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Socio-economic Impact Assessment of Livelihood Security in Agriculture, Animal Husbandry and Aquaculture on the Tsunami-hit Lands of Andaman

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Abstract

Indian subcontinent is highly vulnerable to major natural disasters such as earthquakes, cyclones, floods, droughts, landslides and bushfires. Tsunami, which is a recent addition to this list, had occurred in the early morning of 26th December 2004, after a massive earthquake of 9.2 magnitude on the Richter scale in Andaman & Nicobar islands, resulting in the submergence of large area of farmland, and subsequent drying up of water bodies. It caused moisture stress for the standing crops, livestock and fisheries and affected the livelihood of the people to a large extent. In this context, the present study has been carried out to make the socio-economic impact assessment of livelihood security in agriculture, animal husbandry and aquaculture on the tsunami-hit lands of Andaman. Data have been collected from 150 sample respondents and the survey has been conducted for two periods, pre-tsunami and post-tsunami. The results have indicated that tsunami has ravaged the households, standing crops, farm inputs such as seed, feed and implements, livestock and poultry population, their sheds, fish ponds, etc., thereby affecting the basic livelihood security of the people in Andaman. The rehabilitation measures taken by the government and NGOs have improved their livelihoods by reviving agriculture considerably in the subsequent years and by creating employment opportunities in various farm and non-farm activities. The paper has suggested creating profitable livelihood security to vulnerable sections of the society in the existing socio-economic penury with holistic intervention of the community, government and NGOs.

Introduction

Extreme natural hazards, particularly the hydro-meteorological disasters, are emerging as a cause of major concern in the coastal regions of India and a few other developing countries. These have become more frequent in the recent past, and are taking a heavy toll of life and livelihoods. Low level of technology development in the rural areas together with social, economic and gender inequities enhance the vulnerability of the largely illiterate, unskilled, and resource-poor fishing, farming and landless labour communities. Their resilience to bounce back to pre-disaster level of normality is highly limited. For the planet Earth, the imminent threat, however, is from a vicious spiral among environmental degradation, poverty and climate change-related natural disasters interacting in a mutually reinforcing manner. These, in turn, retard sustainable development, and also wipe out any small gains made thereof (Kesavan and Swaminathan, 2006).

Natural disasters always have devastating effects on the economy; they cause huge human and

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economic losses, and significantly hinder the economic development of a region or a country. When natural disasters strike, crops and livestock are flattened, drowned by storms, and scorched by droughts, water supplies are polluted by salt, and wells run dry when rains fail and obviously, people lose their livelihoods. It must be understood that such crises hit the poor, especially small and marginal farmers, landless labourers, land-poor peasants, socially underprivileged sections and women the hardest (Swaminathan, 2009).

Indian subcontinent is highly vulnerable to major natural disasters — earthquakes, cyclones, floods, droughts, landslides and bushfires (Ambast *et al*., 2007). The high intensity earthquake (approximately 9.2 on Richter scale) followed by a powerful tsunami, which occurred in the early morning of Sunday, the 26 December 2004, brought death and devastation along large parts of the Andaman and Nicobar Islands. Due to its proximity to the epicentre of the earthquake and being surrounded by sea on all sides, these islands bore the brunt of nature's fury (Raja *et al*., 2006). The whole land mass of Andaman and Nicobar Islands got tilted due to the impact with north-west up and south-east down, resulting in 1.5 m elevation and subduction of the earth, respectively. The massive tsunami waves created havoc and resulted in extensive devastation in terms of human and animal lives and loss of infrastructure and forests in the coastal areas of these islands. These coastal areas present highly diversified human activities from inland freshwater rice and plantation-based cropping systems to mangroves and coastal strips used for fishing. The high tide sea water inundated agricultural lands and coconut plantations in several parts of the islands, particularly the eastern coast. Hence, there has been a considerable damage / loss particularly to agriculture, which is the mainstay for the sustenance of the rural and tribal farmers since many decades in these groups of islands. As a result, a majority of these resource-poor farmers have become landless and lost their sources of livelihoods and are forced to live in intermediate shelters provided by the local administration. Livelihood security, according to Food and Agriculture Organization (FAO) is 'adequate and sustainable access to income and resources to meet basic needs'. Livelihoods are secure when households have secured ownership of, or access to, resources and income-earning activities, including reserves and assets, to offset risks, ease shocks and meet contingencies (Chambers, 1989).

In light of the above, a study was contemplated exclusively to assess the socio-economic impact on livelihoods, namely agriculture, animal husbandry and aquaculture to analyze the course of change in the livelihood options of the farmers in terms of crops grown, livestock reared, cropping pattern, employment pattern, alternate sources of household income, constraints being faced, etc. and to suggest suitable policy measures / initiatives to the relevant development departments for a better and sustained agricultural productivity in the tsunami-hit areas of Andaman Islands. Specifically, the paper has examined (i) socio-economic profile of the tsunami-affected farmers having different farm enterprises, (ii) changes in crop profile, cropping pattern and employment pattern on crop husbandry in different seasons, (iii) changes in livestock holdings of farmers, (iv) changes in freshwater fisheries cultivation practices, and (v) constraints in crop, livestock and aquaculture farming at the field level. It has suggested some suitable policy measures also.

The study is expected to generate useful information about the course of change in various agricultural and allied activities and the resultant emerging alternate livelihood options in the Andaman Islands after the tsunami ravaged the agricultural lands and fish ponds. The study would give feedback and required directions to develop appropriate technologies / models suitable for the changed scenario. The study has also provided suitable policy implications for agricultural rehabilitation in the event of tsunami / sea water inundation in the Andaman islands.

Data and Methodology

The study was conducted for two periods, Pre-tsunami (2004) and Post-tsunami (2005 and 2006). Data were collected from 150 sample respondents from 5 different villages of Andaman, namely Guptapara, Mithakhari, Wandoor, Stewartgunj and Chouldari, that were affected intensively by the tsunami. These villages were purposively selected based on the extensive damage suffered on paddy, vegetable, plantation crops and livestock farming. The primary data were collected on the socio-economic profile of the farmers, crops grown, farm land affected, loss of crops and inputs due to tsunami and assistance sought by them, source of irrigation, cropping pattern, incidence of pests and diseases, employment pattern, constraints being faced, animals being reared, housing system, yield particulars,

and employment pattern. Data on aquaculture farming such as number and size of fish ponds, yield, employment pattern, constraints, etc. were also collected. The pre-tsunami information was collected based on recall memory of the farmers in January, 2005 using a pre-structured schedule. The same households were visited again and data were collected for the post-tsunami period of 2005 and 2006 in both rainy (June-July) and dry (February-March) seasons to study the progress in their farm operations and income generation activities. Secondary data were collected from different sources of government publications.

Conventional tools like percentage, and tabular as well as graphical analyses were used to analyse the collected data. Garrett's ranking technique was used to identify and rank the constraints in crop, livestock and aquaculture farming. This technique provides the facility to change the orders of constraints and advantages into numerical scores. The prime advantage of this technique over simple frequency distribution is that the constraints are arranged based on their importance from the point of view of respondents. Hence, the same number of responses on two or more constraints may have been given different ranks. Garrett's formula for converting ranks into per cent is given by Equation (1):

$$\text{Per cent position} = 100 \times (R_{ij} - 0.5)/N_j \quad \ldots(1)$$

where, R_{ij} is the rank given for the i^{th} factor by the j^{th} respondent; and N_j is the number of factors ranked by the j^{th} respondent.

The per cent position of each rank was converted into scores referring to the table given by Garrett and Woodworth (1969). For each factor, the scores of individual respondents were added together and divided by the total number of the respondents for whom scores were added. These mean scores for all the factors were arranged in descending order, ranks were given and most important factors were identified.

Results and Discussion

Socio-economic Profile of Affected Farmers

It is evident from Table 1 that after tsunami attack, the farmers of the affected villages shifted their houses from katcha and semi-pucca type to pucca types. The share of people living in pucca houses had increased during post-tsunami period, from 15.69 per cent to 48.33 per cent. Post-tsunami, about 46.67 per cent farmers had started living in intermediate shelters constructed by the government agencies and NGOs. Across different villages, it was found that cent per cent sample respondents in the Guptapara and Stewargunj villages had shifted immediately (within a year) to the disaster-tolerant pucca houses constructed by mostly NGOs,

Table 1. Socio-economic status of tsunami-affected farmers in the Andaman & Nicobar Islands

Socio economic status	Post-tsunami (2005)						Pre-tsunami (Average for all villages)
	Guptapara	Mithakhari	Wandoor	Stewargunj	Chouldari	Overall	
Households (%)							
Pucca	100.00	0.00	66.67	100.00	7.69	48.33	15.69
Semi-pucca	0.00	0.00	0.00	0.00	0.00	0.00	41.18
Katcha	0.00	0.00	25.00	0.00	0.00	5.00	43.13
Intermediate shelters	0.00	100	8.33	0.00	92.31	46.67	0.00
Family size (No.)							
Adults							
Males	2.10	1.80	2.00	4.40	2.15	2.40	2.02
Females	1.50	1.30	2.67	3.00	1.85	2.02	1.54
Kids							
Males	0.60	0.93	0.92	2.20	0.08	0.90	0.96
Females	1.10	0.60	0.83	0.90	0.31	0.72	1.02

Table 2. Source of income of the respondents a year after tsunami

(in Rs)

Source	Post-tsunami (2005)						Pre-tsunami (Average for all villages)
	Guptapara	Mithakhari	Wandoor	Stewargunj	Chouldari	Overall	
			Farm				
Agriculture	12300	0	7042	4850	723	4423	21637
	(63.08)	(0.00)	(7.19)	(4.63)	(1.15)	(7.13)	(40.30)
Animal Husbandry	5500	0	5042	9870	2462	4103	3567
	(28.21)	(0.00)	(5.14)	(9.43)	(3.90)	(6.61)	(6.51)
Fisheries	500	0	11750	1000	0	2600	1186
	(2.56)	(0.00)	(11.99)	(0.95)	(0.00)	(4.19)	(2.21)
			Non-farm				
Service	0	26600	57500	83000	54369	43763	25725
	(0.00)	(82.52)	(58.67)	(79.26)	(86.12)	(70.54)	(47.91)
Business	1200	5633	16667	6000	5577	7151	1647
	(6.15)	(17.48)	(17.01)	(5.73)	(8.83)	(11.52)	(3.07)
Total	19500	32233	98001	104720	63131	62040	53762
	(100)	(100)	(100)	(100)	(100)	(100)	

Note: Figures within the parentheses indicate percentages to the total income

whereas in the Mithakari village, cent per cent farmers had shifted to intermediate shelters. It is also apparent from Table 1 that the average family size in Andaman has in fact increased subsequent to tsunami, as there was no loss of human life in South Andaman island.

A perusal of Table 2 reveals that the source of income has drastically shifted from farm to non-farm activities after tsunami because many of the respondents had lost their farm land. Across farm sources, the contribution from agriculture fell sharply from 40.30 per cent to 7.13 per cent, and from livestock and aquaculture, it improved marginally from 6.51 to 6.61 per cent and from 2.21 to 4.19 per cent, respectively. It was partly because of the assistance provided by the development departments in the form of free inputs like goat kids, backyard poultry and fish seedlings in the aftermath of tsunami. Among the villages studied, complete shifting of income from farm to non-farm activities was noticed in the Mithakhari village, as there was a little scope for revival of agriculture and animal husbandry, barring aquaculture, as most of the village had subducted due to the impact of earthquake. Moreover, it is a low-lying village close to the coast. On the other hand, the contribution of non-farm activities such as service and business had increased tremendously in all the sample villages, except Guptapara. It was mainly because of job opportunities provided by the NGOs to the educated youth of farming community as skilled workers and supervisors of their developmental activities in the affected areas. Some farmers had themselves started vocational businesses like sale of household essentials and farm inputs, etc.

Impact on Agriculture

Change in Topography

The earthquake and the resultant tsunami have resulted in three different kinds of areas / situations as per the topographical alterations in the Andaman islands. These are: (i) Situation I, where the agricultural lands had experienced the intrusion of sea water once during the tsunami, but it has receded completely; (ii) Situation II, where the lands experience sea water ingression during every high tide and recession during every low tide, especially during new moon and full moon days; and (iii) Situation III, where the lands had completely submerged under sea water as a result of land subduction. Because of this, the soil and water resources, including ponds and dug-wells have become salt affected in the area (Raja *et al.*, 2009). The

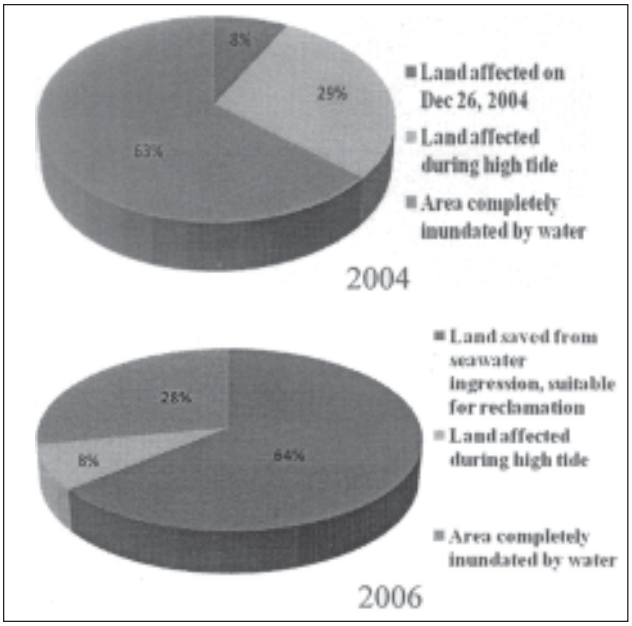

Figure 1. Land affected due to inundation of seawater immediately after tsunami (2004) and in 2006

composition of affected agricultural lands in the sample villages has been depicted in Figure 1. It was found that around 8 per cent of the cultivable area was affected due to salinity immediately after tsunami and 63 per cent of the land was completely inundated by water. But two years after tsunami, as a result of construction of sluice gates and planting of mangrove saplings in the coastal belt by various developmental agencies with community participation, the sea water intrusion has been considerably arrested and as a result, the area under complete submergence was reduced to 28 per cent and the land being submerged during high tides was reduced to 8 per cent. Hence, the land presently saline, which could be reclaimed and brought under cultivation constituted 64 per cent.

Change in Farm-Size

Table 3 shows that the size of the farm allotted to the respondents by the government exhibited a decline as most of the cultivable lands were inundated by seawater. It is also evident from the table that most of the area under crops in the study area witnessed a decline. The change was much pronounced in the case of paddy and the average holding under the crop declined from 2.80 acres to 0.24 acre during the study period, as paddy is cultivated in the low lands in all the sample villages which bore the brunt of high tidal waves.

Table 3. Size of the farms during pre- and post-tsunami situations

(acres)

Category	Period		
	Pre-tsunami	Post-tsunami (2005)	Post-tsunami (2006)
Allotted	3.93	4.10	0.80
Encroached	0.32	1.10	0.16
Paddy	2.80	0.48	0.24
Pulses	0.13	0.01	0.00
Vegetables	1.10	0.26	0.08
Plantation	0.58	0.95	0.08

Change in Cropping Pattern

The tsunami on the island agriculture has resulted in drastic changes in the cropping pattern followed by the farmers (Figure 2). In general, the percentage of area under different crop combinations had declined drastically after tsunami in Andaman islands. Area under paddy and in combination with other crops had witnessed a substantial decrease during the post-tsunami period. It is again due to the fact that paddy was cultivated in lowlands that were mostly inundated by seawater. On the contrary, significant increase was noticed in the area under plantation crops during the post-tsunami period as it was already grown in highlands and farmers had started planting new crops in the aftermath of tsunami.

Loss of Land, Crop, and Farm Inputs

The loss of land and crop value due to tsunami in the study area, depicted in Table 4, shows that loss of farm land under paddy was highest (2.05 acres) amongst all the crops, while in monetary terms, the loss was maximum in coconut (Rs 25183).

A perusal of Table 5 reveals that average loss of agricultural inputs in monetary terms was maximum in the case of farm implements (Rs 13120), indicating that the livelihood options of respondents were affected considerably.

Change in Employment Pattern

Labour employment is a basic source of livelihood for the rural poor. A comparison of labour employment during pre- and post-tsunami periods has been shown in Table 6. It is found that the labour employed had

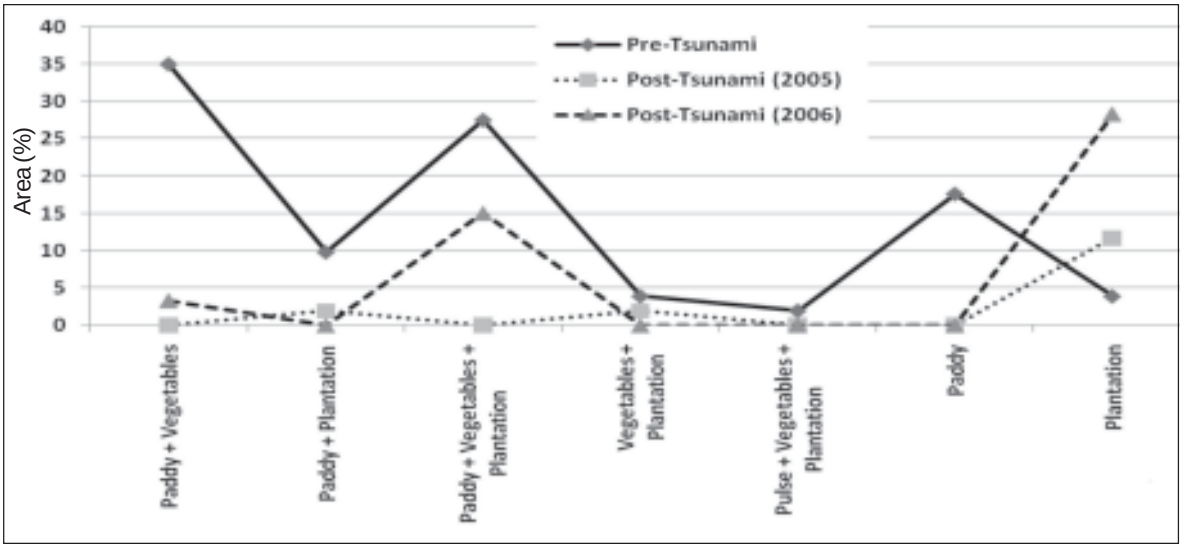

Figure 2. Cropping pattern in selected villages of Andaman island before and after tsunami

Table 4. Loss of land and crop value due to tsunami in Andaman islands

Villages	Paddy		Pulse		Vegetable		Coconut		Arecanut		Fruits	
	Area (acres)	Value (Rs)	Area (acres)	Value (Rs)	Area (acres)	Value (Rs)	Area (acres)	Value (Rs)	Area (acres)	Value (Rs)	Area (acres)	Value (Rs)
Guptapara	0.25	1000	0.02	250	0.92	6600	0.20	15500	0.10	7200	0.00	0
Mithakhari	3.15	18867	0.00	0	0.27	2000	0.37	17767	0.18	1200	0.03	333
Wandoor	0.24	500	0.00	0	0.64	8167	1.04	59375	0.25	11375	0.00	0
Stawartgunj	3.36	25600	0.00	0	0.00	0	0.02	1100	0.01	500	0.01	5000
Chouldari	3.08	14000	0.00	154	0.48	8062	0.52	28154	0.47	12577	0.05	2077
Overall	2.05	12283	0.00	75	0.45	4980	0.45	25183	0.21	6583	0.02	1367

Table 5. Loss of farm inputs due to tsunami in Andaman Islands

Villages	Seed/ Planting materials*		Fertilizer		Farm implements**	
	Quantity (kg)	Value (Rs)	Quantity (kg)	Value (Rs)	Quantity (No.)	Value (Rs)
Guptapara	45.00	420	17.50	250	0.30	18700
Mithakhari	62.33	1640	0.00	0	0.73	7467
Wandoor	1291.67	7192	0.00	0	0.50	36667
Stewartgunj	0.00	0	0.00	0	0.10	500
Chouldari	680.08	2748	186.92	462	0.38	3323
Overall	428.77	2514	43.42	142	0.43	13120

Notes: *****For paddy and vegetables

******Include pump set, motor, power tiller, rice mill, plough, fishing boat and fishing net.

declined drastically during the post-tsunami period, irrespective of the season and type of labour. However, increase in labour employment was observed in 2006 than in 2005. It was due to several rehabilitation measures taken by the government and NGOs. Among the labour type, hired labour was not at all engaged for any purpose during post-tsunami, in 2005, as it was not available during the period and was mostly diverted towards other non-farm activities like earth bunding, construction works, pond and well digging, etc.

Table 6. Labour employment in agriculture during pre- and post-tsunami periods

Seasons	Family labour				Hired labour			
	Men		Women		Men		Women	
	No.	Hours	No.	Hours	No.	Hours	No.	Hours
Rainy Season (Pre-tsunami)	1.61	4.88	1.12	3.88	5.14	5.82	2.53	4.45
Rainy Season (Post-tsunami, 2005)	0.04	0.29	0.04	0.22	0.00	0.00	0.00	0.00
Rainy Season (Post-tsunami, 2006)	0.51	2.18	0.36	1.68	2.24	1.93	1.34	1.19
Summer Season (Pre-tsunami)	1.71	4.16	1.43	3.49	4.00	4.92	2.25	3.63
Summer Season (Post-tsunami, 2005)	0.04	0.29	0.04	0.16	0.00	0.00	0.00	0.00
Summer Season (Post-tsunami, 2006)	0.54	2.47	0.39	2.05	0.29	1.41	0.19	0.99

Impact on Animal Husbandry

Change in Livestock Population

Livestock and livelihoods are inseparable for the farmers in most parts of our country. The livestock are an important alternative source of income for Andaman farmers too. Table 7 presents the status of livestock and poultry population, and loss due to tsunami. In the present study, cattle, buffalo, goat, broiler and duck were identified as the supplementary enterprises that aid the respondents to increase their livelihood. It is evident from Table 7 that after tsunami, there was a drastic decline in the average population, irrespective of the enterprise. The highest change in average population was observed in indigenous poultry, from 59.87 to 10.58 between pre-tsunami and post-tsunami periods and accordingly in terms of monetary value, the highest loss was in indigenous poultry (Rs 5296), followed by adult cattle (Rs 4700), and adult buffalo (Rs 2433).

Change in Animal Housing System

The livestock and poultry housing system witnessed a major collapse after tsunami hit the lands of Andaman (Table 8). It was found that rehabilitation works of goat and poultry sheds improved the livelihood of the respondents only in Chouldari village that witnessed higher percentage in the improvement and reconstruction of animal sheds in the first phase of assistance during the post-tsunami period.

Lack of necessary livestock and poultry sheds after tsunami had a significant effect on the yield of animal husbandry. The livestock and poultry were found housed in the open in the uplands of the affected villages. This coupled with shortage of feed had resulted in a decline in their yield. From Table 9, it is clear that the decline in average yield was highest in poultry, followed by cattle and goat.

Change in Employment Pattern

Table 10 compares the labour employment in animal husbandry during pre- and post-tsunami periods. It is evident from the Table 10 that the labour employed during the post-tsunami period (2005) had declined drastically irrespective of the season and type of labour. However, increase in women labour employment was observed, irrespective of the type of labour in 2006 than in 2005, while a reverse pattern was noticed in the case of men labour employment since more of them were diverted to the activities for revival of agriculture like reclaimation of lands, creation of bunds for checking the sea water intrusion, etc.

Impact on Aquaculture

Incidence of tsunami showed an adverse impact on the aquaculture in the study area. Several ponds were washed away, while many other ponds became dry as a result of alteration in water table due to the impact of earthquake. The harvesting frequency had declined during post-tsunami periods (Table 11). The farmers of Mithakhari and Stewartgunj were mostly crop and livestock growers and there was no fish pond in these villages in pre-tsunami period also.

Consumption Pattern of Tsunami Victims

The post-tsunami consumption pattern of the respondents, given in Table 12, reveals that consumption of vegetables, eggs, milk and meat or fish had, by and large, increased over the years after tsunami.

Table 7. Status of livestock and poultry and loss due to tsunami

(Average number per household)

Particulars	Guptapara	Mithakhari	Wandoor	Stewartgunj	Chouldari	Overall
			Cattle adult			
Pre-tsunami	2.2	1.13	2.08	2.3	1.46	1.77
Post-tsunami	1.5	0.13	0.42	0.2	0.23	0.45
Loss (Rs)	3500	6200	667	8200	4923	4700
			Cattle calf			
Pre-tsunami	1.4	0.8	1.08	1.1	0.54	0.95
Post-tsunami	1.0	0.07	0.25	0.4	0.0	0.3
Loss (Rs)	200	1467	333	1200	1077	900
			Bullock			
Pre-tsunami	1.1	0.67	0.67	0.0	0.31	0.55
Post-tsunami	0.5	0.0	0.17	0.0	0.0	0.12
Loss (Rs)	0.0	4733	0.0	0.0	2154	1650
			Buffalo adult			
Pre-tsunami	0.0	0.93	0	1	1.15	0.65
Post-tsunami	0.0	0.0	0	0.5	0.46	0.18
Loss (Rs)	0.0	6933	0	0.0	3231	2433
			Buffalo calf			
Pre-tsunami	0.0	0.13	0	0.9	0.38	0.27
Post-tsunami	0.0	0.0	0	0.4	0.0	0.07
Loss (Rs)	0.0	133	0	0.0	462	133
			Adult goats			
Pre-tsunami	3.2	1.4	2.75	0.0	2.54	1.98
Post-tsunami	1.1	0.0	1.17	0.0	0.0	0.42
Loss (Rs)	600	2800	833	0.0	5077	2067
			Kids			
Pre-tsunami	2.1	1.47	0.75	0.0	0.0	0.87
Post-tsunami	1.2	0.0	0.58	0.0	0.0	0.32
Loss (Rs)	0.0	667	0	0.0	0.0	167
			Indigenous poultry			
Pre-tsunami	53.3	87.8	30.17	27.2	85.23	59.87
Post-tsunami	28.0	0.0	15.17	16.1	0.0	10.38
Loss (Rs)	2985	8780	2300	1780	8523	5296
			Broiler			
Pre-tsunami	0.0	0.0	0	0.0	76.92	16.67
Post-tsunami	0.0	0.0	0	0.0	0.0	0.0
Loss (Rs)	0.0	0.0	0	0.0	3846	833
			Duck			
Pre-tsunami	6.2	7.53	10.67	0.4	22.31	9.95
Post-tsunami	6.3	0.0	3.42	0.2	0.0	1.77
Loss (Rs)	370	1053	833	40	2608	1063

Table 8. Livestock and poultry housing system in Andaman Islands

(Average number per household)

Villages	Cattle shed		Goat shed		Poultry shed	
	Pre-tsunami	Post-tsunami	Pre-tsunami	Post-tsunami	Pre-tsunami	Post-tsunami
Guptapara	0.90 (80.0)	0.80 (70.0)	0.40 (30.0)	0.40 (40.0)	0.90 (90.0)	1.20 (80.0)
Mithakhari	0.53 (53.0)	0.00 (00.0)	0.27 (27.0)	0.00 (00.0)	1.00 (00.0)	0.00 (00.0)
Wandoor	0.58 (58.0)	0.17 (17.0)	0.42 (42.0)	0.00 (00.0)	1.00 (92.0)	0.67 (58.0)
Stewartgunj	0.30 (30.0)	0.20 (20.0)	0.00 (00.0)	0.00 (00.0)	0.60 (60.0)	0.50 (50.0)
Chouldari	0.77 (69.0)	0.15 (15.0)	0.46 (46.0)	0.08 (80.0)	1.23 (1.0)	0.08 (8.0)
Overall	0.62 (58.0)	0.23 (22.0)	0.32 (30.0)	0.08 (8.0)	0.97 (90.0)	0.43 (35.0)

Note: Figures within the parentheses indicate percentages to their sample size

Table 9. Yield particulars from animal husbandry

Villages	Milk (litres/day)		Eggs/day		Live goats/ month	
	Pre-tsunami	Post-tsunami	Pre-tsunami	Post-tsunami	Pre-tsunami	Post-tsunami
Guptapara	4.50	1.20	14.80	4.40	0.00	0.0
Mithakhari	4.67	4.67	28.60	0.00	0.00	0.0
Wandoor	3.71	0.42	10.50	3.67	0.08	0.0
Stewartgunj	7.10	1.70	10.80	4.50	0.00	0.0
Chouldari	2.92	0.15	21.62	0.15	0.23	0.0
Overall	4.58	1.63	17.26	2.54	0.06	0.0

Table 10. Comparative labour employment pattern in animal husbandry

Seasons	Family labour				Hired labour			
	Men		Women		Men		Women	
	No.	Hours	No.	Hours	No.	Hours	No.	Hours
Rainy season (Pre-tsunami)	1.14	3.05	1.32	4.00	0.08	0.03	0.08	0.05
Rainy season (Post-tsunami, 2005)	0.57	1.05	0.46	1.32	0.00	0.00	0.05	0.22
Rainy season (Post-tsunami, 2006)	0.37	0.72	0.54	0.82	0.00	0.37	0.06	0.25
Summer season (Pre-tsunami)	0.92	2.38	1.24	3.22	0.16	0.11	0.11	0.19
Summer season (Post-tsunami, 2005)	0.51	1.14	0.49	1.38	0.05	0.00	0. 00	0.00
Summer season (Post-tsunami, 2006)	0.45	0.80	0.62	0.96	0.00	0.00	0.00	0.00

Table 11. Change in harvesting frequency in aquaculture due to tsunami

Village	No. of fish ponds	Harvesting frequency/year		
		Pre-tsunami	Post-tsunami	
			2005	2006
Guptapara	8	1.80	1.00	1.00
Wandoor	7	1.14	0.00	0.00
Chouldari	6	0.50	0.00	0.00

Constraint Analysis

Following Garrett's ranking technique, constraints faced by the respondents in crop production, livestock farming and aquaculture have been furnished in Table 11. The increased salinity in farm lands was the major problem in crop production after tsunami attack, whereas shortage of green fodder and loss of fish ponds were ranked first among the constraints faced by the respondents, respectively in dairy farming and aquaculture. It was quite interesting to note that the

Table 12. Post-Tsunami consumption pattern of tsunami-affected farmers

Village	Status of nutrition /day									
	No. of meals/ day/person		Vegetables consumed/ household (kg)		Egg / household (No.)		Milk / household (litre)		Meat or fish / household (kg)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Guptapara	2.9	2.9	0.95	1.45	6.40	12.40	0.35	0.60	2.80	3.80
Mithakhari	2.4	2.4	0.63	0.68	4.00	6.07	0.00	0.03	1.10	1.80
Wandoor	2.0	2.0	0.71	1.25	2.42	5.25	0.08	0.21	0.71	1.42
Stewartgunj	2.0	2.0	1.67	1.70	7.50	8.10	0.65	1.00	2.90	2.95
Chouldari	2.0	2.0	1.67	1.67	5.77	8.62	0.00	0.08	2.62	5.23

incidence of pests and diseases, a major constraint during pre-tsunami, was not at all considered to pose a threat in crop production during post-tsunami period, as the abiotic stress caused by the tsunami waves on the agricultural lands became high priority constraints than the biotic stress factors in the post-tsunami situation.

Interventions to Enhance Livelihood Security

Interventions to increase the livelihood security of the tsunami victims are likely to have positive impact as it involves improving the natural as well as family resources and their management and enhancing the crop and livestock activities in the integrated farming system approach. Intervention by the government and NGOs to provide alternative employment opportunities was observed after the tsunami.

The responsibility of the government to cope up with natural disasters lies in terms of supplementation of physical and financial resources to the victims. It has provided assistance for paddy and plantation cultivation, purchase of farm implements like fork spade, dao, sickle, pickaxe, cross cut saw, plant protection equipments, machineries like pump sets, power tillers, etc., apart from providing assistance for debris clearing, salt scrapping, application of gypsum, green manure and construction of broken dykes/ earthen embankments, sluice gates, check dams, etc. Similarly, it has provided poultry, ducks, pigs, goats and feed blocks for cattle and buffalo. Besides, the government has also conducted oestrous synchronization camps and animal health surveillance camps for bringing animals back to production.

The NGOs that actively participated in enhancing livelihood security of the people were: World Vision, Action Aid, Oxfam (India) Trust, Aparajitha, Voluntary Health Association of India, Nehru Yuva Kendra, Nandi Foundation, Community Enterprise Forum International and Tata Institute of Social Sciences. Most of the NGOs had carried out the "Cash for Work" programme in Andaman as a part of the tsunami relief activities in order to restore the livelihood of the affected people. The works undertaken under this programme were desiltation of water bodies, removal of damaged crops and clearing of fields, strengthening of river bunds, restoration of roads, cleaning of schools and other public places, etc.

Conclusions and Policy Implications

The study has conducted the socio-economic impact assessment of livelihood security in agriculture, animal husbandry and aquaculture on the tsunami-hit lands of Andaman. It has indicated that the houses, standing crops and farm inputs, livestock and poultry population and their sheds and fish ponds were ruined after tsunami, affecting the basic livelihood security of the people in Andaman. After intervention of the government and NGOs with active community participation, the agriculture in these islands has started showing a revival. The rehabilitation measures taken by them have improved the livelihood through creation of employment opportunities in various farm and non-farm activities. By learning lessons from this disaster, the following short-term, medium-term and long-term measures are suggested. While doing so, the geological and geomorphologic changes in the islands need to be kept in view for the ecological as well as livelihood and food security of the people. As short-term strategies, free ration comprising essential food items could be distributed to sustain the life of the affected farming

Table 13. Constraints faced by the respondents in tsunami-hit areas of Andaman & Nicobar Islands

Constraints	Garrett mean score	Rank
Agriculture (Pre-tsunami)		
Increase in incidence of pest and disease attack	74.28	1
Lack of transportation	68.36	2
Development of cracks in fields leading to increase in irrigation	64.55	3
Non-availability of inputs	59.34	4
Non-availability of labour	58.20	5
Agriculture (Post-tsunami)		
Salinity	92.67	1
Uncertainty about future of agriculture in the existing field	90.02	2
Iron (Fe) toxicity	84.89	3
Reduced yield / complete loss	80.56	4
Development of cracks in fields leading to increases in irrigation	74.22	5
Dairy farming (Pre-tsunami)		
Non-availability of good animal breed	68.12	1
Lack of proper scientific knowledge	66.89	2
Lack of credit awareness	52.17	3
Shortage of dry fodder	48.03	4
Shortage of green fodder	44.21	5
Dairy farming (Post-tsunami)		
Shortage of green fodder	83.16	1
Non-availability of good animal breed	78.33	2
Increased incidence of diseases	74.01	3
Non-availabilities of concentrates	56.89	4
Shortage of dry fodder	48.23	5
Aquaculture (Pre-tsunami)		
Non-availability of fish seedlings / fingerlings	74.78	1
Lack of proper scientific knowledge	70.44	2
Salinity	66.10	3
Aquaculture (Post-tsunami)		
Loss of fish pond	89.17	1
Lack of finance to dig a new one	78.34	2
Non-availability of fish seedlings / fingerlings	71.55	3

community. Efforts may be made to provide farm inputs such as seeds, fertilizers, plant protection chemicals, poultry birds, small ruminants, feed blocks, veterinary medicines, etc. for early revival of agricultural activities. Agricultural research institute located in coastal areas like the one in Port Blair could mobilize their scientific staff to farmers' fields to help them in the revival of their agricultural operations and to restore their livelihood options. Diversification from paddy cultivation to pulses, vegetable, coconut, arecanut, medicinal plants cultivations and livestock and poultry rearing could be promoted for better income security of the island farmers. But, at the same time, markets should also be created for these farm products. Since the rehabilitation and management of salt-affected soils and water resources of these islands require a combination of agronomic and engineering measures, construction of structures such as dykes, earthen embankments, sluice gates, check dams, etc. could be undertaken as a medium-term measure. At the farm level, the concept of farm ponds should be promoted to harvest the rain water. This could be done with the assistance from National Rural Employment Guarantee Programme (NREGP). Awareness on the disaster management and preparedness could be created among the farmers of these islands with the help of NGOs and other service

agencies, especially on the aspects of creating seed banks and water banks to mitigate the future emergencies on account of any kind of disasters. Also, there is a need to strengthen community organisations like self-help groups, co-operatives and panchayat raj institutions, etc. as they would complement the services provided by the government and NGOs. As a long-term strategy, creating a coastal bioshield by raising mangroves forests, *casurina,* palms, bamboo and other tree species which can grow near sea will serve as speed-breakers against coastal storms, cyclones and tsunami in these islands. Area-based catastrophic risk indices could be developed in order to devise insurance premiums proportional to objectively determined risk measures in these volcanically-active islands.

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