Food Security and the Changing Climate

Case Studies of Community Adaptation Strategies

December 2012

EMPOWERING PEOPLE FOR CHANGE
PANAP
PESTICIDE ACTION NETWORK
ASIA & THE PACIFIC

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Introduction

Climate change is damaging the wide natural resource base on which millions of people in Asia depend for livelihood. Intense rainfall and flooding, prolonged drought, storm surges and other climate- related stresses have impacted small farming systems' access to land, water, and other productive resources. Besides downsizing food production, global warming is undermining the livelihood of small- scale farmers, landless workers, indigenous peoples, fisherfok, and consumers, and making it even more difficult for the increasing number of the poor to access food in the face of food shortages and rising prices. What makes it even worse is that these sectors vulnerable to the impact of climate change are the least responsible for causing it.

Farmers have, however, responded to environmental changes by gradually changing their agricultural practices, developing new varieties of crops and innovating to maintain productivity. Based on this resilience and drawing on their indigenous knowledge and experience, small- scale farmers in many parts of Asia are now trying to cope with the problems of climate change – changing crop patterns and timings, using local varieties of seeds better suited to floods, droughts and cyclones, conserving water and soil quality, using

natural ways of pest management, etc. These adaptation practices gained affirmation from the UN Special Rapporteur on the right to food, Mr. Olivier de Schutter, when he presented his report, "Agro-ecology and the right to food" in March 2011, stating that "small-scale farmers can double food production in a decade using ecological farming methods."

Pesticide Action Network Asia and the Pacific (PAN AP) hopes to contribute in building public awareness and support through the promotion of community-led initiatives in responding to climate change. It has already published a handbook, "Weathering the Climate Crisis: The Way of Ecological Agriculture" in 2010 and hopes to conduct further studies regarding climate change and agriculture. Through documentation of different climate change-resilient practices, PAN AP aims to conduct an Asia-wide climate change campaign which will showcase biodiversity-based ecological agriculture as a way forward in responding to climate change related crises in food and agriculture.

Collaborating groups

- Sibol ng Agham at Teknolohiya (SIBAT/Wellspring of Science and Technology) – Philippines
- Rural Women's Association "Alga" – Kyrgyzstan
- Shikkha Shastha Unnayan Karzakram (SHISUK/Education, Health and Development Program) – Bangladesh
- National Fisheries Solidarity Movement (NAFSO) – Sri Lanka
- Centre for Human Rights and Development (CHRD) – Mongolia

Building Resilient and Productive Community through Community Enterprise Approach

Shikkha Shastha Unnayan Karzakram
(SHISUK/Education, Health and Development Program)

1.0. Background of the Community in the Context of Climate Change

1.1. Country Context

Bangladesh is in a deltaic plain of a major river basin, which has made it susceptible to floods and cyclones. Besides, the country is extremely populated and one of the most densely populated in the world. At present population density is 1000- plus per square kilometre (km^2) Fifty per cent of the population lives in poverty, 51 per cent of the children are malnourished (Source: www. bangladesh- web. com).

Poverty remains a major environmental concern for Bangladesh. Poverty does not just mean lack of income. It also means a permanent state of vulnerability and lack of access to resources. In order to meet basic needs, the poor of Bangladesh thus are more concerned with the exploitation of the environment than with its protection and regeneration. Due to poverty there is always the extra pressure on the poor to over- utilise environmental resources, resulting to

environmental degradation which, in turn, limits the poor's access to resources.

In Bangladesh, climate change will affect many sectors, including water resources, agriculture and food security, ecosystems and biodiversity, human health and coastal zones. Many environmental and developmental problems will be exacerbated by climate change. In the short term, global warming increases risk of flooding, erosion, and mudslides during the wet season. In the longer term, according to the forecast of the experts on climate change, Bangladesh and Maldives are two countries that will be worst affected because of global warming (www. news. bbc. co. uk). On the other hand, with Sea Level Rise (SLR) by one-metre, 17. 5 per cent of costal low-lying parts of Bangladesh will go permanently under water.

Already, Bangladesh has experienced sharp changes in rainfall patterns, droughts in rainy seasons, late monsoons, recurring floods, and warm winters. These changes are already having major impacts on the economic performance of Bangladesh and on the life and livelihoods of millions of poor people. As an indication of what the future may look like, in 2007 alone, Bangladesh was devastated by two floods, a drought and a massive cyclone.

Because of climate change, sea level rise of 0. 5 metre (m) over the last 100 years has already eroded 65 per cent landmass of 250 square km of Kutubdia, 227 km^2 of Bhola and 180 square km of Sandwip islands. (Source: Daily Prothom Alo, December 2007)

On the contrary Bangladesh is rich in water resources. The area of total inland water bodies is 4. 337 million hectares (ha), of which 4. 047 million ha is open water bodies including floodplains, and 0. 29 million ha is closed water bodies including coastal shrimp farms. In inland waters of Bangladesh, there are about 260 species of indigenous fish, 12 species of exotic fish and 24 species of prawn.

However, there are a number of natural and man-made factors that are putting increasing pressure on the fisheries, including the following:

- Indiscriminate capture of brood fish and their juveniles
- Revenue-based fisheries management through leasing
- Discharge of municipal and industrial waste into the water bodies
- Use of insecticides and chemicals in adjacent agricultural fields
- Reduction of areas of rivers, beels and haors due to siltation
- Over-exploitation of fisheries resources without proper management

The need to maintain freshwater biodiversity whilst increasing the production from Bangladesh's extensive inundated areas and improving the livelihoods of the millions of people who depend on these resources, therefore, remains a serious challenge for today's development policy makers and planners.

1.2 Background information of the case study area

Comilla District is a densely populated area with a density of 1,487 people per km^2 compared to the national average of 1000/km^2. A 1994 study of Daudkandi, Murandnagar, Debidwar and Burichang Upazilas of Comilla, commissioned by BWDB[1], found that marginal farmers formed a large majority 61.7 per cent (owning 59.6 per cent of the land), with just under 30 per cent of households being classified as landless. The study reported that only 0.3 per cent of the population (1,457 people), were involved in fishing[2] at that time.

Due to its low-lying nature, the District had long been recognised as a food-deficit area. In the lowest lying areas, the long seasonal inundation prevents many farmers from growing more than one crop (boro rice or some winter crops). The study revealed that 22.3 per cent of the land was being used for single rice cropping, 58.9 per cent

Daudkandi google satellite map! This place is situated in Comilla district in Chittagong Division of Bangladesh. Its geographical coordinates are 23° 32′ 0″ North, 90° 43′ 0″ East.

for double rice cropping, and 19. 1 per cent for triple rice cropping. Despite the evenness of the topography, there are enough differences in land elevation to allow for some crop diversification away from the typical 'fallow, fallow, boro' cropping pattern that predominates in the lowest areas. In slightly higher (max. water depth 1 m) areas an Aman crop can also be produced, and in the highest (max. water depth 0. 3m) areas, Aus, Aman and Boro sequential cropping is possible. Irrigation coverage, through DTW, STW and LLP, was around 42 per cent of the cultivated area.

In recent years there has been a general reduction in profitability in paddy cultivation due to increased input costs and environmental factors, such as drought or flooding. Nitrogen and sulphur deficiencies in the soil have been identified as constraints to crop yields.

Un(der) employment is common and seasonal out-migration to urban areas (in Dhaka and Chittagong) occurs during the wet season. September to November are recognised as famine months, when great hardship was experienced by farming households. It is at this time when subsistence fishing is most important to marginal farming households, as there is little else to do. Fish caught from the floodplain, albeit in small amounts, contributes greatly to maintaining nutrition standards and good health, and may even provide an income if a surplus is caught. As the area is flooded throughout the wet season, the main mode of transport at this time of the year is in country boats. This limits the free movement of goods and people.

1.3 The Birth of a Model

The possibility of better utilisation of seasonally flooded lands (mostly privately owned) for community-managed aquaculture was first considered by SHISUK in 1996. The Pankowri Fisheries Project was created, and a co-operative partnership involving local landowners and the landless was proven successful.

The project was founded on a business model. The main feature of the model is capital finance through floating shares, in which local households provide capital investment for the development of infrastructure and subsequent investment of a freshwater fisheries business on some 120 ha of land. The project is straightforward in its clarity of vision and for its effective technical approach and traditional knowledge. While the management of SHISUK undoubtedly had a clear vision of where they wanted to go with this project, they nevertheless did not attempt to force a "solution" on the farming communities, but provided dialogue, ideas and the offer for support, and allowed the solutions to unfold from the community itself. One key factor that SHISUK management insisted on was equitable ownership of shares among the community. This decision has ensured that the endeavor would not be taken over by one or a few wealthy families, as seems to be so often the case in Bangladesh.

In this project, the NGO SHISUK has been involved since its inception as a catalyst. Production and profitability has increased over the years. Dividends are being paid out to shareholders on a regular basis and the value of shares has increased manifold. The initiative has been based on transparent and accountable management system, which has spent considerable effort on building a strong board of directors and agreeing on bylaws[3]. In 1997, the project was registered as a company, under the Joint Stock Company Act. For its outstanding contribution to organising community- based aquaculture in the floodplain area, SHISUK was awarded the National Gold Medal in 1999.

News of the success of the Pankowri Project spread rapidly around the surrounding areas, and by 2004 more than 90 similar projects had been established in neighbouring communities. These floodplain aquaculture projects have drastically changed the local landscape. But as might be expected, the 'replicator projects', although many have been successful technically, appear to have less transparency in their operations, less representation by poor people, and are generally less productive and less profitable than the Pankowri and other SHISUK projects.

Following the success of Pankowri, SHISUK expanded its programme during 2003 and 2004, and developed partnerships with six other floodplain projects in Daudkandi. In these new projects, SHISUK has attempted to develop a more inclusive community approach to floodplain aquaculture and has experimented with ways to achieve greater equity and a more significant involvement from women.

In 2005, SHISUK developed a Training Centre at Daudkandi and has been providing training on their floodplain aquaculture approach to DOF officials and other NGO workers since. SHISUK is also promoting their approach in the Chalan Beel area, in coastal polder areas, and is seeing great potential for floodplain management in the climate change affected flood area.

SHISUK continues to modify its approaches, using its seven projects in Daudkandi area as its 'laboratory'. Aware of some of their limitations, they have invited DOF (Department of Fisheries) and WFC (World Fish Center), IFPRI (International Food Policy Research Institute), and IPA (Innovation for Poverty Action) to help them carry out research on a number of socio- economic, management and technical aspects of the model.

2.0. The Operational Principles of Community Enterprise Approach

The concept of Community Enterprise approach intertwines various aspects of resource management within the community for sustainable community development. The approach is a development action (Community initiative for social business) and implies efforts for mobilisation and utilisation of local resources (such as human resources, natural resources, local opportunities and social capital) through active participation of total community. The people within social and cultural linkage and common economic interests, regardless of class, religion, profession and gender, form the society or community of such approach. The basic principles of the SHISUK approach are as follows:

a. **Community engagement** – without targeting any specific group like 'poor' or 'women', the model emphasizes the engagement of the total community associated with natural resources such as floodplains, thereby bringing the whole community into the development process. It facilitates proper utilisation of resources involving the wider community that offers opportunities for direct participation and ownership, thereby empowering the community.

b. **Commercial approach** – the principle is that the investment should be commercially viable where mobilisation of capital

from the community is encouraged through floating of shares for subsequent collective investment, and does not emphasize dependence on credit.

c. **Formation of a representative management body** – the model facilitates the formation of a well representative management body of 'Board of Directors' through selecting (by nomination or election) eligible leaders from the community. This Board of Directors is in effect the community- based organisation that runs the enterprise.

d. **Establishment of good governance** – the model is premised on an enabling environment for good governance to run the business through sustainable management of their resources. Strict control is imposed and considerable effort expended to maintain transparency and accountability in financial transactions. The practice of participatory decision- making is encouraged strongly from the beginning of the initiative and allows 'the right to information' for everybody. Standard bookkeeping and openness to all systems are followed where the NGO helps Board members in keeping records, preparing accounts, and providing training on transparent transactions through Bank.

e. **Institutional partnership with Catalyst** – the catalyst can be involved through share subscription (max 20 per cent of the capital) for their self- reliance, and become community partner involved directly in the community development activities and enjoy equal share of loss or profit. This institutional partnership does not only cover certain portion of financial investment from the catalyst (NGO) but also ensures the capacity building aspects of the entrepreneurship. The NGO stands to benefit from the profits made by the enterprise, or share the loss. Involvement of NGO helps bring in regular R&D ideas to each enterprise and create linkages with other external organisations.

f. Capacity-building trainings for the community – should be provided by the NGO. The trainings include community leadership, record-keeping, biodiversity-based ecological agriculture, integrated pest management (IPM), aquaculture, biodiversity conservation and gardening, etc.

g. Formation of women enterprises – besides the mainstream community enterprise initiative there should be parallel effort for organising the women of the community, initiating savings, and providing them training on Income-Generating Activities (IGA), human rights, leadership and empowerment.

3.0. Process of Community Mobilisation

Widespread awareness about the success of neighbouring projects helped much in replicating the model and in community mobilisation process. In most cases the initial mobilisation took place under very few number of experienced community leaders already involved in neighbouring projects. They had to express their judgments on the feasibility of proposed projects in front of meetings comprising landowners and other stakeholders. If such feasibility was acceptable to the wider section of the community, the process involved the formation of extended 'Implementation Committee' keeping two to three dynamic individuals at the key positions. This committee would then start the next steps of activities formally and proceed more analytically to find out the strengths and weaknesses both from technical and social points of considerations.

After identification of a feasible site and subsequent formation of an Implementation Committee, several motivation meetings need to be organised village-wide or even family-wide if such mobilisation appears crucial. Sometimes community meetings are arranged in public places held through open mic-ing. Initial estimates and planning for establishing the project are also chalked out simultaneously because such information helps to motivate and convince the community. At

the stage when majority of the landowners come under consensus, the formation of 'Board of Directors' or 'Management Committees' takes place.

An important part of the community mobilisation takes place at the time of fund collection. Floating of shares and invitation of subscription either in prescribed forms or informally just registering names are arranged. Doubt and mistrusts are reported in case of self-replication where personal collection of funds takes place. Slow pace in fund collection, misuse of funds and even total defalcation of capital by a single person have been recorded in the field. Smooth and quick subscriptions have taken place in case of SHISUK-supported projects where share money is deposited to the Bank Account and oversubscription by the extended community takes place. A record amount of Taka 6.6 million (USD 81,000) was subscribed by three projects supported by the NGO within a period of about 3-4 months in 2004.

The latter parts of the community mobilisation are comparatively easy and performed by the Board of Directors. When the committee more frequently meets and discusses problems intimately, the solution becomes easier. Once the community can choose the right system for operation and put the right persons to keep the system, the mobilisation of community and resources appear comparatively simpler and more straightforward. But non-compliance or negligence of the operational principles has resulted in inequity and elite capture of some projects and the abandonment of operation of 7-8 projects.

The community mobilisation process took considerable time in majority cases both in self-replication and supervised replication, varying from two to four years (Table 1). The supervised replications took minimum time of one year starting from initial mobilisation up to fingerling stocking. Even so, the process took three to four months to complete important milestones of three projects and was possible to reach up to stocking within the first year.

Table 1: Important milestone against time line for the Floodplain Aquaculture Projects surveyed by PPRC during October 2005

SL No.	Important Milestones	Year 1	Year 2	Year 3	Year 4	Total time (Years)	Remarks
	Name of Project	Motivational meetings & formation of committee	Floating of Share & Fund collection	Infrastructure development	Fingerling stocking		
1.	Dhanuakhola	1986	1987	1987	1987	2	Self-replicated
2.	Asia Fisheries	1999	2000	2000	2001	3	
3.	Podma	2001	2001	2002	2002	2	
4.	Rajhongsi	1998	1998	1998	1998	1	
5.	Shoibal Matshya	1995	1996	1997	1998	4	
6.	Bashora	2001	2001	2001	2001	1	
7.	Moytree	2003	2003	2003	2003	1	
8.	Khosh kandi	2002	2002	2002	2003	2	
9.	Bismillah	2003	2003	2003	2003	1	
10.	Sonali	2001	2001	2001	2002	2	
11.	Shugandha	2002	2002	2003	2004	3	
12.	Rupali	1998	1999	2000	2001	4	
13.	Gauripur	2002	2003	2003	2004	3	
14.	Hazi Matshya	1999	2000	2000	2002	2	
15.	Master Matshya	2000	2000	2000	2000	1	
16.	Balaka	2002	2002	2003	2003	2	
17.	Jhenuk	2001	2001	2002	2002	2	
18.	Ekota	2001	2002	2002	2002	2	
19.	Samata	2002	2002	2002	2002	1	
20.	Sonar Bangla	2002	2002	2002	2002	1	
21.	Homna Fisheries	2002	2002	2002	2002	1	
22.	Baranagar	2003	2003	2003	2003	1	Supported by SHISUK
23.	Chargram	2003	2004	2004	2004	2	
24.	LKS	2004	2004	2004	2004	1	
25.	Khirai	2002	2004	2004	2004	4	
26.	Pankowri	1996	1996	1996	1997	2	

Table 2: Fish production data of Floodplain Aquaculture Projects surveyed by Infrastructure Development project of Department of Fisheries during September 2008

Sl No	Name of the Project	Area (ha)	Total Share holder	Production of Fish			
				Cultured (KG)	Natural (KG)	Total (KG)	per cent of Natural Fish
1.	Pankowri Fisheries Ltd	103.24	536	470223	10664	480887	2.22
2.	LKS Fisheries	51.00	247	134396	3876	138272	2.80
3.	Khirai Fisheries	60.73	248	242139	13600	255739	5.32
4.	Proshanta Fisheries	170.00	777	215,519	21177	236696	8.95
5.	Chargram Fisheries	98.38	618	207139	14530	221669	6.55
6.	Baranagor Fisheries	43.72	295	144598	185	144783	0.13
7.	Dhanuakhola Fisheries	13.41	63	64000	80	64080	0.12
8.	Shaibal Fisheries	38.87	104	419740	190397	610137	31.21
9.	S B Fisheries	18.22	70	58400	3600	62000	5.81
10.	Prantic Fisheries	106.88	50	250000	20540	270540	7.59
11.	Apushi Fisheries	27.13	90	100000	1000	101000	0.99
12.	Bismilla Fisheries	8.50	98	95939	2100	98039	2.14
13.	Koshkandi Fisheries	46.96	200	250000	10000	260000	3.85
14.	Maitree Fisheries	66.80	245	216774	4621	221395	2.09
15.	Asia Fisheries	168.42	559	364560	9000	373560	2.41
16.	Shatata Fisheries	46.76	26	185532	1311	186843	0.70
17.	Shugandha Fisheries	121.46	217	360000	12000	372000	3.23
18.	Himalay Fisheries	72.87	300	200000	4000	204000	1.96
19.	Bashara Fisheries	48.58	160	142678		142678	
20.	Sat Tara Fisheries	50.20	265	106,560	12000	118560	10.12
21.	Raj Hongshi Fisheries	21.45	40	77,200	800	78000	1.03
22.	Shishir Fisheries	14.58	31	154,800	2000	156800	1.28
23.	Padma Fisheries	63.00	197	198,000	2000	200000	1.00
24.	Kushiara Fisheries	16.19	65	148,914	3086	152000	2.03
25.	Rupali Fisheries	35.63	75	90,000	1000	91000	1.10
26.	Sonali Fisheries	6.07	90	30000	3636	33636	10.81
27.	Shuktara Fisheries	11.54	55	43720	280	44000	0.64
28.	Rupashi Fisheries	8.10	90	40000	500	40500	1.23

Sl No	Name of the Project	Area (ha)	Total Share holder	Production of Fish			
				Cultured (KG)	Natural (KG)	Total (KG)	per cent of Natural Fish
29.	Shonartari Fisheries	12.15	163	79500	650	80150	0.81
30.	Rupchada Fisheries	54.67	360	160000	2000	162000	1.23
31.	Pasgasia Fisheris	10.80	5	12,600	1050	13650	7.69
32.	Mokka Modina Fisheries	10.97	110	20000	1000	21000	4.76
33.	Shapla Fisheries	14.57	58	185,900	1600	187500	0.85
34.	Shingula Fisheries	32.39	137	64,000	2800	66800	4.19
35.	Rupali Fisheries	16.60	75			0	
36.	Marufa Adarsha		110	9320	3040	12360	24.60
37.	Masranga Fisheries	10.93	36	41,080	1120	42200	2.65
38.	Pashchim Noaddha	14.22	15	10583	445	11028	4.04
39.	Shornali Fisheries	36.44	41			0	
		1,852.43	7,156	5,593,814	361,688	5,955,502	6.07

4.0 Impact of the Model

The Enterprise Approach model has demonstrated success in multiplying production, generating income and employment, ensuring sustainable management of the water resources, protecting bio-diversity, and contributing to social fertility, sustainable agriculture and favorable productive ecology.

4.1 Economic Impact

4.1.1 Enhancing fisheries resources: Production of fish from aquaculture relieved acute fish crisis prevailing in open floodplain areas where severe over-fishing has caused significant depletion in catch. So-called free access to the common property resources enables blind exploitation of the resources to the point of resulting in complete collapse of the resources. The community initiatives in aquaculture projects are the positive steps taken to protect the ensuing collapse of fisheries resources albeit in limited scale.

The low lying areas under the projects possess many canals and ditches. These canals and ditches are the deepest areas where natural fish can take shelter during the dry period and can breed during the next rainy season. In case of free accessed open water, such ditches and canals are harvested fully through complete drying.

On the other hand, such ditches are not dried completely inside the project area, because the land owners (ditch owners) are specially compensated from the management. The communities will know better the effect of keeping some natural fish as brood for the next year. Once fish can breed, the spawn can grow to fry – fingerling - juvenile and up to adult within the protected area inside projects. Thus both production and biodiversity of fish are protected and enhanced just like 'sanctuaries' to give benefit to the local people.

4.1.2 Additional benefit for fisher community: The Fishers community has gained new dimension in their occupation for harvesting the fish produced in the floodplain projects. The diminishing trend of their traditional occupation, as prevailing elsewhere in the country, has been reversed in this project area through the community- based aquaculture projects. In each project, two to five fishers' groups, each group comprising 8 to 12 fishers, are needed to complete the harvesting within 4- 5 months. Gross employment generation from harvesting ensures a flat earning of Taka 200 (USD 2. 40) per fisher per day throughout the year.

4.1.3 Employment generation: Acute unemployment around the floodplain area is prevalent. Potential labour force has to migrate to urban areas to seek jobs. There are huge amounts of investments from the community during the establishment of each project. To accomplish this huge economic activity, new employment opportunities have been created in the locality. The nature of employment has also diversified to great extent. One can choose from the range of options like self- employment, daily

wage basis employment, or contact basis employment for longer period. Starting petty business in fingerling supply, fry nursery and feed supply, opening small shops in any growth centre, or operating rickshaw- van or mechanised trolley as useful carrier of goods on rural roads are some of the examples of self- employment created.

4.1.4 Increased agricultural productivity: Soil productivity has increased following the use of natural fish feeds during the operation of aquaculture activities, as well as the use of cow dung at the rate of 2- 3 kg/ dec during the preparation stage and at a rate of one quarter of this dose during post- stocking period as the need arises. Good amount of fish feed like oil cake, rice bran, etc, also supposed to be left unused, going back to the soil during the flooded season, has good consequences on the phosphate and organic matter content of the soils.

Fish feces also have good effects on manuring the soil underneath. All of these increase organic contents in the soil and help increase agricultural productivity. Rice farmers in pilot project area reported that average paddy yield has increased 15- 20 per cent at post- project situation.

4.1.5 Reduced agricultural production cost and use of underground water: This trend is also evident in the pilot project area in Daudkandi experience. Fish- feed, fish fertilizers and fish droppings inseminate the land up to a good extent that reduces need for chemical fertilizers for crop cultivation. This is an effective by- product, reducing production cost for paddy farming. A systematic step- by- step water drainage from the fishery, which is completed just before the paddy transplantation season (December) will enable farmers to transplant crops without ploughing. It also saves the use of underground water as the community can hold the surface water until the plantation season.

The lands under aquaculture remain clean and soft and do not require tilling or de- weeding before planting of seed or seedlings, whereas farmers in the past had to spend around Taka 1,500 per acre (USD 50/ha) for clearing, allowing multiple savings for these farmers. Besides the economic savings and gains, reduced application of chemical fertilizers is setting the environmental equilibrium in the locality.

4.1.6 Sustainable Agriculture: A remarkable shift in the farming systems is noticeable in the project area in terms of input use and environment protection. The rice farmers as a result of motivational efforts and aquaculture practice have reduced use of chemical fertilizers and pesticides. Recycling of household agricultural inputs like rice bran and cow dung during aquaculture is said to have increased soil fertility significantly. Moreover, unused fish feed associated with the fecal matters is believed to have increased the soil fertility further. At the end of harvesting, en masse plantation of rice helps less infestation of pest. Significant change in the farmers' behaviour has also been noticed as majority of the rice farmers interviewed in February 2007 reported not using pesticides in two Unions of SHISUK's commend area.

Department of Agriculture Extension (DAE) has been implementing Farmers Field School (FFS) throughout the country in more than three decades. The participants of each FFS were selected randomly from scattered villages from selected unions. SHISUK found out that the conventional selection process was a constraint to have better impact, as IPM practice was not easy for the participant farmers who comprise a little fraction of the total farmers and the rest of the farmers are not motivated to follow the same farming principles. Based on the lesson, DAE has tested an alternative approach on SHISUK's request, which is to select at least 40- 50 per cent farmers of a selected field for FFS, so that they can motivate/influence others to practice IPM as a whole to have an impact. It was a successful experiment as the focus area of agriculture field became pesticide- free area within a year,

which also had a "demonstration and trickle down" effect on the neighbouring field farmers.

The first IPM club, constituted of the trained and motivated IPM practitioners, was also formed by the farmers in SHISUK's commend area in February 2003. So far 2,479 enthusiastic farmers of 46 villages have formed 67 IPM clubs in the sub-districts. SHISUK has taken an initiative for networking these IPM clubs and to form a forum of farmers. Sixty-seven IPM Clubs were invited to 4 daylong workshops to discuss the issues on self-monitoring of pesticides, safe food and organic agriculture. SHISUK also involved them to develop a database on pesticide use and its adverse effect on their community. A detailed plan has been worked out for future actions, like the clubs have members' savings of Taka 26,81,576 (USD 33,000), with which they planned to start a credit program for the group members and also to look for alternatives for collective investment.

4.2 Social Impact

4.2.1 Impact on Poverty and Gender This approach does not only help in lifting households out of extreme poverty through increasing incomes, enhancing asset bases and improving employment opportunities, but also serves as a catalyst to allow households to 'reach the next rungs of the ladder' by integrating them into the wider community both socially and economically. A community-wide integrated approach is necessary to sustainably lift households out of extreme poverty. Such approach (i) helps average households within the community (whereas solely targeting the extreme poor does not help them overcome the stigmatisation they experience) and (ii) institutionalises economic gains (whereas, for example, providing assets on an individual basis entails the risk of distress sales). The enterprises have strong multiplier effects through the creation of backward and forward linkages, which will further support sustainability.

The approach promotes peaceful coexistence of community members, reduces insecurity, especially for women, and improves gender relationships within project communities, as project participants are working together for both collective and individual benefit, whilst male household members observe the economic benefits brought by women's involvement in collective enterprises.

It is evident that community cohesion has increased as a result of reduced outward migration and displacement due to improved livelihood opportunities at home.

4.2.2. Social networks It is clear that social networks have increased. The local level leaders of the projects meet with each other in project offices and share and exchange information on various aspects of rural life. The construction of the embankments has increased mobility of the people during the wet season and hence increased social interaction. Most projects have funds

for community expenditures that help strengthen community relationships.

4.2.3. Law and order situation and conflict resolution There is considerable evidence to suggest that the law and order situation has improved as a consequence of the projects. Poor people now find work in the project, at non-traditional labour times of the year, and therefore refrain from becoming involved in criminal activities. Conflicts are also said to have decreased and resolved out of the court through participation of local level institutions, individuals and in some case of Pankowri, the Board of Directors. Solaiman (2007) reports that floodplain aquaculture projects have increased the level of interaction between neighbouring villages and have a wide, positive benefit.

4.2.4 Increased food security and nutrition intake Priority is being given to buy fish for the community people at reasonable farmgate prices before transporting to the market. Projects also distribute some fish to the extremely poor people. Moreover the shareholders (community members) can buy fish on credit around the harvesting season and pay during receipt of dividend or land rent which enables more intake of fish.

4.3 Impact in Responding to Climate Change-related Issues

In the disaster-prone area poor and marginal farmers and fishing families are the usual victims due to their individual financial and physical incapacity. There is no safeguard or risk-sharing mechanism to protect their livelihood. Frequent flooding, erosion and lower fertility of arable land make the agriculture-based Bangladesh economy dilapidated where majority of the population are farmers. The number of climate refugees or the migration of rural people, especially farmers, inside and outside the country, multiplies due to the disposal of holdings, unemployment and poverty. The nexus of human traffickers even takes the advantage of their misfortune.

The projects are addressing the climate change effects through the following adaptation and mitigation measures.

4.3.1 Improved groundwater table and reduced contamination in groundwater Concentrations of dissolved Arsenic in the aquifers of Meghna basin ranges from below detection limit ($<5.2\ \mu g/l$) to as high as $676.8\ \mu g/l$. Depth profile of Arsenic concentrations in the groundwater (Fig. 23a) shows that occurrences of high Arsenic (exceeding WHO guideline value of $10 \mu g/l$) is maximum in the shallow aquifers (<150 m) and the deeper aquifers (>150 m) are mostly below the WHO guideline value. Spatial distribution of groundwater Arsenic in the shallow aquifers (Fig. 23b) further depicts the typical patchy occurrences of high Arsenic in the alluvial aquifers of western part in the study area (Daudkandi, Muradnagar, Debidwar, Chandina).

Though the Holocene deeper (>150 m) aquifers are low in dissolved Arsenic (mostly $<10\ \mu g/l$), they are at risk of cross contamination from the upper shallow aquifers, as the deeper aquifers are not separated from the shallow ones by continuous impermeable layers. Large-scale abstraction of groundwater, particularly installation of high-capacity irrigation wells in the deeper aquifer, would certainly increase the risk of cross-contamination.

It is also evident that there is a trend of improvement of the ground water table in the pilot project area in Daudkandi. It may be the result of more time for recharging the ground water table, as well as less drawing from the underground water for irrigation due to better management of the flood water (systematic drainage to keep the soil wet during the sowing or plantation).

4.3.2 Restrict migration to urban area The community-based enterprises created significant amount of employment locally where the working people can stay within the community and contribute to household activities during the off periods.

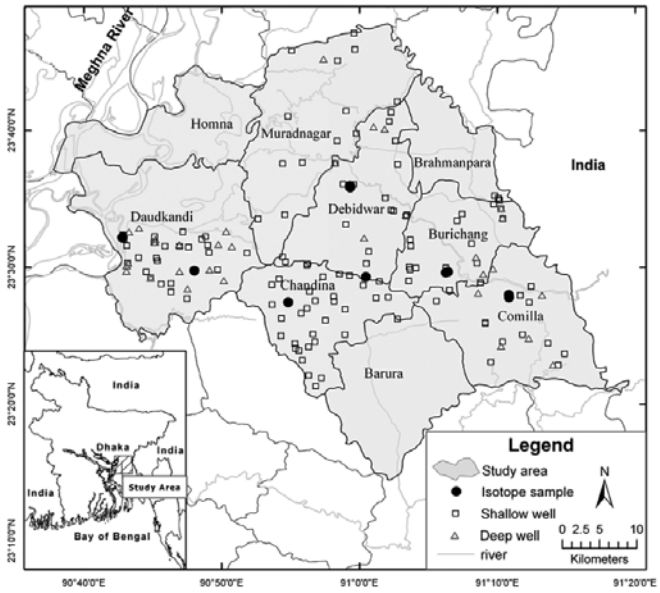


Figure 6. Groundwater sampling points and geological section line (E-W).[4]

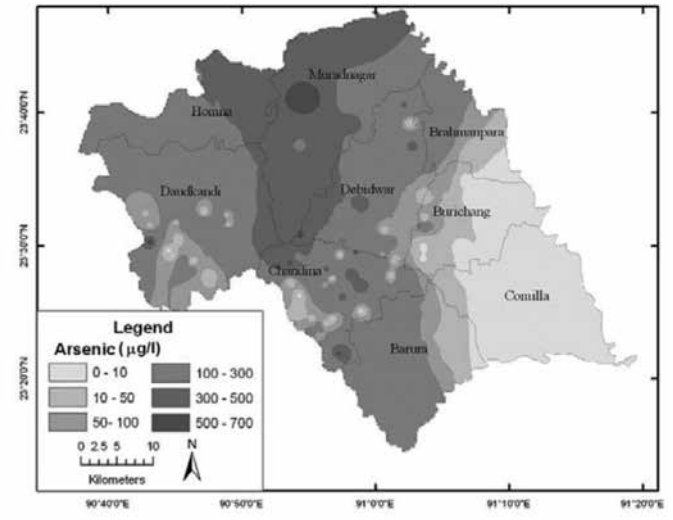
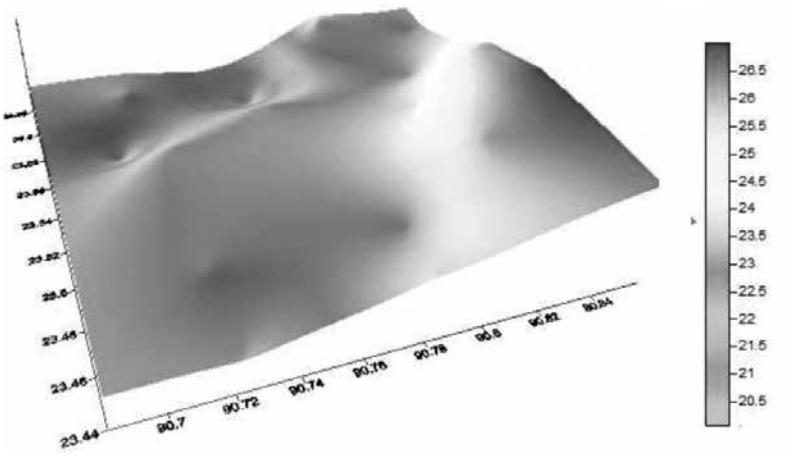
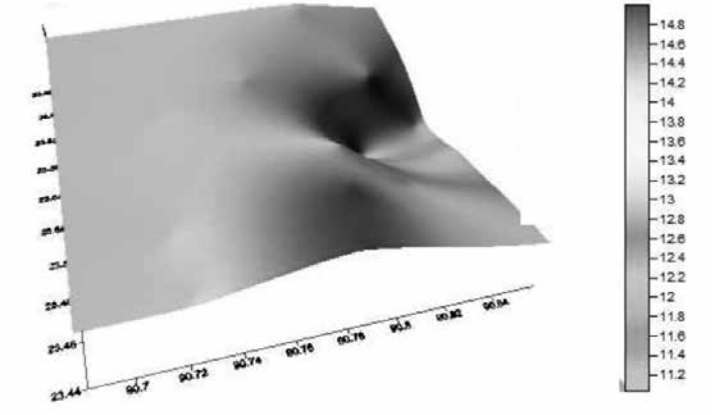


Figure 23. distribution pattern of groundwater arsenic concentrations in the study area.



depth of ground water table varies from 20.5 m- 26.5m (1986)



depth of ground water table varies from 11.2m- 14.8m (2008)

Opportunities for many new small- scale businesses also open up. Many household small ponds can turn into fingerling's nursery/ hatcheries to be sold to the project. With the increased economic activities around the project, there are many growth centers being set up.

4.3.3 Building Community resilience Floodplain fisheries are robust renewable resources, and can remain extremely productive and diverse through proper management. Attempts to protect Bangladesh's floodplain resources from mismanagement and to ensure their equitable use have been made including the establishment of community- based organisations (CBOs) to facilitate the management of the resources by the community. The approach has integrated the overall community and sustainable management of the resources.

The approach helps to establish self- esteem, mutual respect and togetherness within the society through facilitating more interaction and participation, and to create a favourable environment for good governance. As a result the down- trodden, landless, rich and poor, local administration, community leaders, etc, have the opportunity with equity in the participatory management process leading towards a sustainable socio- economic development. This keeps an augmented atmosphere for better social tie and integrity.

By way of active involvement and practice, and by teach- ins when required, the stakeholders have become familiar with these concepts and workable apts. Ability to cope with natural disasters such as storms, floods and droughts, and to adapt to ongoing processes resulting from climate change (e. g. loss of biodiversity due to reduced rainfall and increased drought) has been enhanced throughout the project, at both the household and wider community levels. The stakeholders have undertaken adaptation and mitigation challenges in changing environments/ climate through collective risk sharing, reduction of production cost, promotion of better marketing mechanism and sustainable

management of their own resources. The positive social impacts of the project, as outlined in the previous sections, have improved the communities' abilities to respond collectively, whilst the economic gains the project brings have increased households' resilience in facing these events.

5. Policy Advocacy

The Community Enterprise Approach in Floodplain management pioneered by the NGO SHISUK (Shikkha Shastha Unnayan Kazakram) in the Daudkandi area since 1995 has been able to attract national and international attention. For its outstanding contribution in community mobilisation and self- reliant initiatives at the Pankowri Fisheries, SHISUK was awarded 'National Gold Medal' in 1999 by the Ministry of Fisheries & Livestock, Government of Bangladesh. The Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP) carried out an evaluation for the Community Initiatives for Fisheries Development in Pankowri Fisheries project in 2001 with the aid from the Pesticide Action Network Asia and the Pacific (PAN- AP). The Department of Fisheries recognised the innovative approach of SHISUK and invited to prepare a Technical Manual on 'Strategic Planning and Implementation Guidelines on Community Based Floodplain Aquaculture' in 2004.

Thus, SHISUK was able to steer significant stimulation at policy level regarding the concept of Community Enterprise approach, and now the government of Bangladesh has adopted the model and undertaken different projects to replicate this model in other districts. Due to its potential to improve the rural economy, the development of the fisheries resources was regarded as an important means of reducing poverty and boosting pro- poor growth.

SHISUK's initiatives have also been marked by the Food and Agriculture Organization (FAO) as 'a promising model for self-reliant, community- based development' and expressed its interest to

A Happy family of a female group member who took loan from their CBO for bamboo-basket making.

understand the model in greater depth in order to see what relevance this approach might hold for the other countries in the region. With the partnership with PAN- AP, SHISUK has been rendering technical support to the community- based organisations for agro- ecology and food sovereignty. Much of these achievements have received wide coverage in media, both in electronic and print, depicting details of success stories of the community development and fighting process against hunger, social discrimination and poverty.

In 2005, SHISUK developed a Training Centre at Daudkandi and has been providing training on their floodplain aquaculture approach to DOF officials and other NGO workers since. SHISUK is also promoting their approach in the Chalan Beel area, in coastal polder areas, and is seeing great potential for floodplain management in the climate- change affected flood area.

Endnotes

1 Bangladesh Water Development Board

2 Presumably full time fishing, as virtually all rice farming households fish at certain times of the year.

3 There is some evidence to suggest that they have not been completely successful in this and that significant corruption is going on within the Pankowri Board of Directors.

4 Arsenic in Groundwater of Bangladesh: Options for Safe Drinking Water- Asia – Swedish Research Link Programme 2004- 2008, Prosun Bhattacharya, Gunnar Jacks, Mattias von Brömssen; Kazi Matin Ahmed, M. Aziz Hasan; Stockholm; August

Weathering the Climate Crisis: Community Approaches to Climate Change

Rural Women's Association "Alga"

Background

Kyrgyzstan is a landlocked country in Central Asia with a total area of 198,500 square kilometres (km^2) or 19,850,000 hectares (ha). It is bordered in the north by Kazakhstan, in the east and southeast by China, in the southwest by Tajikistan and in the west by Uzbekistan. It became independent from the Soviet Union in August 1991. The country is divided into six provinces (oblasts).

The country is largely mountainous, dominated by the western reaches of the Tien Shan range in the northeast and the Pamir- Alay in the southwest. The highest mountain is the Victory Peak (Tomur Feng, 7,439 metres above sea level) at the eastern tip of the country, on the border with China. The mountain stands in the Mustag massif, one of the world's largest glaciers, covering 1,579 km^2. About 94 per cent of the country is located at more than 1,000 meters above sea level, and 40 per cent above 3,000 meters. Much of the mountain region is permanently covered with ice and snow, and there are many glaciers (covering about 4 per cent of the territory).

The cultivable land is estimated at 10.1 million ha. The total population is about 5,515,600 (September, 2011), of which 61 per cent is rural. Kyrgyzstan is the second poorest country in Central Asia.

The climate in Kyrgyzstan is continental with hot summers and cold winters, during which frost occurs all over the country. The frost-free period is 185 days per year in the Chu valley, 120-140 days per year in the Naryn valley and 240 days per year in the Fergana valley. Double cropping is therefore limited to vegetables. Average temperatures in the valleys vary from -18 degrees Centigrade (C) in January to 28 C in July. Absolute temperatures vary from -54 C in winter to 43 C in summer. The average annual precipitation is estimated at 533 millimetres (mm), varying from 150 mm in the plains (Fergana valley) to over 1,000 mm in the mountains. Precipitation occurs during the winter season, mainly between October and April, when temperatures are low. Rain-fed agriculture is therefore very limited. Snowfall constitutes an important part of the total precipitation. About 10 per cent of the territory, situated at the lowest altitude, is classed as arid.

The country can be divided into two hydrological zones: the flow generation zone (mountains), covering 171,800 km^2, or 87 per cent of the territory; and the flow dissipation zone of 26,700 km^2, which is 13 per cent of the territory. Most of the rivers are fed by glaciers and/or snow melt. Peak flows occur from April to July, with 80-90 per cent of the flow in the period of about 120-180 days extending to August or September.

The total number of natural lakes in Kyrgyzstan is 1,923, with a total surface area of 6,800 km^2. The largest lake is Lake Issyk-Kul with a total area of 6,236 km^2.

Due to the glacier and snow origin of most of the rivers, low and unreliable flows are often the rule in the months of August and September, which correspond to the latter part of the growing season.

Regulation of these flows is thus needed to ensure that adequate water supplies are available over the whole cropping period.

The Kyrgyzstan Glaciers are a vital part of the landscape and serve as moisture accumulators. The glacier in Tien- Shan covers an area of 0. 5 km^2 but if it melts can produce water of 200 ha, inseminating the soil. Thus the total amount of preserved water in the mountains of Kyrgyzstan in the form of glaciers is 650 billion cubic metres (m^3), which transcends at an increased rate of almost 12 times, while it flows as a river in the country.

Kyrgyzstan acknowledged the problem of global climate change and in 2003 ratified the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC). It is estimated that the energy sector of the country is responsible for approximately two-thirds of total carbon dioxide emissions, and in absolute terms this amount will likely grow, even with the increase in share of produced hydropower. Related to the global climate change in Kyrgyzstan is a problem of deglaciation. The area occupied by glaciers has decreased by 20 per cent lately and there are concerns that glaciers in the country can disappear by 2100.

According to geologist Bakutbek Ermenbaev, who is an expert at the national hydrogeology agency, global warming is the main factor that has led to the excessive melt. He argues that, within a century, all of the country's 2, 200 glaciers could disappear, if world leaders do not come to an agreement this year. The thing about the Kyrgyz glaciers is that they are of paramount importance to water supplies in Central Asia, together with other ice spreads in neighbouring Tajikistan. Careful and sustainable exploitation is therefore absolutely necessary, so that all the lands being irrigated from rivers spawned by the glaciers do not experience the adverse effects of drought. "In normal circumstances the glaciers would melt in the summer season, but regain their size in the winter," Ermenbaev reveals, adding that over the past years this has not been the case. The amounts of ice depleted in the summer did not grow back in the winter.

"On average, all around the country, we can say the glaciers have decreased in size by about 20 per cent. In the last 20 years this has been happening more rapidly than in the previous years. When a glacier starts melting it creates small lakes, and each year the size of those lakes is growing," the expert explains. The thing about this trend is that it appears beneficial in the short term. Downstream countries will benefit from more water for their cotton-growing industries, but within a few decades the supplies will be completely depleted, leading to massive economic consequences.

"The process of melting glaciers is a very serious problem for Kyrgyzstan because the main water resources are connected first of all with the glaciers," Anna Kirilenko, ecology expert, said.

Specialists also say that glacier melting would have a severe impact on the agrarian sector and food security. Some farmers are already experiencing the impact. "I grow tomatoes, cucumbers and cabbages every year. Usually I would have a good harvest and good money, but previous years there was almost no water from the river coming from the mountains and in water channels. This year's harvest is all gone because in August for almost two weeks there was no water and all plants dried out," Aiymkhan Israilova, a small-scale farmer in Krasnaya Rechka village, said.

Ryskul Usubaliev from the Central-Asian Institute for Applied Geosciences (CAIAG) said that one of the factors affecting food security is the uneven location of the glaciers. "Those parts of the country that have fewer glaciers and the largest population will experience shortages of water in the summer irrigation period. Some regions, the western part of Chui valley in particular, are already suffering from such a shortage," said Usubaliev.

Kyrgyzstan also acknowledged the problem of desertification and in 1999 it acceded to the United Nations Convention to Combat Desertification. Desertification poses a real threat for Kyrgyzstan. According to the Country Development Strategy for 2009–2011, of

10. 6 million ha of total agricultural land more than 88 per cent were found to be degraded and subject to desertification. Areas of soil re-salinisation have increased and claimed 75 per cent of all arable land. Approximately half of all pasture lands are classified as degraded for both vegetation and soils.

Waste of the mining industry poses a direct threat to the environment of both Kyrgyzstan and neighbouring countries. Located at high elevations in a fragile mountain environment, the mining industry has generated hundreds of millions of tons of waste rock and tailings in dumps and tailings ponds which serve as a source of permanent pollution to the environment of heavy metals, radioactive materials and cyanides. The bulk of the mining waste is located in river basins, and since Kyrgyzstan belongs to those areas subjected to a great extent to natural disasters such as earthquakes and landslides, this presents high risk of trans- boundary pollution. The potentially affected population in Kyrgyzstan, and near border areas of Kazakhstan, Uzbekistan, and Tajikistan are estimated at 5 million.

Climate change consequences affect markets, nations and the environment, and most importantly, people. In order to grasp the full effect of climate change, it is necessary to understand how societies deal with this issue: who loses their livelihoods first when weather patterns shift? Who cares for sick family members when they drink contaminated water? Who survives natural disasters, droughts, floods and famine?

The World Bank Strategic Framework on Climate Change and Development acknowledges that "the poorest countries and communities will suffer the earliest and the most" from climate change. Poverty, however, is not a uniform phenomenon; social roles and hierarchies defined by ethnicity, geography, class, language and other factors diversify the experience of poverty within nations, communities, even households. For women, unequal divisions of labour, decision- making power and access to resources have resulted in a widespread "feminisation of poverty," leading the Women's

Environment and Development Organization (WEDO) to argue that "women are the most vulnerable and best poised to curb the effects of climate change. "

Climate change in Kyrgyzstan as well as in other countries affects many sectors, including water resources, food security, ecosystems and biodiversity and human health. Main impacts of climate change in the country today are melting of glaciers which cause desertification, flooding, shortening of natural water resources, soil erosion, sharp changing of day and night temperatures which causes shifts in crop growing seasons, and sharp increase in the rates of extinction of many habitats and species.

The rural population makes up the greater part of Kyrgyzstan's population. According to statistics women comprise 60 per cent of rural population. Agriculture in Kyrgyzstan is a significant sector of the economy. According to statistics it comprises 35. 3 per cent of the total gross domestic product (GDP) and occupies 55 per cent of the total labor force. Only 7. 5 per cent of the total land area is used for crop cultivation, but 44 per cent of the land is used as pastures for livestock. Because of the many mountains of Kyrgyzstan, animal husbandry remains a significant part of the agricultural economy. Cultivation is centered in the Ferghana Valley, Talas and Chuy Provinces. Among Kyrgyzstan's agricultural products are tobacco, cotton, potatoes, vegetables, grapes, fruits, and berries. As far as total production, the largest crop is assorted types of animal fodder to feed the livestock of the country. The second largest crop is winter wheat, followed by barley, corn, and rice. Significant animal- derived products include sheep, goats, cattle, and wool. Chickens, horses, and pigs are also present. In some regions, yaks are herded and bred. Of these, the top products for export are cotton and tobacco. Meat is also exported.

Women play significant role in agriculture of Kyrgyzstan, rural women are 60 per cent of rural population. Besides the homework women are responsible for collecting water and firewood, crop diversification,

alternative cultivation methods, food preparation, and small- and medium- scales harvesting.

Women farmers are often the first to lose their livelihoods in climate change affected communities and last to find new work in formal sectors. Moreover, women spend up to four hours per day collecting water and firewood, thus their opportunities to participate in wage earning activities are decreasing. Double burden of rural women's lives is the obligatory responsibility for healthcare, childcare and food provision. Thus women farmers are most interested in adaptation and mitigation measures that support small- scale crop production and access to renewable energies inside the household for domestic use.

At the same time impacts of climate change are new phenomena in Kyrgyzstan and farmers have just started to carry out adaptive changes on the weather and management practices. Traditional knowledge has played a significant role in adaptation efforts, especially in the frame of low technologies. Farmers have been coping quite well with changes in climate through traditional knowledge and practices although the country has no climate change adaptation policy.

Alga conducted case study research in Chui oblast, northern part of Kyrgyzstan. Chui oblast is the biggest administrative and geographical district of the country, named after the river. Intermediate research was conducted in 20 villages using interviews, questionnaires and focus group discussions with farmers and experts. Case study research reveals that farmers do not understand the science of climate change but they rightly observe and feel its effects. Farmers observe a number of practices to adapt to climate change, for example, diversification of varieties and species of domestic livestock, changing intensity of production and geographical areas for planting and livestock mixed cropping, agro- forestry and developing seeds for local climate. Various water use and conservation strategies include surface water and groundwater irrigation. But unfortunately farmers can not deal with some specific impacts of climate change. Sharp changing of day and night temperature, humidity and other weather parameters

influence pest and disease spread. Higher temperatures speed up the lifecycle of some insect pests, for example, so that pest populations grow faster. Similar impacts on disease vector insects will affect the spread of some diseases. And outbreaks of many plant diseases are directly related to climatic conditions. Farmers just use agrichemicals to break the chain of pest and diseases spread.

There is a common saying that water is the defining link between the climate and agriculture. Kyrgyzstan, being an upstream country, is playing the role of a "water tower" in Central Asia. In Kyrgyzstan agriculture consumes 70–90 per cent of total water use. Due to water resources shortening and drought, farmers use the method of drip irrigation. This method helps to save available water resources and for farmers to use it more effectively. Water is pumped from water reservoir and flows into pipes with emitters scattered throughout the plot, which discharge the water into the soil near the plants by means of a slow- release mechanism. Method of drip irrigation is very effective to apply just enough water to ensure good harvests. Special knowledge is needed to construct the system. Farmers pointed out that the cost of the system (pumping equipment, mechanisms, and spare parts) is expensive.

"I wish to have drip irrigation at my field. Water is the big problem, especially in last couple of years. Previously I thought water distributors wanted to have extra money for water, but then I believed that it was a problem of water shortening. I do not want to suffer more losing harvest. I have to pay credits back, but have to have drip irrigation first to have more harvest and money," said Attokurov Talant, Ivanovka village.

Some farmers are starting to re- plan their field. If previously rows with plants in the fields were long (up to 3 km), now farmers make short rows across each other.

Smallholder irrigation is most important where farmers' resources are limited. It evolved from traditional irrigation practice with

limited external intervention. The practice emerged from knowledge obtained through observation and experimentation, handed down through generational experience and wisdom. Current practices encompass both traditional knowledge and modern techniques, and irrigating communities are capable of assimilating and adapting outside knowledge and experiences to improve their own situation. Smallholder irrigation schemes have a number of advantages compared with large-scale irrigation. In addition, they are farmer-managed and have high water-use efficiency and low environmental degradation. Such methods help to use water more effectively and prevent washing away ground soil.

Agricultural land is strongly affected by excessive use, anthropogenic pressure and climate change of course. Swamping, increased salinity and erosion processes contribute to the loss of the biological productivity of land. Water erosion is the most dangerous. About 10-20 tonnes per ha of soil particles are washed away during irrigation and 70 tonnes per ha of soil is washed away from un-irrigated arable lands by precipitation. On the other hand, as a result of land reforms conducted in recent years, land re-distribution issues have mainly been resolved, yet work related to improving agricultural land has almost ceased and land has not been reclaimed. All these have led to reduced soil fertility that currently is estimated as critical.

Another initiative used by local farmers to save water, avoid water contamination, preserve ground water, and save soil is the construction of wetlands. There is a constructed wetland in Ivanovka village. It is constructed of three main parts: sedimentation tank, filter and last storage for infiltration or reuse, where also the effluent can be sampled and monitored. Wetland is designed for grey water including shower and kitchen wastewater from a household of 7 persons. Construction of wetland needs special knowledge and expensive financial inputs. Constructed wetlands can also be made using low-tech equipment such as pump, pipes and foil. Clay can be used as a sealant as well. If there is enough slope, a pump may not be needed.

Another initiative used by farmers in Kyrgyzstan to preserve groundwater and to enrich soil is construction of urine diverted dry toilets (UDDT) in place of pit latrines. The principle of a UDDT is to keep feces and urine separated. For this purpose special seats or slabs are needed, which safeguard the separation. After the separation, the feces are covered with an absorbing organic material and kept directly in a special feces chamber or in a container placed in the feces chamber of the toilet. The urine is stored in a tank. Due to the separation, urine can be used easily and safely as fertilizer on household level without extra sanitising. Before feces can safely be used, they have to be sanitised, i. e. pathogens have to be eliminated. This is achieved by different methods, such as alkaline treatment with ashes, adding soil and sawdust, and storing. Construction of UDDTs and recycling organic materials contribute to safeguarding soil fertility and improving its structure and water retention capacity, while providing a natural alternative to chemical fertilizers. In this practice the term "agricultural reuse" refers to a wide range of productive, ecosystem- oriented reuse options. This includes reuse in what could be considered traditional agriculture, i. e. on farmers' fields where crops such as cereals are grown. It also includes the reuse not only of nutrients but also of grey water, the organic content of wastewater and energy.

Climate change focuses attention on crops and species planting in relation to drought and weather intolerance. Low crop yields result from degraded lands, inherent low soil fertility and inadequate water supply related to climate change and variability.

Farmers depend on their crops, so the need is for crops that are able to perform in difficult environments, but also produce high yields when conditions are more favourable. Agro- biodiversity is under threat. Farmers try to choose seeds of local origin. But as far as almost all structures for seeds production were destroyed with the collapse of Soviet Union, farmers cultivate seeds of local origin which they believe are resistant to climate change and more adaptive to temperature fluctuations. Some farmers shift to cultivating crops

that are more tolerant of droughts and temperature fluctuations. Another practice used by farmers to cope with climate change impacts is crop diversification, which means increasing the varieties of crops cultivated in the farm. Crop diversification acts to reduce susceptibility to climatic variability which results in crop failure.

Temperature is very much related to growth cycles. There are two major forms of extreme temperature stress on crops - heat and cold. An increase in temperature speeds up development and low temperature slows the process. Farmers say that for the last years they have noticed the break of cycle between sowing and harvesting as sharp changes of day and night temperatures happen often. Thus crops do not grow at all. Many farmers plant seedlings in place of seeds. Planting of seedlings are more effective. To avoid sharp changes of day and night temperatures and to protect roots of plants farmers use the method of planting seedlings using oilcloth. Farmers prepare usual row, cover it with simple oilcloth (1 mkr) and make slots for seedlings. Each seedling is planted in separate slot. This method helps to prevent weeds and protects roots from temperature fluctuations. Another benefit of this method is economy of water, i. e. water runs by oilcloth, every seedling has its own portion of water and water doesn't flush away the soil.

Climate change impacts on soil deterioration, which is one of the main challenges to future agriculture and food security. Farmers who realise problems of soil degradation add compost, crop residues, animal manure, and chipped wood. Of course organic in the soil means less carbon dioxide in the atmosphere. For example farmers explain that organic in the soil means returning crop residues to the soil. Farmers use compost for a small scale field. Compost is an inexpensive alternative to chemical fertilizers, and it is less likely to harm sensitive roots. Compost greatly enhances structure of soil. Another attempt of farmers to preserve soil and prevent desertification is planting of trees around. Planting of trees is considered to be land management practice spanning both adaptation and mitigation methods. Tree-based systems have some obvious advantages for

maintaining production during wetter and drier seasons, trees are less susceptible than annual crops to weather. Tree-based systems also deliver products such as fruits, fuel wood, fodder and construction materials. By adding trees to their systems, farmers are actively adapting to weather changes and contributing to mitigation of future climate change. This method does not request much financial allocations and additional work.

There is also the practice of constructing solar greenhouses for small-scale farms or at households. Farmers point out that it is expensive and needs special knowledge. Another method of using solar energy is solar drying of products for further selling. Solar drying is being practiced for the preservation of food and agriculture crops among farmers in Chui oblast. Previously it was done particularly by open sun drying. This process has several disadvantages like spoilage of product due to adverse climatic conditions like rain, wind, moist, and dust, loss of material due to birds and animals, deterioration of the material by decomposition, and insects and fungus growth. Also the process is highly labour-intensive, time-consuming, and requires a large area.

With cultural and industrial development, artificial mechanical drying came in practice. This process is highly energy-intensive and expensive which ultimately increases product cost. Moreover, this type of fruit drying is not affordable for rural families. Thus solar drying is the best alternative as a solution of all the drawbacks of natural drying and artificial mechanical drying. There is an easy method of solar drying construction, moreover, where cabin and table form solar dryers, does not request any special construction materials, and all materials available at home can be used for construction.

Briquette making exemplifies the potential of appropriate technology. It saves trees and prevents problems like soil erosion and desertification by providing an alternative to burning wood for heating and cooking. It substitutes agricultural waste like hulls, husks, corn stocks, grass, leaves, food and animal garbage for a valuable resource. It improves

health by providing a cleaner burning fuel. This is dramatically true in rural areas, where cattle dung in many cases is used for heating and cooking. And in these situations, it also improves agriculture by preserving the dung for pastures and gardens instead of letting it all go up in smoke. The briquettes are also designed for holding, growing, and protecting seedlings. These methods are starting to gain popularity almost all over the country, and farmers find them affordable and convenient. Solar dryers and Briquette- making saves energy and time, occupies less area, improves quality of the product, makes the process more efficient, and protects the environment. All these methods do not require special knowledge and materials.

Adaptation is a process through which societies make themselves better able to cope with an uncertain circumstance. There are many options and opportunities to adapt to climate change impacts. These range from technological options to the individual level. Knowledge transfer is essential to enable adaptive action. Climate change requires a global framework for international cooperation. Adaptation action is a vital part of this framework. Actions to enable adaptation to climate change pose opportunities to promote sustainable development.

A successful framework must directly involve assistance for adaptation. The same policies and policy instruments should be necessarily developed in attempting to tackle the climate change impacts. Government initiatives and interventions are useful in mitigation strategies. These can be in the form of regulations and standards, policies and regulations. Increasing public awareness, advisory services and good education and training programs can form part of the effective policies and instruments to reduce climate change impacts.

The threat of climate change problem is growing and due to the nature of the problem, national actions through regional and international mechanisms are required. However, these actions must be carried out within a sustainable development framework. Traditional knowledge and coping strategies must be maintained and strengthened;

otherwise, adaptive capacity may be weakened as local knowledge of the environment is lost. Strengthening this indigenous knowledge and building upon them further strategies will create more community ownership and involvement in the process. In order to achieve it and in order to strengthen farmers' capacity to adapt to climate change, it is necessary to educate farmers. Awareness creation can strengthen farmers' capacity to adapt to climate change and variability through:

- Sensitisation of farmers to climate change and inter- linkages with livelihood;
- Dissemination of information on adaptation to climate change and its impact on farmers through workshops, radio and TV broadcasts, cultural events, demonstrations and exchange visits, as well as public awareness materials such as brochures, posters and fliers with clear illustrations in understandable languages.

Fighting Drought and Water Deprivation in the Upland Community of Takilay in Roxas Mountain Range

Sibol ng Agham at Teknolohiya (SIBAT), Inc.

Sitio Takilay is located in the southern part of Bgy. Saravia about 15 kilometres southeast of the town center of Koronadal, in the province of South Cotabato, in the region of Mindanao in southern Philippines. The community sits atop a hilly portion of the Roxas mountain range that holds the municipalities of Koronadal, Tupi and Banga.

Bgy. Saravia could be reached via regular transportation until the adjacent barangay of El Gawel. Sitio Takilay then could be reached from Saravia through a 2- kilometre climb along a steep rugged foot trail.

The B'laans of Sitio Takilay

The Blaan Tribe is one of the indigenous tribes of southern Mindanao, largely found in the provinces of South and North Cotabato, Sarangani Province, General Santos City, and Davao Del Sur. The Blaan tribe consists the 4th largest tribe among the 18 ethno- linguistic groups that

were recorded to have inhabited Mindanao long before the Spanish colonisers came to the island. Population estimates made in 2006 revealed that at least 500, 000 Blaans are currently spread across the mountains of South Cotabato, Sultan Kudarat, Sarangani, Davao del Sur and North Cotabato. [1]

The B'laans of Roxas Mountain Range live and farm on some 350 ha that consist the ancestral territory of the B'laans in these parts of South Cotabato. There exists remnants of primary forest near the community; residual and secondary forests in the foothills and in the northwestern side towards the adjacent village of El Gawel. They originally settled in what is today called The sitio of Takilay (named after a big tree called 'kilay', which abounds in the community) . The Muslim- Christian conflict that besieged Mindanao in 1974 forced the villagers to leave the place. Takilay officially became one of the sitios of Bgy. Saravia in 1983.

Within the generally weakening indigenous patterns of Blaan lives, the traditional gender roles within the household remains strongly paternal or male dominated. The men in a typical B'laan village dominate the traditional political structure as members of the tribal bong *fulong*[2]. The women cannot hold the position as chieftain or fulong; they however participate in the selection of the tribal chieftain through a community meeting or process.

While traditional women's place is assigned to be in the home, as mothers and housewives, the women have a large share in the farm work with the men. The men prepare the land and the women plant and maintain the corn and rice crops in the entire season. Men and women plant the root crops in the swiddens while the men haul the produce from the farms to their houses and to the market down in El Gawel, where the women do the selling.

In the typical Takilay household, it is the woman who performs most child rearing tasks, from caring, bathing and helping children (who go to the school in El Gawel) with schoolwork. They also perform

most house maintenance activities, from cleaning, washing clothes, cooking, pounding rice and milling corn. The men gather and cut firewood for cooking. Collecting water from the spring sources are mostly done by women and children.

Agriculture and food production in the drought-prone conditions of Roxas Mountain Range

The B'laans of Sitio Takilay are upland farmers who have traditionally eked out their subsistence in the dry and largely cogonal parts of Koronadal watershed and forest reserve. They grow corn in narrow valleys and upland rice on hillsides or swidden farms through slash-and-burn or shifting cultivation. Corn is the dominant crop and harvested 2 to 3 times a year. Root crops (yam sweet potato, cassava), bananas, and coffee are also grown in these swiddens. Vegetables are grown in the valleys, swiddens and on backyards for household consumption and for market. A few chickens and pigs are raised for domestic consumption and are also sold in the market in El Gawel.

Food crop shortages, soil erosion and depletion of soil fertility describe the agro-physical conditions in the area, from a survey conducted in 1993. The produce are periodically not enough to tide the B'laans over between croppings. Root crops are the main survival crops for the B'laans during lean months. The men go out for paid work or pamugon in other farms. They also make and sell charcoal and sell bamboo for cash.

In 1995, the community was assisted to increase crop productivity, soil fertility and agroforestry. These efforts had increased productivity through multi-cropping and vegetable gardens, and had resulted in the decrease in the slash-and-burn or swiddening activities. It was evident, however, that the drought condition made severe by the lack of water supply deterred fuller productivity potentials in these

uplands. Farming is rain- fed or crop production is entirely dependent on climatic conditions.

The lack of potable water aggravates deprivation and the impact of drought in Takilay.

The inadequacy of water supply for both agricultural and household use is severe for most parts of the year. Dry months followed by torrential rains periodically affect the hillside crop production. Droughts dry up the crops and cause food shortages. The attack by rats often decimated crops or harvests. During these times, root crops become the only means to survive. Torrential rains erode the hillsides that affect the fertility of the soil.

Women and children used to fetch water daily from a spring, a shallow well and rain water for drinking and cooking. Washing and bathing were also done in the spring, which is about 917 metres away from the cluster of houses and 500 metres down below through a steep descent. It was estimated that each household was able to fetch only about 50 litres per day (or about 4. 9 litres per day per person) using small containers. Together with the children, they woke up before dawn to go to water sources. The few pigs raised in the backyards survived on rain and waste water. Carabaos used other more accessible spring source.

The inadequacy of water was said to be the cause of rampant maladies of dehydration, allergies and skin disorders among the villagers. Using water for drinking from the open spring source was said to be the cause of diarrhea and vomiting. Cholera outbreaks happened almost yearly upon onset of the rainy season, with the contamination of the spring water. Sanitation was poor with the absence of latrines. Before the installation of the water project, the community accounted for the death of young children who were most susceptible during disease outbreaks.

The lack of water impairs the capabilities of the community members to fully function in their daily lives. Their susceptibility to diseases especially during rainy months is high owing to the unsafe source of drinking water. Their deprived conditions are made more severe during such epidemic episodes, as hospital care is far and cash is unavailable to buy medicine.

The PV solar water pumping project was built amidst the devastating drought of 1997

The project was conceptualised and built through a collaboration between the community, the local NGO and SIBAT. The people's organization KAGATA (or the Kasalngad Galabek de Takilay) and local NGO took the lead role in organising and mobilising the local labour while SIBAT provided the technical support. Spring surveys and water studies were conducted by SIBAT which yielded several technical options. The solar PV project was deemed as the most appropriate design to bring the water up from the spring source 150 metres below, needed to deliver the water volume requirement for potable use of the community. The critical factor for the decision is the high pumping distance; the steep location of Sitio Takilay placed a large limitation on the feasibility of a simple water system design.

The members of KAGATA played the most important role in realising the project in the entire construction work that was disrupted by a severe El Niño occurrence in 1997. It brought a severe food shortage from the drying up of the land and crops, then followed by a massive rat infestation. Rats infested the remaining root crops on the fields, leaving nothing for people to eat, and forcing farmers to eat poisonous wild yams. The men left the community for paid work outside the community.

The construction work was resumed by allayon teams, just after few months of recovery, but soon enough the rains came. The slippery

foot trails made hauling much more difficult. Men and women helped in the hauling of materials (gravel and cement, GI pipes, mounting frames and other items) on their back, for a distance of more than 2 kilometres from El Gawel on a trek that was almost a vertical climb for one and a half hours to the site. The children carried stones and building materials coming home from school in El Gawel. The teams helped in the actual construction work of the reservoir and in the installation of the pump, the pipes and the transmission line.

After 5 months of continued work, the determination of the local people and the support by the local NGO and SIBAT produced the completion of the first PV solar project in South Cotabato on September 1998. The project is a clean and compact system; its design removes the use of batteries whose disposal poses a problem to the environment. It services 42 households at 100 litres per day per household, through faucets on the sides of the reservoir.

It was the community's determination and the practice of the allayon that completed and kept the project running for 14 years today.

The community is able to manage and sustain the project with the local women at the helm

A Water System Committee composed by women of the community was assigned by KAGATA to oversee the daily and overall operation of the water system. The committee enforces policies, such as the share of 100 litres per day by each household for optimisation. The committee is in charge of collecting membership fee per household (Php15/ USD 0. 36) and a monthly fee (Php10/ USD 0. 25) to meet maintenance costs which were agreed in the General Assembly of the KAGATA. The committee enforces the organised filling up of buckets from 4 taps or faucets from the reservoir. They also took care of cleaning the panels every month, clearing or trimming the

surrounding tree shade. The women play the crucial role in sustaining the project through their meticulous care and concern for the source.

Local para-technicians were trained to monitor and troubleshoot whenever needed. They keep an eye on changes in the characteristics of the system and make regular check-ups.

Reforestation efforts by men and women of KAGATA were carried out to ensure the conservation of the watershed source of Takilay. The initial reforestation covered 4 ha along the creek where the springs are located. A nursery was developed in November 1997; hard trees were bagged and were planted in the rainy season of June 1998. To date, reforestation continues. Endangered species of hardwood (kamagong, red and yellow narra) were collected and planted. Grafted species of fruit trees were also integrated in the watershed area.

The PV solar water pump has enhanced the resilience of Takilay village in confronting drought and deprivation

The availability of water supply, even during dry months or summer, had improved the daily lives of the people and changed the pattern of water collection in the community. There is more water to meet the needs of households, of hygiene and sanitation, and even of backyard gardens.

The reduction of hours of water fetching augmented the time of both men and women for production work and for work in the home. According to the men, there is some increase in income from farming due to increase in the size of land that they are able to till (because of added hours), producing more crops for food and market.

Sanitation and hygiene have substantially improved. Children can go to school cleaner and earlier than usual.

They have seen less incidences of diarrhea, stomach ache and vomiting attributed to the cleaner and safe water that is sourced from closed reservoirs, than directly from an open surface source. The most important effect is the non-occurrence of the yearly epidemic that killed children most especially.

The time spent by women in fetching water was reduced by more than one hour each day (the washing site is also much nearer), removing the body aches caused by the drudgery of hauling water on a steep climb from the source.

The droughts and torrential rains continued and became more heightened in the mountains of South Cotabato. But the determination of the indigenous people of Sitio Takilay to work, under most dire circumstances for the solution of their deprivation made them even more hardy and resistant to the ravages of nature and climate change.

Recommendations

After 14 years of operation, there is a need today to rehabilitate the submersible pump and move the delivery point closer to the households, or enhance the delivery system. The community desires that the water supply reach their households, and the water volume be increased for them be able to increase water for their gardens and livestock.

Endnotes

1 The population and spread of B'laans in the region thus have placed them of significance in the non-Muslim ethnic part of Mindanao (collectively referred to as Lumads). It is important to make mention of the conflict-ridden context of Lumad Mindanao where Blaans and other ethnic groups survive and wage a continuing struggle to assert their right to land and development, together with their Muslim brothers with whom they have chosen to remain distinct from.

2 Changes that transpired in the socio-political contexts of Mindanao over time, have resulted in corresponding changes in the political structures of the Lumads, including those of the Blaans. While there is a significant weakening of the roles of the traditional leadership on the whole, certain elements still remain, particularly in areas where the presence of elders is yet strong. In these areas, the institution of elders called the *bong fulong* or the body of elders led by the tribal chieftain or *fulong* -- plays a distinct complementing role to the administrative functions of the local official government. The *bong fulong* is consulted on the settlement of disputes (such as land and marital issues), arrangements and community rituals, or matters that relate to tradition and those that cannot be settled through the local government process. There is a consultative process established at the *sitio* (village) level through interplay of the traditional leaders and official local government unit official, before cases are brought to the *bong fulong*.

3 Swiddening, or shifting cultivation on hillsides, is a common age-old farming practice for subsistence among the upland Lumads i.e., found to still prevail among the B'laans. The swidden practices of B'laans, still show the traditional subsistence pattern undergoing different stages in a cycle of shifting cultivation. There are two important indigenous crop management practices in the swidden: multiple cropping (several crops are planted at the same time in the same swidden) and staggered relay cropping

(combinations of crops with different periods of planting and harvesting). These allow the availability of certain food crops in case of food failure brought about by pests or drought. The conservationist practices are observed to gradually erode as the farmlands continue to narrow, and the fallow periods shorten and the swiddening areas are extended.

Community-Based Efforts at Building Resilience Against Drought and Lean Months in Central Visayas, Philippines

Sibol ng Agham at Teknolohiya (SIBAT), Inc.

Panaghiusa is one of the 7 sitios of Barangay San Vicente in the municipality of Trinidad, province of Bohol. It is located 3 kilometres from the town center and can be reached in 30 minutes by motorcycle (habal- habal) and any 4- wheel vehicle through a rough road network year round. Sitio Panaghiusa has a total population of 232 households with an average household size of six.

The topography is mostly characteristically plain and gently sloping with some hilly to mountainous portions. Rice, corn and root crops are grown on the plains, while bananas, coconut, fruit trees such as mango and jackfruit are grown on the slopes. The hilly to mountainous parts are mostly uncultivated and cogonal and are classified as moderately eroded areas. The types of soil found in the area are ubay clay loam, ubay sandy loam and hydrosol[2] that are suited for production of rice, corn and vegetables and growing of fruit trees.

Bohol belongs to the 4th climatic type under the Corona Classification where rainfall is evenly distributed throughout the year making it suitable to grow rice. It is also generally dry with alternating wet and

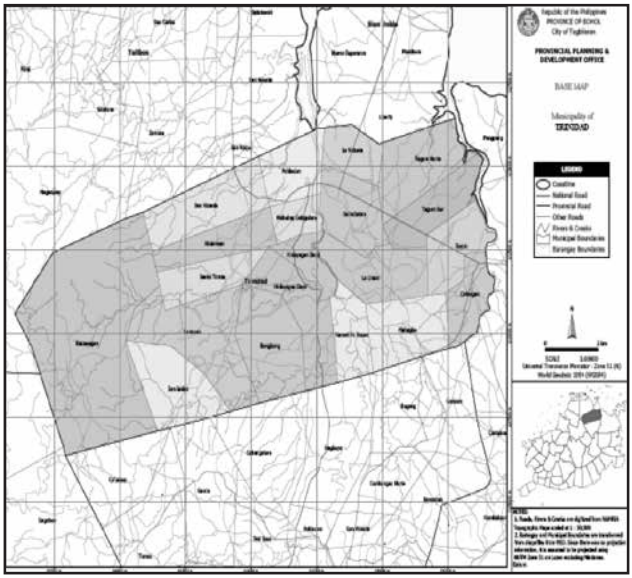


Figure 1. Bgy. San Vicente is located in the northwest part of Bohol

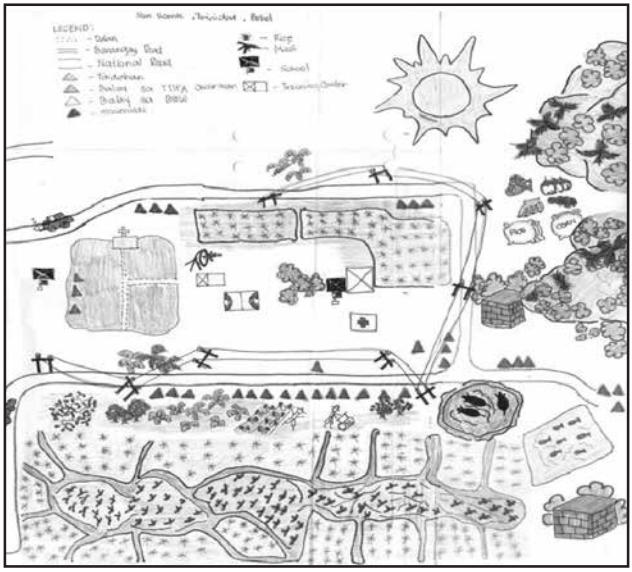


Figure 2. Spot map of the barangay showing Panaghiusa community

dry periods increasing in length and intensity. The area is prone to drought and is intermittently visited by extreme drought and tropical cyclones.

The farmers of Panaghiusa gained ownership of their land through organised struggle against corporate landowners

The main farmers' organisation in the community is the Trinidad-Talibon Integrated Farmers Association (TTIFA), organised in 1989 to fight for the ownership of their farmland, which was attained in 1990.[3] The organisation was able to secure a mother CLOA (certificate of land ownership award) and individual CLOAs as tenurial instruments for the 1,000 ha of land they were occupying and continue to farm today.[4]

The organisation has since sustained the initiatives for the well-being of their members. TTIFA provides basic health services and alternative medicine in the absence of a public health centre in the community. The organisation also supervises a primary school and a daycare centre. Ninety-five per cent of the residents have attained primary or elementary education while only 5 per cent have reached high school. Children pursuing secondary level attend school in Trinidad town centre.

Food productivity and high costs of production are problems in Panaghiusa

Farming is the main source of food and income in Panaghiusa. Rice is the major staple crop grown, while crops like corn, root crops and banana are consumed and sold for cash. There are just a few vegetables grown (such as squash, bottle gourd and eggplants) due to limited supply of water. Root crops that do not require water to grow form an important cash crop, being sold in the town centre about 7

times each month and producing some income for the farmers to buy basic household needs such as salt, soap, cooking oil, kerosene for wick lamps, matches and tobacco.

Other common sources of cash are fruits and coconuts. Women in nearly every household raise poultry (chickens) and livestock (native hogs, goats) mostly for emergency cash. The households however are unable to expand livestock as well as vegetable production due to limited source of water.

Cultivable land is limited by lack of water and implements and poor soil. Rice cultivation is rain-fed and done only on a half hectare (ha) of land, even with an average farm size per household of 2.4 ha on plain and sloping lands. About a hectare is planted to corn and root crops and the rest is either left idle, or mostly used for pasture and growing coconuts. Cultivation is limited by the lack of irrigation water (farms located on the lower portions are able to collect and impound water but still cannot get enough to improve production), farm implements, and draft animals. Labour force is family-based, and women's tasks include planting, weeding, harvesting and postharvest tasks of threshing and winnowing. The soil has low organic matter and is highly acidic due to the intensive use of chemical fertilizers and pesticides.

Using conventional methods,[5] rice farming is done in two cropping seasons per year: the *panuig* (from July to September) and the *pangamihan* (from October to February). Before the 1980s, farmers planted rice three times a year. For the third cropping (*pang-ang-ang*), planting used to start in March and harvest then would be on the first week of June. Early maturing varieties were used for *pang-ang-ang* which was needed to shorten the period of lean months. The third cropping disappeared due to extreme drought and prolonged dry months experienced since 2000.

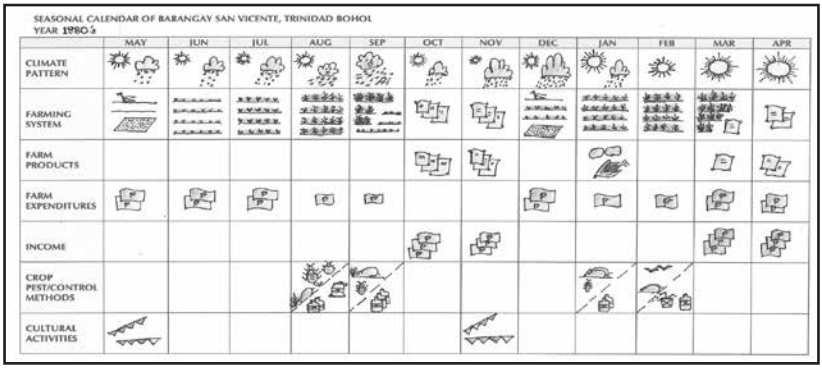


Figure 3. The cropping calendar as remembered by farmers in the 1980s.

The cropping calendar remembered by farmers in 1980s showed predictability of seasonal changes, when the pattern was more stable and no drastic weather changes occurred. Cropping seasons could then still be predicted following the seasons. Only few farmers then were using chemical fertilizers and pesticides; the majority practiced cultural, mechanical and preventive measures in controlling pests and diseases of rice. Pests and control methods during 1980s did not pose serious problems to farmers, since only few insect and pest occurrences were experienced, but were manageable. Farm expenditures were high during land preparation and harvesting because of the labour expenses but generally, there were less expenses because the use of chemical fertilizers and pesticides were not yet extensive. Rice production was then higher than in the recent times, according to farmers.

Production costs are high for the conventional farming method. Production costs per hectare amount to about Php 3, 750 per hectare per cropping, and is usually borrowed from informal local lenders. Commercial seeds are used (under conventional method) at an average of 60- 80 kilograms. [6] Production costs are broken down as follows:

3 bags of urea at Php 800/ bag/ hectare	=	Php	2, 400. 00
Herbicide (Argroxon, 250 ml)	=	Php	800. 00
Harrowing at Php100/ day for 2pax/ 2 days	=	Php	400. 00
Pesticide (karate)	=	Php	150. 00

Rice harvest is periodically low. On an average season, harvest is 24 sacks of palay for panuig and 22 sacks of palay for pangamihan, or a total of 46 sacks of palay for half hectare, annually. In the dryland conditions of Panaghiusa, rains are not enough for first cropping, which explains the little difference in yield between two seasonal croppings.

Rice harvest commonly goes to pay for the production loans, to sell for cash, or to keep as food stock for over a three-month period for the family. The harvest falls short to meet the food needs for the entire year. Respondents say that they endure on the average five (5) lean months rice, meaning there is no rice for food in the stocks, which is then being filled by the corn crop. [7]

Floods can seriously affect the rice crop. While water supply is lacking during the dry months, Sitio Panaghiusa suffers from flooding due to rains. It is a flood-prone area, being plain and low-lying. The farms have no water drainage system, good waterways or natural land contours to drain the waters from the mountains to the sea. Just a day of rain can already create waterlogged condition in different parts of the village, which would remain for days or weeks. Flooding delays or affects the cropping calendar of farmers and makes newly planted rice susceptible to snail or *kuhol* infestation. [8]

Corn production is not enough for farmers to subsist on through lean months of rice. Corn is grown in two croppings while root crops are through multiple or strip cropping. Both are for home consumption and cash. Corn production uses two methods, namely conventional (which uses pioneer hybrid) and traditional (which uses *takuro* and *tinigib*) varieties. Production expenses for corn are usually borrowed

from local creditors. Costs reach up to Php 7,450 for one hectare as shown in the following:

Rental for tractor	=	Php	1,500.00
4 bags of urea	=	Php	3,200.00
Seeds	=	Php	2,000.00
Planting	=	Php	600.00
Plowing	=	Php	150.00

Harvest of 70 sacks per hectare yields about 15 sacks or 750 kilograms of milled corn. The sold harvest is used to pay for loans and the rest are for consumption. About 5 sacks remain to tide the households over for the next 2½ months when rice produce is consumed.

After each planting season, farmers need to go out and find work for wages, where the most common are carpentry, *habal-habal* driving, and housekeeping or childcare services given by women in Talibon, Tagbilaran, Cebu or Manila.

When total income by the household (from selling staple crops, vegetables, root crops and livestock, to off-farm wages) is compared against total farming expenditures (labour, fertilizers, pesticides, milling, etc.) and household expenditures (food,

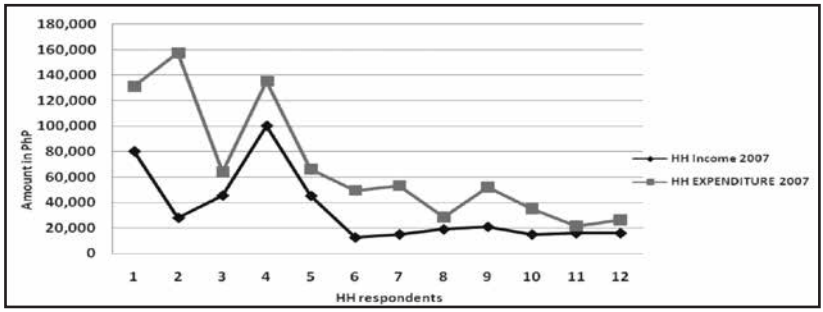


Figure 4. The comparison between household Income and Expenditure for 12 farmer respondents (Year 2007)

Food and income from agriculture, thus, are not enough to adequately provide for the typical farming household in this village, despite the availability of land, cropping viability of lowland farming and suitability of resources.

clothing, medicines, basic needs), the following figures are revealed, for a sampling of 12 households studied in Panaghiusa. In 2007, the total expenditures per household were estimated to be much higher than the total incomes, when the majority of the farmers were still into conventional farming and low external input methods or LEISA.

Inadequate supply of potable water is also a main problem in the dry conditions of Panaghiusa

Water has been a main problem of Panaghiusa for many years. Farming is rain-fed and water supply for drinking has been generally insufficient. Potable water is collected from one jetmatic pump found near the *sitio* proper while water for other uses are sourced from 3 open dug-wells found in the main clusters of households. Residents can only fetch 3 to 4 gallons per day for drinking and cooking. The lack of water has also resulted in sanitation and health problems. Majority of the households do not have latrines, which has been a major cause of intestinal diseases especially among small children.

Fetching water is a task mostly for women and children. Women fetch water twice a day, at an average of 3 hours per day, due to the long queues of residents. This is on top of their traditional chores like cooking three times a day, taking care of children, cleaning the house, washing clothes, and their tasks in the farm and backyard gardens.

Children fetch water every morning before they take a bath before

school and in the afternoon after school. In school, children still fetch water from the nearest open dug well about 30 meters from the school to clean the classrooms, drink and water the plants. These tasks have been observed to bear upon the time and concentration of children in their studies.

The lack of potable water has caused the prevalent incidences of water- borne diseases particularly amoebiasis.

Climate change aggravates problems of food security and agricultural productivity of rice farmers

The province of Bohol has suffered from alternating extreme weather events that have visited the country a number of times since 1973. Three El Niño events and two devastating tropical cyclones and floodings from 1973 to 1998, battered San Vicente, leaving destruction and food shortages in their wake.

The typhoons in 1984 (*Nitang* and *Ruping*) flooded the whole community that destroyed crops in scale for months. Typhoon *Nitang* of strength no. 4[9], occurred in early 1984 and destroyed crops and houses and blew over rooftops. It was severe flooding that destroyed the community's rice crop. There was no production of rice in four months due to flooding and army worms. Some 90 per cent of the population were affected by hunger for 4 months. They coped with eating *baang* (pith of palm tree) and wild root crops (*kot* and *bot*, and ube yam found along the streams). The root crops had to be carefully prepared to remove the toxic substances.

Historical records say that immediately about 30 per cent of the population especially children suffered from diarrhea attributed to contaminated water. The respondents remember the epidemic scale of skin disease called *kurikong* and sore eyes or *piskat* in the aftermath of the floods. The cows were afflicted with *kalambre* or hemorrhagic

septicemia. Typhoon *Ruping* (Signal #3) came in the same year. While the devastation was not equal to that wrought by *Nitang*, most coconut and banana trees were felled by the very strong winds.

El Niño or drought events since 1973 all resulted in the drying up of all crops and vegetation in the lowland farms of Bohol. Typhoon occurrences, meantime submerged rice paddies in Trinidad and in other lowland municipalities for an average of 2 days. The rice plants survived but their productivity failed due to lodging. The pattern of rainfall and dry periods have since become very variable that farmers say that their crops are always almost hit by either drought or flood during their reproductive stages.

The El Niño event in 1997-98 dried up all the water sources and vegetation in lowland farms. After the long dry spell, army worms attacked and wiped out the fields. The local government distributed chemical pesticides to farmers to control the pests, but their crops had already been damaged. The 1997-98 El Niño event was the worst drought event experienced in the memory of Trinidad farmers.

Changes in the cropping seasons.

Erratic changes in weather were observed by the farmers since the cropping seasons of 2000, after the El Niño occurrence. Since then, Panaghiusa farmers have found difficulty following the old season of planting – some start cultivating in the months of May until August for the first cropping, where harvest then falls on December to January. The variability in the rainfall pattern has created an uncoordinated pattern of cropping in the community, resulting in the reduced number of cropping periods (from three to two or one).

The above calendar shows that, the period 2000-2010 has been generally dry (the longest drought occurring during 2008-2010). The climate pattern is no longer predictable, thus farmers can no longer plant in the usual cropping periods. During extreme drought and flooding, only few farmers are able to plant rice. Present

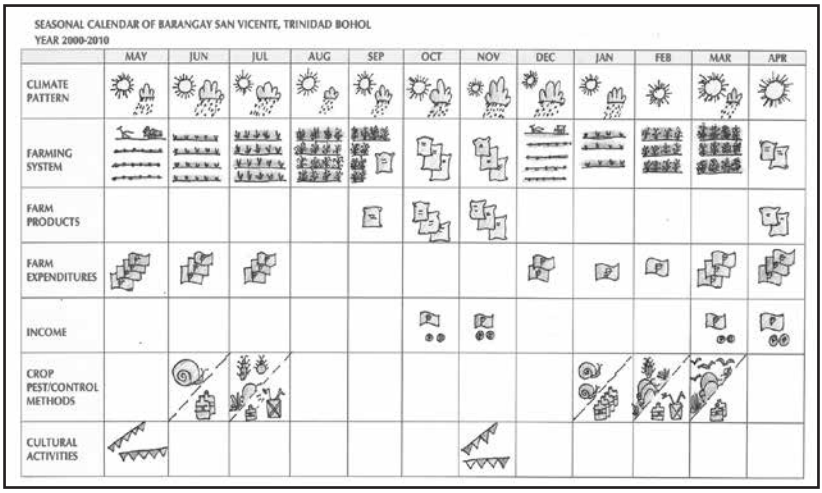


Figure 5. The cropping calendar has changed from the observation of farmers since 2000.

crop pests and diseases experienced by farmers are rice black bug (*pyangaw*) , golden snail (*kuhol*) , rat (*ilaga*) infestations, and *tungro*. Conventional farmers today extensively use chemical fertilizers (6- 7 sacks of mixed complete and urea) and pesticides (Karate, Aquatin and cocktails) . Farm expenditures therefore are higher in 2000- 2010 than in the 1980s. Rice harvest too was generally higher then than today, even with more extensive use of chemical inputs.

The compounded problems of low food productivity, dry conditions and lack of water have been met by organised community-based initiatives on sustainable agriculture and appropriate technology.

Introduction of Sustainable Agriculture in 2007

Sustainable agriculture was introduced to TTIFA in 2007 through a collaboration between TTIFA, FARDEC (Farmers Development Center) and SIBAT. The objective was to improve food production, soil fertility and seeds conservation. Diversified integrated farming was introduced and developed in community- based and organised manner.

At present, about 70 per cent of farmers have adopted organic agriculture practices, and only about 20 per cent still use chemical sprays on rice and vegetables. Some eighty per cent of farmers grow vegetables organically, with the rest yet on low external input methods (LEISA).

Loren (a TTFA farmer): "I prefer using traditional varieties vs. hybrid because traditional varieties can withstand adverse climatic changes and pest outbreaks. G2 can withstand floods, Maligaya variety cannot be affected by strong winds".

Sustainable agriculture has helped the conventional farmers in the community to effect an increase in their farm productivity attended by a much lower cost of production due to avoided costs (seeds, fertilizer, herbicide and pesticides). They have learned to make and use organic fertilizers and other organic methods of controlling pests.

The following sustainable agriculture practices and adaptive measures to climate change have so far been introduced and practiced in Panaghiusa.

(1) Improvement of seeds through varietal adaptability trials.[10] Varietal trials are approaches to collecting and adapting new varieties in the community for staple crops rice and corn (VAT) and vegetables (CAT), respectively. These are found to be sustainable ways to improve the farmer seed system within the community by providing adapted and quality collection of seeds that undergo study by farmers. With these trials, sources of food crops are increased and are made less vulnerable to extreme drought and flooding.

The trials are done through community-based efforts -- from planning to implementation, the community decides on how

and where to conduct the trials. Farmers also choose the varieties that they want to undergo on trial, decide on the committee members to monitor the trials, and evaluate the performance of each variety on trial. The adaptive seeds are also exchanged with other farmers and communities, a way to support the local seed system.

There are now a total of 27 traditional rice varieties undergoing VAT through SRI at present in Panaghiusa. There were seven (7) traditional rice varieties that showed good results and are now being distributed to individual cooperators for further adaptation trials. These are also being shared with the people's organization (PO) partners in barangays in the nearby municipality of Ubay. Several types of vegetables are also in the process of crop adaptability trials in the area.

(2) System of Rice Intensification (SRI)[11] was agreed upon by farmer members of TTIFA, as a means to adapt to changes in climate.

SRI experiments begun in 2010 in combination with adaptive seeds that have undergone varietal adaptability trials (VAT) for several croppings. The experiments so far have exhibited positive results in terms of yield. While the work is continuing, many farmers in the *sitio* have already joined in the innovative process. SRI technology opens an opportunity for farmers to learn other ways of rice farming. Farmers in the *sitio* have become interested in SRI because it is not expensive and does not require expensive chemical fertilizers, and farmers can save on seeds. Some 45 per cent of farmers in Panaghiusa have shifted to SRI as of the present.

Economic relief experienced with the shift to organic farming.

There has been some relief in the economic conditions by the year 2011 owing to a reduction in farming expenditures (decreased

Sustainable agriculture has offered the most resilience in agricultural production in the face of prolonged and extreme drought and flooding in the condition of Panaghiusa. This has contributed to increasing food security through increased yield and food types, to enable the community to survive the periodic lean months. Sustainable agriculture has also improved the soil, seeds and farm management by the community.

farming inputs) with the shift to organic farming. Farmers also spend less on food because of increase in food crops through backyard vegetable gardens.

The graph below shows estimated income versus expenditures of 12 household respondents studied in 2007, shown in Figure 6 below.

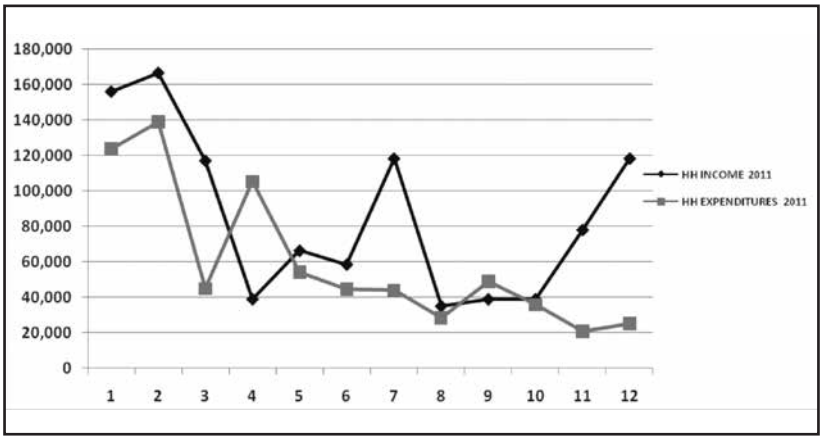


Figure 6. Graph showing the household Income versus household expenditures of TTIFA farmers

Community-Based Potable Water Systems Development (CBWSD)

The water project constructed in Panaghiusa is a product of tripartite collaboration between SIBAT, FARDEC and TTIFA. [12] The whole project preparation (survey, conceptualisation and planning) was actively participated in by the community members. The construction was a community undertaking. The strong unity and organisation among TTIFA members built and completed the project within the target schedule, on September 2009, through a mechanism to mobilise every household in the construction work without sacrificing individual farm activities. Men, women and children had specific tasks during the construction period.

The water project is a gravity- fed system that produces potable water supply for 49 households and water supply for backyard vegetable gardens, and TTIFA's nursery and demonstration farm. The water system consists of two intake structures, two water tanks (one main 22 m^3 and one small water tank in the school vicinity) and seven

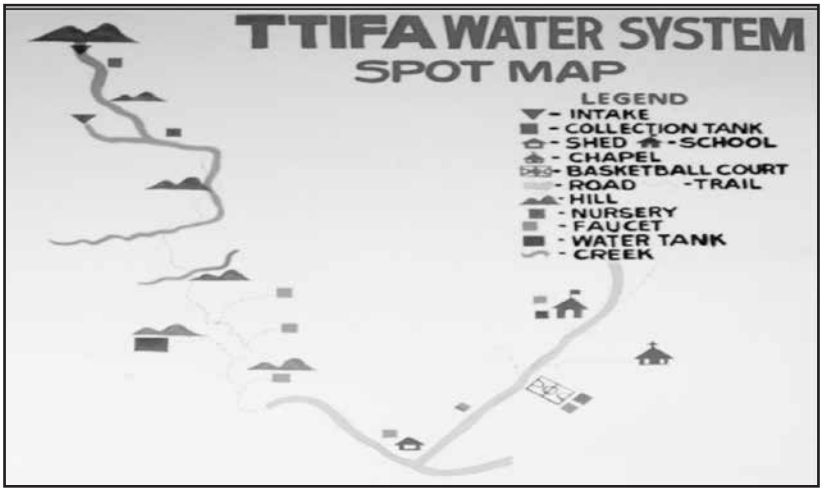


Figure 7. The lay-out of the TTIFA water system

public tapstands. The water system provides 64, 800 litres/ day which is estimated to be enough for the needs of the beneficiary households, and has a good quality being sourced from a spring in the forested part of the village forming the upper water source of a small stream. [13]

A water project management committee elected by TTIFA is responsible for operating and managing the system, with members with assigned tasks.

All members of the committee were trained by Engr. Rainer Kraft on basic water system theory and design, plumbing works, and system maintenance. They were also given training on fund management, as well as know- how on water quality and the protection of the spring catchments.

System maintenance covers monthly routines such as cleaning the intakes, water tanks and checking on the pipes and faucets for leakage or other possible damage. The status is regularly checked and monitored by the committee.

The committee meets every month to address and collectively find solution to issues. Crucial ones are presented to the general assembly for resolution.

A monthly water fee of Php30 per household is being collected to pay for maintenance. The collection is kept in the water project bank account.

To legally affirm the community or PO ownership of the system, the TTIFA water system has been registered with the Philippine Securities and Exchange Commission (SEC). This aims to protect the project from unnecessary intrusion by others.

The water project alleviates them from the dry conditions in Panaghiusa and results in concrete benefits to the local people[14]

Water project beneficiaries have now enough potable water for their household needs. Though the people are yet fetching water from public faucets or tapstands, the accessibility and availability of the source is a far cry from the deprivation they felt in the past. While there is some decrease in the water volume during very dry months, the people have learned to better manage the situation by saving and storing water.

Children can now fetch water from near their houses. They go to school earlier and have more time to play and study at home. The tapstand by the schoolyard saves time and effort by the children in fetching the water needs of the school.

The women have found more ease in doing chores in the house; house cleaning, cooking, and washing clothes can be done easily with available water supply. They have more time to work in the farm, and can yet water the gardens and care for the livestock.

The community-based nature of the water project enables the beneficiaries to manage the project to their full benefits. The members are not mere consumers who pay a private utility (as in conventional water systems in rural areas) but are owners who address all issues (from technical to day-to-day matters, from payment to conservation and optimization) that includes the protection of the water source.

The number of backyard growers of vegetables has increased with the availability of water supply and the increase of varieties introduced. Vegetable gardens provide additional food and income for the household.

There has been a reduction in the incidences of amoebiasis and diarrhea compared to its prevalence in the past when the community relied on open- dug wells for drinking.

The water supply is also being used to support the technological activities in the communal farm: vermin- composting, vegetable gardening, making of bio- sprays and KNF, as well as poultry production. The communal farm is able to grow and produce more diverse crop varieties owing to water availability. The water washed out from the faucets also go directly to the rice paddies where the VAT trials for the SRI are being performed.

The members have planted trees and plan to sustain and expand tree planting and reforestation for the entire forested parts of the community. There is a plan to expand the water project to the next villages and to lobby the local government unit for funding.

Endnotes

1 The community project which showcases the adaptation experience presented here, is an outcome of collaboration between the organisation (TTIFA), the local NGO (FARDEC) and the author, SIBAT. The experiences were an outcome of the collaborative partnership to integrate sustainable agriculture in the struggle for agrarian reform waged by TTIFA with the support of FARDEC.

2 The ubay series is a dominant soil type in the area, relatively mature soils, well drained but highly acidic. Potassium, phosphorus and organic content are relatively low.

3 TTIFA was organised in 1989 to wage a struggle (started in 1986) for part of the land occupied by the Bohol Cattle Ranch (BCC) which became successful in 1990.

4 The individual CLOA however means a relative or temporary tenurial security over the land, where true security depends on meeting yearly amortisation payments. Threat of dispossession therefore comes from inability to pay amortisation; and surrender of instrument as collateral for loan, or through VOS or Voluntary Offer to Sell to another party.

5 Conventional methods of farming started to be widely used after 1980s (until the introduction of sustainable agriculture program in 2007).

6 These commercial high-yielding rice seeds were introduced to farmers through government projects that eventually threatened the previously existing traditional varieties in the community and made farmers dependent on these. The indigenous knowledge and practices on seed keeping were nearly lost.

7 Food consumption is estimated to be at 84 kilograms per person per month, average consumption per household of 5 persons is 5,040 kilograms. From the information on the average annual harvest of unhusked rice (palay), annual deficit is computed at

3, 545 kilograms. The computed average lean months for rice is at 8 months. Farmers declare it at 2 ½ to 5 months when root crops and other sources of cash income are included.

[8] Floods that mostly happen during early stage of growth encourage mollusk (kuhol) infestation, which substantially eat up rice plants if left uncontrolled.

[9] Signal number 4 is one level up from the maximum intensity level of 3 that is considered normal or common every year.

[10] In sustainable agriculture, VAT and CAT are seed production systems which promote adaptation to local conditions, integrated type of cropping and are farmer- controlled.

[11] SRI is a system to improve rice production which promotes a set of appropriate technologies that exhibit adaptive resistance to biotic (living factors such as insect pests) and abiotic (non-living factors such as) stresses that affect the living organisms. SRI is a system of production to address climate change which is becoming an increasing problem, but also ensures higher yields, lower cost of production, reduced water requirements, and less environmental impact.

[12] The Panaghiusa water system development project was supported by funds from EED.

[13] The water is of neutral smell and taste and is used over a long period as source of drinking water. Conductivity is between 0, 3 and 0, 4 mS, thus, the water is safe for drinking.

[14] The impact study of the 3- year old water project was conducted in June – July, 2011 through household survey and focus group discussions (FGD). At present, there are 49 households benefitting from the water project. The 12 household respondents (25 per cent) were obtained through a clustered random sampling method. There are equal numbers of male (6) and female (6) respondents interviewed. All household respondents are active members of TTIFA.

Weathering the Climate Crisis: The Way of Ecological Agriculture Case Studies of Community Approaches to Climate Change

National Fisheries Solidarity Movement (NAFSO)

Introduction

In recent years, people in South Asian countries have faced serious floods, droughts, gales, storms, hurricanes, and became displaced and vulnerable, due to climate change.

The worst affected though least responsible sectors for this situation are small food producers, such as small holder farmers, small scale fish workers, herders, pastoralists, forest dwellers, and the women in all those sectors. They are the people who totally depend on land, water, forest and grasslands, which are directly affected due to climate change.

Sri Lanka has also experienced extreme weather conditions of severe droughts where farmers have lost their crops in consecutive seasons in the past decade. Some places in the dry zone have experienced droughts, while in the wet zone, farmers have experienced floods and lost their cultivations. Both situations have caused the decrease in food production and serious loss of farmers' incomes.

People explore possibilities for their survival while living with the environment. Farmers have learned that the hybrid varieties of seeds are not tolerant of the extreme weather conditions. What they have experienced in the process is that the indigenous seeds, seed paddy in particular, have high potential to survive in extreme weather conditions.

This study presents various experiences of paddy farmers as well as vegetable growers in one district of dry zone in Sri Lanka – how they have overcome drought with indigenous seeds, traditional knowledge of farming systems, and various adaptations, while living with the nature. The main learning is that sustainable and ecological agriculture as well as traditional knowledge are the key components of the success to overcome the situation.

1. Study Sites

- NAFSO selected three study sites in dry zone – 2 from agricultural and 1 from fisheries areas where there are small- scale food producers with high production capacities from their lands. All three sites are experiencing adverse effects of present extreme weather conditions in the forms of salt water intrusion into the coastal lands in the fisheries areas and agricultural lands with serious drought. The communities of both the sites at Navadankulama and Palugassegama have experienced serious decline in agricultural productions of paddy and vegetable cultivations, loss of income and destruction of livelihoods of the farmers.

  Nugasevanagama coastal community at Mundel lagoon area has also experienced the salt water intrusion into their lands and the farmers have lost their cultivations and drinking water facilities, too.

- In all these 3 sites the small food producers, although affected seriously, have become victorious due to their conscious attempts to overcome the impacts.

- The 3 sites for the study are well organised as famers' societies with regular meetings and common activities. They also have implemented some successful adaptation strategies to cope with climate change in agricultural and fisheries areas.

- There are leaders who are ready to share their climate adaptation experiences with the fellow farmers and citizens as a whole. Some of them are running their own environmental agriculture practices and model farms to educate other people who come to them for advice.

- Environmental adaptation methods are available as practical models in the fields of the selected farming communities.

2. Outline of the Study

Description of Study Site

Study Site 1: Palugassegama

Palugassegama is located at Saliyawewa Grama Seva division of Karuwalagaswewa divisional secretariat at Puttlam administrative district in the north western province in Sri Lanka. The study site is situated at the 32nd km post of Puttlam- Anuradhapura road which is neighbouring Willpaththu National Park, the largest national park in Sri Lanka. The average temperature of the year is around 32- 34 degrees Centigrade (C). The monthly average rainfall is around 78 mm which is one of the lowest rainfall areas in the country. There are rough winds throughout the year.

The area is situated in the dry zone, hence, there are a number of species of trees which are common to dry zone forest cover such as Palu- Manilkara hexandra, Kaluwara- Diospyros ebenum, Khomba- Azadirachta indica, Kumbuk- Terminalia kattapa, Mara- Albizi lebbeck, Katakaliya- Bridelia retusa, Burutha- Chloroxylon swietenia etc. However, due to destruction of forest cover, there are some species emerging, such as Andara, Eraminiya, Karanda, Indi, etc. These trees are seen in a secondary growth area of a virgin forest cover.

Coconut is not grown well due to the dry weather, but banana and jackfruit are abundant in the area. Other than these, the fruit species such as beli, wood apple, mango, citrus species, lemon, oranges are also found in the area. Maize, ladies fingers, lufa, beans, murunga, sweet potatoes, maniok are also grown. As the village is near Wilpattu National park, there are a number of herbal plants that may be found for medicinal purposes. In wetlands, paddy cultivation is predominantly used and this is one of the main sources of income for the farmers in the area.

The population density is low in the Palugassegama area and within 2 1/2 km^2 there are 1,195 people living in the village. Due to the high poverty situation and less organized community, the infrastructure and health facilities are not provided. People go to the closest hospital which is 4 km from their village at Ihalapuliyankulama for health services. At the same time there is no school for the children, even for primary school. Children should go to Saliya Model school which is 2 km away from the village.

Well- developed roads are not available – the Puttlam- Anuradhapura road is the only main constructed road recently. Ninety per cent of the side roads that give access to the houses are made of gravel or mud and in poor condition.

At present, the village tanks are filling with mud and the capacity is decreasing due to various reasons. In the village there were 10 tanks and now there are only 5 tanks for agriculture purposes. The rest of the tanks have been abandoned due to many reasons, including lack of proper maintenance and regular management by the government as well as by the farmers' societies.

For education facilities, in Puttlam district there are only 6 national schools and 23 primary schools, and the district has the highest education facilities in Sri Lankan education system. The number of all the schools in Puttalam district is 340.

Annually during the dry season, people in Palugassegama area face serious threat from diarrhea and fever epidemics. Sometimes skin diseases are also prevalent among the people in the area, mainly among children.

Palugassegama is a historical area where a number of archaeological sites may be found. Ancient rajamaha vihara temples and religious institutions are also commonly seen in Palugassegama and neighbouring villages.

Study Site 2: Nugasevanagama, at Mundel Divisional Secretariat area of Puttlam administrative district in North western province of Sri Lanka.

Nugasevanagama is situated at 106 km post of Chilaw - Puttlam high way. The boundary from the western side is Mundel lagoon and in the east is Navadankulama village. The annual average temperature is around 32- 35 C and annual rain fall is around 936 mm.

The main vegetation of the village is coconut plantations while mangroves are also seen as natural vegetation around the lagoon. Main mangrove species along the coast in Sri Lanka are also common in Mundel lagoon.

For example, Maha Kadol- Rhizophora apiculata, Mal Kadol- Bruguiera gymnorhiza, Punkanda- Ceriops tagal, Kirala- Sonneratia caseolaris, Sonneratia ovata, Sonneratia griepithi, Manda- Avicennia marina, Avecennia officinalis, Averi Kadol- Aegiceras corniculatum, Thela- Excoecaria agallocha, Karankoku- Acrosticum aureum, Bariya- Lumnitzera racemosa.

At the same time, there are a number of plant species grown in the village enriching high biodiversity in the village. Some of the species are common to the previous site. These are Khomba- Azadirachta indica, Kumbuk- Terminalia kattapa, Mara- Albizi lebbeck, Katakaliya- Bridelia retusa, Terpantine, Pandanus species, Maha Ravana Ravula and also some plant species with spines such as Andara, Karanda, are also found in the Nugasevana village.

The silted sand is mainly spread in the village, and this is due to the use of lands for prawn farms for 15 years, which are abandoned today. Some areas could be seen as muddy plot of lands like paddy fields, which are actually abandoned prawn farms. It is not only salty, but also mixed with chemicals due to massive prawn farming in the past.

The population density is 1, 350 persons per km^2 and the facilities for the people are better than Palugassegama community. Mundel National school and Mangalaeliya primary school fulfill the education facilities of the children. The Mundel district hospital and Madurankuliya hospital provide health facilities to the community. Mundel lagoon is the main source of income for lagoon fishermen, and some fishermen claimed there is a serious declining of fish due to discharges of effluents into the lagoon. However, they also claim that there has been gradual improvement in the fish catch due to the abandonment of the prawn farms in the area.

For drinking water purposes there is a community- managed water project. One of our interviewees was the chairperson of the said water project at Nugasevanagama. This is the only source of water for the people because of the salty water intrusion into their wells and contamination of brackish water in the village.

Study Site 3: Navadankulama village of Mundel Divisional Secretariat area at Puttlam administrative district at North western Province in Sri Lanka.

Navadankulama is situated at the 106 km post of Chilaw - Puttlam road and opposite to Nugasevanagama in the east. Navadankulama is more of an agricultural community and the majority depend on paddy farming. There are a number of large coconut plantations, which belong to the owners who are residing outside the village either in Chilaw or Colombo, providing job opportunities to villagers. People work in the plantations, plucking coconut, engaging in day- to- day labour activities in the estates for daily wages.

The Navadankulama tank provides water facilities during the Maha season, the second or dry season which collects water during the rainy season. However, the dry seasons are sometimes extended to years, and no water is collected for agriculture, which makes it difficult for the paddy and vegetable farmers to cultivate.

The basic health and education facilities are similar to Nugasevanagama community as both are adjacent villages. The tree species are also common to both Nugasevanagama and Navadankulama villages. The main difference is that there are no Mangrove species other than Kaduru, Kottamba in Nugasevanagama, which are commonly found in Navadankulama area.

The following tables show the rainfall and temperature [Maximum] patterns during the last decade of 2001- 2010 in Puttlam district where all the 3 study sites are situated.

Table 1: Monthly Total Rainfall -Puttlam for the period of 2001-2010
Tr.= Trace[Less than 0.1 mm]

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2001	114.5	44.7	Tr	327.6	13.2	51.9	8.3	0.2	24.1	46.4	199.3	115.1
2002	20.9	36.1	139.0	410.0	100.9	11.5	Tr	0.8	14.0	334.1	237.8	279.3
2003	106.5	7.7	142.1	190.4	99.3	93.3	133.9	12.2	3.4	277.6	167.1	46.5
2004	4.7	2.6	44.8	112.7	212.1	69.4	1.9	2.5	87.2	279.0	283.9	119.1
2005	65.7	43.8	73.3	175.8	18.2	7.4	19.9	Tr	3.3	170.0	324.5	135.9
2006	128.9	35.3	229.3	64.7	85.0	5.3	2.2	5.0	118.6	497.8	275.2	73.5
2007	49.8	16.4	5.7	246.4	4.0	24.4	26.3	20.2	54.1	149.6	111.7	209.9
2008	17.5	79.5	189.9	157.5	7.2	11.6	17.6	87.2	20.2	472.1	224.1	57.3
2009	43.9	19.4	127.8	195.0	16.0	31.7	6.7	94.1	8.2	70.7	232.3	111.1
2010	5.6	1.0	7.7	147.1	52.4	11.9	35.3	52.5	247.4	89.9	353.1	330.0

Source: Director General's Report- Department of Meteorology

Table 2: Monthly Average Maximum Temperature in Puttlam for the period of 2001-2010

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2001	29.8	21.7	23.8	24.3	27.5	26.3	25.8	26.2	25.8	25.8	23.4	22.5
2002	31.3	22.1	23.6	23.7	26.9	26.5	26.3	25.9	26.3	24.4	23.6	22.6
2003	30.1	22.5	23.2	24.8	27.1	26.5	26.5	26.6	26.7	24.5	23.4	22.6
2004	32.4	21.4	23.9	25.0	26.1	26.5	26.4	26.3	25.4	24.5	23.6	22.5
2005	30.8	21.9	23.9	24.7	26.3	27.3	26.3	26.2	26.4	25.3	23.1	22.1
2006	29.7	21.6	23.2	25.0	26.1	26.3	26.0	25.8	25.3	24.3	23.5	22.1
2007	30.7	21.5	22.2	24.1	27.0	25.9	25.6	25.9	25.6	24.5	22.2	22.0
2008	30.4	21.7	23.2	24.3	26.8	26.8	25.8	25.5	25.3	23.7	22.9	21.5
2009	30.1	20.4	22.6	24.9	27.2	26.4	26.0	26.0	26.1	24.1	23.2	23.1
2010	31.0	21.9	23.6	23.6	26.4	26.7	25.9	25.6	25.5	25.4	23.6	22.7

Source: Director General's Report- Department of Meteorology

History and internal and external factors impacting the sustainability of the community focusing on climate change-related disasters and how these have affected the lives, livelihoods and other aspects of community life.

External Factors:

- *Droughts and human elephant co-existence issues*
  Elephant attacks on paddy farmers and chena cultivations are evident in many occasions. However, these have increased as there are no water and food in the forest for survival of the elephants in Wilpattu National park. Food scarcity due to drought for the other animals has also caused serious damages to the farmers' cultivations, and monkey attacks have increased.

- *Spread of epidemics such as diarrhoea and dengue fever*
  Dengue has become a serious attack to human life in many parts of the country. The spread of dengue mosquitoes has been reported, and the number of deaths due to dengue fever is also reportedly to have increased during past few years. At the same time, some CSOs engage in education campaigns to prevent the diarrhea epidemics in the areas of Palugassegama and Navadankulama.

- *Spread of fish diseases due to prevalence of prawn farms in the area*
  In the "golden era" of prawn farms, Nugasevanagama village was one of the most attractive areas for prawn farming. But almost all the prawn farms have been affected with white spot disease due to environmental pressures.

  The discharges of effluents into the lagoon also caused the spread of the disease and some ulcers on the fish skin.

- *Ground water became brackish and salty*
  In dry zone areas water scarcity is a major threat to the well-being of the people. Water borne diseases are spreading in many areas due to lack of drinking water facilities. When the potable water wells are contaminated with salty water, they become brackish and undrinkable. This situation was evident in Nugasevanagama area at the time of prawn farms. Although people had raised the concern, nobody was listening because of the 'gold rush' at that time in prawn farming. There was no water available for farming, drinking or washing because the wells became salty.

- *Very low rainfall*
  Rainfall is a decisive factor for the richness of natural resources. When there is low rainfall, the ecosystem is almost disturbed and the level of productivity goes down. The rainfall in the past decade became very low in the study area and caused the decline in food production and the level of income of the farmers.

- *Floods- Increased frequency and intensity of extreme weather altered rainfall and seasonal patterns*
  In some seasons, the level of precipitation and the intensity have increased and disturbed the agriculture practices of farmers. It has seriously damaged the harvest when there should be dry season but instead, there is rain. This is serious as after investing all the possible ways, when farmers are ready to harvest their yield, rain damages the crops and eventually destroys the life of the farmers.

Internal Factors:

- *Infertile land and chemical contamination*
  The salt water intrusion due to prawn farms and increase in salinity level due to low water level have made the land infertile. At the same time, the chemical contamination due

to use of chemical fertilizers and other agro- chemicals in the fields has caused poisoning and decreased the income of the farmers.

- *Marshy and muddy land due to abandoned prawn farms*
  Useful agricultural lands have become useless as they are now muddy and marshy due to massive prawn farming. Most of the lands along the lagoon were converted to prawn farms and later were abandoned due to spread of diseases. The carrying capacity of the environment had been exceeded. Now, there are no prawn farms operating and the land is muddy and marshy with high salinity.

- *Increase in the number of some insects which are harmful to human health*
  It is reported the dengue and other epidemics have spread in the country due to mosquito growth. The increasing temperatures as well as the environment are conducive to the growth of mosquito. This has been reported not only in the study areas, but also almost all around the country. Increased number of dengue fever- related death has been reported in the country.

- *Increase of some skin diseases among the communities*
  People have claimed increased skin diseases in the study areas which need to be studied further, especially their direct relationship with climate change. However, people say that this was not a common situation in the past and only recent phenomenon.

- *Destruction and depletion of fish, prawns and crustaceans in the lagoon,*
  Depletion of fish stocks are reported among the fishermen in study area due to destruction of lagoon environment. People claim that this is due to the disturbance of the environment, the cutting down of mangroves, and the usage of the same

land as prawn farms. The income of the fishermen and also some food habits of women and children have changed. Women and children used to collect wild prawns and some crustaceans such as crabs from the lagoon as well as in the mangrove grounds for their own consumption, being one of the cheapest sources of protein for the poor families in the lagoon. Now there are no more such practices and no more collection of prawns and crabs from the lagoon.

- *Slow flowing of flood water and consequent destruction*
  When there was rain, it was overflowing. However, the floods flowed slowly into the lagoon or to tanks due to various reasons. There were some bunds along the streams or prawn farms blocked the water from flowing to the lagoon and to the sea. Then the flood situation became serious as well as the damage.

Some effects due to climate factors:

- Spending considerable amount of money for drinking water and food items
  Some communities which did not spend money for drinking water before have to spend money now due to water scarcity. Lack of drinking water is the most controversial effects of the prawn farms.

- Destruction of palm trees such as coconut, palmyrah, etc,
  It is a well known fact that coconut trees need considerable amount of salt for their growth. However, due to salt water intrusion and the increased soil salinity, the coconut cultivation is also affected negatively and it is reported to be dying.

- Disturbed livelihoods
  The rural poor communities do not have the capacity to get organized and overcome such situations due to poor organizing

abilities. Due to loss of income and indebtedness, people tend to commit suicide. There has been a reported increase in the number of such cases, and social unrest is reported in the rural communities.

- Lagoon fish and varieties of prawns and crabs have been depleted and threatened due to chemicals, which have also spread harmful insects. The acidity of the soil in the area is changing and failing to grow even grass.

- Loss of biodiversity as plants and animals struggle to adapt to new conditions of changed rainfall patterns, increased temperature, and extreme weather patterns

Existing community-based organisations that are involved in implementing climate change adaptation strategies.

a. Praja Shakthi Development Foundation
Community- based organisation which promotes environmental agriculture practices among rural farmers. It distributes indigenous seeds to its members which propagate the seeds in their own farms called Blue Green Garden at Neela Bamma. Two members interviewed have gained the basic knowledge of environmental agriculture from Praja Shakthi Foundation.

b. World Vision Lanka
World Vision Lanka is also promoting sustainable agriculture among farmers. They promote indigenous seeds and provide seed paddy among their membership.

c. Govi Diriya/ Gama Naguma
This is a government scheme which promotes organic farming practices. This work is carried out through Samurdhi welfare scheme targeting the poorest families in the villages. However, the Govi Diriya scheme is promoting home garden practices and

provides some assistance for the families. It proposes to provide SLR 10,000/USD78) worth of tools, seeds and fertilizer to a family.

d. National Fisheries Solidarity Movement (NAFSO)
NAFSO is a network of people's organisations, which is spread among fishing communities around the country. NAFSO promotes environmental agriculture practices among fisher and rural communities. Praja Shakthi Development Foundation is one of the partner organisations of NAFSO and the practical environmental agriculture site which is run by PSDF is one practical example of their commitment on sustainable agriculture in the country.

e. Vanni Foundation
Vanni foundation also promotes sustainable agriculture among rural communities in Puttlam district.

f. Sanasili Foundation
Sanasili foundation is operating in Karuwalagaswewa divisional secretariat which also promotes sustainable agriculture among rural families in the area.

a. Adaptation Practices and Analysis

- **The main adaptation mechanisms learned in this study are as follows:**
Use of drought and flood resistance seed paddy,
Use of environmental agriculture practices,
Use of coir filter as a method of filtering salt from the brackish water,
Cultivation of temperature resistance seeds,
Mechanisms to adapt to drought and floods, such as use of plates, pots etc for plant vegetables, fruits, etc. - Protection from floods and also a method of water management,

- Documentation of the strategies to adapt to the climate change impacts experienced in the area should record what is actually practised in **step-by-step** detail and include other details like indigenous knowledge, supportive social norms/ structures, innovative skills, observation skills, etc.

1. Mr. M. W. P. R. Somapala, is a small- scale farmer who owns 140 perches of land at Palugassegama, which is a small plot of land compared to the others in the area.

1. M.W.P.R. Somapala, [74 Years]
Palugassegama, Saliyawewa, Agriculture area

He lost his income because of the destruction of agriculture practices in his home garden due to increase in temperature and extended dry season which destroyed his livelihood and pressed him to find some alternatives for the survival of his family.

In the beginning, he discussed this among his fellow village men who faced similar situations. But they weren't able to come up with successful solutions to the difficulties he faced.

At this stage, he was able to contact Praha Shakthi Development Foundation, which is based at Karuwalagaswewa divisional secretariat area, which at that time was researching some adaptation practices for droughts in Neelabamma in the neighbouring area. Mr. Somapala attended two training programmes at Neelabamma Blue Green Garden (BGG) training centre to learn some alternative agriculture practices together with some small holder farmers like him.

Praja Shakthi conducted a training programme which educated the farmers on environmental agriculture practices such as how to

cultivate crops with the pattern of rain and dry seasons, some climatic adaptation practices such as use of pots to minimise the use of water, use of organic fertilizer to improve the crop environment to retain water for longer periods, the phase out of chemical fertilizers which destroy the organisms to improve soil quality.

The most attractive method for Mr. Somapala is the use of pots to minimise the use of water for crops.

After that there was an opportunity for Mr. Somapala to attend a practical training programme at Gami Seva Sevana training centre, given to him by Praja Shakthi foundation. The improvement of the home garden and organic farming practices was introduced at the training programme.

Among all these programmes, what struck Mr. Somapala most was the cultivation of food crops for the family using minimum amount of water. At the same time, he explored the possibilities of collecting some drought-resistant vegetable varieties. At the later stage of the work, some seeds were found from World Vision Lanka which helped to enhance the home garden with the adaptations to drought.

Some vegetable species such as snake gourd (local variety), bitter gourd, beans (local variety called mist beans and another variety called *pathuru* beans), pumpkin (drought-resistant variety called drought pumpkin) were grown.

At the same time, local yam varieties, which needed minimal water, were grown. Yam varieties such as *Kiri Ala* (milk yam), and *Val Yam* (Liana type yam) are two of them.

Mr. Somapala has a small plot of paddy farm, too. He uses some indigenous seed paddy to cultivate his paddy field. World Vision Lanka and Praja Shakthi Foundation provided him with indigenous seeds for the paddy farming which were collected from the Movement for Protection of Indigenous Seeds.

Some paddy seeds such as Marthavalu, Rathdal, Kalu Heenati, Suvadal which are drought- and also flood- resistant are grown in his paddy field for his own consumption as well as for selling.

At the same time Mr. Somapala uses some paddy variety called Handiram, which is resistant to insects as the bark of the seed is thick.

All these things Mr. Somapala learned through the experiences of his ancestors. Mr. Somapala needs only the organic matters such as cow dung, Gliricidia leaves and urine of animals as fertilizer for his small home garden.

Mr. Somapala has some traditional knowledge gained through years of experience. But it is important to mention that he had not used this knowledge and never practised it in the past to adapt to such difficulties as droughts or floods, infection of insects, etc. He is saying now that he will no longer use any artificial or harmful practices as the most important matter is to live with the blessings of nature and adjust to its precious resources.

Some of the traditional knowledge Mr. Somapala has shared:

If the harvest of orange, lemon and wood apple, mango is low, an extended drought season should be expected and farmers have to adjust. Also, it is a clear sign that if flowers of Kaduru and Wara species are high, there will be very low rainfall during the season, so drought will follow. However, if the sour fruit species are giving high yield, it is a sign of rain in the near future.

Also if there will be a rainy night, the dusk sun rays could be seen as a sign of a cobra. People call it *Boomi Nagaya*, (which is earth cobra). It is important to mention that the sun rays of the dusk can be seen as seven cobras, and people should expect floods. If the sun rays of dusk are seen in muddy brown colour, there will be a dry night which is good for hunting.

When it comes to the pest management systems, there are some environmental practices. For instance, people plant some flower varieties such as daas pethiya, ata petiya to minimise pest attacks. Marghosa is a good fungicide and people have used it for generations.

2. In 2003, the prices of vegetables went up and poor people could not afford to buy them for their consumption. The fishing practices were also not viable any more as the prawn farms destroyed the lagoon environment.

2. K.K. Gunapala, [61Years]
Nugasevanagama, Mangalaeliya, Fisheries area

Mr. Gunapala decided to find an alternative for his survival and engaged in vegetable cultivation. But the situation was not so healthy as the lagoon reservations and mangrove forests were converted and brackish water intruded into the coastal and lagoon areas. So the vegetable cultivation was a nightmare to him and was not practical in the beginning as there was no fresh water to cultivate vegetables. But Mr. Gunapala did not easily give up and wanted to find a solution through his fellow farmers group at Nugasevanagama.

In the beginning, Mr. Gunapala discussed the matter with his fellow farmers at the monthly farmers meeting. The farmers' group was informed about the farmer leader Mr. Joseph Fernando of Navadankulama, the neighbouring village, and his attempts to have sustainable farming. Mr. Gunapala approached Mr. Joseph and discussed a possible solution for the brackish water intrusion that contaminated the fresh water and also led to loss of drinking water facilities.

Mr. Gunapala, together with Mr. Joseph and the farmers' team, attempted to find some solutions through various methods such as the use of pots to cultivate crops which was not so difficult, although finding water was a problem. However, the most attractive attempt was to find some way to filter the brackish water. The group attempted to filter the brackish water using coir dust and some coconut husks on an experimental basis. This method proved to be the most successful and it is what they continue to use at present.

The system they adopted is a layers system (Helmalu system in local language) , with layers of soil and coir dust in it. One layer above all includes brackish water supply. The second layer below is coir dust and the lowest layer is used to plant vegetables. There was no success seen at the beginning as the coir dust layer was thin and had to be widened and more space for filter had to be created.

At the experimental stage, Mr. Gunapala planted brinjals, pumpkin, ladies fingers, maniok and long beans.

The experiment was successful, and later, coconut, mahogany and banana were planted as tree species. At a later stage, the farmers felt that it was no longer necessary to use coir filter for coconut, banana and mahogany tree planting. What was needed was soil filter instead of coir filter. For those plants, farmers used a simple technique which used soil as the filter. There was the need to dig a pit with the depth of 2 1/2 feet at all the four sides of the plant and to fill this pit with soil. The soil serves as the filter which reduced the salinity of the water. However, it was important that some salinity was expected for the cultivation of coconut in the ground. As the farmers said, both the filters were successful and the vegetables were grown with much success, too. The income of the farmers increased and this was a great success for them.

3. The first job of Mr. Joseph Fernando was to spray chemicals in the paddy fields as a day labourer. In addition to that he worked as a tenant of a paddy land. In 1998, he met a team of SEDEC, Caritas

3. Joseph Fernando, [48 Years]
Navadankulama, Agriculture area

Chilaw and he learned organic farming activities from them. In 1998 he attempted to apply the organic farming methods he learnt from SEDEC; they introduced some techniques which are adaptive methods to make paddy farming drought- resistant, such as Suwadal seeds. Only Mr. Joseph's farm survivedwhile almost all the others were destroyed with drought. But the total yield was only 20 bushels at that stage.

Even though his paddy field survived the drought, life was so hard and the family members complained of this unusual practice. They were under the impression that, because of the organic farming methods Mr. Joseph used, the yield decreased. In 2000, Mr. Joseph thought to use chemicals in some parts of the field and organic matters in other parts. In that year, he got 40 bushels which was double from the previous years. But the problem was not the techniques used, instead the methods that the farmers followed. For instance, when farmers collected the yield of Suwadal paddy seeds, half of the yield fell on the paddy field itself. But the correct method was to use sacks to collect Suwadal paddy in the field. Mr. Joseph did not do in the beginning due to ignorance.

But at later stage he learned the methods and by 2003- 2004 the yield per acre increased to 50- 60 bushels. From that time, Mr. Joseph started the cultivation of organic paddy farming totally, using indigenous seeds. He obtained training from Mr. Upawansa, a veteran agriculturist who trained farmers on environmental agriculture at Angunukolapalassa agricultural training centre. He had introduced a new system called Nava Kakulama which is now well known among organic farmers.

Mr. Joseph Fernando had followed these practices to adapt to the extreme climate conditions:

Used Seed varieties resistant to extreme weather conditions

Used Seed paddies which are drought and flood-resistant

Used the following vegetable varieties which are drought-resistant seeds.
Pathuru beans, *thumba karawila*, *batu karawila*, *brinjals* (eggplants), *batu*, pumpkin, *kekiri*, *lufa*, snake gourd, snake chilli.

Used some fruit varieties which are drought-resistant:
Melon (local variety), banana, guava, citrus, orange

Agricultural practices:
Mr. Joseph has grown crops in small pots in his home garden. This system helps him protect the crops from drought as well as from floods. In the pots, the texture of the soil is conditioned to retain water for longer periods, hence, the crops manage with limited water available for several days.

At the same time the creation of the conducive environment using Jeeva Muthra, [Urine] and compost fertilizer for the crops was done. With this system, the dry conditions are managed to a certain extent.

Attended training programmes and some institutions where Mr. Joseph Fernando gained knowledge on how to use indigenous seeds, as well as on preparations of organic fertilizers.

There is enormous importance in having organic methods to use indigenous drought and flood- resistant varieties of paddy seeds Mr. Joseph has had several opportunities to learn from various institutions.

Mr. Joseph is a member of Praja Shakthi Foundation, which propagates indigenous seeds that are drought and flood- resistant

varieties. A field visit was organised to visit the institution and he gained the knowledge on some rare seed varieties from the Movement for Protection of Indigenous Seeds (MPIS).

In 2004, a training programme Mr. Joseph participated in Indonesia contributed to his knowledge of indigenous seeds, and of some traditional practices to control the pests. Since 2005, Mr. Joseph has engaged in fruits and vegetable cultivations using indigenous seeds in a dry zone region in Sri Lanka.

At this stage, one indigenous paddy variety used called Kalu Heenati, gave 79 bushels per acre (0. 4 hectares) which was one of the highest yields at that time from Navadankulama paddy farming area.

Mr. Joseph received several training programmes in Sri Lanka through Praja Shakthi Foundation, SEDEC, World Vision Lanka, etc., during this period. Cambodia and Bangladesh were the other two countries that Mr. Joseph visited to gain knowledge on organic farming and indigenous seeds promotions.

He had faced serious difficulties when he used traditional varieties and was pressured to use improved seeds. But he did not listen to that and continued learning and reached success. Now while other farmers in the same paddy field area face drought and the threat of income loss, Mr. Joseph continues harvesting high yield and higher income.

Table 3: Some Paddy Varieties with different Abilities to tolerate in extreme climatic conditions

Name of the Seed Paddy	Duration [Months]	Importance	Yield Bushels per Acre	Important matters
Kottiparum	4 1/2 - 5 1/2	Flood Resist	60	Common use
Devaraddiri	4 1/2 - 5 1/2	Do		Common use
Hata Panduru	5	Do		
Muthu Manikkam	4 1/2 - 5	Do		
Kuru Hondarawalu	4 1/2 -5	Do		
Dik Vee	5	Do		Common use
Lumbini	41/2 - 5	Do		
Muthu Samba	5 - 5 1/2	Do		Common use
Kahata Vee	5- 5 1/2	Do		
Murunga Kayan	4 1/2 -5	Do		Common use
Masuranvee	5 - 5 1/2	Do		
Gahala	5 - 5 1/2	Do		
Hata da Vee	2 1/2	Drought Resist		
Suwadal	2 1/2	Do		Common use
Rathdal	2 1/2	Do		Common use
Polayal	2 1/2	Do		Common use
Gonabaru	2 1/2	Do		Common use
Kalu Bala Vee	2 1/2	Do		
Bala Murunga	2 1/2	Do		
Kalu Murunga	2 1/2	Do		
Maruthavalu	2 1/2	Do	Joseph get 80 bushels	
Kalu Heenati	2 1/2	Do	Joseph get 79-90	Joseph and Somapala
Pachchaperumal	2 1/2	Do	Joseph get 80	Joseph use this variety
Handiram	4	Resist to insect attacks as the thickness of the bark of seed		Somapala use this variety

Source: Survey conducted on climatic Adaptations of agricultural sector by NAFSO, October 2011.

Mr. Joseph says, "I am a successful farmer in my community as most of the others suffer from drought and loss of income, I am the one who gets some income with less inputs. Others spend lot and get nothing. The seed paddy I use are drought- resistant and I am propagating this idea with my fellow farmers to use the same methods. "

In all three places the following crops and seeds have been used to adapt to extreme climate conditions.

Long bean, local melon variety, lemon, pomegranate, cucumber, *kekiri*, *thumba karavila* (bitter gourd variety) are some of the vegetable varieties which could tolerate dry conditions with limited amount of water.

Also, Gingely, Kurakkan, Meneri are some crops which need less amount of water.

- **The communities have come up with these practices:**
  All three communities were motivated by external factors. Some organisations which are promoting environmental agriculture and indigenous seeds have been the motivators of the communities. Series of training programmes were given to the leaders who then shared the same with their fellow members in the farmer society. The serious situation they faced due to extreme weather patterns caused them to get involved in the process which helped them to uplift their income.

- **The prerequisites in order to apply the practices effectively:**
  Soil conservation is a very important factor to apply the adaptations, such as use of indigenous seeds which are adaptive to extreme weather conditions of severe droughts or floods. Traditional knowledge on environmental agriculture is a very important factor as this gives much co- existence with nature. When the weather patterns are followed, along with the movements of the sun, etc., this will contribute to effective applications.

Also, having basic practical knowledge of effective organic manure production, annelid liquid extraction, etc. , are some of the important factors.

At the same time farmers need to have knowledge which seed variety is important for what type of weather pattern. Then they can use those varieties effectively in such weather conditions. To implement this successfully, there should be traditional knowledge of some environmental indicators such as low yield of mango, wood apple and citrus fruits, which could mean low rainfall or extended drought while high yield of sour fruits such as tamarind means one can expect high rainfall during the season. This is important for selecting seed varieties for cultivation as some varieties are more drought- resistant while others are flood-resistant.

Some people who have had knowledge of weather patterns for years can tell the months of the year which would have high and low rainfall. Also, some people know which dates of the month they can expect rain and when the dry season starts, etc. All these are local knowledge people have gained through living with the environment.

The factors that helped make these practices successful (e.g. special skills, traditional knowledge, social support)

Some of the people in the communities have a memory of the climatic patterns, and it has become important to use traditional knowledge, techniques, and environmental agriculture practices. Some of the people have knowledge and great memory when the serious floods affected the communities and what were the environmental conditions prior to those situations. A person shared his experience of seeing 7 cobra rays at dusk before the 1948 floods in Karuwalagaswewa area.

People need knowledge from the older generations and commitment to continue what they have learned. Also, there should be a practice

which promotes the use of traditional seed varieties and to find them preserved by organisations, communities, groups who promote the indigenous seeds and practices of environmental agriculture.

- **The impacts of these adaptation practices on the community**
  In Navadankulama farmers society, the farmers do not wait until the rain comes filling the tanks before they do the agriculture practices. Now, people use the water which flows at the early stage of rainy season to initiate their cultivation of the paddy field. Earlier, the farmers waited till the tank was full and for the water coming from the government mechanism. Now, people know when to start the cultivation to get maximum yield and to earn income.

  In Palugassegama, the community used some mechanisms to grow vegetables in pots and used minimum amount of water for that. Earlier, they waited for the rain to come during the season to cultivate their lands. This pattern has changed now and people follow the environmental conditions fully and apply these to sustain their agriculture practices.

  At Nugasevana, which was having saline water intrusion into their agricultural land and some filtering mechanisms were used, the community also conduct their agriculture practices successfully today. It is also important that almost all the farmers use some techniques to keep the soil in a conducive manner using organic fertilizer such as cow dung, so they are receiving some income while using their products for their own consumption.

- **The limitations of the practices:**
  Getting the seeds on required time is one of the biggest problems as it is not promoted by the government or the agricultural institutions as a practice of adapting to the climate crisis. There should be a trust- building opportunities on indigenous varieties while highlighting successful stories among the farmers as

important practice. But today there is no such practice and only few organizations are attempting to promote the idea.

Also, some of the seeds for cultivation are not germinating. Sometimes they exceed 50 per cent of the total seeds, making it difficult for farmers to adequately secure seeds for planting.

Sometimes, the seeds which farmers get are mixed varieties. For some seeds the life span is 3 1/2 months while some are for more than 4 months. This disturbs the harvesting time and the process of collecting seed paddy for the next season.

As Mr. Joseph Fernando narrated, the seed paddy is not the biggest problem for him. But there should be a mechanism to propagate seed varieties which need more systematic approach for cultivation of seed paddy. This is expensive and needs some external assistance. Also, 20 perches land is not enough for the cultivation of vegetables.

At the same time, there is no comprehensive mechanism to sell the traditional, organic paddy in the market. This has discouraged the organic farmers who use traditional seeds.

There is also the serious issue of the use of chemical fertilizers, insecticides and pesticide in the paddy filed and other agricultural areas which contaminate and destroy the regenerative capacity of mother earth. Once farmers use the seeds which are not used to those chemicals polluting lands, the harvest becomes low in the beginning and discourages farmers to engage in brave practices again.

The tanks, which are the sources of water for the dry zone paddy fields, are becoming shallow due to mud and soil from erosion and earth filling. This has caused farmers to give up the paddy farming and agriculture practices as a whole in dry zone areas.

Farmers have raised the concern on government assistance for the propagation of traditional, indigenous seeds among the farmers.

- **The potential for replicating and up-scaling the practices:** The eagerness to carry out indigenous seeds which are drought-tolerant and resistant has emerged. This clearly came up at the FMr. K. K. Gunapala is a member of Mahasen farmers society at Mangalaeliya, and they have conducted a training programme to raise the awareness on indigenous seeds and traditional environmental agriculture as a measure of climate adaptation in agriculture. At the same training programme, some indigenous seeds were distributed as a promotion of the paddy farming using traditional variety of seeds.

Joseph Fernando in his traditional Farm

Gunapala is working in his farm at Mundel Lagoon

Also Mr. Joseph is having a practical home garden called "Ranpath Organic Farm" which is a model farm for indigenous seeds promotion in his own village. The commitment and convictions of those who attended are the main potential to replicate the practices At the same time, farmers like Mr. Joseph and Mr. Gunapala's commitment and eagerness to share their knowledge with fellow farmers are crucial.

Mr. Joseph also conducted various experiments using various leaves, dung, animal urine, annelid liquids to improve the quality of the soil, which is needed for indigenous seeds to grow.

b. Conclusion : A summary of the key findings and results

People can adapt to the situation and have good solutions for the climatic disasters as Joseph and Gunapala clearly say.

- Some of the strategies that can be used are selection of some special rice seeds and the use of natural filtering system.
- Sharing experiences and organising themselves to investigate new systems.
- The awareness and the skills training are useful for people's attitude changes. (Farmer Joseph started his work as assistant of oil spreader to paddy field as daily labourer until he met one of the animators from Caritas)
- People's traditional knowledge is advantageous for their livelihood.
  They can prepare for droughts and floods. According to Gunapala, "When the sun is going to the west side the late evening its shine can be identified as *bhuma naga* (snake heads). If it is 7 or 9 it means the dry season, and if it is very dark it means future flood. "
- Promotion of organic farming is necessary for regenerating the earth.
- Only small farmers and fishers can solve the nutritional issues and the hunger in the world as they can adapt to the adverse climate conditions and sustain earth and the lives in the environment.

Recommendations

There is a tremendous need for adaptation measures in the agriculture sector, with a pressing need for capacity- building within communities to ensure better protection from and response to droughts flooding and income losses. There is a need for education about climate change in food- producing communities, particularly among farmers and fisheries who bear a unique burden from the changing climate. Efforts should be made to empower farmers and particularly women to mobilise into collective action, identify best practices for adaptation, and scale up adaptation practices. Government should make efforts

to promote sustainable small-scale farming and integrate strategies that promote adaptation practices that are both non-discriminatory and responsive to farmers' unique vulnerabilities to climate change. Lawmakers and local leaders should ensure that farmers and fishers gain full access to means of income and production, benefits from adaptation strategies, and participation as stakeholders in community-level decision-making.

- Traditional knowledge of farmers must be promoted and documented for next generations.
- Destruction of the environment is the sign of natural disasters and man-made plunder. The laws and regulation must be implemented according to that.
- The local experiences and the good practices must be promoted and spread nationally for the benefit of all.
- Protection of indigenous seeds and the plants must be a policy by GO.

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Case Study Report on Climate Change Impacts on Herders' livelihood

Centre for Human Rights and Development (CHRD)

A. Case study site

Background information

Bayangol *soum* (district) of Uvurkhangai *aimag* (province) is located in the central part of Mongolia and is 1,430 metres above sea level. The *soum* has a total land area of 354,257 ha of which 350,600 ha is pasture land. Its main economy is animal husbandry that in 2010, the *soum* recorded 288,294 heads of livestock, making it the leader in the district and second in the whole of Mongolia in terms of livestock produce. Bayangol *soum* is subdivided in 6 *bags*/ *baghs* (sub-districts) and has 648 winter and springs camps, 173 simple wells and 78 engineering- designed wells. The *soum* has 4,634 people in 1,306 households.

Eighty- six (86) per cent of the households in the *soum* earn a living from the livestock industry where a household has an average 221-237 heads of domesticated animals. Some local herders were even recognised nationally and won state prizes such as "State Good

Herdsman" or "Herdsman with a Thousand Livestock." Bayangol *soum* also boasts a local breed of sheep called *Borjigot* brown sheep which totals 57 per cent of the overall sheep herd in the *soum*. In 2001, some families have started to plant vegetables; and currently, 23 families are planting potatoes on a 4. 6 ha of land which produces 32 tonnes of the crop every year.

B. Impacts of natural disasters related to climate change

During the course of this research, group as well as individual discussions were conducted involving local herders and those who served in the *soum* public administration organisations. The names and photos involved in this study can be found at the end of this article. The discussions mainly evolved in the following major questions, with corresponding answers:

1. **How have been the impacts of climate change observed in your respective *bags/baghs*?**

    a. Water level is decreasing. It is observed in lowering of water level in wells.
    b. Number of pasture plants is dwindling.
    c. There is a shortage of pasture plant as herders compete with each other to graze their livestock.
    d. Increased and prolonged dust storm. It starts right after Moon festival which is sometime in January or February and continues until June. Before, it used to be short and happen only in March and April.
    e. Dust storm and sand cover plant roots hindering their growth. Plants and small bushes covered with sand form small sand hills.
    f. Emergence of new types of weeds which were never seen before in the *soum*. Many of them are not edible by livestock and some of them are even poisonous to the herd.

g. Sudden change in rainfall pattern. Most of rain is happening in the end of August and September causing many issues.
h. Winter starts suddenly with drastic temperature fall, while summer has extreme hot days. Temperature extremes in winter and in summer go on for many days and become very difficult for herders to withstand.
i. Desertification is on the rise that even the *soum* centre is now being covered with sand.
j. Wild animals are getting fewer resulting to increase in the population of rats and other pests and eventually causing destruction of pasture.
k. There is no other alternative place to graze; moving to mountainous area is not suitable for livestock.
l. It was the first time to experience in 2009- 2010 after so many years, a heavy *zud* (extremely snowy winter) killed 60 per cent of livestock in the *soum*.

2. What are the negative consequences of climate change on the livelihood of the herders?

a. Since 2000, climate change impacts worsened the quality of the "*Borjigot* brown sheep".
b. Herders primarily rely on their livestock; when they lose their livestock in the occurrence of *zud*, they are heavily affected both economically and emotionally.
c. The live weight and size of animals such as cattle, sheep, goat and horse, are decreasing.
d. Prolonged sunny days and intense heat, causing livestock to spend lesser time to graze and resulting to thinner animals.
e. When livestock cannot get enough fat and strength for winter, they become vulnerable to extreme cold and eventually die.
f. Until recently, herders could altogether graze their livestock; however, the pasture has worsened causing a need for herder families to be divided in different camps/ pastures just for their livestock to get enough food.

g. Previously, herders milk their sheep in July and August enough to prepare milk products for winter. Currently, the changes in the rainfall pattern have weakened the livestock's ability to produce ample amount of milk for both their offsprings and human consumption.
h. Sheep no longer produce enough felt for household use and market compared in the past.
i. Harsh winter lessened the ability of the livestock to copulate.
j. Herders are pushed more and more of their income to buy feeds for their livestock rather than for household needs. Many herders were indebted to commercial banks, who in turn take the herders' livestock as collateral for loans.
k. Less rainfall means lesser pasture lands and intensified competition among the herders to graze their livestock. This situation is also true in the neighbouring *soums*.
l. Herders have to constantly move year-round in search of pasture lands, denying them the chance to live comfortably. They even lose their properties in the main camps from looters.
m. Constant moving and camping is risky and economically unprofitable to the herders; also leaving the natural environment with garbage, ash and print of camps.
n. Women and children bear most of the brunt of constantly moving camps, lessened milk and food derived from livestock.

> *"The cost of livestock products is getting cheaper. Last winter, local meat price decreased that one (1) whole goat meat was sold to a middleman for MNT 2,000 (USD 1.45). Our family sold 20 heads of sheep for only MNT 170,000 (USD 123) in order to buy hay and fodder for the other livestock."*
>
> - A woman herder from the third *bag/bagh* in Bayangol *soum*.

o. In order to protect their livestock, herders go as far as 200-300 km in search of better pasture and water, leaving women

and children behind with few herds to milk and sustain the families' livelihood. The last *zud* nearly killed all the people's livestock and forced the herders to relocate in the safer *soum* centre in search of jobs. Due to lack of profession and/ or not meeting the required health and age for employment, herders often end up unemployed after moving into the *soum* centre.

p. The traditional culture of training race horses is nearly gone. Horse- racing has already become a business venture rather than a cultural endeavour.

q. New livestock diseases unheard of before are now occurring.

r.

> *"It seems not easy for livestock to get used to global warming. Herders might get used to the changing climate over time. Some of them are successful in experimenting on adaptive ways, some were unsuccessful. There is no venue providing herders with information on how to cope with natural disasters brought about by climate change."*
>
> - Ganjuur, herder of the fourth *bag*.

s. Traditional clothing made from sheep wool, on training sheep dogs and horse- and camel- riding is nearly gone.

t. Moving away of the *soum* in search of grazing lands makes it difficult for the herder families to access public services; children often drop out of school because of constant moving.

> *"From ancient times, we herders live in harmony with nature, we can easily cope up with disasters and other weather disturbances. However, today's disasters are much more devastating. There is a need to invent effective measures to withstand calamities, to learn from others and share with them each and everyone's best practices. Herders need to cooperate with each other. Although the government undertakes some measures, often these measures are not effective."*
>
> - Chuluunbat, herder of more than 100 heads of livestock

3. What new coping strategies or innovations are used to overcome these negative consequences and what are the results?

a. There was a study that the number of livestock exceeded that grazing capacity of the *soum*. The last *zud* took the lives of many livestock, thus, the population now probably fits the capacity of the area. However, since there is no entity who can officially attest to this, the only thing left to do is to guess.
b. Herders understood that increase in numbers of livestock is not important. Having a few livestock with good productivity is more important. Therefore, to improve the productivity of the local breed "*Borjigot* brown sheep" and make more tolerant to *zud* and drought, 30 rums/musk oxen of "Barga" breed were brought from the Dornod (eastern) *aimag*.
c. Herders started to fence pastures to be utilised during harsh weather seasons. Bayangol *soum* has fenced 4 ha of pasture land. This will be enough to graze 200 heads of livestock for 3 months. There are tens of hectares of land not used in summer and autumn because of lack of water. Therefore, these lands may be fenced and then can be used in winter when it is covered by snow. Many herder families are now collectively involved in such activities.
d. Herders collect grasses brought by strong winds from mountainous areas and gathered in trenches and ravines and stored for winter.
e. Herders collect green grass, mix them with pressed yogurt and then left to dry. They also collect and dry horse dung in autumn. These are all traditional ways to prepare fodder for livestock during harsh seasons. Since ancient times, dried horse dung was used as medicine for the livestock.
f. Grass and fodder are cheaper in autumn which makes it cheaper to fatten the livestock, which in turn, increases the income of herders.

g. Herders have begun planting potato and other vegetables. Green mass from these vegetables and weeds are collected for livestock fodder.
h. Herders also plant sea- buckthorn (a deciduous shrub) to keep the level of soil and underground water and protect water streams. In 2005 herders, started planting sea- buckthorn on a 5- ha land.
i. Families who lost their livestock during the last *zud* in 2010 are hired by other people as paid labourers/ herders.

4. What structures and mechanisms are needed in order to effectively implement these new strategies and innovations? Is it possible to replicate these new strategies in other *aimags* or *soums*?

a. Herders are organised in groups, partnerships and cooperatives. There are currently 10 partnerships in the Bayangol *soum*, while 4 herder groups are working together in the neighbouring Altan *bag* of Taragt *soum*.
b. These groups are composed mainly of families with more or less similar number and types of livestock, living nearby and using the same pasture and water sources. Some of them may even be related.
c. They also establish cooperatives to plant crops, sea- buckthorn and sell these to the market. One such cooperative has 8 member households who have lost significant number of livestock during the 2010 *zud*. Currently, each of the 8 households has around 50 heads of livestock.
d. Herders also cooperate with each other to graze their livestock systematically. For instance, in Ergen denj *bag* of Bayangol *soum*, a family grazes only young livestock in one year, while the second and third family could let their coupled sheep herd in the same area.
e. Herders in the third *bag* of the *soum* have already started scheduling their use of the pasture lands.

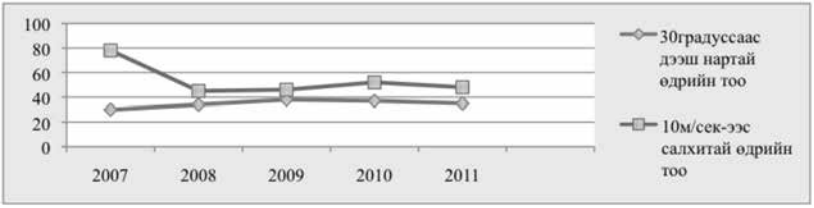
f. Herders of the fourth *bag* have already collectively fenced a portion of the pasture land to be used during winter.
g. Herders of the fifth *bag* collectively transport their livestock products to the market in Arvaibheer (Uvurkhangai *aimag* centre) or Ulaanbaatar cities to minimise transportation costs and earn additional income.
h. An ADB-funded project organises herders in groups and constructed wells in unused pastures Bayangol *soum*. The World Bank also established a "sustainable livelihood" programme which supports herders in pasture management.

Data of the local hydro-meteorological station on climate and its change

Table 1. Days with extreme hot temperatures (more than 30° C) and with strong winds (more than 10 m/sec speed) for the last 5 years[1].

Years:	2007	2008	2009	2010	2011
Number of days with temperature more than 30° C.	30	34	38	30	35
Number of days with winds with 10m/sec speed	78	45	46	51	47

Figure 1. If to show by graphic table 1 data

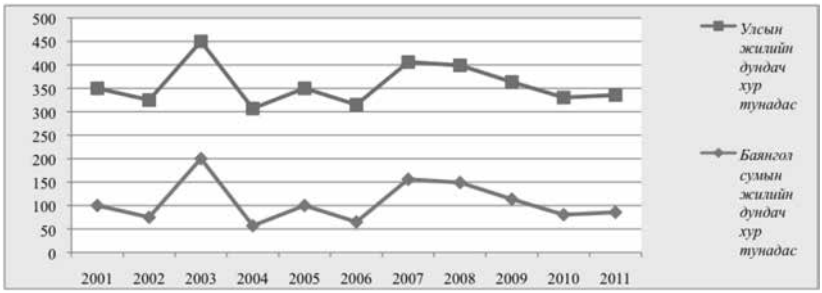


Red line shows days with winds more than 10 m/sec speed
Blue line shows days with temperatues more than 30°C

Table 2. Annual precipitation for the last 10 years[2]

Year:	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Annual precipitation in mm	100,0	75,0	200,0	57,0	100,0	65,0	156,0	149,0	113,5	80,4	85,6

Figure 2. Comparing the *soum* annual precipitation with the state annual average



Red line shows state average
Blue line shows Bayangol *soum* annual precipitation

Frequency of zud and drought[3]

2000 and 2009 had heavy zud[4], 2004 had drought[5].

C. Conclusion

Climate change has caused an increase in the frequency of natural disasters such as *zud*, drought, dust and sand storms, etc. Herders in the Bayangol *soum* utilised different strategies in coping with the changing climate, be it traditional or situational. And even though exposure to and vulnerability from climate change, herders were able to relatively adapt to the changing climate.

The strategies which are effective in the current condition and replicable to other *soums* and *aimags* are the following:

1. Expansion of herders' initiatives and paying attention more on productivity rather than the number of livestock
2. Initiatives of using pasture in a planned/ scheduled way and fencing of pasture lands to be used in winter, with active participation of herder groups.
3. Protecting soil and underground water supply through planting of sea- buckthorn.

4. Herders organise themselves through their own initiatives and collectively invest their labour and properties for their own interests, and continue the tradition of nomadic animal husbandry.
5. It is possible to spread a good practice of herders organising themselves and accessing the market without going through the middlemen and thus increasing their income.
6. Herders have no access to information on the impacts of climate change to their environment and livelihoods, as well as best adaptive practices to global warming. They also have limited capacity to forecast and prevent climate change, and rely on limited information from the media and their own observations.
7. Herders are not aware of the government policies on climate change, preventing them to reap the benefits of those policies.

D. Recommendations

1. The central and local public administration need to study the movement of nomadic herders throughout the year, including the capacity of the pastures and its resources, and implement an effective structure and mechanisms to manage these.
2. Develop and implement policies with active participation of the herder, paying attention to livestock productivity based on studies of the effectiveness of herd composition.
3. Support and facilitate formation of herders' groups, and establish partnership between young and old generation of herders.
4. Government policy should encourage herders' initiatives to protect water through planting, and assist herders to build their capacity, develop their business, run small processing facilities and provide access to market.
5. The government should provide herders with information on climate change, forecasts on its impacts, best coping strategies used nationally and globally, and create information dissemination

facilities in order to protect the livelihoods of current and future generations of herders.
6. There is a need to advertise and inform herders of the government policies and actively involve the herders in the policy development, monitoring and evaluation of these policies.
7. There is a need to improve the veterinary service and herders need to be provided with knowledge on first- hand assistance and prevention.
8. To involve, as much as possible, herders and CSOs in designing, implementing and monitoring of programmes, projects and decisions on aid designed for herders, and to build herders' capacity for such participation.
9. Support CSOs and herders through funding, and to organise meetings which would provide the herders the opportunity to express their views.
10. To create a fair supply and trading structure connecting herders to the market.

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This case study was undertaken and written by N. Bayarsaikhan, board member of Food Coalition and head of the NGO Steps Without Border, and by B. Usukhjargal, supporting member of the Food Coalition and resident of Bulgan *soum* of Soth Gobi *aimag*. Urantsooj Gombosuren, chairperson of CHRD- Mongolia and Food Coalition provided consultancy on the conduct of this study.

Endnotes

1 Data from the hydro- meteorological station of the bayangol *soum*, 3Uvurkhangai *aimag*

2 As above

3 As above

4 In each of zudes in 2000- 2002 and 2009- 2010 more than ten million livestock died. Thousands of herder families lost entire livestock.

5 Өвөрхангай аймгийн Баянгол сумын Ус цаг уурын харуулын ажиглалт мэдээ

Annex 1.

List of herders involved in the group discussion which was held in the room of the chair of the *Soum* citizens assembly at November 14, 2011 from 12.00-15.00.

	Names	sex	Which *bag*
1	S.Tsetsegmaa	female	5th *bag*
2	R.Dulam	female	5th *bag*
3	Kh. Demchig	male	3rd *bag*
4	A.Erdenebat	male	3rd bag
5	L.Batsukh	male	3rd bag
6	Ya. Tsolmon	female	4th *bag*
7	Sh.Erdenesaikhan	male	4th *bag*
8	S.Erdenetogtokh	female	Governor of the 2nd *bag*
9	B.Amarsaikhan	female	6th *bag*
10	G.Sumya	female	1st *bag*

Annex. 2

Herders involved in individual interviews

Herder Gaanjuur, 5th bag, has more than 1000 heads of livestock

Chuluunbat, senior herder of the 3rd bag

N.Tsengel, herder of Bayangol soum, trainer of the race horses

Yo.Chinzorig, governor of "Golden step" bag of the Taragt soum of Uvurkhangai aimag (for the last 12 years)

Wintering situation of herders

Preparation of winter fuel of herder Tsengel

Herder Gaanj uur is grazing coupled livestock

Herder Tsengel, member of herders' cooperative Shows seabuckthorn

A warm device to receive young animals in winter at pasture

ABOUT PAN AP

Pesticide Action Network Asia and the Pacific (PAN AP) is one of the five regional centres of PAN, a global network dedicated to eliminating the harm caused to humans and the environment by pesticides and promoting biodiversity-based ecological agriculture.

PAN AP's vision is a society that is truly democratic, equal, just, and culturally diverse; based on the principles of food sovereignty, gender justice and environmental sustainability. It has developed strong partnerships with peasants, agricultural workers and rural women movements in the Asia Pacific region and guided by the strong leadership of these grassroots groups, has grown into a reputable advocacy network with a firm Asian perspective.

PAN AP's mission lies in strengthening people's movements to advance and assert food sovereignty, biodiversity-based ecological agriculture, and the empowerment of rural women; protect people and the environment from highly hazardous pesticides; defend the rice heritage of Asia; and resist the threats of corporate agriculture and neo-liberal globalization.

Currently, PAN AP comprises 108 network partner organizations in the Asia Pacific region and links with about 400 other CSOs and grassroots organizations regionally and globally.

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