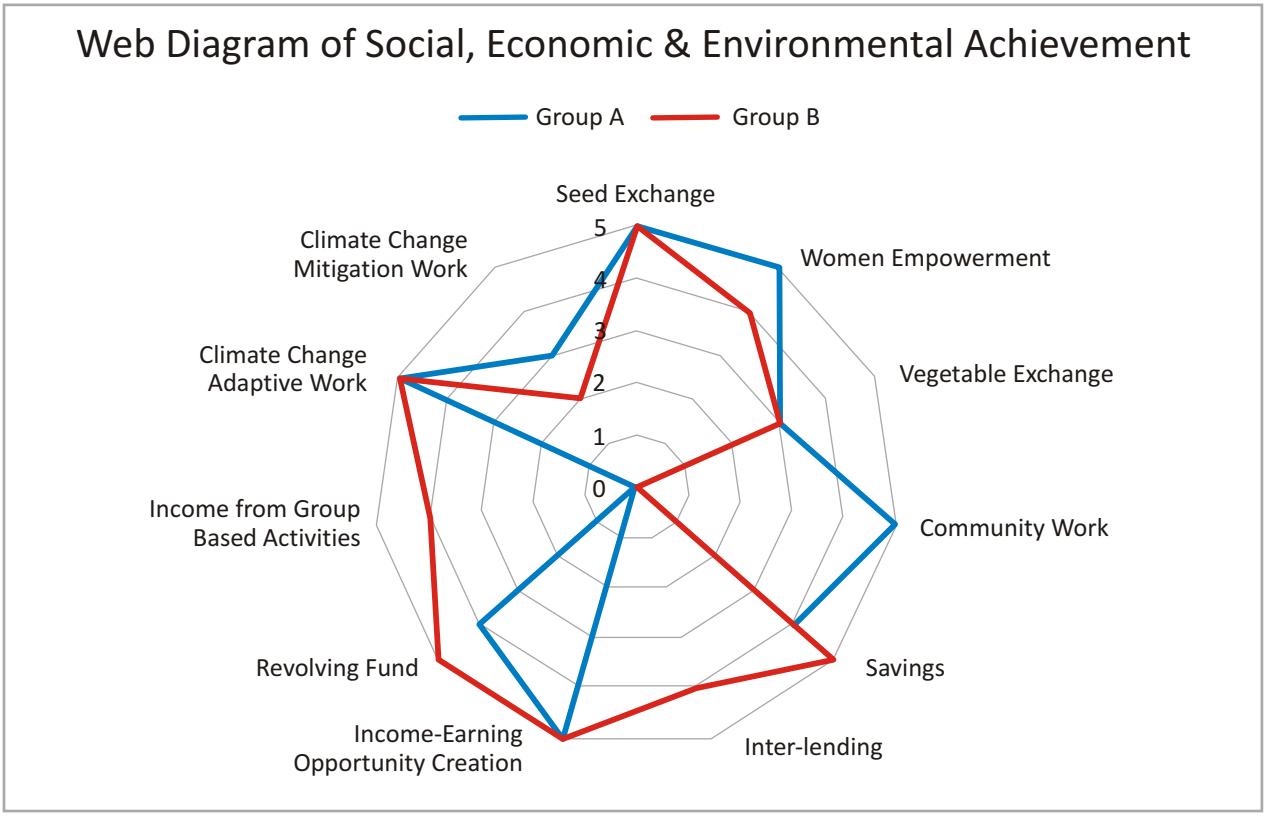


Table 3 : Social, Economic and Environmental Achievement of two Sample Groups:

Sl. No.	Category of Variables	Name of Variables	Rating of Group A	Rating of Group B	Explanation of Rating
1.	Social	Seed Exchange	5	5	Types of seed exchange in every season: 0-No exchange 1-1 type of seed exchange 2-2 types of seed exchange 3-3 types of seed exchange 4-4 types of seed exchange 5-5 & more types of seed exchange
2.		Women Empower-ment	5	4	■ Sharing Things to Other Members· ■ Participating in Own Development Programs· ■ Linkage with Government· ■ Helping Each Other in various activities· ■ Continuing group-based Business 0- None of the above topics observed 1- Any one of them observed 2- Any two of them observed 3- Any three of them observed 4- Any four of them observed 5- All the above topics observed
3.		Vegetable Exchange	3	3	0- No Exchange Occurred 1- Vegetable exchanged for 1-2 months in a year 2- Vegetable exchanged for 2-4 months in a year 3- Vegetable exchanged for 4-6 months in a year 4- Vegetable exchanged for 6-8 months in a year 5- Vegetable exchanged for 8-12 months in a year
4.		Community Work	5	0	0- No Community Work5-Any Community Work (like Social Forestry Creation, Mangrove Planting etc.)
5.	Economic	Savings	4	5	0- No Savings 1- Rs 1/- to 1000/- Savings 2- Rs 1001/- to 2000/- Savings 3- Rs 2001/- to 3000/- Savings 4- Rs 3001/- to 4000/- Savings 5- Savings more than Rs 4001/-
6.		Inter-Lending	0	4	Availability to all Members· Loan taken by all Members· Fulfilled the Need of Each Member· Timely Interest Re-payment· Timely Loan Repayment 0- None of the above topics observed 1- Any one of them observed 2- Any two of them observed 3- Any three of them observed 4- Any four of them observed 5- All the above topics observed
7.		Income-Earning Opportunity Creation	5	5	0- None of members got the opportunity 1- 1 to 20% of members got the opportunity 2- 21 to 40% of members got the opportunity 3- 41 to 60% of members got the opportunity 4- 61-80% of members got the opportunity 5- 81-100% of members got the opportunity
8.		Revolving Fund	4	5	0- No Revolving Fund 1- Rs 1/- to 10000/- Revolving Fund

Sl. No.	Category of Variables	Name of Variables	Rating of Group A	Rating of Group B	Explanation of Rating
					2- Rs 10001/- to 20000/- Revolving Fund 3- Rs 20001/- to 30000/- Revolving Fund 4- Rs 30001/- to 40000/- Revolving Fund 5- Revolving Fund more than Rs 40001/-
9.		Income from Group-based Activities	0	4	0- No Income 1- Rs 1/- to 500/- Income 2- Rs 501/- to 1000/- Income 3- Rs 1001/- to 1500/- Income 4- Rs 1501/- to 2000/- Income 5- Income more than Rs 2001/-
10.	Environ-mental	Climate Change Adaptive Work	5	5	0- No Climate Change Adaptive Activity Taken 1- One Climate Change Adaptive Activity Taken 2- Two Climate Change Adaptive Activities Taken 3- Three Climate Change Adaptive Activities Taken 4- Four Climate Change Adaptive Activities Taken 5- Five & More Climate Change Adaptive Activities Taken
11.		Climate Change Mitigation Work	3	2	0- No Climate Change Mitigation Activity Taken 1- One Climate Change Mitigation Activity Taken 2- Two Climate Change Mitigation Activities Taken 3- Three Climate Change Mitigation Activities Taken 4- Four Climate Change Mitigation Activities Taken 5- Five & More Climate Change Mitigation Activities Taken

Figure 12 : Web-Diagram of Social, Economic and Environmental Achievement of two Sample Groups



5.2.2 Understanding Weather Parameters

People should aware about day-to-day weather. They will be able to know the climate and changes which have been occurred into it. The condition of main weather parameters which have the direct impact on agriculture are displayed on a board for the farmers before 5 days. This weather forecast consists of the temperature and rainfall (its amount and density). There are 12 weather forecast boards in the project area.

Simultaneously a climate-volunteer is present in each targeted village of Ramganga GP to measure the actual status of temperature and rainfall daily.

The following Graphs are the representations of their Data:

Figure 13 : Monthly temperature variance (Data collected from the volunteers)

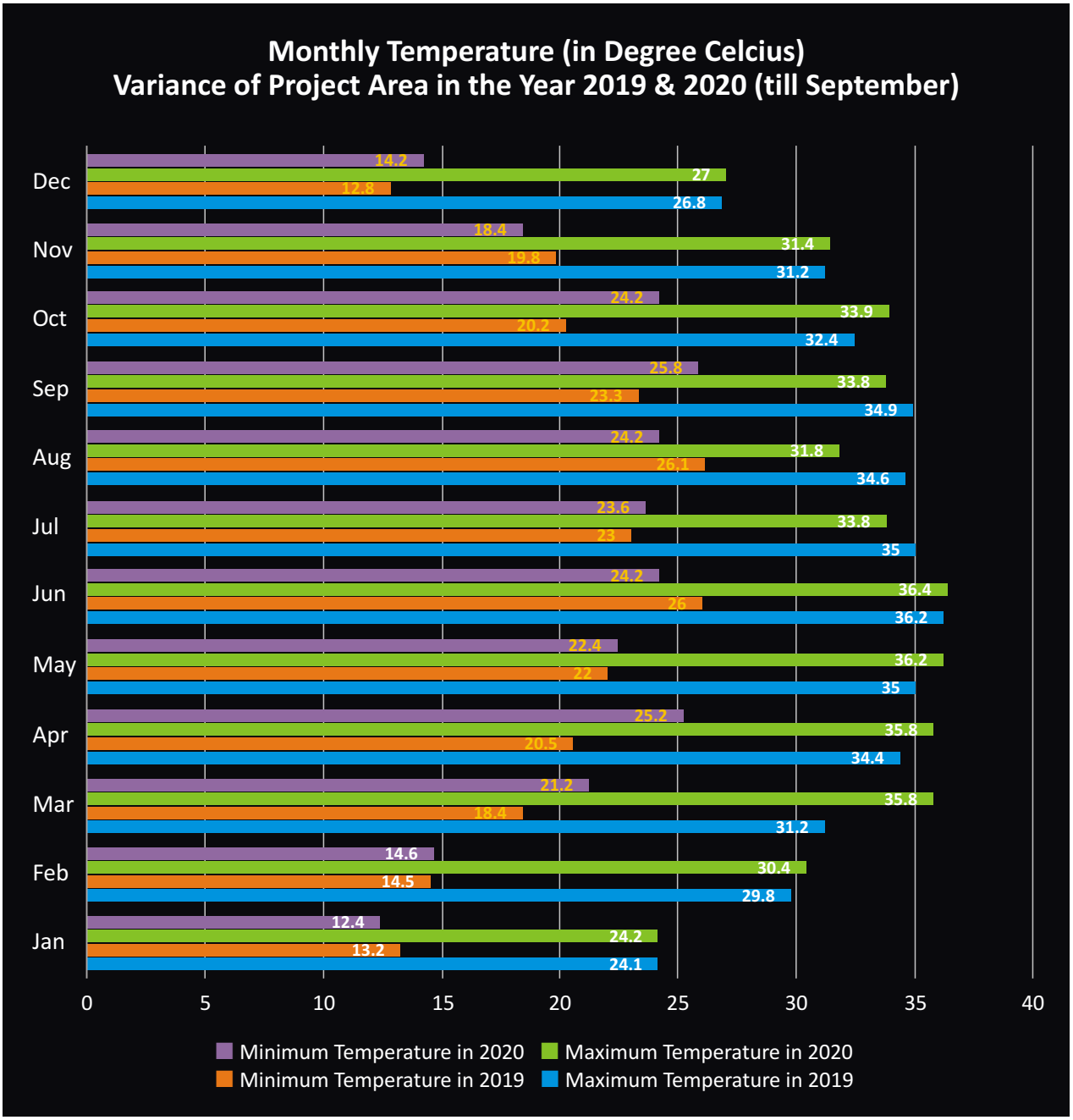


Figure 14 : Daily Average Rainfall of different months in the years, 2019 & 2020 as per the data of volunteers:

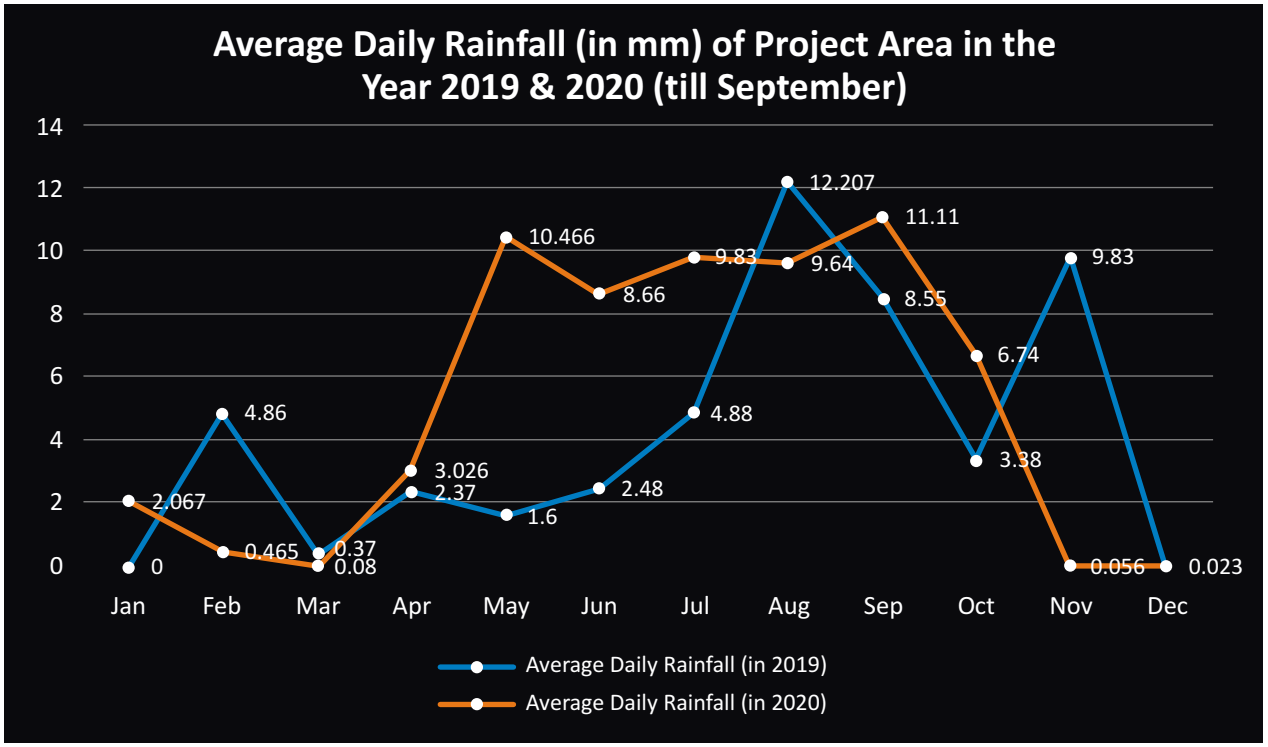
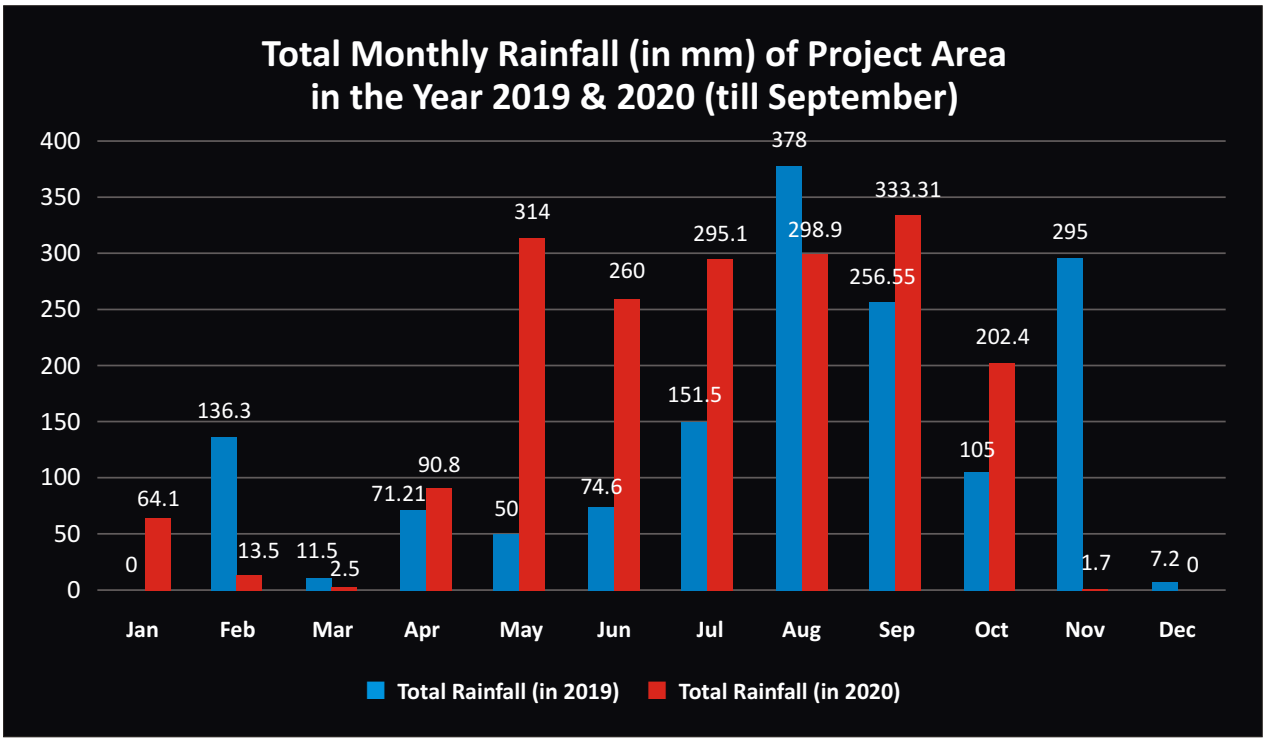


Figure 15 : Total Monthly Rainfall of the Years, 2019 & 2020



5.2.3 Awareness on Climate Change and Knowledge Enrichment through Hand-holding Supports

5.2.3.1 Climate Change Awareness:

The target of climate awareness sessions is to make people aware about the changes occurred in climate, the reasons behind it and suggest them some ways to mitigate climate change.

79 nos. of such sessions are arranged in three years of the project and 12341 nos. of people are benefited with these.

International Mangrove Conservation Day Celebration

Rally for Awareness

World Environment Day Celebration

Awareness at Local Club

5.2.3.2 Hand-holding Support through School Gardening:

4 nos. of school gardens are established in 4 different school grounds to give them practical knowledge about climate change adaptation. Name of these 4 schools were Dakshin Mahendrapur F. P. School, Gayadham F. P. School, Dakshin Shibpur Netaji SSKM, Dakshin Gobindapur Narayanitala F. P. School. The areas of School garden are 240 square ft., 380 square ft., 800 square ft. and 2520 square ft. respectively. Students of the four schools gets very excited to learn from the school gardening.

Sapling Distribution

School Gardening

Every school garden plays 7 beneficial roles for the studentslike Development of Values, Vocational Skill Development, Personal Development, Academic Skill Development, Social Skill Development, Life Skill Development and Physical Well Being. Their value system is developed as

they started to respect every living being even plants and pests. Their vocational skill on cultivation is developed through school gardening. Their mental health and personality are developed by spending time with green vegetables. Their academic skill on Mathematics, English, Life Science and Environmental Science is enriched through gardening. As they are working with friends and maintain the garden by co-operating each other, their social skill is also developed. Their life skill is also developed by observing plants' growth day by day which is necessary for maintaining life. Some physical exercises are also done through gardening and they become able to get organic healthy foods in their lunch. So, their physical well-being is also maintained.

The steps which are taken during School Gardening as follows:

i. Preparation of a Plan and Seeking Permission from the teachers
ii. Initiation of Class Discussion regarding School Garden
iii. Selection of Interested Students
iv. Finalization of Garden Space
v. Arranging compost, seeding materials etc.
vi. Preparation of Soil with Compost
vii. Plantation of Seeds with Students
viii. Regular Monitoring
ix. Irrigation, water management and organic manure application with Students
x. Integration of Subjects with School Garden
xi. Experience Sharing

The students takethe gardening activity very enthusiastically. There are 25 girls and 32 boys in Dakshin Mahendrapur F. P. School, 54 girls and 69 boys in Gayadham F. P. School, 32 girls and 22 boys in Dakshin Shibpur Netaji SSKM and 72 girls and 61 boys in Dakshin Gobindapur Narayanitala F. P. School, who actively participated in the activities under school gardening.

The vegetables which are cultivated in the school gardens, namely Tomato, Turnip, Small Fenugreek, Brinjal, Ipomoea, Radish, Coriander, Red Amaranth, Green Amaranth, Sweet Potato, Spinach, Chili, Beans, Okra and Beet. These 15 types of vegetables are cultivated in organic way. The students shared many positive feedbacks. They learnt about identity of vegetables, different ways of cultivation, eco-system of a vegetable garden and relation of cultivation following weather conditions. They also came to know about the changing climate and adaptation strategies which should be taken in agriculture. They also knew about role of green vegetation to reduce climate change. They also shared their experience with their parents and requested them to apply their learning in cultivation.

One of the Students said, "I have never imagined that a garden can teach us so many things. I am thankful to the organization."

5.2.4 Introduction of Integrated Farming System (IFS) in small agricultural businesses

Climate change has profoundly affected the environment as manifested in the vagaries of nature. It has also impacted agriculture and the natural resource base of the Earth.

It is need of the hour to cope with the devastating effects of climate change and the only options are to

adapt to it, lowering emission rate and increasing carbon sequestration through suitable land use and land use changes like afforestation.

Making agriculture climate smart through integrated approach is also an ideal solution to ensure the food security of the ever-increasing global population at a time when there are twin problems of land degradation and carbon emissions.

The integrated farming system is a combined approach aimed at efficient sustainable resource management for increased productivity in the cropping system.

It involves different components like trees, crops and livestock arranged spatially and temporarily over the same unit of land for the best utilisation of available resources. Various types of plants, livestock, mushroom, aquaculture and other aquatic flora and fauna are managed for maximum productivity in such a way that one complements the other. The waste generated from one component is recycled and used as a resource for the other.

It is asystem to protect and conserve land and water resources from depletion. In the state like West Bengal where majority of farmers holding less than one hectare of land and practicing subsistence farming, risks are heightened through mono cropping.

Becoming climate smarter

Integrated farming has immense potential to make farmer's climate smart through the cultivation of different crops on the same land and using farm resources sustainably:

- Integrated Farming System involves integrated resource management for maximum productivity.
- It also involves best utilisation of the growing space through the integrated farming approach.
- Nutritional and economic security is ensured for better health of the farm family as they get different fruits, cereals, vegetables, livestock products and cash crops from their own land. It boosts food security through local production and consumption and checks migration.
- This improves soil's physical and chemical properties, its nutrient status and biological components. Such interactive systems affect the microclimate and provide a strong base to good agricultural practices for increased productivity.

Climate Smart Farmers evolved due to Project Activity

89 farmers have converted their small farms into Integrated Farming System with the project support. They have five different sub-systems which are namely

- Upland Cultivation (Nutrition Garden)
- Lowland Cultivation (Paddy Cultivation & Relay Cropping)
- Aquaculture (Fish & Crab Cultivation)
- Livestock Rearing (Cow, Goat, Poultry & Duck Rearing)
- Organic Manure Preparation Unit (Vermi-composting Unit, Pitcher for Liquid manure preparation, Azolla Cultivation Unit, Bio-gas Oven etc.)

Figure 16 : Farm Design before Project Implementation

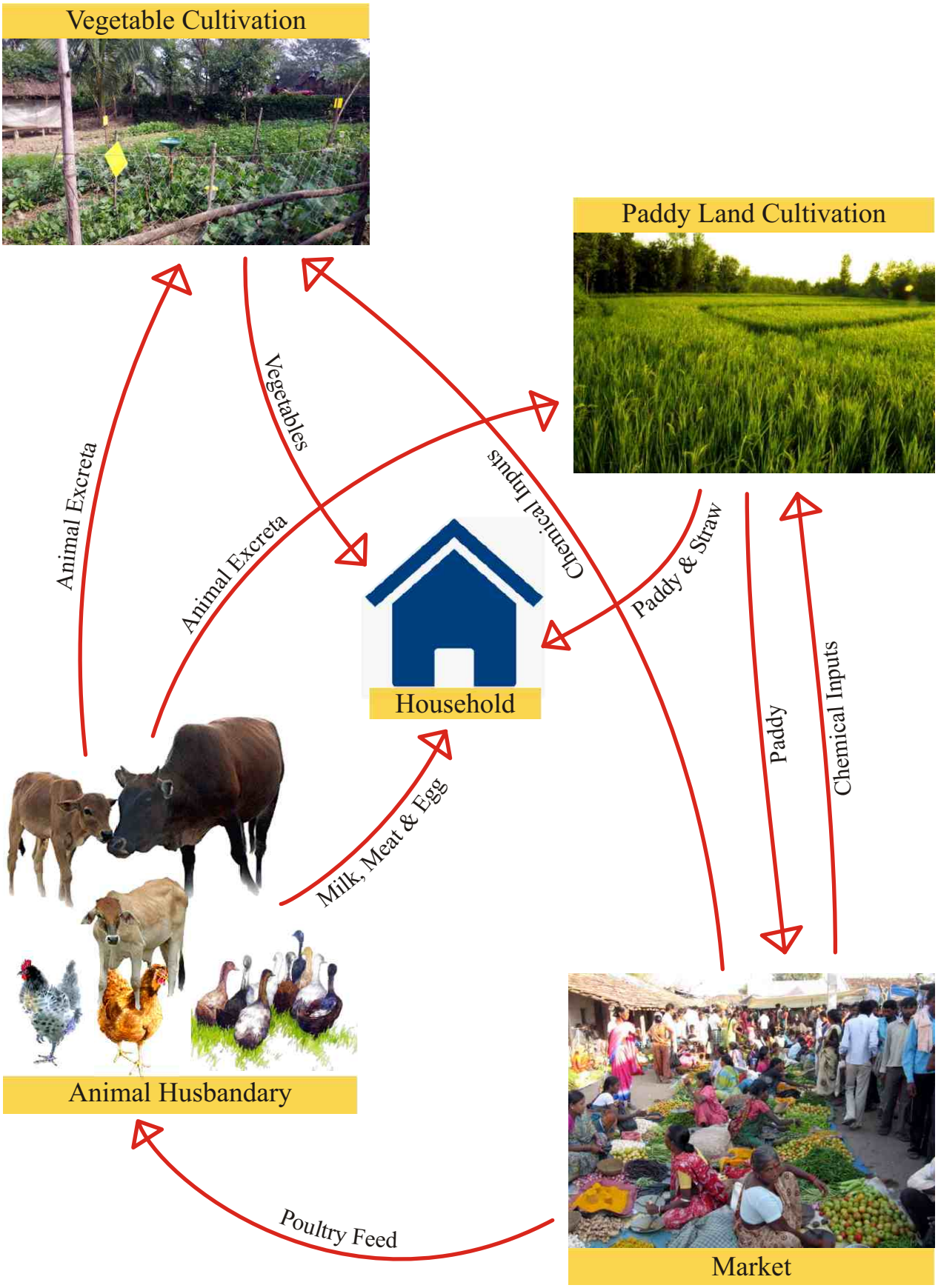
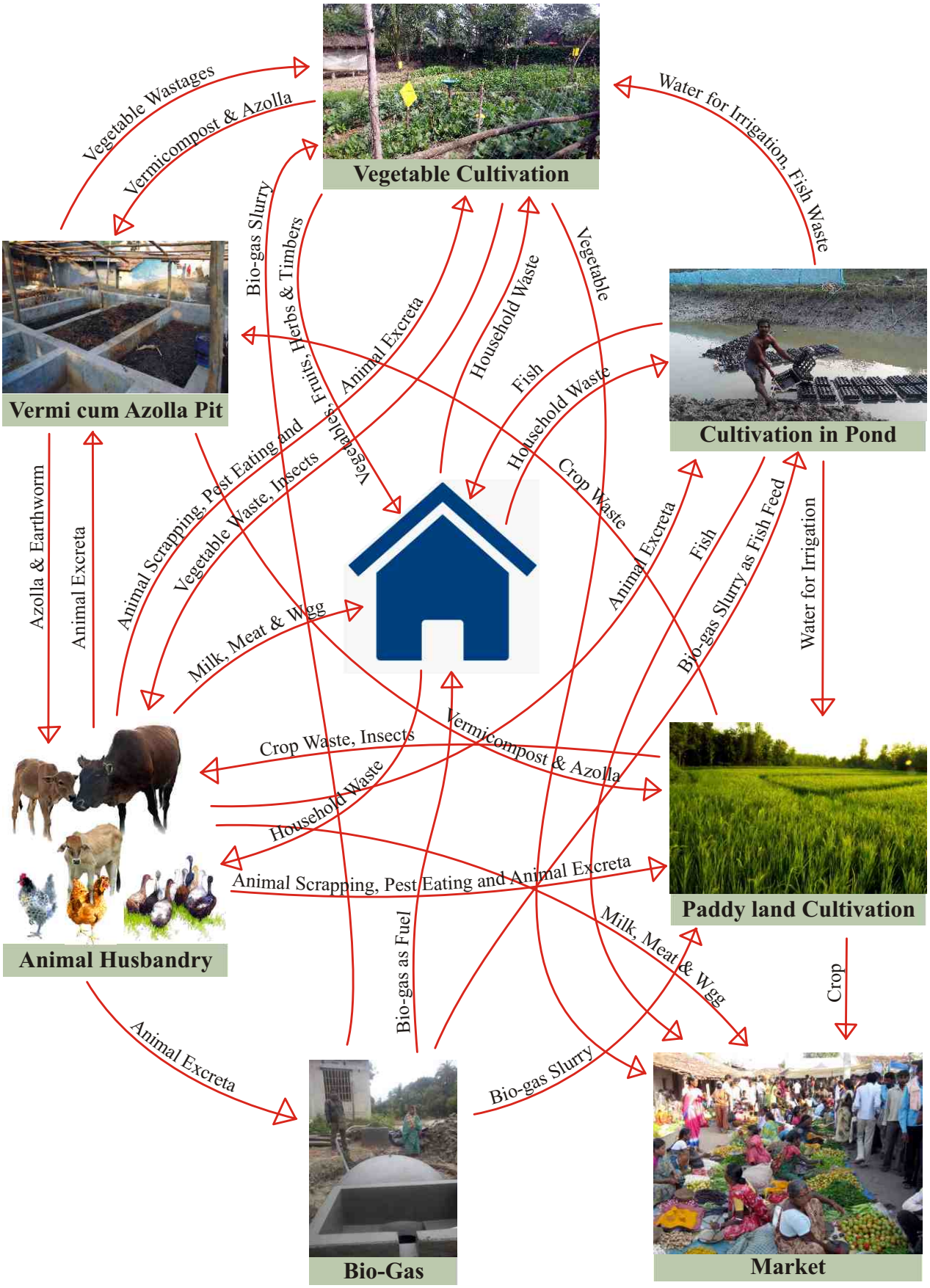


Figure 17 : Integrated Farming System Design after Project Implementation



5.2.4.1 Case Study 1: ShephaliKandar_A progressive Farmer

Shephali Kandaris a very hard-working farmer. Cultivation of land and sell of the agricultural product is the main livelihood of her family. They lived at Gobindapur village of Ramganga GP with her father-in-law, mother-in-law, husband, three daughters and a son. They mainly cultivated single crops and applied chemical fertilizers and pesticides in their field. Due to erratic rainfall and unstable temperature variance, their crops were failed. They were even unable to get the cost of cultivation from vegetable selling. Due to this, they were becoming poorer day by day. They used to use chemical fertilizers and pesticides and follow the single cropping technique. The cost of cultivation was very high. They usually got 400 kg of paddy by cultivating the land twice a year and 140 kg of vegetables from the upland for only 6 months in a year and 100 kg fishes from the pond.

In the meantime, the family came across with DRCSC and got several trainings and hand-holding support of climate adaptive agriculture during the year, 2018. In the next year, during April'18 they planned for an integrated farming system development. They took idea from DRCSC and implemented it on their 0.24 ha land. Within this land, upland is of 0.04 ha, low land of 0.13 ha and 0.07 ha of Pond respectively. They made a new drainage system and with this soil, the embankment of the low land is broadened. The small modification of the land increased its productivity. A rain water harvesting tank is built to store rain water and use it for irrigating crops of the upland during the dry-spells. A vermi-composting pit is also installed to prepare high quality organic input for cultivation. The half-decomposed household waste and crop waste are put into the pit. The earthworms ate the waste and formed the vermi-compost. Gradually the farm intensified its yields by more than two times by using the inter and intra-integrations of each sub-system. There are mainly three types of ecological systems, namely Upland Ecology, Lowland Ecology and Pond Ecology.

The upland ecology consists of vegetables and animals. The integration of vegetables and animals is such as the excreta of animals used as the plant-nutrient and vegetable wastages are used for animal feeding (intra-integration). The excreta of animals are also used as fish-feed and wastages of vegetables are also transformed into compost and used during lowland cultivation (inter-integration).

The lowland is mainly used for paddy cultivation during rainy season and relay cropping during winter season. During rainy season, it also helped in duck rearing and fish cultivation. Fishes are wandering in the paddy field and consumed the Zoo-plankton and Phyto-plankton of field and grew faster. Duck consumed small insects of the field. The pests of paddy field are consumed by them (intra-integration). The crop waste of lowland is used as plant nutrition in upland and crop-husk is used for fish feeding (inter-integration).

Pond water is used for fish cultivation and duck rearing. They feed on the available Zoo-plankton, Phyto-plankton, insects, snails etc. (intra-integration). The pond water is also used for irrigating crops cultivated at upland and lowland (inter-integration).

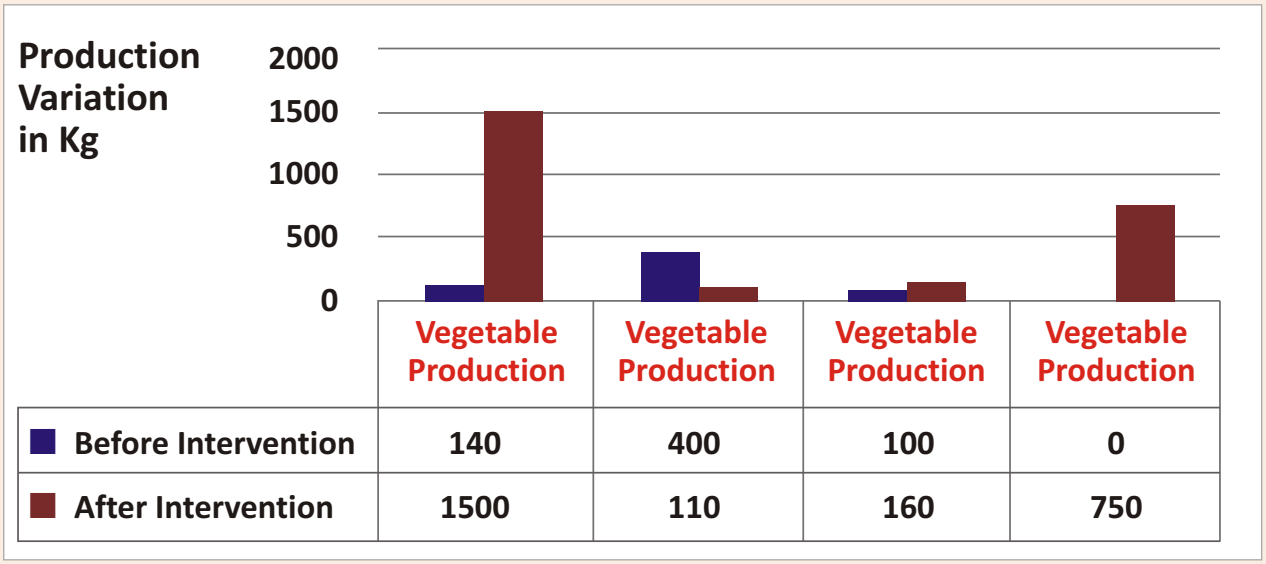
Some trees are planted at the boundary of upland cultivation. They are considered as living-fence. They play multiple roles. The leaves of the plants are used for preparing organic inputs. Its brunches

are used as fuel. They protect the vegetables from animal attack. They also give fruits to the family.

Even there were two super-cyclones in 2019 and 2020; they acquired an unbelievable success from this model using all the above-mentioned techniques. They cultivated vegetable varieties such as Amaranth, Ipomoea, Ceylon Spinach, Elephant foot Yam, Brinjal, Okra, Bitter gourd, Ridge gourd, Snake gourd, Cucumber, Pumpkin, Bottle gourd, Cowpea, Chili, Coriander, Beans, Beet, Carrot, Maize, Broad beans, Radish, Spinach. In this regard, it should be mentioned that they used to cultivate 5 to 6 varieties before the project intervention. They learned from the project activities that maximum varieties of crops should be cultivated to reduce the climate risk. In case, one variety is destroyed by the bad weather another might be survived. Some permanent trees are planted in their field namely drum stick, banana etc. There are some natural foods in their field like Water Spinach, Centinela, *Helencha* (Marsh Herb),*Kulekhera* (Long-Leaved Barleria) etc. They have produced 1.5 quintal vegetables in one year from the embankment and upland. They have got profit of Rs 15000/- from vegetable cultivation, Rs 13970/- from livestock rearing. They have also got 160 kg fish from pond and 112 kg paddy from low land. They have made profit of Rs 17600/- from fish and Rs 1064/- from the paddy. They have prepared more than 750 kg vermi-compost from the wastages and used it in cultivation.

Shephalididi shared, "We are very happy now by getting this farming system. We want to spread the knowledge among our neighbors, friends and relatives."

Figure 18 : Production Variation of Farming System after Implementation of the Project



5.2.4.2 Case Study 2: Smritikana Samanta_A Self-sustained Woman Farmer

Smritikanadidi and her husband are very much fond of rearing livestock and cultivating land. They live with their son and daughter. Though her husband is a para-teacher by profession, he invested most of his leisure time in cultivation. They first came across with the organic farming from a farmers' training arranged by Ramakrishna Mission through a local club. But they didn't get any full phased training. So, they were very keen to get in-depth knowledge of organic farming. They were also very much worried to know techniques which would help them in combatting ill-effects of climate-change. During that period, they were selected as the beneficiary of "Sundarbans Climate Adaptation Project" implemented by DRCSC. Smritikanadidi became a member of the Mutual Co-operation Group formed by the project personnel. They gradually came to know about some climate adaptive agricultural techniques and ecological farming methods through several training programs.

They requested the group members to provide the facility of integrated farming system development in their 0.2 ha agricultural land. The total land was a low land. They have dug a pond at a corner of the land in 0.05 ha and made upland and broadened the embankment of the land for cultivation with the




evacuated soil. They have got 0.05 ha upland for cultivation. The remaining 0.1 ha low land is used for paddy cultivation and relay cropping.

They also took help from the Govt. Sundarini project and made a large animal shelter. The entire animal droppings are processed and used as the input of cultivation. They have established bio-gas ovens by taking Govt. and NGO help. They don't use animal droppings directly; they use the entire amount in bio-gas oven and bio-gas slurry is used in cultivation. They also use bio-gas slurry as fish-feed.

Previously they used to get 6 sacks of paddy from this 0.2 ha land during rainy season and 50 kg Elephant Foot Yam during winter. Total monetary value of these crops was Rs 9200/-.

After project implementation, they have cultivated vegetables in upland and on the broad embankment in the whole year. The crops are namely Tomato, Okra, Beet, Carrot, Chili, Cowpea, Ivy gourd, Beans, Spinach, Radish, Small fenugreek, Turnip, Elephant foot Yam, Taro, Amaranth, Bitter gourd, Coriander, Brinjal, Ash gourd, Bottle gourd, Pumpkin, Ipomoea, Ceylon spinach, Cucumber, Ridge gourd, Snake gourd. They also cultivate paddy in the low-land during rainy season and Green gram, Potato, Onion during winter season. The total amount crop produce was 1872 kg in the previous year. They also got 231 pcs. of banana from banana plant. Total income from this crop was Rs 29189/-. They invested only Rs 5050/- for purchasing seeds, neem oil, purchasing fuel for irrigation, ploughing cost and engaging labour. The whole fertilizers for cultivation came from home-made compost and bio-gas slurry. During Bulbul and Amphan Cyclones, some crops were damaged. But they cultivated again and got this result. According to them, root and tuber crops and Banana, Papaya and Okra could be survived in the cyclone.

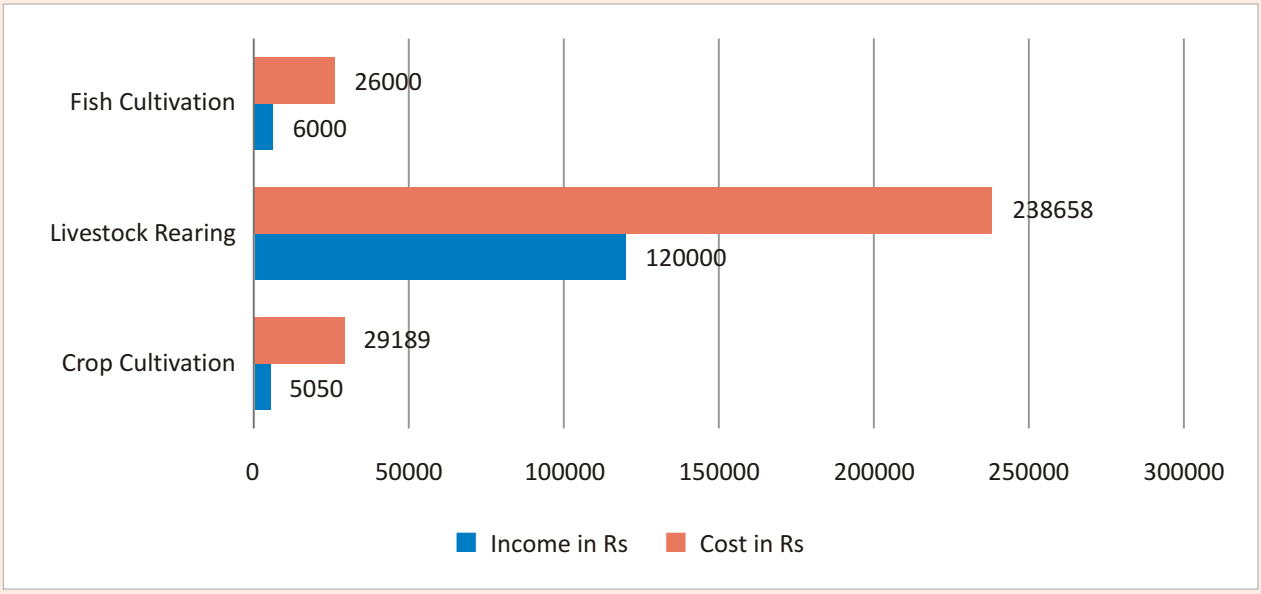
In their animal shelter, there are 4 adult cows and 4 calves, 4 adult goats and 9 calves and 18 poultries. The cost of livestock rearing is nearly Rs 120000/- in one year. They get a good return from the livestock. They got 300 quintal cow dung, 30 quintal goat litter and 2.5 quintal poultry litter in the previous year. They also sold livestock of Rs 46000/-. They sold milk of Rs 185000/-. They also got egg of Rs 7500/- and consumed 48 kg poultry meat.

They invested Rs 6000/- and cultivated *Magur, Rui, Katla, Mrigel, Telapia, Mourala, Pabda, Sol and Latha* fish in their pond and got total return of Rs 26000/-.

They also get some uncultivated crops from their field which are*Saur, Kulekhara, Shushni, Helencha* and also some fruit trees like Mango, Guava, Jackfruit and Indian Goose berry.

Smritikanadi shared, "We have only some fodder scarcities during May, August, September and October. There is no other problem in my farming system. There are many advantages of this system like there is less disease infestation in crops, cultivation system is viable in extreme weather condition, soil quality is improved (highly fertile and low salinity) and human disease is also reduced for consuming organic products."

Figure 19 : Cost versus Income of different sub-systems of the IFS



5.2.5 Nutrient Supply from Home-gardens

In order to counteract an unbalanced diet and malnutrition, vegetable gardens are cultivated at the household level. 1644 nos. of targeted households are given support to cultivate fruits, vegetables and herbs. The supports are like seeding material of fertile and nutrient-rich varieties, organic fertilizer and organic insecticides. In order to make the best possible use of the limited space, such plants are chosen that thrive in different horizontal levels and have different light requirements. The diversity of species also ensured a diverse and nutrient-rich harvest over the year. 72 nos. of model nutrition gardens are also established in the field area to motivate people and set examples of climate adaptive gardens in front the beneficiaries.

There are six different categories of crops in this nutrition garden. First category is leafy vegetables. The vegetables under this category are Small Fenugreek, Ipomoea, Spinach, Green Amaranth, Red Amaranth, Sour Sorrel, Ceylon Spinach etc. Second Category is fruit vegetables like Brinjal, Okra, Ridge gourd, Snake gourd, Bitter gourd, Bottle gourd, Ash gourd, Pumpkin, Tomato, Maize, Cucumber, Ivy gourd, Turnip etc. Third Category is leguminous vegetables like Broad Beans, Cow pea, Beans, Velvet Bean, Winged Bean, Pigeon Pea, Black Gram, Green Gram, Yard Long Beans etc. Fourth Category is Root and Tuber Crops. Yam, Elephant Foot Yam, Potato, Carrot, Taro, Beet etc. are under this category. Fifth Category is Spices which are like Chili, Ginger, Turmeric, Onion, Mustard, Coriander etc. Sixth category are those plants which are cultivated due to their medicinal benefits. These plants are like Basil, Aloe vera, Marigold, Water hyssop, Periwinkle, Green Chiretta, Bone-setter plant, Stink vine etc.

There are three types of plants:i) Perennial plants like Lemon, Guava, Drum stick etc. ii) Semi-perennial plants like Papaya, Banana, Ivy gourd etc. and iii) Seasonal crops like Chili, Brinjal, Cow pea etc.

16 nos.of local wild plants typically gathered by the local population within their environment are also cultivated as they have a particularly high nutritional content and are very resilient and only require little care. These wild plants are namely *Thankuni, Helencha, Punjabi Palang, Katoa Danta, Kulekhara, Gime, Chikni, Madranga, Telakucha, Brahmi, MechiShak, Gandal,* Water Spinach, Wild Amaranth, Sweet Potato and Wild Jute.

Figure 20 **:** Design of a Kitchen Garden before Project Implementation

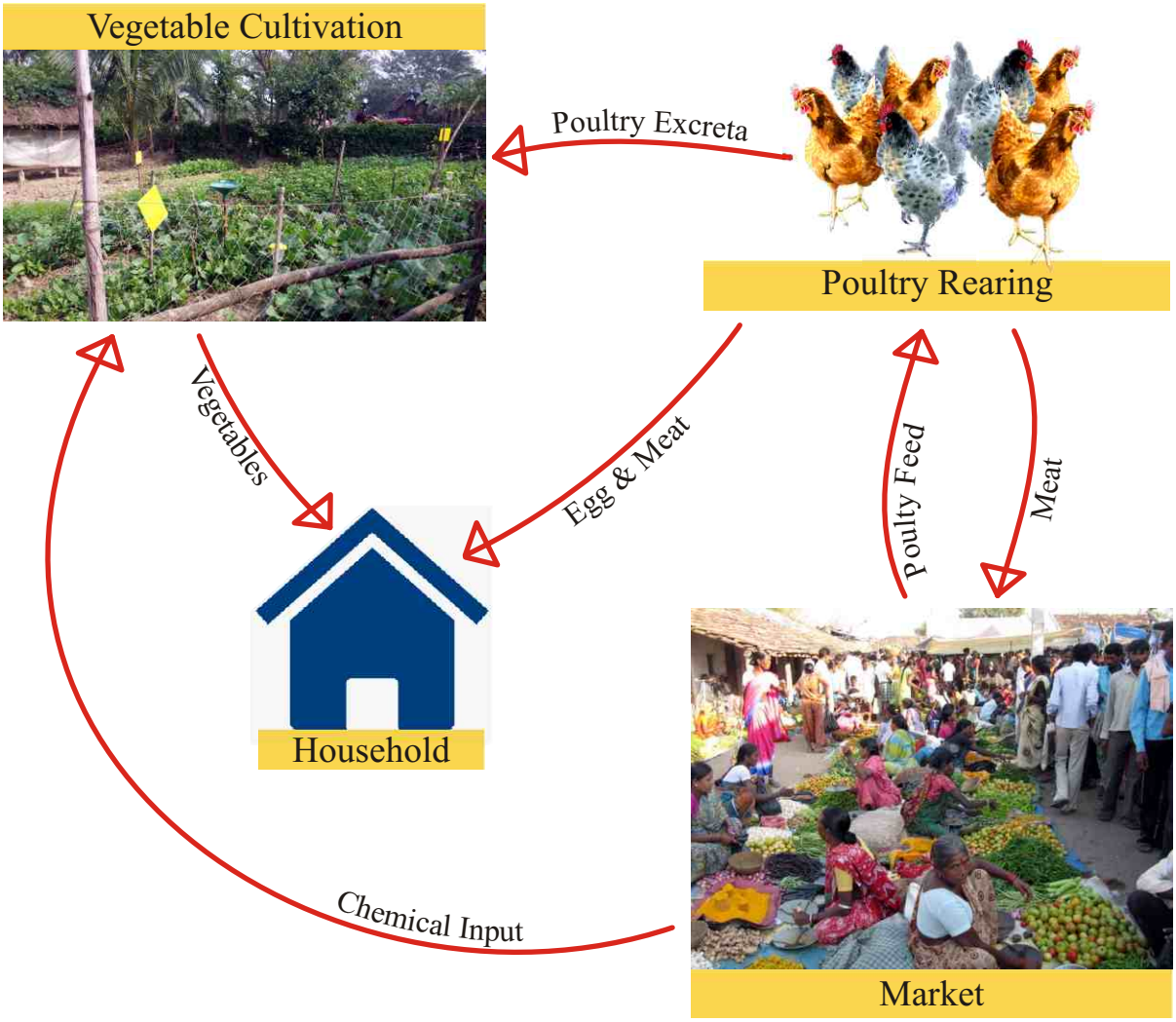
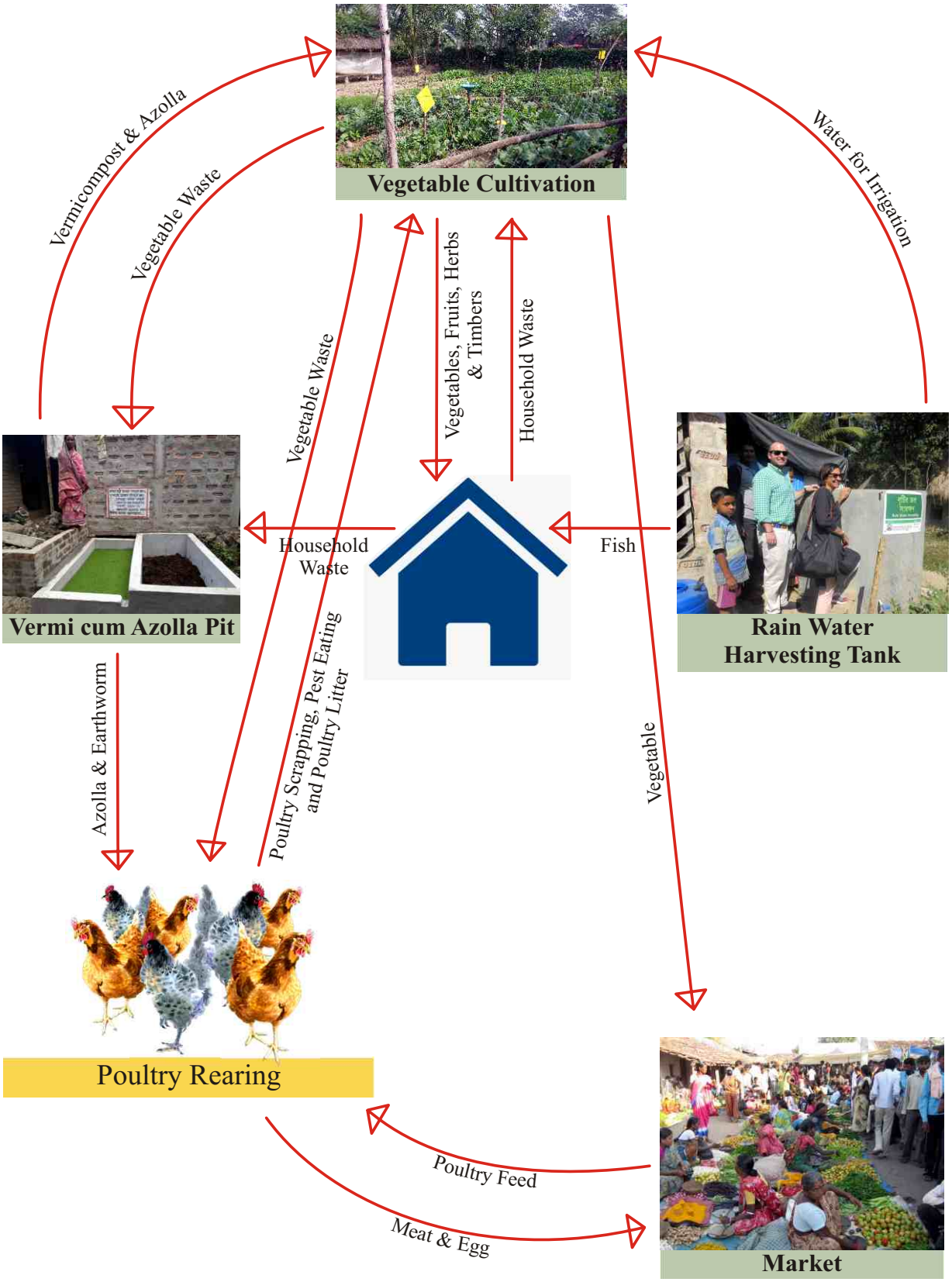


Figure 21 : Design of a Model Nutrition Garden after Project Implementation



There are four sub-systems in every model vegetable garden namely:

a) Vegetable Garden
b) Poultry House
c) Vermicompost cum Azolla Production Unit
d) Rain Water Harvesting Tanks

The idea is to prepare a poultry house at the middle portion of the garden. One half of the land will be cultivated in a season and the other half will be opened for the grazing of the poultry. In the next season, the bare land will be fertile with the scrapping of poultry and the decomposition of poultry litter. In that season, the previously bare land will be cultivated and the other half will be free for the poultry. Some mulberry cuttings have been cultivated along the boundary for poultry feeding and some creeper vegetables will be cultivated outside the boundary to make the grazing land shadowy.

5.2.5.1 Case Study 1: Garden as a Guardian

Rina Bhunia is a courageous lady. She is living only with her younger daughter. She reads in class IX. Her husband died 8 years ago and elder daughter got married just after 6 months of her husband's death. She worked hard to bring up her younger daughter carefully. She cultivated land and bearing all the household expenses. She used to practice single cropping and chemical farming. She cultivated 2-3 types of vegetables at a time. She was unable to cultivate her garden for the whole year round due to scarcity of water. Moreover, her crops failed due to changing climate and she was very upset due to this. They were unable to get sufficient amount of nutritious food from garden due to less yield as well as from market as their income was very low.

At the meantime, she came across with the Sundarbans Climate Adaptive Project implemented by DRCSC and became interested to join as a beneficiary. After becoming a beneficiary of SCA project, she got several training on climate adaptive agriculture. After getting training, she has made an integrated nutrition garden on 4th November, 2018.

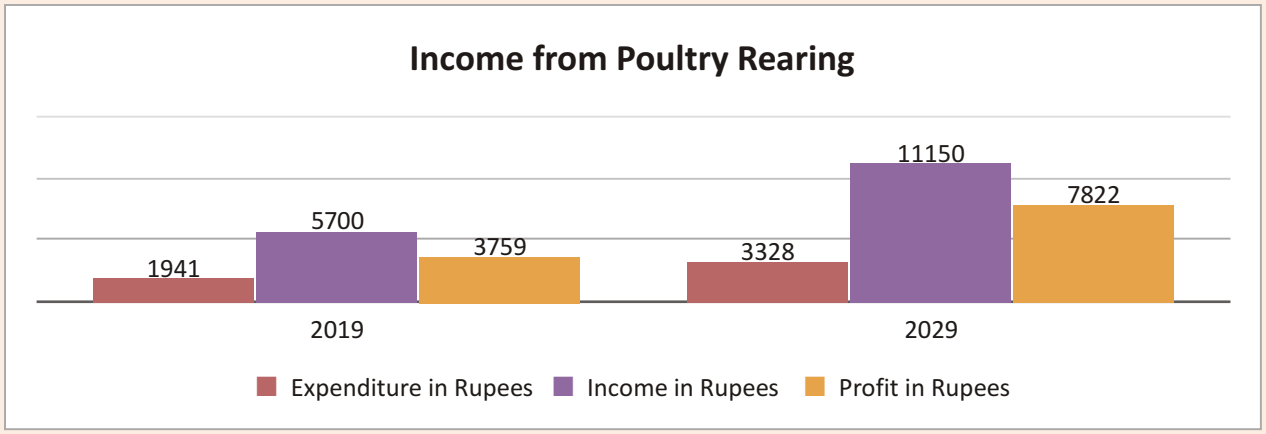
Integrated Nutrition Garden (ING) has replaced the existing single cropped kitchen garden. With this ING, she has utilized front, backyard and the open space within their homestead to grow some nutrient reach vegetables, fruits etc. through recycling of household waste, grey water etc. and cultivate indigenous poultry in a symbiosis method. Poultry eats wastages of leafy & fruit vegetables and poultry litter is used for growing vegetables. She cultivates one half of the land in a season and the other half is opened for the grazing of the poultry. In the next season, the bare land becomes fertile with the scrapping of poultry and the decomposition of poultry litter. In that season, the previously bare land is cultivated and the other half kept free for the poultry. Some mulberry cuttings are cultivated along the boundary for poultry feeding and some creeper vegetables are cultivated outside the boundary to make the grazing land shadowy. She and her daughter consume at least 450 gm of green vegetables/ fresh fruits every day round the year and get some animal protein by consuming poultry meat and eggs. They also get some income from this semi-structured poultry farming.

During 2018, she cultivated Spinach, Amaranth, Ipomoea, Small fenugreek, Tomato, Brinjal, Cowpea, Beans, Okra, Coriander and Pumpkin at a time in mixed farming technique and got 70.5 kg

vegetables yield. In the whole year of 2019, she cultivated Ipomoea, Ivy gourd, Ridge gourd, Pumpkin, Ceylon spinach, Okra, Elephant foot Yam, Brinjal, Chili, Cowpea, Amaranth, Carrot, Radish, Spinach, Turnip, Bottle gourd, Beet and Coriander. The total vegetable yield was 168.6 kg. In the year 2020, 49.8 kg from Pumpkin, Ridge gourd, Ipomoea, Cowpea, Cucumber, Ceylon spinach, Ivy gourd, Okra, Brinjal, Bitter gourd, Spinach, Red Amaranth, Green Amaranth, Coriander and Radish. Some crops were damaged due to Amphan Super-cyclone. But she got some yield due to its climate adaptive farming system whereas her neighbours didn't get any yield after the hit of Amphan. She irrigates her field during dry-spells and at the summer season by using water from the rain water harvesting tanks.

She started poultry cultivation with 20 nos. of poultry. 1 died in disease but 13 pcs. of them were sold in market and other 6 pcs were consumed respectively. Total weight of the poultry was 52 kg and monetary valuewas Rs 5700/-. Whereas her cost of cultivation was Rs 1941/-. Thereafter she again cultivated 30 pcs of poultry by investing Rs 3328/- and got total income of Rs 11150/-. They didn't buy any vegetables from market during 2018 and 2019 as their produced vegetables were sufficient for them. Though they didn't get sufficient vegetables in 2020, they bought from market with their profit. She shared, "This garden has become our guardian. It not only gives us nutritious food, but also gives us some income. I spent my maximum time in gardening which gives me an eternal mental peace."

Figure 22 : Yearly Expenditure, Income & Profit from Poultry Rearing in Model NG



5.2.5.2 Case Study 2: Comparative Study of Five Model Nutrition Gardens:

The five farmers from five different villages of the project area are selected for this study. These five farmers are Palashi Paikara from Indraprastha village, Jharna Pramanik from Ramganga village, Borna Das from Dakshin Gobindapur village, Shephali Kandar, Uma Dakua from Sagarmadhabpur Village.

The vegetables which are cultivated in these gardens like Red Amaranth, Radish, Spinach, Small Fenugreek, Green Amaranth, Coriander, Brinjal, Okra, Tomato, Turnip, Carrot, Beet, Beans, String Beans, Broad Beans, Pumpkin, Bottle gourd, Chili, Bitter gourd. The vegetables are chosen because they are nutritious, draught and heat tolerant, fairly tolerant against pest and disease, propagation material/seed can be saved.

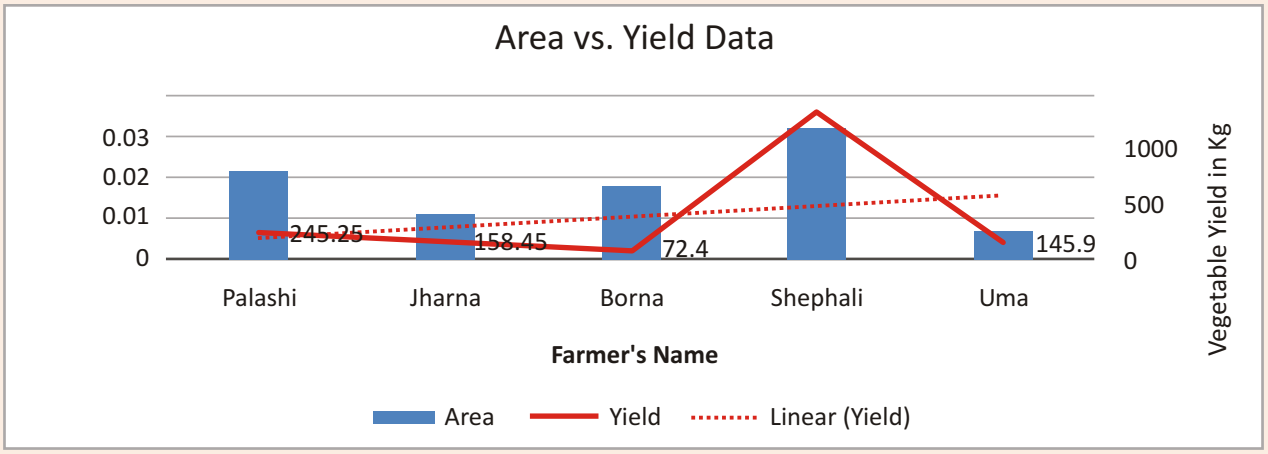
Table 4 : Comparison of Vegetable Yield of Five Model Gardens

Name of Beneficiary	Area of the Garden (in Acre)	Yield from Vegetable Cultivation (in kg)	Amount of Vegetable used for self-consumption (in kg)	Amount of Vegetable distributed (in kg)	Amount of Vegetable Sold (in kg)
Palashi Paikara	0.022	245.25	129.5	2.75	113
Jharna Pramanik	0.011	158.45	93.9	12.35	52.2
Borna Das	0.018	72.4	40.9	3.5	28
Shephali Kandar	0.032	1368.5	78.5	2	1288
Uma Dakua	0.007	145.9	119.4	26.5	0

*The duration of activity is 7 months.

All the families said that they stopped buying vegetables from the market. Some of them are also selling the extra vegetables locally, the money from which is saved to meet various household expenditures. With this money, they bought those vegetables which are not available in their field such as pointed gourd, cabbage, cauliflower etc. and oil, salt, spices etc.

Figure 23 : Area vs. Yield Data of Five Model Nutrition Gardens



The yields of vegetables differ due to the difference in irrigation, nutrient management and pest management practices. From the overall table, it is proved that this model is successful for providing sufficient amount of vegetable. Taking average of the above data, it can be said that, on an average, 1990.5 kg of vegetables can be produced from 0.09 acre of Model Nutrition Garden in 7 months (June to December).

It can be concluded that, if a family has 6 members consisting 4 adults and 2 children and has 0.010 acre of land (around 436 sq. ft.), it can produce required quantity of vegetables easily.

[**The required amount of food for 4 adults and 2 children for 6 months: 189 kg

The required quantity of vegetables for adult	=	200 gms per day per person
The required quantity of vegetables for child	=	125 gms per day per person
Per day requirement of 4 adults and 2 children	=	(4*200) + (2*125)
	=	1050 gms
Requirement of Vegetables for 7 months	=	210*1050
	=	220500 gms
	=	220.5 kg

From the above table, 0.09 acre of land is required to produce 1990.5 kg of vegetables.

So, to produce 220.5 kg of vegetable, 0.010 acre of land is required.]

Vegetable wastes are used for producing vermicompost. The vermicompost and azolla produced in the pit are used for vegetable cultivation and poultry feeding respectively.

Table 5 : Comparison of production from Vermi cum Azolla Pit in five Model NGs

Name of Beneficiary	Volume of the Vermi-compost Pit (in cubic-ft)	Volume of the Azolla Pit (in cubic-ft)	Yield from Vermi-compost pit (in kg)	Yield from Azolla pit (in kg)
PalashiPaikara	27 (6ft*3ft*1.5ft)	18 (6ft*3ft*1ft)	120	0
JharnaPramanik			116	19.5
Borna Das			114	15.5
ShephaliKandar			60	5
Uma Dakua			89	28

Taking average of the data described in the above table, it is cleared that 99.8 kg Vermi-compost can be produced from a 27 cubic-ft compost pit & 13.6 kg Azolla can be produced from an 18 cubic-ftAzolla pit in 5 months. The required area for the Vermi cum Azolla pit is 36 sq-ft. As it is the first-time experience, some of the beneficiaries are unable to give sufficient amount of feed for Earthworm and could not grow Azolla properly. Their skill is now developed after the practical experience.

Table 6 : Comparison of use of Rain Water Harvesting Tanks in five Model NGs

Name of Beneficiary	Volume of the Tank (in cubic-ft)	Water holding (in litre)	Use of Water (in litre)	Yield from Fish (in kg)
Palashi Paikara	98.2	2781	2200	3.9
Jharna Pramanik			1500	6.7
Borna Das			1000	0
Shephali Kandar			8000	0
Uma Dakua			6900	4.8

The tank is mainly built to harvest rain water and use it during the dry spells. Due to climate change, the nature of rainfall has become erratic. So, to make highest use of this erratic rainfall, rain water harvesting tanks are necessary to be installed. Some of the beneficiaries used the water of the tank by supplying water from the pond. But all of them agreed that this is useful for irrigation of the Nutrition Garden. Some of them are unable to cultivate fish into it due to lack of skill. But they are taking initiative to make it successful in the next season.

Table 7 : Comparison of production of Poultry Rearing in five Model NGs

Name of Beneficiary	Batch No.	No. of Chicks introduced	Mortality	No. of Egg	Total Weight of Poultry (in kg)	Total Weight of Poultry Litter (in kg)
PalashiPaikara	1	20	8	0	28	60
JharnaPramanik	1	50	10	0	130	62
	2	30	4		42.8	40
Borna Das	1	20	1	0	33.2	40
ShephaliKandar	1	20	2	47	36.6	45
Uma Dakua	1	20	6	0	28	60

The farmer who rotated the poultry cultivation more times got more yield. Poultry litter is used for vegetable cultivation. The following table showed the result.

The comparative study has proved that this model is able to provide a huge quantity of vegetable and animal protein to the beneficiary household.




5.2.6 Crab Cultivation_An Alternative Income Source

Crabs are mainly grown in the saline water of rivers in the Sundarbans area. But it can also be a very good income source of the Sundarbans dwellers. It is proved by the project activity under Sundarbans Climate Adaptation Project. Due to the effect of climate change, the salinity of each water source of Sundarbans has been increased. Taking advantage of this change, the project personnel of DRCSC suggested the beneficiaries to cultivate crab in their individual pond along with the fish maintaining some scientific techniques. They not only benefitted by consuming it but also earn money by selling it. 24 nos. of beneficiaries are supported with protective nets and 10 nos. of beneficiaries are supported with crab fattening boxes for crab cultivation.

5.2.6.1 Case Study 1: Crab_Acting as a source of Nutrition for Pregnant Woman

Jharna Giri Berais one of the villagers of Sagarmadhabpur village. She has taken initiative to find whether crab cultivation at individual pond is useful or not, with the help of Sundarbans Climate Adaptation Project. She has a 65ft X 65ft pond. Depth of this pond is 8.5 ft. She lives with her husband, a daughter and a son.

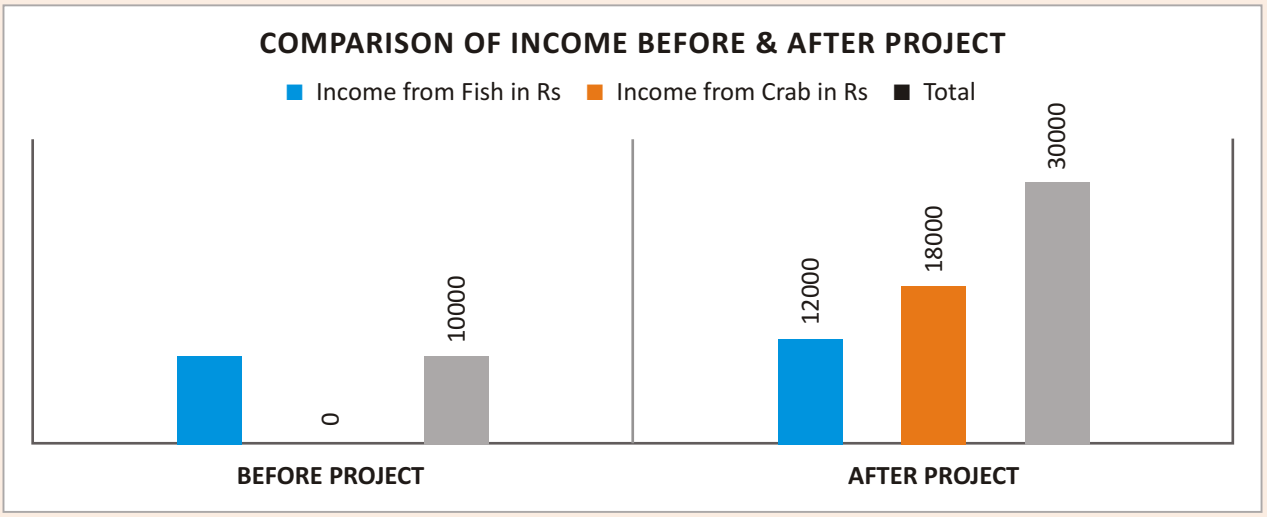
She used to cultivate fish only in her pond. She earned Rs 10000/- by selling fishes during March'2018. She became a beneficiary of Sundarbans Climate Adaptation project during July'2018. In the next month, she has taken support of 84 metre nylon net to surround her pond and bought 100 pcs of small crabs from the neighbouring fish & crab collectors (from river). After that she has observed that crabs are growing very fast in her pond. During this period, she was pregnant and had vomiting tendency to eat any food. But she was able to eat crab. So, she started to eat crabs every day. She and her husband started to catch crabs from nearby creek. They got more than 300 pcs.of small crabs from it and put it into their pond to grow. She shared that she had consumed crabs of worth Rs 10000/- during this period. They also sold crabs of Rs 4000/-. After that they made the pond dried during March'20 and got fishes of worth Rs 12000/- and crab of worth Rs 4000/-. They invested only Rs 500/- for feeding them. So, their income from the pond became two times more. On 20th May, 2020

the devastating super-cyclone, Amphan hit their land. Saline water enters into their pond, but it couldn't do any harm to the crabs.

The multi-species cultivation in the pond has not only made greater income, it has also proved its viability even after salt water flood. Jharnadi is very happy by getting this knowledge support and technical guidance. She wants to continue it in the future also and suggested the neighbouring farmers to take this method as their alternative income source.

She has invested her profit in land shaping and crop cultivation and made her plot as an Integrated Farming system model.

Figure 24 : Comparison of Income from Pond before and after Project



5.2.6.2 Case Study 2 : Crab Fattening_ a Source of Income to Housewife

Under the Sundarbans climate adaptive project, several climate adaptive models are formed crab fattening in floating box is one of them. The boxes are floated by the pipe and one crab is reared in each box. There are several problems in open crab cultivation. First of all, every crab goes in between moulting phases, 3 times in a year after attaining morphometric maturity. During the moulting phase, it becomes very soft and weak. If any hard crab can find it, it can be consumed. Another problem is flood which occurred very frequently in this area due to climate change. During flood, crabs are drowned into another place and a vast economical problem is occurred. As the boxes are floating, it can be raised with the raise in water level.

Suparna Das is a housewife and lived in Sagarmadhabpur village of Ramganga G.P. in South 24 Parganas district just beside the Gobadiariver. She lives with her husband and only son. Except their

home, they have only a pond of 2 decimal area. They used to get Rs 2100/- per annum from fish cultivation. She and her husband Shrimanta used to catch fish and crab from the nearby river. All crabs were not marketable due to its shape & size. So, they used to get very less amount of money from market. After becoming beneficiary of Sundarbans Climate Adaptation Project, Suparnadidi has taken training and exposure on crab fattening. She is very much interested to implement it in her pond. So, she has started with 50 boxes. They use to sell the marketable crabs after catching it from river using their homemade crab catching machine. All the grade C crabs are poured into the boxes. She uses to feed the crabs with small fish and dry fish. Within 3 months, she has sold 100 nos. of well grown crabs and earned Rs 8577/-. So, there is ample scope of much more income throughout the year.

She has faced some problems during summer days (two months when pond water was very less) and market problem during COVID lockdown situation. But she is so much interested in this activity that she is interested to continue it further.

5.2.7 Livestock Rearing_ an Income Opportunity for Landless People

Landless people are the most vulnerable segment among Sundarbans dwellers. Their condition has become more vulnerable due to climate change. As the crop failure is increased and also input cost of cultivation increased, the land owners are not taking any agricultural labourers for cultivation of lands. So, the landless people are losing their income opportunity.

When they are finding their income opportunity, project personnel offered them to take livestock rearing as an alternative income source. Some climate adaptive technologies are taken under the livestock rearing. Such as shed is made properly so that domestic animals and birds can be saved from the heavy rainfall or temperature extremities. The breeds are so chosen that they could be survived in the changing climate. Their food habit is also made considering the changing climate. 500 beneficiaries are supported with livestock (small birds and ruminants) for cultivation.

5.2.7.1 Case Study 1: From a Goat Farmer to a Business Woman

The dwellers of Sundarbans are fighting for their existence from years ago. Praneta Das is a great example of a fighter. She is dwelling at the river bank of Gobindapur village at Ramganga GP. She has only the homestead to dwell. Her husband is a daily-labour. But he couldn't bear all the household expenses. Pranetadidi learned tailoring so that she could earn money for her family. In the meantime, she is chosen as a beneficiary of Sundarban Climate Adaptation project. She has made a mutual co-operation group with other 10 women. The name of her group is *Sabuj Sathi Swanirvar Dal-1*. She learned how to cultivate fallow land of homestead from this project. Then she started cultivation and produced vegetables and potato from her small upland. Her group members selected her for livestock rearing. She was supported with Rs 3000/- for goat rearing on 5th December, 2018. She bought two

female Black Bengal goats with this money. She made a small goat shelter beside the cattle house by her own. It cost nearly Rs 1000/-. After 6 months, one goat gave 3 babies and another gave two. Out of 3 babies, one died due to low birth weight. After two months, she sold all the four babies with Rs 4950/- as her goat shelter is very small. The female goat which had given birth to three babies gave 2 babies again in 6 months interval. Again, she sold them with Rs 1400/-. She didn't spend a single penny of goat selling for household expenses. Moreover, she took some money from her husband and made a small shop in the river side. She has started to sell tea, betel vine and other grocery items. Depending on the demand, she has started to sell different food items during afternoon. Her shop is going very well. Her daughter is going to nearby college. The two female goats have again given birth to 4 babies. One is crossed with *Patnai* variety to have a test whether it is profitable or not. So, she has 6 nos. of goats, two are *Patnai* and black Bengal crossed and 4 others are purely Black Bengal. In her own words, "I have invested only Rs 500/- for their medical purpose and they have given me 10 nos. of children in 1.5 years. I am very grateful to project personnel who have given me better chance to continue my livelihood. My family members are also very happy now for greater income opportunity."

5.2.7.2 Case Study 2 : Cultivator to Producer of Chicks

Rekharani Kamila is a marginal farmer, dwelling at Debichak village of Ramganga GP. She has been selected as a beneficiary of Sundarbans Climate Adaptation Project since April, 2018. Due to her less land-holding, she was supported with indigenous poultry so that she took it as an alternative livelihood option. Initially, the project supported her with 21 nos. of chicks during March, 2019. She also bought 10 more chicks by her own. Total worth of 31 chicks were Rs 1550/-. She made a poultry shed with Rs 3000/- with the project support. Unfortunately, 6 nos. of chicks died due to chicken pox. Out of 25 remaining chicks, 7 were

male and 18 were female. Rekhadi uses market food for the 0 to 1-month aged chicks. After that she uses wheat, paddy, wheat flour, paddy husk and boiled rice to feed poultry. Though paddy, paddy husk and rice are from her own field, she buys market food, wheat and wheat flour. She invested Rs 9880/- for feeding poultry in last year. She uses the female poultry for giving birth to new chicks in indigenous process. 5 nos. of male chicks were sold after one year. She got Rs 1350/- from this selling. Her family members consumed 6 nos. of poultry of worth Rs 1296/-. She got 1440 nos. of eggs from females. Market value of eggs was Rs 7200/-. She also got 180 nos. of new chicks from them. She sold 150 nos. of chicks with Rs 7500/-. 30 more nos. of chicks have been reared by her at home. She has also kept 12 nos. of female and 2 nos. of male for further chick production. Worth of poultry in stock is Rs 6480/-. Moreover, she has got a vast amount of poultry litter which has been used for vegetable cultivation and poultry cultivation. Rekhadidi shared, "I am very much benefited with this poultry rearing. Neighbors have learned the value of indigenous variety. So, the demand of chicks is very high. My son has become interested about poultry rearing and he has started commercial poultry rearing. We are also able to impress our relatives by feeding them indigenous chicken meat. The plenty availability of organic matter has also increased our vegetable and paddy production."

5.2.8 Seed Bank for the Cultivators

Not only money can be transacted in Banks, seed can also be transacted like bank. Sundarbans Climate Adaptation project has proved it with its activities. The beneficiaries are divided into 140

groups. 56 nos. of groups are supported with a rack and some containers to save and inter-lend seeds among the members. After every agriculture season they preserve seeds into it like a bank. Again, they lend seeds from it when a particular agricultural season starts. This rotation goes on 3 times in a year. 56 nos. of group-based seed banks and 4 nos. of community-based seed banks are established in the project area. Each group has the access to the community-based seed banks. The community seed banks get a considerable income by selling indigenous seeds.

5.2.8.1 Case Study: Seed Banking by PrachestaMahila Dal

Prachesta Mahila Dal is one of the 140 MCGs under Sundarbans Climate Adaptation project. There are 13 members in this group. They started their seed preservation during winter season in 2018. They started with preserving seeds of 50g Broad beans, 25g Beans, 10g Amaranth, 150g Spinach, 30g Okra, 40g Cowpea, 150g Ceylon spinach and 25g Coriander in that winter season. There after they again preserve seeds in every Summer, Rainy and Winter season. During winter season in 2019, they cultivated their land by taking seeds

from the project. But, the super-cyclone, Bulbul hit the project area in November, 2019 and most of the seeds got damaged in the heavy rain during this cyclone. So, they became very upset. But they got seeds immediately from the bank and cultivated their land again within 15 days after the cyclone and they got a very good yield. They also provided some seeds to their neighbors so that they could also cultivate and got nutrition as early as possible. So, the bank not only saves the group members during natural disaster but it has also done some social work.

In the year 2020, the group members also have sold some seeds from their seed bank. They have sold seeds of 625g Cowpea, 75g Beans, 275g Amaranth and 2 kg Spinach and have earned Rs 761/-.

5.2.9 Zero energy Cold storage:

Commonly cold storage needs a power supply to keep perishable things fresh. But there are two problems with that power supplied cold storage. First of all, the cost of cold storage is very high and the running cost is needed for power supply. Secondly, the power generating source may occur some pollution which has an ill-effect on environment as well as on climate.

So, the project personnel have found out some techniques so that the excessive vegetables could be stored into a cold storage. But it should be made with minimum cost and no power source will be needed. It is named as Zero energy Cold storage. The cold storage is made of brick. There are two walls in 6 inches gap and the gap area is filled with sand. The lid is made of thermocol and straw so that temperature isolation could be made with the inner environment and outer environment. To cool the inner environment, water should be given in the sand layer every day. 5 nos. of such zero-energy cold storage are established in the field area. 2 farmers are regularly using it. Their quantity of excess vegetables is so much that they can sell the vegetables in the village 'hat' (arranged twice in a week). The vegetables which are remained unsold in a 'hat' are stored in the cold storage and sold in the next 'hat'.

5.2.9.1 Case Study : Comparative study among three Cold Storages

The effectiveness of Cold storage is examined by comparing the results of three cold storages during 21st to 24th September, 2020 in rainy season. The atmospheric moisture at that time is in between 95% to 99%. There are excess vegetables in the household. But they are not able to keep it fresh at home. The project personnel have tried to find whether it will remain good in the zero-energy cold storage or not. They have studied it with four vegetables namely Ceylon spinach, Brinjal, Ipomoea and Bitter gourd. 500g of each vegetable are kept inside the cold storage and out of the cold storage.

Table 8 : Weight variance of vegetables in different cold storages

Name of Vegetable	Day	Out of the Cold storage	Weight in Cold storage-1	Weight in Cold storage-2	Weight in Cold storage-3
Ceylon spinach	3 day after putting vegetable	458g	460g	487g	488g
Brinjal		475g	475g	487.5g	498g
Ipomoea		421g	462.5g	475g	499g
Bitter gourd		450g	462.5g	475g	487.5g
Ceylon spinach	6 day after putting vegetable	383g	385g	400g	450g
Brinjal		133g	135g	250g	145g
Ipomoea		Rotten	100g	125g	150g
Bitter gourd		142g	150g	144g	275g

Figure 25 : Comparison of Weight variance of Leafy Vegetables

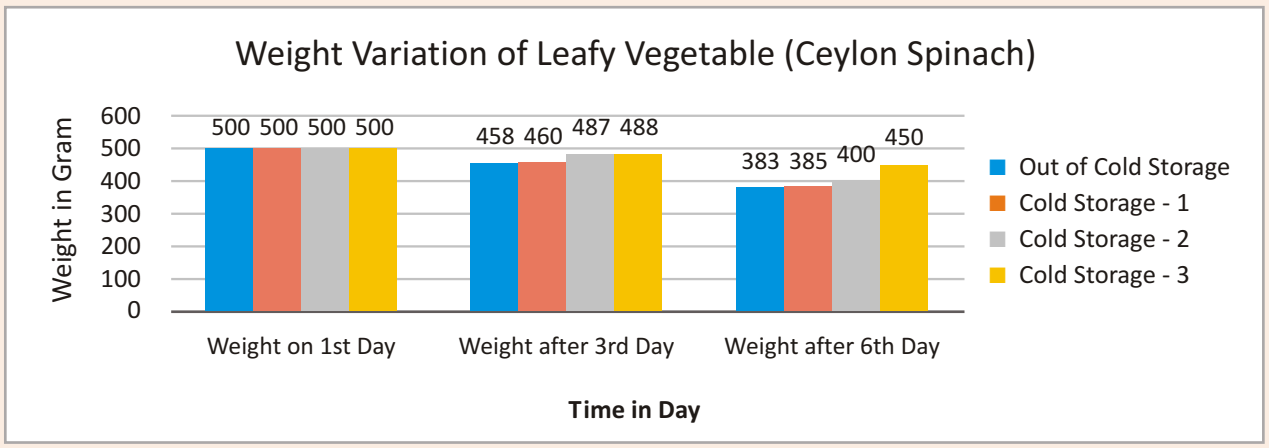


Figure 26 : Comparison of Weight variance of Fruit Vegetables

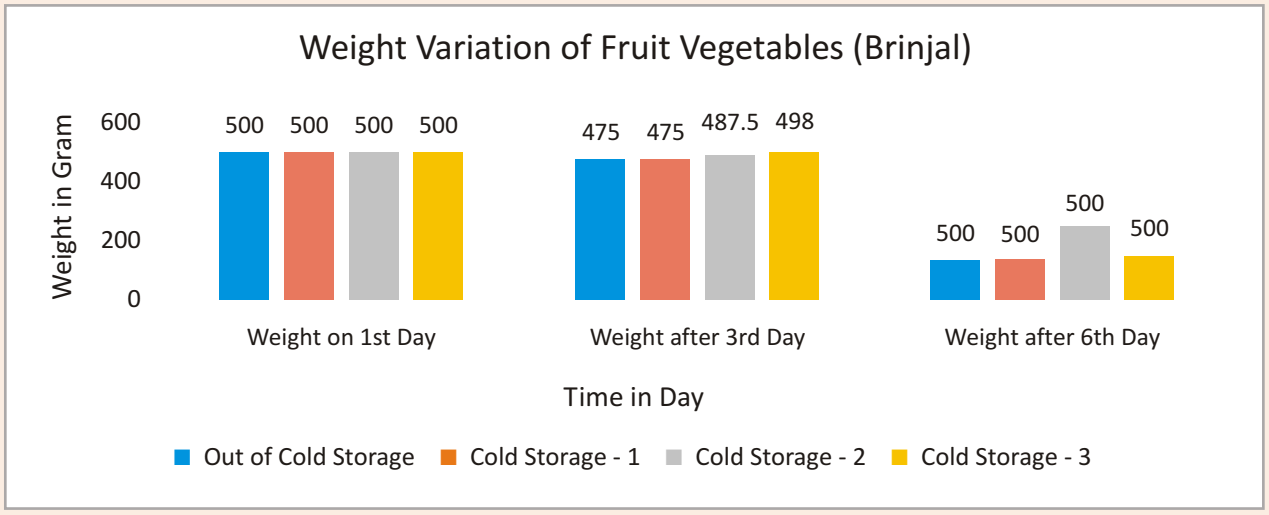


Table 9 : Comparison of Condition and Colour of different Vegetables

Name of Vegetable	Day	Out of the Cold storage	Condition & Color in Cold storage-1	Condition & Color in Cold storage-2	Condition & Color in Cold storage-3
Ceylon spinach	1st day	Fresh & Deep Green	Fresh & Deep Green	Fresh & Deep Green	Fresh & Deep Green
	After 3 day	Dried & Green	Fresh & Green	Fresh, Light Green & Yellow	Fresh, Tight and Light Green
	After 6 day	Slightly Rotten & Yellow	Slightly Rotten & Green & Yellow	Slightly Rotten & Green & Yellow	Slightly Rotten & Yellow
Bitter gourd	1st day	Fresh & Deep Green & Greenish White	Fresh & Deep Green & Greenish White	Fresh & Deep Green & Greenish White	Fresh & Deep Green & Greenish White
	After 3 day	Tight, Yellow & Green	Fresh, Yellow & Green	Fresh, Green & Yellow	Fresh, Greenish White & Yellow
	After 6 day	Rotten	Slightly Rotten & Yellow	Slightly Rotten & Green & Yellow	Partially Rotten, Yellow & Light Green
Brinjal	1st day	Fresh, Light Green and White	Fresh, Light Green and White	Fresh, Light Green and White	Fresh, Light Green and White
	After 3 day	Slightly Rotten, Brownish Green & White	Fresh, Light Green and White	Fresh, Light Green & White	Fresh, White & Brownish Green
	After 6 day	Rotten	Slightly Rotten & Light & Brownish Green	Slightly Rotten & Brownish Green	Partially Rotten, Light & Brownish Green
Ipomoea	1st day	Fresh & Light Green	Fresh & Light Green	Fresh & Light Green	Fresh & Light Green
	After 3 day	Dried, Green & Yellow	Fresh, Yellow and Green	Slightly dried, Green, Yellow and Brownish	Fresh, Yellowish and Green
	After 6 day	Rotten	Slightly Rotten & Green & Yellow	Slightly Rotten, Yellow & Brownish green	Slightly Rotten, Yellow, White & Brownish

The above tables have proved that the vegetables can be kept fresh for 3 days after putting in the cold storage. The vegetables may be partially rotten in it after 6 days. But it will never be dried into the zero-energy cold storage.

5.2.10 Floating Garden_An Alternative source of Nutrition

Erratic and heavy rainfall is the acute problem of the Sundarbans area. As this Delta is just after the bank of the Bay of Bengal, it generally becomes very much vulnerable during rainy season. During severe floods or heavy rainfall in the monsoon, the water of the pond, river, canal etc. get overflowed and mostly the fish species in those water bodies run away from it and create a huge loss. The people of this region are very much frightened to see the erratic nature of the climate and search for an option to cope up with this situation. Development Research Communication & Services Centre (DRCSC)

has developed a model to rear fish and cultivate small amount of vegetable in a structure which can be floated in any water body. This structure is also helpful for the landless people. They can rear fish and cultivate some vegetables with this model in any canal or other common water-bodies. During flood or inundation, this floating garden is automatically shifted to other places with the rising of the water surface without hampering the production. This structure can be made of locally available materials like; Bamboo, Net, Iron Rod, Plastic drums and Rope. The vegetables are cultivated into the tray placed on the iron structure and fish at the lower part of the structure and into a net submerged into the pond-water. 11 nos. of floating gardens are established at Ramganga GP.

5.2.10.1 Case Study: Garden on Pond Attracted People

Angur Paul is a housewife. But she takes every responsibilities of agriculture with her husband. But her area of nutrition garden is so low that all her cultivated crops are destroyed during heavy rain. But her dedication to cultivation is so much that she cultivates the land again and again. She became a beneficiary of Sundarbans Climate Adaptation project during 2018. The project personnel observed her dedication in cultivation. They suggested her to make a floating garden on her pond and cultivate vegetables during rainy season. They supplied materials like plastic drum, steel frame etc. and she made it with the help of her husband. Then she cultivated vegetables like Broad beans, Chili, Ivy gourd and Ceylon spinach. When the season was over, she got 500g of broad beans, 500g of chili, 2.5 kg of Ivy gourd and 1 kg of Ceylon spinach. She also gave 1 kg of Tilapia fingerlings into this structure. She got 7 kg of fish from it after 6 months. She is very much happy by cultivating on this floating garden. Her neighbours come to her to see the floating garden and praise her for her new initiatives.

5.2.11 Group based Income Generating Programme

Sundarbans, the vulnerable deltaic zone of India is the observer of various types of climatic hazards like cyclone, flood etc. The Kolkata based non-profit organization, DRCSC is trying to reduce the vulnerability and finding out livelihood opportunities to combat the rising climate risks through different interventions under Sundarbans Climate Adaptation project. There are 29 nos. of group-based income generating programmes established in the project area and 144 nos. of households benefited with these activities. The income generating programmes are including Honey processing, Fish Cultivation, Fish Feed Making, Poultry Rearing and Pulses Dumpling Preparation.

5.2.11.1 Case Study : Fish feed_ for Empowerment of Group Members

The project area is a water-logged area. Every household of this area has one or more than one pond. The local people are also very much fond of eating fish. So, they produce fish in their pond and buy fish feed from market or use local food. The project has a scope of generating group-based livelihood option for the empowerment of the group.

All the members of Nibedita Mahila Dal (a Mutual Cooperation Group (MCG) formed by DRCSC) of Ramganga village, Patharpratima Block, South 24 Parganas District of West Bengal chose the fish feed production as their livelihood option due to its high demand. They took training for it and prepared fish feed collectively with Maize, Mustard cake, Nut cake, Rice and Agrimin Forte (a calcium tonic). They started their journey during December, 2018.

During the initial stage, the local people had no faith

on their product as the members were unable to packet and label it. But the people have gained their faith after using it and now it has a high demand among them.

It is worthy to mention that due to erratic nature of the climate, pond-based ecosystem get shampered and this external support of organic feed for fish not only gives good nutritious food for fish and enrich the pond ecosystem but it also provides good income for the group-members. Initially the women group prepared 11 Quintal fish feed within 6 months. Total selling cost was Rs 39,805/-. Their net profit was Rs 5500/-. They wants to carry on this activity in coming days also. They have also prepared some medicated fish feed with Turmeric, Neem leaves, Garlic and Basil Leaves for better health of the fish.

5.2.12 Use of Alternative Energy during Cooking

The rising in temperature due to global-warming is harmful to everyone. But, the people of Sundarbans are mostly affected due to this. If the average temperature of the world increases, it will melt the ice of the polar region and eventually the water level of the sea and ocean will increase which compel the deltaic region of Sundarbans to go under the water. So, all the residents of Sundarbans should try to save it at any cost. Considering the world-wide problem, the project has introduced different types of energy sources and also found some techniques to reduce the use of wood during cooking. 1255 nos. of Smokeless Ovens, 39 nos. of Improved Ovens, 120 nos. of Solar Cookers, 7 nos. of Solar Dryers and 39 nos. of Bio-gas Ovens are established in the project area.




5.2.12.1 Case Study 1 : Improved Oven increases the Interest of Cooking

The name of the beneficiary is Manashi Shyamal. She lives at Gobindapur Village of Ramganga G.P. in South 24 Parganas district of West Bengal. She is a member of a Mutual Co-operation Group named Piyali Swanirvar Mahila Dal.

Manashi took an improved oven which needs electricity to rotate a fan and wood as fuel. She experienced that it requires only 1.5 kg wood for cooking of one hour. On the other hand, a conventional oven required 4 kg wood for same amount of cooking. That means the oven saved 2.5 kg wood per hour. So, she is able to save nearly 1800 kg wood in a year.

This particular oven is helpful to reduce the consumption of wood which implies that it can save some existing plants from being used as fuelwood. On the other hand, the user will be benefited during fuel wood scarcity.

Manashidi shared, "This oven is very helpful to me. It is cheaper than LPG also. Its fuel requirement is very low. I have prepared various types of mango pickle with it. When I am in hurry, I can't think cooking except this oven."

5.2.12.2 Comparative Study among five Different Types of Ovens:

The wood requirement, time requirement, Environment friendliness and comfort of cooking have been tested on five ovens namely Smokeless Oven, Improved Oven with Fan, and Improved Oven without Fan and Bio-Gas oven. The same test has been replicated in three different models. The average of three tests of each oven has been considered. The test has been performed on 600 g rice, 400 g potato and 150 g pulses. The potato has been boiled in rice and pulses have been cooked differently. There are possibilities of cooking two dices simultaneously in Conventional Oven, Smokeless Oven and Bio-Gas Oven. But the improved oven is for cooking a single dice at a time.

Observations for Smokeless Oven, Improved Oven with Fan, and Improved Oven without Fan and Bio-Gas oven are comparable with the Conventional Oven. But, the case of solar cooker is different. So, it is described in a note.

Table 10 : Comparison of five Different Cooking Models

Property	Conventional Oven	Smokeless Oven	Improved Oven with Fan	Improved Oven without Fan	Bio-Gas
Required Wood (in kg)	1.82	1.53	0.95	0.98	0
Required Time (in Minutes)	31	32	39	51	44
Rate of Environment Friendliness	1	2	4	3	5
Rate of Comfort	3	4	4	4	5

Note: Solar Cooker required 3 hours in summer days. But it is unsuccessful during rainy season. The ideal timing of cooking with Solar Cooker is 9 a.m. to 12 p.m.

Though the time requirement for cooking in Conventional Oven is least, it consumed maximum amount of wood. Again, Bio-Gas needed no wood. But it is very expensive to install. The poor people cannot afford it. But, the other ovens, i.e., Smokeless Oven, Improved Oven with Fan and Improved Oven without Fan are affordable to all and can save huge amount of wood. The time requirement for smokeless oven and conventional oven is almost equal. But, if a person cooks with Smokeless Oven, he/she can save wood 1.45 kg wood per day which means approximately 529.25 kg wood per annum. For Improved Oven without Fan and Improved Oven with Fan, it will be 1533 kg and 1587.75 kg per annum respectively. So, the people of Sundarbans can save 1.5 Ton wood per annum and reduce the carbon-di-oxide emission if they can use the improved oven.

5.2.13 Mangroves, the Incomparable Resource of Sundarbans to Save the Dwellers

Mangrove is beauty of Sundarbans. Mangroves not only save the island from being drowned into the Bay of Bengal but also give a pleasant climate to the dwellers of Sundarbans as a gift. Mangroves' root hole is a beautiful place of breeding for saline fish. They act as wind breaker during cyclone and save the island. Poor people of Sundarbans collect non-timber forest products (NTFPs) like Leaves, Fruits, Honey, Wax etc. as a livelihood.

But the people of Sundarbans have become so greedy that they have started to cut mangroves to make agricultural land, homestead etc., for the purpose of fuel and also to earn money by selling woods. Population Explosion in Sundarbans has made the situation more vulnerable. The no. of mangroves has become so less that it is considered as one of the root causes of rapid change in climatic factors.

The beneficiaries decided to plant and conserve mangrove on the river bank to reduce climate change and also save the embankment. In three years of the project, they have planted 212200 nos. of mangroves including seeds and saplings in 26.73 ha of coastal area and saved 9 KM of negatively impacted coastline. The average height of the mangroves is more than 3 feet during the project end.

5.2.13.1 Case Study : Mangroves_a Barrier of River Bank Erosion

Mangroves are planted in different patches into the project region. One of such patches is situated in the Dakshin Shibpur village of Ramganga GP on the embankment of Gobadia River. Its area is 1.28 ha. 30 nos. of willing women from 3 Self Help Groups namely Bharatmata Swanirvar Dal, Laxmi-Narayan Swanirvar Dal and Nodi Swanirvar Dal chose this patch for conservation and plantation of mangrove during July, 2018. Firstly, they bounded the area with net, rope and bamboo. Then, they planted 3100 pcs. of saplings and 9400 pcs. of seeds into this boundary on 28th July, 2018. All the 30 participating household lives in the other side of the river bank. Their family members have to fight a lot to bear household expenses almost every day. They took training and support from the project to

do organic farming. As its input cost is low and yield becomes high, they can earn more profit from agriculture and become happy.

They have faced a lot of challenges to plant and save mangroves in this patch. At first, they took permission from the local govt. for plantation. They had to fight against the local fishermen who used to keep their boat into this patch. Finally, the fishermen agreed to place their boat in different position. They also quarreled with the local goat farming households who used to send their goat for grazing. Goats damaged 700 pcs. of mangroves. When the situation

became out of control, local panchayat announced not to send goats into this patch. After solution, 800 nos. of new seeds which came naturally by high tide generates seedlings into this patch. Most of the mangrove species which have been planted or naturally grown are *Bains*. Moreover, there are *Kankra, Hargoja, Gneoa* etc. The average height of the planted mangroves on 15th January, 2020 is 5 ft. They have also prepared nursery of 30000 saplings in the two years of the project and shared to the members of the other village for plantation.

Bina Mondal, one of the SHG members said, "The embankment is degrading day by day. 20 years before, our house was 200 ft apart from the patch towards the river i.e., the place is totally lost into the river. We don't want to lose our land anymore. I hope that these trees will be grown fast and save us from drowning."

5.2.14 Social Forestry : Enrichment of Greenery

Sundarbans, the largest mangrove forest of world is not only rich in mangroves only, but there are also many multi-purpose trees in the locality of the Sundarbans dwellers. Due to several reasons, these trees are abolished by the human beings and it is also one of the reasons of climate change.

To reduce the causes of climate change, multi-purpose tree plantation is taken under the Sundarbans Climate Change Adaptation project. In three years of the project, 35818 nos. of such trees are planted along 36.38 km roadside. There are 46 types of multi-purpose trees planted in the roadside. The varieties are namely Mango, Black Berry, *Neem, Mahogony,* Jackfruit, *Sishu, Shirish,* Arjuna, *Krishna Chura, Radha*

Chura, Minjiri, Humming Bird Tree, Acacia, Indian Beech, Rain Tree, Sandal Tree, Ipil Ipil, Lemon, Water Apple, Sapota, Betel nut, Star fruit, Papaya, Carandus plum, Java Apple, Betel nut, Guava, Coconut, Deodar, Subabul, Lebbeck, Golden Shower tree, Orchid tree, Hibiscus, Oleander, Bur-flower tree, Banyan tree, Raspberry, Wood Apple, Tamarind, Thorny Acacia, Hog plum, Indian lilac, Java Bean, Malabar Silk Cotton tree, Ber and Star gooseberry. The average height of the plant is more than 4 feet at the project end.







6. Evaluation of Adaptive Measures

6.1 Evaluations on Adaptive Interventions

6.1.1 Weather Forecast:

- It is a Climate Change Awareness Intervention.
- Forecast is exactly accurate for next three days. But it slightly changed after that.
- People are very much interested to know about the rainfall, as it directly affects their day-to-day work.
- The dwellers are very much benefited during super-cyclone 'Bulbul' & 'Amphan' as they knew about it before time and able to take preparation.
- Farmers are able to take decision of bed preparation, transplantation etc. by knowing the status of the weather before 5 days.
- Women are taking decision of Paddy boiling (a step of rice preparation from paddy) after observing the weather board. (As they needed sunny days to dry the paddy after boiling)
- 50% of the observers agreed that their perception of weather increased after display.

6.1.2 Awareness Generation on Climate Change:

- This is also a Climate Change Awareness Intervention.
- More than 10 thousand people get clear knowledge about the world-wide problem, climate change.
- 80% of them have reduced cutting wood in any purpose to reduce climate change.
- 90% of them have started using organic fertilizer in their cultivation.
- 50% of them have planted perennial trees in their homestead.
- 20% of them have shared their knowledge with their neighbours so that this knowledge could be disseminated among more people.
- More than 5 thousand students have taken oath to be responsible to reduce causes of climate change.

6.1.3 Vegetable Gardens at School:

- This is a Climate Change Awareness and Adaptive Intervention.
- 367 students get knowledge about sustainable climate adaptive agricultural techniques.
- More than 500 students get organic vegetables in the mid-day meal.
- More than 300 students have shared their knowledge with their parents and motivated them to take climate adaptive agricultural techniques.
- More than 150 students have understood mathematics and life science very well from garden.
- 100% of the students participated in gardening have understood the importance of plants in their life.
- 50% of them have taken spending time in garden as a hobby and are very much interested in watering plant.

6.1.4 Integrated Farming System:

- It is a Climate Change Adaptive Intervention.
- 89 farmers have converted their small farms into Integrated Farming System.
- 100% of them are getting vegetables, fish and animal protein round the year from their homestead and are not depending upon market. Their diet variation is also increased due to plenty availability of food.
- 60% of them are distributing excess vegetables among neighbours and relatives and their social status is increased.
- 100% of them are selling excess vegetables and livestock and earned money. Their income has increased by two times.
- 100% of them are preparing organic inputs at their home with the wastages which have come

from their household works and cultivation, and reduce buying inputs from market.

- 5% of them has made their Integrated Farming System self-sustained and they aren't depended upon market even for the agricultural inputs like seeds, organic fertilizers, organic pest repellents etc.
- 100% of them agree that their farming system is resilient in climate change. They get some vegetables and earn money from livestock even after natural disaster.
- 100% of them have observed that the fertility of soil of their land is increased.
- 100% of them have reduced environmental pollution by re-usingthe wastages in cultivation by which they have reduced the cause of climate change also.

6.1.5 Nutrition Garden:

- This is also a Climate Change Adaptive Intervention.
- 100% of targeted household have taken support of indigenous seeds and made nutrition garden based on their available homestead.
- A wide range of vegetable varieties has improved their food security.
- 40% of them are getting vegetables for round of the year.
- 35% of them are able to sell excess vegetable in the market.
- 95% of them are preparing organic inputs in their homestead.
- 80% of them have strengthened the bonding with neighbours by distributing excess vegetables of their garden.
- 75% of them are able to save their vegetables partially during natural disaster by following the techniques like raised bed, mixed cropping etc.
- 90% of them have agreed that their digestive problem has been reduced taking organic vegetables.
- 65% of them cultivate strategic crops for using them in the lean period.

6.1.6 Crab Cultivation:

- It is also a Climate Change Adaptive Intervention.
- Net Surrounded Crab Cultivation and Crab Fattening in Boxes give alternative income opportunity to 34 nos. of Sundarbans Dwellers.
- 100% of them have increased their total income from ponds as they are getting income from both fish and crab.
- Climate Resilience of Aquatic Cultivation has increased as Crabs can tolerate more fluctuation of Salinity than Fish.
- 10 nos. of people who have taken crab fattening boxes as their alternative income source are getting more income than the net surrounded crab cultivators.
- Crab boxes are more adaptive in flood situation. But crab shouldn't be kept in the boxes in drought situation. Hot pond water is harmful for crabs.

6.1.7 Small Ruminants & Birds Rearing:

- It is a Climate Change Adaptive Intervention.
- 30% of total beneficiaries have taken support of small ruminants from the project as they have very less amount of land-holding.
- 95% beneficiary households have small ruminants at their homestead.
- 80% beneficiaries are treating small ruminant rearing as their main secondary income source after the agriculture.
- 100% of small ruminant cultivators are using their livestock wastage as the input of vegetable cultivation.
- 90% of small ruminant cultivators are not depended upon market for animal protein.

6.1.8 Transaction of Seed Bank:

- It is a Climate Change Adaptive Intervention.

- 40% of Self-Help Groups formed under Project maintain Seed Transaction under Seed Bank.
- 50% Groups have access to Community Seed Banks formed under the project.
- Community Seed Banks procure Seeds from the group seed banks and sell to others.
- 29 types of Indigenous Seeds are conserved and transacted through the Seed Bank.
- 30% Groups get a considerable income from selling indigenous seeds.

6.1.9 Zero Energy Cold Storage:

- It is a Climate Change Adaptive Intervention.
- The effectiveness of Zero energy cold storage is increased by increasing the quantity of water and frequency of watering in the sand layer.
- It is used by the beneficiaries mainly during two seasons of cultivation, rainy and winter seasons. Some of them also use it during summer season.
- Vegetables are never dried in the Cold Storage. But it might be rotten after a week.
- Freshness of vegetables remain unchanged for first 3 days.
- The lid of the cold storage should be air-tight to get the highest effectiveness of it.

6.1.10 Floating Garden:

- It is a Climate Change Adaptive Intervention.
- The effectiveness of floating garden is the highest during rainy season.
- The amount of compost should be more than the soil for cultivating vegetables on it.
- The model is adaptive in flood situation. It saves vegetables from water-logging and fish from drowning during heavy rain and saline water flood.
- 100% fish harvesting is possible in this model.
- The management of fish and vegetable is easier in this model.

6.1.11 Group based Income Generation Programme:

- This is a Climate Adaptive Intervention.
- 144 nos. of beneficiaries have generated 29 nos. of different alternative income sources through this activity.
- This activity not only provide monetary support to participants, they also get mental support from other group members.
- It strengthen the bonding of the group members.
- The participants have faced market challenge several times. But it has not suppress their interest to continue the work.
- New income generating programmes are created under this intervention.
- Some new skills are developed among the participants like fish feed making, guinea pig rearing, several types of *bori* (lentil dumplings) preparation, honey processing etc.
- The group revolving fund is increased by this intervention as a part of profit from these activities shared in group account.

6.1.12 Alternative Energy Use:

- It is a Climate Change Mitigation Intervention.
- 80% of beneficiary households benefit environment by using alternative energy.
- Consumption of Wood has reduced during cooking due to use of Alternative Energy. So, tree cutting is reduced for fuel purpose.
- Emission of Air-pollutant, Carbon-Di-Oxide has decreased by reducing wood consumption.
- The green-house gas, Methane ($CH_{4)}$ emission reduce by converting cow-dung into Bio-gas slurry.
- Effectiveness of Cow-dung has increased for cultivation and using as fish-feed by transforming it into Bio-gas Slurry.
- Beneficiaries are introduced with 4 completely new technologies which are namely Improved Oven with Fan, Improved Oven without Fan, Solar Cookers and Solar Dyers.

- Beneficiaries get new skills of using different alternative energy sources.

6.1.13 Social Forestry:

- It is a Climate Change Mitigation Intervention.
- 36.28 km roadside gets green vegetation. This reduces the soil erosion of road slopes.
- Project area gets 35818 nos. of green trees and enriches its environmental beauty.
- The trees consume a huge amount of Carbon-Di-Oxide (CO_2) and give Oxygen (O_2) in return of it.
- It has strengthened the carbon cycle.
- It has reduced air pollution.
- An opportunity has been created for future to get food and fodder easily.
- It gives shelter to different kinds of birds and enriches the bio-diversity.

6.1.14 Mangrove Plantation & Conservation:

- It is a Climate Change Mitigation Intervention.
- Mangrove forest area has been increased by 26.73 hectors.
- 9 km negatively impacted coastline gets green vegetation and is saved from being abolished by nearby river.
- 212200 nos. of mangrove trees have been grown at the coastal area to save the Sundarbans Island.
- It gives opportunity to different kinds of fish to lay egg at its rooting zone and saves them from being extinction.
- It gives shelter to different kinds of birds, supplied food and enriches the bio-diversity.
- Most of the human activity requires O_2 and emits CO_2 in return of it. It has strengthened the carbon cycle by absorbing Carbon-Di-Oxide (CO_2) and giving Oxygen (O_2).
- It has enriched the scenic beauty of the coastal region.
- It gives fresh breeze to the dwellers and reduces climate extremities.
- It gives shelter to different types of crabs at its rooting zone.
- Mangroves are acting as wind breaker at the coastal region.

6.2 Conclusion:

The endangered flora & fauna of Sundarbans have been regenerated and also conserved through project activities. The dwellers have learnt to protect them in a sustainable manner through different skill development trainings. The local people have also been eligible to manage their existing resources positively and adapt the changing climate using several scientific techniques. They are also able to face the natural disasters and save their lives and livelihoods as they have taken several awareness trainings and got exposure to several alternative income earning strategies. But these programmes should be spread among more no. of people to save the wonderful forest of the Earth from being drowned.

6.3 Taking forward Adaptive Actions for next phase of Implementation

A. Area Extension: The Project Work has a very positive result in the targeted villages. So, the work is needed to be extended in more vulnerable areas of Sundarbans and the knowledge of Climate Change Adaptation should be spread if we want to save Sundarbans and its dwellers.

B. Value Addition: The low cost easy to maintain processing facilities should be established for value addition of Organic Produces. It will give more income to the beneficiaries. Moreover, they have felt difficulties in marketization of fresh vegetables. The local market hasn't so much demand to take all their produced crops. As the vegetables are perishable, most of them are damaged very soon and can't get the next market day. So, it will be better to process them and make them marketable them in different form.

C. Marketization: Farmers should be capacitated to collect and collate their marketable surplus and reach the market through concerted effort. They should be taught about how to make a proper business plan. A proper market linkage should be generated so that the farmers can avail themselves of getting better market price.

D. Alternative Income Generation Programmes: More and more people should be guided and capacitated to go for alternative income generation opportunities. Skill building programme on natural resource-based vocations can be an area to explore in future to reach to a greater number of people.

E. Weather Information Services: To address climate change adaptation the weather information service is vital for the area. There is a scope to explore in this area through concerted effort.

F. New Technique for Mangrove Plantation: Mangroves are the main spinal cord of Sundarbans. We planted the mangrove saplings in the flat coastal zone. But new techniques should be incorporated for sapling plantation in the straight coastal belt where breaching of river bank is very frequent.

G. Sustainable Natural Resource Management: The rich Natural Resources of Sundarbans are deteriorating to provide food and livelihood to the dwellers. The proper management skill should be generated among the dwellers so that they could secure their livelihood without hampering the natural resources and ensure climate resilient food by themselves. Thus, the human beings along with other animals and plants will survive for long without disturbing one another.

H. Flora & Fauna Conservation: Local multi-purpose plant species, mangroves and the natural food species which are available in the farmers' field, but have become extinct now. These should be conserved through plantation and using organic farming techniques in farmers' field. If it is possible, some species should be brought back.




Annexure I

Crop Varietieswhich are found in Field Area

Before Project Implementation

Sl. No.	Type of Crop	Name of Crop
1.	Cereals	Paddy
2.	Oilseeds	Sunflower
3.		Mustard
4.	Pulses	Green gram
5.		Black gram
6.	Cash Crop	Betel leaves
7.	Leafy Vegetables	Spinach
8.		Green Amaranth
9.		Indian Spinach
10.		Water Spinach
11.	Fruit Vegetables	Egg plant
12.		Tomato
13.		Okra
14.		Bitter gourd
15.		Ridge gourd
16.	Legumes	Yard-long bean
17.	Tuber	Potato
18.		Taro
19.	Spices	Chili
20.		Onion

After Project Implementation

Sl. No.	Type of Crop	Name of Crop
1.	Cereals	Paddy
2.		Maize
3.	Oilseeds	Sunflower
4.		Mustard
5.		Sesame
6.		Linseed
7.	Pulses	Green gram
8.		Black gram
9.		Grass pea
10.	Cash Crop	Betel leaves
11.	Leafy Vegetables	Spinach
12.		Green Amaranth
13.		Red Amaranth
14.		Indian Spinach
15.		Water Spinach
16.		Small fenugreek
17.		Sour sorrel
18.	Fruit Vegetables	Egg plant
19.		Tomato
20.		Okra
21.		Bitter gourd
22.		Ridge gourd
23.		Ash gourd
24.		Bottle gourd
25.		Ivy gourd
26.		Snake gourd
27.		Pumpkin
28.		Cucumber
29.		Turnip
30.	Legumes	Yard-long bean
31.		Pigeon pea
32.		Bean
33.		Cowpea
34.		Broad bean
35.		Velvet bean
36.		Winged bean
37.	Root & Tubers	Potato
38.		Taro
39.		Yam
40.		Sweet potato
41.		Carrot
42.		Elephant foot Yam
43.		Beet
44.	Spices	Chili
45.		Onion
46.		Ginger
47.		Coriander

Newly Introduced Crop after Project Implementation

General Crops Cultivated before Project Implementation

Annexure II

Rejuvenated Local Natural Varieties (Uncultivated Crops)

1.	Kolmi	Water Spinach
2.	Helencha	Marsh Herb
3.	Kulekhara	Long leaved Barleria
4.	Shushni	Water Clover
5.	Saur	Giant Taro
6.	Panjabi Palang	Ceylon Spinach
7.	Katoa Data	Stem Amaranth
8.	Gime	Indian Chickweed
9.	Chikni	-
10.	Madranga	-
11.	Telakucha	Ivy Gourd
12.	Brahmi	Water Hyssop
13.	Gandal	Paedaria
14.	MechiShak	-
15.	Pat Shak	Jute Mallow
16.	Thankuni	Indian Pennywort


Marsh Herb


Indian Chickweed


Stem Amaranth


Giant Taro


Long leaved Barleria


Ivy Gourd


Paedaria


Water Clover


Ceylon Spinach


Water Hyssop


Water Spinach


Indian Pennywort


Jute Mallow

Some of our Activities

Exposure visit on Crab Cultivation

Mushroom Cultivation

School Garden

Multi-tier Cultivation

Replication of Activity by non-beneficiary household

Cultivation on trellis above the canal at IFS Model

Mangrove Plantation & Conservation
at Mridanga Vanga River Bank

Mangrove Plantation & Conservation
at Shuka River Bank

Group members sharing their feedback

Salt-tolerant Paddy Trial

Group based Fish Cultivation

Group based Guinea Pig Rearing

Group based Pulses' Dumpling Preparation

Internal Group Exchange Visit

Relief Distribution after dual hit of COVID-19
& Amphan Super-cyclone

New Pond Excavation for Rain Water Harvesting
& Sustainable Aquaculture

Tube-well Installation for Safe Drinking Water

International Mangrove Conservation Day Celebration

Farmers' Convention

Display of Mangroves Seed

Video Documentation on Project Work

Group based Poultry Rearing Visit by Project Personnel

Project Work Appreciation by Local ITI College