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Vulnerability to Climate Change:
Adaptation Strategies and Layers of Resilience

Farmers' Perceptions of Climate Change in Sri Lanka: Quantitative Analysis

Frank Niranjan, MWAP Jayatilake, NPC Uddika, Thakshila Dhananjani, Dharshana Laksiri, Cynthia S Bantilan, Naveen P Singh

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Dr Frank Niranjan
Country Co-ordinator of the Project
Sri Lanka
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Executive Summary

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and Sri Lanka Council for Agricultural Research Policy (SLCARP), recognized the complimentarity of their objectives and the need to facilitate the implementation of the research project on natural resources management, entitled ''Vulnerability to Climate Change: Adaptation Strategies and Layers of Resilience'' in seven Asian countries, including India, China, Sri Lanka, Bangladesh, Pakistan, Vietnam and Thailand. Accordingly, they have been working together to implement the project in Sri Lanka. Climate change is the most important global environmental challenge facing humanity today. Farmers in the Asian countries need to adjust to climate that is changing and accordingly adapt with layers of resilience in their farming practices and investment decisions.

The overall objectives of the project are to improve understanding of the climate variability and its impact on the rural poor in Sri Lanka, identify the best practices and institutional innovations for mitigating the effects of climatic change and develop strategies to address socio-economic problems relating to climatic change. The aim of the project is to identify and prioritize the sectors most at risk and develop gender equitable agricultural adaptation and mitigation strategies as an integral part of agricultural development in these less-favored areas. This includes innovations in agricultural institutions, the role of women, social capital and social networks.

Methods to address the complex challenges and emerging constraints due to climate change in agriculture require a multifaceted approach that encompasses innovations in policy, institutions and new technologies. This study tackles the urgency of identifying adaptation strategies and layers of resilience at the micro and macro levels with critical interventions to reduce vulnerability to water scarcity, drought, desertification, land degradation and future marginalization in the rural areas.

Quantitative analytical methods were used to understand key relationships of social and biophysical inter-linkages with reference to socio-economic, institutional and political drivers of change. Purposive and stratified sampling techniques were employed in selecting the study areas and the households. The main thrust of this study was to assess vulnerability to climate change mainly in the Dry Zone of Sri Lanka. Among the Dry Zone Districts, Hambantota, Puttalam and Anuradhapura Districts were purposively selected. This was the first strata of this sampling. The second strata was the selection of Divisional Secretariats in the three districts. Ambalantota Divisional Secretariat in Hambantota District, Vanathawilluwa Divisional Secretariat in Puttalam District and Horowpothana Divisional Secretariat in Anuradhapura District were purposively selected based on the rain-fed nature in agricultural operations. The total sample size was 210. The total sample was separated into marginal (0-1 ha), small (1-2 ha), medium (2-4 ha) and large (> 4 ha) households.

Farmers' perceptions on climate change were elicited through a quantitative questionnaire. Information about onset of rains, seasonal totals, distribution within the seasons, frequency of rain events, frequency and length of dry spells, the size of storms, erosivity of rains, cessation of rains, etc, were gathered. Although farmers' perceptions on temperatures, sunshine hours, wind speed, etc, were collected, the main focus was on the rainfall related parameters.

Results were discussed at the Stakeholder Consultation and Policy Dialogue on Vulnerability to Climate Change: Adaptation Strategies and Layers of Resilience on 5 April 2011 with the participation of the Hon. Mahinda Yapa Abywardena, Minister of Agriculture and other officials. Results reveal that both the Maximum and Minimum temperatures have been increased. Extreme

temperatures (No. of days reported higher temperature) also increased with the increase of temperature. The behavior of rainfall pattern is erratic. Even though Decadal Variability has decreased for some climatic seasons, inter seasonal variability was reported as high.

All households interviewed have indicated impacts of climate change and the most commonly occurring weather related shock was drought. Alternative forms of agriculture (changed from seasonal crops to perennials), available institutional approach (Government aid and subsidies during critical periods), preference for collective actions in agricultural, social and economical events, and information exchange mainly done through neighbors were also highlighted as important issues.

Mainstreaming adaptation strategies such as 1) Establishment of irrigation scheme 2) Construction of tube wells 3) Improving existing water resources 4) Providing subsidies 5) Providing drinking water facility, were identified. Adaptation strategies by farmer categories were identified as follows:

- Marginal Households (0 - 1 ha): Diversification of means of their livelihoods.
- Small Households (1 - 2 ha): Improvement of water availability through watersheds
- Medium Households (2 - 4 ha): Receiving water through watershed conservation
- Large Households (>4 ha): Mobilization and use of collected resources

Barriers to adopt alternative forms of agriculture were identified as: Lack of financial support, long time span to reap benefit, poor knowledge base and lack of information flow-back to policy makers, and lack of research and development.

Policy directives to optimize adaptation to climate change were identified as; 1) Farmers' perception and response to climate change / shocks, 2) Poor knowledge base and information flow-back to policy makers, 3) Dense state service providers (Vertical), 4) Limitation of community solidarity – limited (Horizontal), 5) High state dependency / politics undermine community cohesion and collective social capital formation, 6) State vs community balance and 7) Gender issues.

1. Introduction to the Study Area

In Sri Lanka, meteorological data observation was started in 1850, but taking systematic observations was started in 1865 (Premalal 2009). The network climatic data collection stations extend across the country and cover the various agro-climatic zones. Sri Lanka, being a predominantly agrarian society, has a rich tradition where the lives of people are closely related to the climatic changes throughout the year. As an island in the Indian Ocean located to the south of the southern tip of India, the people benefit from two monsoonal rains and also intermittent rains. The cultivation cycles are in close synchrony with the climate cycles. The lifestyles and culture are closely associated with farming that is very dependent on irrigation water. The massive network of man-made small tanks that are scattered throughout the "dry zone" of the island stands testimony to ancient knowhow and reconciliation with the natural weather cycles. Thus, the rural communities in the island had sophisticated methods of predicting rain and dealing with the climate to harness its energy to sustain their livelihoods.

This study attempts to make sense of the data collected on climate by the state departments as well as the experiential knowledge of the communities living in the selected areas to assess the reality with regard to climate change and its implications. The ADB-ICRISAT-SLCARP study is unique to the extent that it has attempted to study farmers' perceptions on climatic change and adaptation

processes as well as interpretation of the hard data collected over several decades on various climate indicators. The basic research questions explored were:

i) How do farmers perceive climate change or its variability and respond?
ii) Which are the individuals or groups that are vulnerable to such changes?
iii) What kind of adaptive capacities do they have to build resilience when situations get worse?

There is a widespread belief that there is a significant climate change. What is relevant is to find out the farmers' perceptions regarding these changes and assess their vulnerability and identify the adaptation practices. The adaptive capacities were identified. Four villages practicing rainfed farming were selected for the study from three districts from the dry zone. They are as follows:

Districts selected from the Dry Zone	Rain-fed villages
Puttalam	Mangalapura
Anuradhapura	Galahitiyagama
Hambantota	Bata-Atha Mahagalwewa

The village Mangalapura is in the Grama Niladhari[1] Division of Mangalapura, located in the north of Puttalam District, in the Divisional Secretariat Division of Vanathavilluwa. Mangalapura is located 30 km north of Puttalam, which is the main city of the district. The villagers experience a long dry period from May to October where the maximum temperature is around 37 degree centigrade in March. The onset of the Northeast Monsoons is usually in the 1st week of November. The rains continue till the end of December.

The farmers were classified as follows:	
Size of land holding in ha	Category of farmers
Less than 1	Marginal
1 – 2	Small
2 – 4	Medium
Above 4	Large

There are instances where the village has developed and grown originally as a state property. Establishment and development of settlements were facilitated by the government in the 1950s. In the 1960s, plots of lands of 10 ha each were allocated to public servants of executive grade for cultivation purposes. Since then these officers and the workers who accompanied them started buying other surrounding lands for cultivation. This process led to the gradual development of a village. Beneath the surface soil of the village area lies a layer of sedimentary limestone. This area has grown to be a major supplier of limestone to the cement industry of the country. Residents of this area have been facing severe shortage of drinking water. The available water has a high calcium and magnesium salt content. It was in the 1970s that three large-scale tube wells were constructed by the government to provide drinking water through taps to the villagers.

[1]Grama Niladhari Division is the smallest administrative unit in Sri Lanka. Grama Niladhari is the officer in-charge of that unit.

The village Galahitiyagama is in the Grama Niladhari[1] Division of Arnolondawa, located in northeast of Anuradhapura District, in the Divisional Secretariat Division of Horowpothana. Galahitiyagama is located 18 km north of Horowpothana, the closest town to the village. The village experiences a dry period from July to October, and the maximum temperature is around 37 degree centigrade in the month of March. The onset of the Northeast Monsoons is usually in the 1st week of November and continues till the end of December. The farmers were classified based on their land holdings, as in the previous village, for the study. Unlike in the previous village, no farmers were in the marginal category (less than 1 ha) in Galahitiyagama. They all had land holdings more than 1 ha.

Agriculture is the main livelihood of 90% of the villagers and this goes back to the commencement of the village in 1900. Paddy and chena cultivation dominate over the other cultivations and water supply to paddy is done through 3 small village tanks. Chena cultivation depends on direct rainfall. The majority (90%) of the villagers use wells for drinking water. Most years, during the dry periods, the village tanks dry off and villagers do not have sufficient drinking water in the wells, which compels them to walk long distances for water sources. This village does not have electricity. However, nearly 50% of the households have solar power units. One part of the village borders a state forest reservation.

The village Mahagalwewa in the Grama Niladhari Division of Mahagalwewa, is located in the north of Hambantota District, in the Divisional Secretariat Division of Sooriyawewa. Mahagalwewa is located 7 km north of Sooriyawewa, which is the closest town from the village. The village is characterized by a dry period where the maximum temperature is around 38.6 degree centigrade in the month of September. The onset of the Northeast Monsoons is usually in the 1st week of November and continues till the end of December. Land holding size varied across the households. The village Mahagalwewa was established in 1959 with the rehabilitation of the village tank, when a few families came and settled in the vicinity.

The village Bata-Atha of the Grama Niladhari Division of Bata-Atha South is located in the southern coastal border of Hambantota District, in the Divisional Secretariat Division of Ambalantota. Bata-Atha is located 11 km west of Ambalantota, which is the closest town from the village. The village is characterized by a dry period from July to October where maximum temperature was around 38.6 degree centigrade in the month of September. The onset of the Northeast Monsoons is usually in the 1st week of November and continues till the end of December. A three-year period of drought started in 1980 and most of the permanent trees including coconut cultivations were destroyed. The next severe drought was experienced in the year 2000 and the rainfall pattern then experienced was very erratic. Here too, the landholding size varied indicating economic and social inequities. This village was initiated in 1973 with the distribution of lands to fishing communities. Chena cultivation was undertaken as small scale operations when the village came into being, but presently, chena cultivation and rain-fed agriculture operations are not common. This is mainly due to the gross marginal income earned from fishing being much higher than that from agriculture. Quite a number of villagers have government and private sector jobs. At the beginning (1973), domestic water requirement was supplied by a tube well; pipe water was supplied in 1998. Fisheries industry is the major source of income for the villagers since the establishment of the village and paddy cultivation was started in 1978 on a very limited extent of land with irrigated water provided by a government sponsored project by the Mahaweli Authority. Chena cultivation was practiced till the declaration of the wildlife reserve in the village area in 2006. Home gardening is restricted to a few households who

have pipe borne water for cultivation. Livestock can hardly be seen in this village. Detailed socio-economic profile of the above villages, which includes population, number of households, average family size, gross cropped area, literacy rate, percent income below the poverty line, average annual rainfall, soil type, source of irrigation and major crops grown are summarized in Table 1.

2. Methods

2.1 Sampling design

Purposive and stratified sampling techniques were employed in selecting the study areas and the households. The main thrust of this study was to assess vulnerability to climate changes mainly in the Dry Zone of Sri Lanka. Among the Dry Zone Districts, Hambantota, Puttalam and Anuradhapura Districts were purposively selected. This was the first strata of this sampling. The second strata was the selection of Divisional Secretariats in the three districts. Ambalantota Divisional Secretariat Division in Hambantota District, Vanathawilluwa Divisional Secretariat Division in Puttalam District and Horowpothana Divisional Secretariat Division in Anuradhapura District were purposively selected based on the rain-fed nature in agricultural operations.

Overall vulnerability was calculated for Hambantota, Puttalam and Anuradhapura Districts using (Patnaik and Narayanan method, 2005)[2]. Based on this assessment, Hambantota and Puttalam were considered to be very highly vulnerable while Anuradhapura was less vulnerable in 1977. In 2007, Puttalam was still highly vulnerable, Hambantota was moderately vulnerable and Anuradhapura was less vulnerable.

One Grama Niladhari Division from each Divisional Secretarial area was selected – Mahagalwewa Grama Niladahari Division in Sooriyawewa Divisional Secretariat area and Bata-Atha South in Ambalantota Divisional Secretariat area, Mangalapura Grama Niladhari Division in Vanathavilluwa and Arnolondawa in Horowpothana Divisional Secretariat Division – to capture the variability in the Dry Zone Districts of northern, southern and eastern parts of Sri Lanka. The study villages were finally selected as Mangalapura, Galahitiyagama, Mahagalwewa and Bata-Atha. The total sample size was 210 (Table 2). Graphical illustration of the study area is depicted in Fig.1a, Fig. 1b and Fig. 1c. The total sample was separated into marginal (0-1 ha), small (1-2 ha), medium (2-4 ha) and large (> 4 ha) households.

The rationale of the categorization was based on the understanding that each group has different levels of vulnerability and adaptive capacities based on their resources base and factors affecting the same. Details of the study sites, which include agro-ecological regions, district, annual rainfall, area under irrigation, type of terrain, major soil group, land use pattern, availability of agro-meteorological data and its period and the location of representative agro-meteorological station are shown in Table 3.

[2]Patnaik U and Narayanan K. 2005. Vulnerability and climate change: An analysis of the eastern coastal districts of India. Paper presented at the Human Security and Climate Change International Workshop, Asker, Norway, 21–23 June.

Table 1. Socio-economic profile of the study villages as of 2008.

Characteristic of Socio-economic profile	Puttalam District	Anuradhapura District	Hambantota District	
	Mangalapura	Galahitiyagama	Bata-Atha	Mahagalwewa
Geographical locations	8° 01' N 79° 55' E	8° 22' N 80° 28' E	6° 10' N 81° 10' E	6° 10' N 81° 10' E
Human population	1417	1179	1935	825
Total number of households	394	344	484	225
Average family size	3.6	3.4	4	3.7
Gross cropped area (ha)	1820	168	342	610
Literacy rate	93.3	90.3	89	89
% Below poverty line	22.3	24.4	32.4	32.4
Average annual rainfall (2001 - 2008)	1275mm	-	1234 mm	1234 mm
Annual average number of rainy days	61	-	77	77
Average annual minimum temperature (°C)	21.0	-	22.0	22.0
Average annual maximum temperature (°C)	34.0	-	31.0	31.0
Soil type	Red yellow Latasol	Reddish brown earth	Reddish brown earth	Reddish brown earth
Sources of irrigation	Tube wells	Tank and wells	Canal and wells	Tank and wells
Major crops grown	Cowpea, water melon, green gram, chili, manioc, cashew	Paddy, maize, foxtail millet, chili	Sesame, maize, finger millet	Paddy, sesame, finger millet
Main occupation of the villagers (% of population)	Farming (60-70%)	Farming (100%)	Sea Fishing (60-70%)	Farming (80-90%)
Cropping seasons	*Yala & Maha	Yala & Maha	Yala & Maha	Yala & Maha
Improved technologies partially adopted	High yielding varieties, fertilizers, power sprayers, tractors, water pumps, agro-wells, tube wells	High yielding varieties, fertilizers, power sprayers, tractors, threshers, harvesters	High yielding varieties, fertilizers, sprayers, tractors, threshers	High yielding varieties, fertilizers, power sprayers, tractors, threshers, harvesters, water pumps

*Yala (March-September); Maha (October-February)

Source : Focus Group Discussions in the study villages, Key informant questionnaires and district data, 2010, Farmers' perceptions of climate change in Sri Lanka: Quantitative Analysis

2.2 Sources of data

Primary data in relation to farmers' perceptions were gathered from sampled households through personal interviews.

Table 2. Stratified sampling of villages.

District	Divisional Secretariat	Grama Niladhari Division	Village	Sample Size
Hambantota	Sooriya Wewa	Mahagal Wewa	Mahagal Wewa	50
	Ambalantota	Bata-atha South	Bata-atha South	50
Puttalam	Vanathavilluwa	Mangalapura	Mangalapura	50
Anuradhapura	Horowpothana	Galahitiyagama	Galahitiyagama	60
Total sample size				210

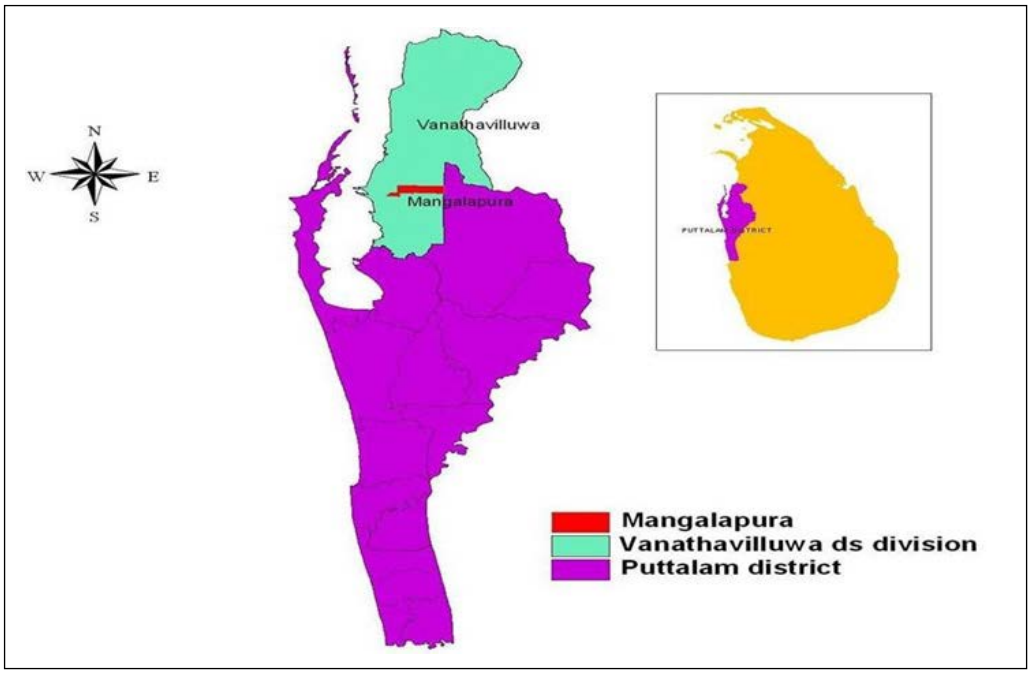

Figure 1a. Study village in Puttalam District.

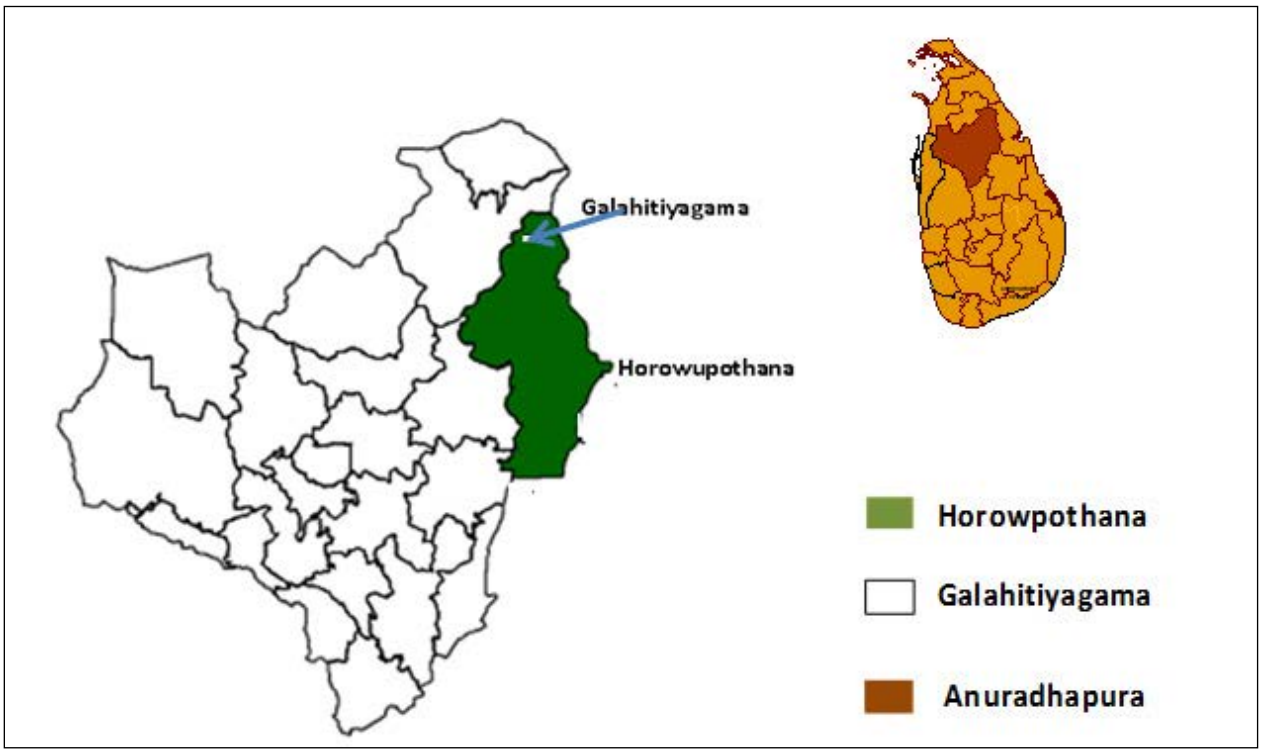

Figure 1b. Study village in Anuradhapura District.

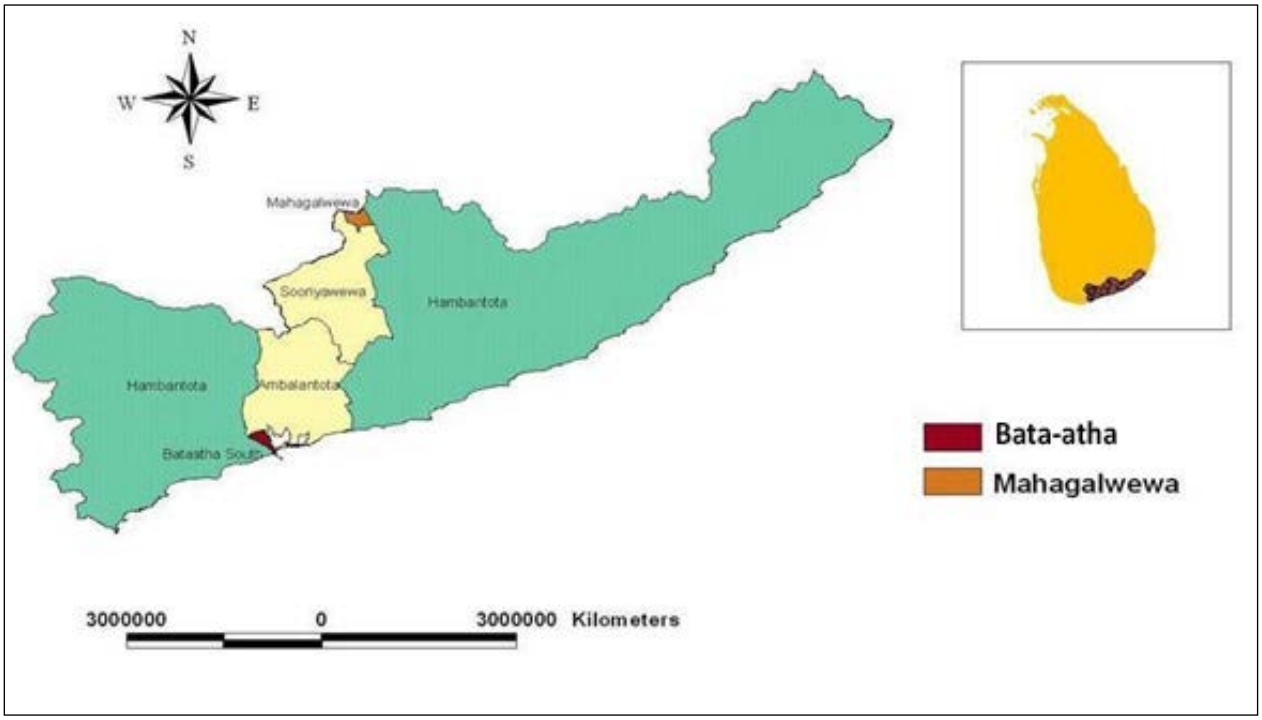

Figure 1c. Study villages in Hambantota District.

Table 3. Details of the study sites.

Agro - Ecological Regions	District	Annual Rainfall (mm.)	Area under irrigation (%)	Terrain	Major Soil Groups	Land Use	Data Type and Availability	Period (years)	Selected Agro - Meteorological station
DL1b	Hambantota	>900	9.6	Undulating	Reddish brown earth and low humic gley soils	Rainfed upland crops, paddy, scrub, mixed home gardens, forest plantations	Rain fall	1975-2008	Angunakola-pelessa
							Temperature -Min. Max.	1975-2008	
							Humidity	1975-2008	
							Pan evaporation	1975-2008	
							Sun shine hours	1975-2008	
							Wind speed	1975-2008	
							Soil temperature (5/10cm)	1975-2008	
DL3	Puttalam	>800	5.5	Flat and slightly cudulating	Red yellow latosol and regosol soils	Cashew, coconut, condiments, scrub, Natural forest	Rain fall	1975-2008	Eluwankulama
							Temperature -Min. Max.	1975-2008	
							Humidity	1975-2008	
							Pan evaporation	1975-2008	
							Sun shine hours	1975-2008	
							Wind speed	1975-2008	
							Soil temperature (5/10cm)	1975-2008	
DL1b	Anuradhapura	>900		Undulating	Reddish brown earth and low humic gley and soils	Rainfed upland crops, paddy, scrub, mixed home garden, forest plantations	Rain fall	1975-2008	Vavuniya
							Temperature -Min. Max.	1975-2008	
							Humidity	1975-2008	
							Pan evaporation	1975-2008	
							Sun shine hours	1975-2008	
							Wind speed	1975-2008	
							Soil temperature (5/10cm)	1975-2008	

2.3 Data collection

Qualitative data have been gathered at the village-level through individual interviews using a semi-structured questionnaire. General information, cropping patterns, inputs use, markets and infrastructure, occupation, livelihoods, average annual farm income, indicators of weather/climatic variability, impacts, groundwater table, common property resources, land and water management have been gathered through a structured questionnaire for 1970 and 2008. The information gathered was supplemented by means of narratives, timelines and transect walks. A total of 16 Focus Group Discussions and 210 individual interviews were conducted.

Figure 2. An individual interview at a farmer's field.

Figure 3. An individual interview at a home.

2.4 Data analysis

The quantitative information gathered through personal interviews was analyzed after coding responses for each question. Extremely contradictory statements regarding climatic events and its impacts were analyzed using a matrix.

3.Comparison of Village Situations

3.1 Degree of changes in infrastructure

The development of pre-schools, schools and family health were improved in all four villages over the period of time from 1970s to 2008. However, railway facilities, universities, veterinary doctors, veterinary hospitals and artificial insemination centers were not available in all four villages. Road development was seen in three villages except Mahagalwewa. Development of banks, hospitals, Grama Niladhari Office, Divisional Secretariat, Samurdhi Development bank, water supply, telephone and electricity were available in three villages except Galahitiyagama in Anuradhapura District. Internet facilities were available only in Mangalapura (Table 4).

3.2 Human Development Indices

The proportion of food insufficient households was reduced over the period of 1970-2008 in three villages except Galahitiyagama, which showed food insufficiencies in off-cultivation periods. Villagers did not have off-farm activities to earn extra income for their households, hence they faced difficulties in obtaining meals on certain days. However, in all four villages, temporary mud and wooden houses were replaced by permanent houses. Major reduction of farmland was observed. Availability and quality of drinking water has shown a minor decrease in all the villages. Child nutrition has improved; infant, child and maternal mortality had reduced while general health of the people had improved in all four villages. Education, literacy rate, access to information had improved in all four villages. Energy sources for cooking (firewood) had improved while electricity had improved in Mahagalwewa and Bata-Atha villages (Table 5).

3.3 Degree of change in climatic characteristics over the period 1970–2008

Among all the household categories of the four selected villages, 100% of the respondents in marginal households, small households and medium households perceived that the climate has changed during the period 1970-2008. Among the respondents in the large household category, 95% of the farmers said that the climate has changed. The majority of the respondents in all household categories in all four villages said that the weather forecasting ability has changed during the period. Quantum of rainfall, intensity of rainfall and number of rainy days were reduced according to the perception of all household categories. Furthermore, they are of the view that temperature has increased over the last 40 years.

Table 4. Perception distribution of respondents by degrees of change in infrastructure in the study villages over the period 1970-2008.

	Farmer perception on degree of change over the period of 1970-2008			
Infrastructure	Mangalapura	Galahitiyagama	Mahagalwewa	Bata-Atha
Road	+1	+1	0	+1
Railways	0	0	0	0
Banks	+1	0	+1	+1
University	0	0	0	0
Hospital	+1	0	+1	+1
Police Station	+1	0	0	+1
Grama Niladhari Office	+1	0	+1	+1
Preschool	+1	+1	+1	+1
Divisional Secretariat	+1	0	+1	+1
Office of the family health officer	+1	+1	+1	+1
Pradeshiya Sabha	-1	-1	0	0
Samurdhi Development Bank	+1	0	+1	+1
School	+1	+1	+1	+2
Artificial insemination center	0	0	0	0
Veterinary doctors and Veterinary hospital	0	0	0	0
Water supply (Tap water)	+1	0	+1	+1
Telephone	+1	0	+1	+1
Electricity	+2	0	+1	+2
Internet	+1	0	0	0

-2 Major decrease, -1 Minor decrease, 0 No change, +1 Minor increase, +2 Major increase

Table 5. Perception on periodical changes in various Human Development Indices (1970-2008).

	Farmer Perception (1970-2008)			
	Mangalapura	Galahitiyagama	Mahagalwewa	Bata-Atha
Proportion of food insufficient households	-1	+1	-1	+1
Households unable to get even 2 meals a day (%)	-1	+1	-1	+1
No. of households with mud houses (%)	-2	-2	-1	-2
Households having wooden huts (%)	-2	0	-2	-2
Households with permanent houses (%)	+2	+1	+2	+2
Availability of farm land (%)	-2	-2	-2	-2
Availability of food (%)	-1	0	-1	+1
Availability of drinking water	-1	-1	-1	-1
Quality of drinking water	+1	-1	-1	-1
Child nutrition	+1	+1	+1	+1
Infant mortality	-2	-1	-2	-2
Child mortality	-2	-2	-2	-2
Maternal mortality	-2	-1	-1	-2
General health of the people	+1	+1	+1	+1
Ability to cope with drought	+1	-1	-1	-1
Availability of consumer goods	+1	+1	+1	+1
Ownership of durable goods	+1	0	-1	-1
Availability of energy (sources for cooking)	+1	+1	+1	+1
Availability of energy (sources for lighting)	0	0	+1	+1
Education/Literacy	+2	+1	+1	+2
Information flow	+2	+1	+2	+1

-2 Major decrease,-1 Minor decrease, 0 No change, +1 Minor increase, +2 Major increase

3.4 Technological (Machinery and equipment) change over villages

Generally, minor increase of agriculture machinery was observed across the four villages during the period 1970–2008. However, there was no change in number of some machinery in Mahagalwewa and Bata-Atha in Hambantota District. In fact, dish tractors, combine harvesters, harvesters and threshers were not found in Mahagalwewa and Bata-Atha villages. Details of the change of machineries over the period are presented in Table 6.

Technological adaptation may be considered either as (i) introduced or (ii) non–introduced influence. Introduced influence can be described as the technology that is introduced by an outside agency to ease the activities of the villages. Non-introduced influences are those that are invented or discovered by the villagers themselves.

Table 6. Distribution of farmers' perceptions by degrees of change in dynamics of mechanization in the study villages over the period 1970-2008.

	Farmer perception on degree of change over the period of 1970-2008			
Machinery	Mangalapura	Galahitiyagama	Mahagalwewa	Bata-Atha
Tractors	+1	+1	+1	+1
Dish tractors	+1	+1	0	0
Harvesters/Combine harvesters	+1	+1	0	0
Water pump sets	+1	+1	+1	+1
Sprinkler and Drip irrigation sets	+1	+1	+1	0
Spray equipment	+2	+1	+1	+1
Threshers	+1	+1	0	0

-2 Major decrease, -1 Minor decrease, 0 No change, +1 Minor increase, +2 Major increase

Mangalapura Village

Introduced technologies: Introduced technology is defined as any form of technology that farmers adopt having obtained them from outside the knowledge base they have developed from generations of farming experiences. Introduced technologies are again divided into machinery and crop recommendations. Some of the examples given from Mangalapura village for machinery were: tube wells, deep water pumps, drip irrigation system and net houses, while hybrid seeds, fertilizer recommendations and agro–chemicals were considered as crop recommendations. New melon hybrid (sugar baby) was introduced in the year 2000 and with this new crop recommendation, yields and gross margin of the farmers have increased.

There are three tube wells installed in three locations in 1965 in Vanathavilluwa. Among them, only one is working at present. There were three small tube wells installed at Mangalapura during the period 1987–1995, but none of them are functioning at present. Two wells are found in Mangalapura but none of them are usable at present. The drip irrigation system is being used by larger-scale farmers in coconut plantations. Current depths of a tube well and normal well are between 9 m and 90 m (30 ft- 300 ft). Water availability in villus[3] is at a minimum level during dry

[3]Although there are no large natural lakes in Sri Lanka, there are several flood-plain lakes, commonly referred to as villu, which cover a total area of 12,500 ha. Often they are cut-off former river bends. (http://wordnetweb.princeton.edu/perl/webwns=villus)

periods. Villagers in Mangalapura do not have sprinklers for cultivation, and other equipment that would save time and increase input efficiency and crop yield were available at a minimum.

Non-introduced technologies/practices: Some of the crops, farming systems and village-level technologies, which are used by the villagers at Mangalapura were: Perennial crops (fruit crops such as mango, citrus, etc), short term high value crops / early escapers (hybrid melon sugar baby), Chena cultivation (purely a rain-fed agriculture system with zero fertilizer and zero agro chemicals used during Yala season by the first generation farmers), pitcher irrigation to save plants from water stress situations and change the time of commencement of cultivations. The above practices that are used traditionally by farmers through learning by doing may be considered as direct adaptation measures for climatic variabilities and their impacts. Adaptation of non-introduced practices varies among the different farmer categories.

Galahitiyagama Village

Related technological adaptations were described in the previous village scenario. Based on these definitions, some of the examples for machinery technology adopted by the farmers at Galahitiyagama were tractors (2-wheel and 4-wheel), tractor mounted big threshers and disk harrowers. These machineries helped farmers to complete their seasonal farming operations within a very short period of time. Hybrid seeds, new fertilizer recommendations and new agro-chemicals were considered as crop recommendations among the introduced technology. A new hybrid corn named Pacific was introduced as a cash crop in the year 2000, and helped to increase the gross margin of the villagers in general. There were two 4-wheel tractors, eighteen 2-wheel tractors and implements such as disc harrowers in the village.

The use of these machineries and implements helped farmers to complete land preparation as quickly as possible with the onset of rains. Usually, reddish brown earth in the village gets muddy during the rainy season while crust formation is seen during the dry period. Hence, land preparation activities are difficult during the dry period. The village Galahitiyagama ranked at the top in using technology to increase efficiency in farming in terms of land and labor. Therefore, use of technology has helped farmers to reduce drudgery in farming activities. There was a varying degree of adoption of technologies among different types of farmers. Improved technology has reached the village in the form of big threshers that are being used widely throughout the village for threshing paddy. Information on new technology has been received from adjacent villagers and from the media and paddy farming has become profitable. This new technology can be used regardless of the unfortunate climatic conditions. Hence, almost all the villagers have shown their willingness to adopt these new machineries to reduce the drudgery in paddy cultivation and thereby have been able to increase the gross margins. The System of Rice Intensification (SRI) method[4] has been adopted by most of the paddy farmers in the village. Apart from this method, pitcher irrigation method has been used by villagers in coconut cultivation during dry periods.

Mahagalwewa Village

Introduced technologies: Technologies introduced to the Mahagalwewa village were farm machinery such as 4-wheel tractors, 2-wheel tractors and threshers. Villagers have been introduced to the rainwater harvesting systems to increase the water availability for farming activities. A community

[4]SRI method has been an appropriate answer to meet the impacts of climate change. Since zero tillage is practiced, minimum water is required for paddy cultivation and attractive harvests can be obtained by following this method.

water supply system was introduced by the Government to provide the need for drinking water. Hybrid paddy varieties have also been introduced to the farmers as crop recommendations.

Non-introduced technologies: Since the agricultural activities of the village are affected by the water stress, farmers have adopted crops that require minimum water such as sesame and finger millet. Perennial crops such as coconut and fruit crops are also cultivated.

Bata-Atha Village

Machinery and equipment such as 4-wheel and 2-wheel tractors have been introduced to Bata-Atha village. Hybrid seeds and fertilizer have been used as crop recommendations for vegetable and paddy cultivations. Since vegetable cultivation is carried out in the homegarden level, these crop recommendations have increased the domestic production. Non-introduced technologies have been adopted by the farmers, through their own experience gained over generations of farming to increase their level of income. Hence, adaptation of non-introduced technologies varied with successive generations of the farmers.

3.5 Changes in associations/groups and institutions

Changes were observed about the associations prevailing in the four villages. Milk collecting centers were reduced in all the four villages over the reference period. Indigenous cattle were reared by all four villages for home consumption of milk. Milk is not sold in these villages at all times. Cattle were mainly reared for sale, especially during the off farming period where there was hardly any money for living. Decrease of cattle population was observed in Bata-Atha too, mainly due to the migration of most of the villagers to sea fishing, which generates comparatively more income. There was not much improvement in the numbers of farmer societies except in Mangalapura village. The number of welfare societies, pre-schools and children's societies showed a minor increase in all the villages over the period of the study. A minor increase was observed in agricultural development societies only in Galahitiyagama, while no changes or no societies were available in Mahagalwewa and Bata-Atha villages (Table 7).

Mangalapura

Various institutions have been providing their services to the village communities to support their adaptive efforts. Basically, two forms of institutions were identified as formal and informal depending on their organizational structure. Formal institutions are structured organizations, and informal institutions are those systems that were created more out of a sense of belonging, shared beliefs and faith of the people. In this exercise, attention was paid to judge enabling mechanism of all institutions when the community faces any extreme climatic event. Extending the same exercise, perceptions of public officers, adult males and females who are residing in the village were ranked based on the services rendered by these institutions in terms of providing subsidies, information and assistance in emergency situations.

Table 7. Perception distribution of respondents by degrees of change in association and groups in the study villages over the period 1970-2008.

Village association and groups	Farmer perception on degree of change over the period of 1970-2008			
	Mangalapura	Galahitiyagama	Mahagalwewa	Bata-Atha
Milk co-operatives	-2	0	-1	-1
Farmers' Society	+1	-1	-1	0
Welfare Society (Funerals)	+1	+1	+1	-1
Women's Society	+1	+1	0	0
Children's Society	+1	+1	+1	+1
Preschool Society	+1	+1	+1	0
Dayaka Sabha (Based on temple)	-1	-1	+1	+1
Agriculture Development Society	-1	+1	0	0

-2 Major decrease, -1 Minor decrease, 0 No change, +1 Minor increase, +2 Major increase

Informal institutions: Informal institutions are systems that were created more out of a sense of belonging, shared beliefs and faith of the people. Examples of such informal institutions listed by public officers and adult males and females in Mangalapura village were Dayaka Sabha at temples, societies at churches, senior citizens' society and School Development Society. The services of the above mentioned institutions in the village vary in different degrees and these are highlighted in Table 7. In the event of a drought or a flood, people were more likely to trust family members and relatives. In addition to these, the villagers were able to rely on the government and non-governmental organizations.

Galahitiyagama

In 1970s, the death donation society was the major organization that supported villagers in emergency situations. At such times, villagers worked together and they were of the view that the government's intervention was at a minimum. At present, relief programs are being implemented by the World Vision Organization, an international non-governmental organization (INGO), in addition to the Welfare Society, in case of an emergency. Further, the Grama Niladhari also offers help at every urgent situation. The health sector has been developed under the management of the leaders of societies in the village. It was stated that the delivery of aid received at an emergency was carried out fairly. Further, the villagers said that priority was given to poor people and widows in granting relief aid packages.

During the period of disasters such as droughts, villagers have to work on daily wages. Dry rations were provided during times of drought as World Bank Aid based on Check Roll procedure. Villagers have shared their harvest during times of emergency. Relief programs provided by the government have been distributed among the people fairly. As people are provided with relief aid such as *Janasaviya* during the times of drought, they seem to have more strength to overcome the ill effects of such situations. Further, they have obtained loans by organizing themselves into groups, depending on the extent cultivated. At present, they are in a better situation to face the droughts since agro-wells were introduced by the World Vision International. Women of the village are of the view that the living conditions of the villagers have improved.

The suggestions of all members were gathered regarding the importance of institutions. The major contribution was made by one person (Chairman of the Farmers' Society). Youths also showed an interest in expressing their ideas. All the members participated actively in ranking institutions. No difficulties were observed in arriving at conclusions. It was stated that effective service was extended by institutions such as the children's society, school, family health center and Grama Niladhari office. Further, it was stated that a close and friendly service was rendered by these institutions. Even though two opinions were brought forward on the Agrarian Service Centre, the group could arrive at an agreement. However, the enthusiasm shown in expressing opinions on the Samurdhi Office was at the minimum level and it was stated that the service of the Samurdhi[5] Office was in no way satisfactory. However, when both Venn diagrams were discussed, a disagreement arose on the closeness of the service rendered by the Family Health Officer. Since the visits made by the Family Health Officer to the village were not so satisfactory, they agreed to change the ranking from close to distant.

Mahagalwewa

Public officers were consulted about the various institutions located within the village and whilst they were naming such institutions, all the other participants too contributed well, by naming at least one institution. It seemed that there is a significant difference in the results among public officers, male and female village participants. During the discussion which took place later, the females proved to provide the most accurate information. Further, it was observed that the institutions treated males and females in different ways. Females stated that they were not provided with the service required to them by the police station. However, one adult male intervened and reminded them that the security was given by the police during the period of terrorist threats. He asked the women whether they had forgotten the help given by them when the women had fled to jungles to escape from terrorists. The general opinion among the people was that the institutions that provided them with more services at times such as droughts were Divisional Secretariat and Grama Niladhari office. Further, they stated that the police station and the Family Health Officers provided information when there was a need in problematic situations.

Bata-Atha

During the discussion, it was understood that a limited group always enjoys benefits from certain institutions. However, the expression of ideas was somewhat hindered due to the presence of officers from the institutions under discussion. As an example, Samurdhi Officers raised some questions when participants decided to rank Samurdhi Office under the category of Average service. Further, they stated that they are provided with more services by the fisheries society, Grama Niladhari, school, health services officer and Divisional Secretariat and close relationships are maintained with these institutions. Further, it seems that the institutions involved in youth affairs were not at an outstanding level. There were different views on the services provided by the rural hospital at Ranna. Women stated that the hospital always lacks necessary medicines and therefore it was a common experience to transfer patients to other hospitals. However, males were of the view that the services of the hospital were at a satisfactory level when the difficulties of the area were taken into account. Youths considered the services of the hospital as average. Forthwith, several adult farmers agreed that their previous decision was wrong. It seemed that the women were expressing their views frankly.

[5]Samurdhi is a Government welfare program to alleviate poverty in Sri Lanka. Janasaviya was the earlier name given by the previous political party.

3.6 Changes in water conservation measures and status of tube wells and wells

Depth of the groundwater table has increased in Mangalapura and Galahitiyagama while no change was perceived in Mahagalwewa and Bata-Atha. Minor increase of the number of tube wells was observed in Mangalapura while minor decrease was observed in Galahitiyagama. Tube wells were not observed in Mahagalwewa and Bata-Atha. Tube wells had failed over the reference period in Mangalapura and Galahitiyagama, but major increase of the number of wells was perceived in Mangalapura while minor increase was observed in all other villages (Table 8).

Table 8. Perception distribution of respondents by degrees of change in status of wells and tube wells in the study villages over the period of 1970-2008.

	Farmer perception on degree of change over the period of 1970-2008			
Wells and Tube wells	Mangalapura	Galahitiyagama	Mahagalwewa	Bata-Atha
Ground water table (ft)	+2	+1	0	0
No of tube wells	+1	-1	0	0
No of tube wells failed	+1	+1	0	0
No of wells	+2	+1	+1	+1
No of wells dried	+1	+1	0	0

-2 Major decrease, -1 Minor decrease, 0 No change, +1 Minor increase, +2 Major increase

Mangalapura

In 1965, the Government had started the digging of tube wells in Mangalapura and villagers had experienced having sufficient water for cultivation of crops. Supply of pipe borne water for cultivation was started in 1971 and farmers received sufficient water for crop production. Villagers then experienced a flood situation due to heavy rains during 1977; roads were damaged as a result of this flood. In 1978, cashew cultivation was started by the cashew corporation and villagers gradually shifted from seasonal crops to cashew cultivation. The year 1983 was again a bad year for all the villagers since a drought occurred and it caused severe damage to coconut plantations. Apart from this damage, water shortage was experienced throughout the village. Although cashew and coconut gave them a steady income, they lacked ready cash for their daily expenses. In 2002, villagers faced a shortage of drinking water and had no water for cultivation purposes. During this period a drinking water supply scheme was initiated by an international non–government organization, World Vision International. This project provided water for about 120 households in Wagawa area in the village. As in the previous years, change of rainfall pattern and delay in onset of monsoons were experienced in the year 2009; hence, shortage of drinking water was experienced in the village. Castor, a new crop to the area, was introduced to the villagers on a very limited scale. Severe drinking water shortages were experienced by the majority of the villagers, especially during the monsoon withdrawal periods of August-September and January-February.

Figure 4. Water transportation to houses.

Figure 5. Careful collection of water from a well.

Galahitiyagama

Farmers in Galahitiyagama were used to conserving water using agro-wells (Figure 6) and water harvesting tanks (Figure 7) during the prolonged drought periods. They did not have tube wells or water pumps.

Figure 6. An agro-well in Galahitiyagama.

Figure 7. Water harvesting tank in a house at Galahitiyagama.

Mahagalwewa

Tube wells, agro-wells, drip irrigation and sprinkler irrigation systems were not available at Mahagalwewa. Farmers cultivate their lands under rain-fed conditions.

Bata-Atha

During the early stages of colonization, people of the village used water from the stone well situated in the village for drinking, while the lagoon was used for other requirements. During droughts, they had to spend nearly 4-5 hours travelling to fetch water from a nearby village. During the period 1978–1980, water shortages for cultivations occurred due to abandoning of the village tank; paddy cultivation was almost given up by the villagers. In 1980, the villagers faced a drought that continued for two and a half years. The Government provided aid to the villagers during this period. Cultivation of seasonal crops has declined, including their major seasonal crop, sesame. Chena cultivations have drastically declined and only some of the seasonal crops were confined to the home garden level.

Water Conservation Techniques

Water harvesting techniques were observed in Galahitiyagama and not in the other three villages. Minor decreasing trends of watershed development and management were observed in all villages. A minor decrease of in situ moisture conservation techniques was observed in all villages. A minor increase of extradition of groundwater was observed in Mangalapura and Galahitiyagama villages. A minor decrease of drainage management was observed in all villages, while a minor increase of sprinkler and drip irrigation were observed in all four villages. Tanks were found only in Galahitiyagama and Mahagalwewa, but renovation and construction of dams were not done over the period from 1970-2008(Table 9).

Table 9. Perception distribution of respondents by degrees of change in water conservation practices in the study villages over the period 1970-2008.

	Farmer perception on degree of change over the period of 1970-2008			
Water conservation practices	Mangalapura	Galahitiyagama	Mahagalwewa	Bata-Atha
Rainwater harvesting	0	+1	0	0
Development and maintenance of watersheds	-1	-1	-1	-1
In-situ moisture conservation	-1	-1	0	-2
Extradition of groundwater	+1	+1	0	0
Drainage management	-1	0	-1	-1
Use of sprinklers	+1	+1	+1	+1
Use of drip irrigation	+1	+1	+1	0
Construction of dams	0	-1	-1	0

-2 Major decrease, -1 Minor decrease, 0 No change, +1 Minor increase, +2 Major increase

3.7 Degrees of change in employment

A minor decrease was observed in the farming (crop production) and livestock sectors in all four villages over the period 1970–2008. Involvement of farm labor has also shown a minor decrease during the same period. A minor increase was observed in the service and business sectors along with a minor increase in non-farm labor. Minor increase of outward migration from the village was observed during the period (Table 10).

Table 10. Perception distribution of respondents by degrees of change in employment in the study villages over the period 1970–2008.

	Farmer perception on degree of change over the period 1970-2008			
Type of Employment	Mangalapura	Galahitiyagama	Mahagalwewa	Bata-Atha
Farming (crop production)	-1	-1	-1	-2
Livestock sector	-1	-1	-1	-1
Service sector	+1	+1	+1	+2
Business	+1	+1	+1	+1
Labor–farm	-1	0	-1	-1
Labor–non farm	+1	+1	0	+1
Outward migration	+1	+1	+1	+1

-2 Major decrease, -1 Minor decrease, 0 No change, +1 Minor increase, +2 Major increase

4. Details of the Selected Villages

4.1 Galahitiyagama village

Galahitiyagama village is situated in the Anaolondawa Grama Niladhari Division at Horowpothana Divisional Secretariat area in Anuradhapura District. The total human population of the village was 281 during the year 2008. Primary occupation of the villagers is mainly based on agriculture related activities. Farmers' perceptions of the climate change and related issues are summarized in the following sections.

4.1.1 Demographic Features of Galahitiyagama village

Total geographical area of the Galahitiyagama village was 180 ha in 2008 and it has not changed during the period under consideration according to farmers' perceptions. The village population can be classified into 3 categories based on the size of holdings as marginal (0-1 ha), small (1-2 ha) and medium (2-4 ha) households. Number of small and medium households has increased while the number of marginal households has reduced during the period (Table 11).

Table 11. Demographic features of Galahitiyagama village.

Demographic feature	Number in 2008	Degree of change
Geographical area (ha)	180	No change
Marginal households (0–1 ha)	65	Major decrease
Small households (1–2 ha)	3	Minor increase
Medium households (2–4 ha)	2	Minor increase
Large households (>4 ha)	0	No change

4.1.2 Cropping pattern, livestock activities and input use

4.1.2.1 Cropping pattern

The cropping pattern has changed based on the cultivated seasons. Yala and Maha are the two major cultivating seasons in Sri Lanka. The Yala season starts in March and ends in September while the Maha season starts in October and ends in February. According to the perceptions of the farmers, the cultivated area of finger millet, okra, maize, paddy and other crops (fruits) have increased in the Yala season during the period while the area of other crops have decreased (Table 12). The average yield of chili, onion, finger millet, maize, okra, groundnut and paddy have increased in the Yala season. In the Maha season, the cultivated area of paddy and foxtail millet has increased while the cultivated area of chili, onion, finger millet, green gram, black gram, maize and mustard has reduced (Table 13). The average yields of chili, onion, finger millet and green gram have reduced in the Maha season. Cropped area of mango and papaya has increased during the period 1970–2008.

Table 12. Cultivated area and distribution of respondents (%) by crop cultivated during Yala season over the period 1970–2008.

Crop	Cultivated area (ha)		Degree of change (n=60) (%)				
	1970	2008	Major decrease	Minor decrease	No change	Minor increase	Major increase
Chili	5	2	5	0	2	0	0
Onion	1	0.3	2	0	0	2	2
Finger millet	3	4	0	0	2	5	0
Black Gram	0.4	0	2	0	0	0	0
Maize	0.2	2	0	0	0	0	0
Okra	0	1	3	0	0	5	0
Groundnut	0	0.1	2	0	0	0	0
Sesame	1	0	3	0	0	2	2
Pumpkin	0.4	0	0	0	0	0	0
Paddy	6	22	2	2	3	18	8
Other	1	2	0	0	0	0	2

Table 13. Cultivated area and distribution of respondents (%) by crop cultivated during Maha season over the period 1970–2008.

Crop	Cultivated area (ha)		Degree of change (n=60) (%)				
	1970	2008	Major decrease	Minor decrease	No change	Minor increase	Major increase
Chili	3	2	3	2	7	8	2
Onion	3	0.5	12	0	2	5	0
Finger millet	16	4	5	15	7	3	2
Green gram	12	3	8	15	2	7	0
Cowpea	1	1	3	0	5	5	0
Black gram	2	1	5	0	2	7	0
Sesame	1	1	5	2	0	3	2
Groundnut	1	1	5	0	0	3	0
Pumpkin	2	2	7	2	5	10	0
Paddy	74	89	5	7	17	12	15
Maize	62	60	5	18	15	20	23
Foxtail millet	9	18	8	3	7	15	15
Mustard	1	0	2	0	0	0	0
Other	1	0.3	3	0	3	0	0

4.1.2.2 Input use for crops

There is an overall perception of positive change in terms of certain aspects of modernization in agriculture. The majority have perceived that the land preparation by tractors has increased while the use of bullocks has decreased during the period (Table 14). According to the majority of the farmers, the number of irrigations has not changed. The majority have said that usage of compost, urea and Muriate of Potash (MOP) has increased and usage of labor has not changed during the period. Manual weeding has decreased while mechanical weeding has increased. Usage of herbicides and pesticides has increased while Integrated Pest Management (IPM) has decreased during the period.

Table 14. Distribution of respondents (%) by degree of change in input use over the period 1970–2008.

	Degree of change (n=60) (%)				
Input use	Major decrease	Minor decrease	No change	Minor increase	Major increase
Land Preparation					
Tractors	0	0	2	38	60
Bullocks	48	47	5	0	0
Improved seed	2	0	5	47	47
Type of Irrigation					
Pump set	0	0	0	17	3
Sprinkler	0	0	0	5	0
Others (Pitcher irrigation)	0	2	5	10	0
Frequency of irrigation	0	8	62	30	0
Fertilizers					
Farm yard manure	0	0	3	7	5
Compost	0	7	2	32	15
Cattle penning	7	3	7	13	10
Urea	0	0	2	25	73
Muriate of Potash	0	0	2	28	70
Labor usage					
Male	10	20	37	27	7
Female	7	23	35	23	12
Family labor	7	17	50	25	2
Weeding					
Manual	18	50	18	3	8
Mechanical	0	5	7	40	22
Herbicides/Weedicides	0	0	0	37	63
Pesticides	2	0	2	38	58
Integrated Pest Management	28	47	18	7	0

4.1.2.3 Livestock population

According to actual livestock population data during the period 1970–2008, total populations of cattle, buffalo, goat and poultry have increased (Table 15). This is in line with the overall increase in the village population and numbers of families that rear livestock.

Table 15. Actual livestock population in 2008 and farmer perception on degree of change in livestock population over the period 1970–2008.

Livestock population	Number in 2008	Degree of change
Cattle	185	Major increase
Buffaloes	140	Major increase
Goat	80	Major increase
Poultry	210	Major increase

4.1.2.4 Input use for livestock activities

Most of the farmers who carried out livestock activities in a limited scale have not used the inputs available in markets (Table 16). According to most of the respondents, usage of vaccines and medicines has increased during the period. Mostly, these animals were led to grasslands for free grazing.

Table 16. Distribution of respondents (%) by degree of change in input use for animals over the period 1970–2008.

	Degree of change (n = 50) (%)					
Input use for animals	Major decrease	Minor decrease	No change	Minor increase	Major increase	Did not use inputs
Dry fodder	2	3	2	8	3	82
Cultivated green fodder	0	0	2	2	0	96
Grasses & hand-picked/ collected green fodder	8	5	7	15	2	63
Concentrates	0	0	2	3	0	95
Compound cattle feed	0	0	0	2	2	96
Minerals & vitamins	0	0	2	7	2	89
Vaccines	0	0	0	20	10	70
Medicines	0	0	2	20	8	70
Artificial insemination	0	0	2	0	2	96
Improved animal breeds	0	0	3	3	0	94

4.1.3 Market and Infrastructure

4.1.3.1 Input market

Galahitiyagama village is located 18 km away from the main market place, Horowpothana. The nearest market place to the village is Kapugollewa and it is located 8 km away from the village.

According to the majority of the farmers, in 1970s seeds were available within the village and the availability has decreased during the period (Table 17). In 1990s through 2008, seeds and fertilizer were brought from markets located within 20 km distance from the village, mostly from Horowpothana and Kapugollewa. Availability of seed in the market during 1970–1990 is relatively low compared to 1990-2008, (Table 18). Availability of fertilizer in the market has decreased during the period 1990–2008. Availability of agro chemicals has not changed during both periods.

Table 17. Distribution of respondents (%) by distance from the village to the input market over the period 1970–2008.

	1970 (%)			1990 (%)			2008 (%)		
Input	Within the village	0-20 km	>20 km	Within the village	0-20 km	>20 km	Within the village	0-20 km	>20 km
Seed	54	5	1	19	40	1	6	53	0
Fertilizer	2	57	1	4	55	1	4	55	1
Agro chemicals	1	58	1	1	58	1	1	0	1
Cattle feed	1	2	0	0	0	0	1	0	0
Others (Machinery)	0	0	0	0	0	0	0	0	0

Table 18. Distribution of respondents (%) by degree of change in input availability in the market over the period 1970–2008.

	Degree of change (n=60) (%)									
	1970–1990					1990–2008				
Input	Major decrease	Minor decrease	No change	Minor increase	Major increase	Major decrease	Minor decrease	No change	Minor increase	Major increase
Seed	0	63	32	5	0	0	22	73	5	0
Fertilizers	0	2	78	20	0	0	87	13	0	0
Agro chemicals	0	2	90	8	0	0	3	97	0	0
Cattle feed	0	5	0	0	0	0	5	95	0	0

4.1.3.2 Output market

After 1990s the output market for most of the agricultural products was within the village. Due to the involvement of wholesalers, the villagers have sold their products within the village (Table 19). The majority have said that output market for food grains and pulses, milk and other agricultural commodities has not changed during the periods 1970–1990 and 1990–2008. In 1970, the majority have sold their food grains and pulses, vegetable and maize at nearby markets while in 2008 they have sold their products in their village itself. During 1990–2008, the involvement of local agents and wholesale dealers has increased (Table 20).

Table 19. Distribution of respondents (%) by availability of output markets within the period 1970–2008.

	Where sold (%)					
	In village Itself			Nearby market		
Items	1970	1990	2008	1970	1990	2008
Food grains and pulses	27	50	85	68	50	15
Oil seeds	2	7	8	8	2	3
Vegetables	17	32	33	30	22	10
Other agricultural commodities	0	7	15	18	12	2
Milk	3	7	12	3	7	5
Animals	7	10	7	0	0	2
Poultry and eggs	8	5	0	0	0	0
Maize	12	32	63	43	40	13

Table 20. Distribution of respondents (%) by distance from the village to the sales point over the period 1970–2008.

	1970 (%)			1990 (%)			2008 (%)		
Output	Within the village	0-20 km	>20 km	Within the village	0-20 km	>20 km	Within the village	0-20 km	>20 km
Food grains and pulses	25	70	0	48	52	0	83	17	0
Oil seeds	2	8	0	7	2	0	12	0	0
Vegetables	17	28	0	30	23	0	35	10	0
Maize	12	43	0	28	40	0	63	13	0
Other agricultural commodities	0	18	0	7	12	0	15	5	0
Milk	3	3	0	7	7	0	12	5	0
Live animals	7	0	0	10	2	0	5	2	0
Poultry and eggs	8	0	0	3	0	0	0	0	0

4.1.4 Occupations and livelihood

4.1.4.1 Primary occupation

Agriculture is the main source of income of the village. The majority of the villagers were involved in agriculture based occupations during the period 1970–2008. More than 90% of the farmers were involved in fine cereal based farming and coarse cereal based farming during the period 1970–2008 (Table 21). Above 80% of farmers were involved in vegetable cultivation in 1970s and 1990s while 65% were involved in 2008. About 60% were involved in cultivation of pulses in 1970s, while in 2008 it has decreased to 17%. The percentage of farmers involved in dairy and goat farming has reduced

during the period. The percentage of farmers involved in services and migration has declined. According to the majority of the respondents, fine cereal and vegetable cultivations were mainly influenced by better price premium, higher returns and high demand. Pulses cultivation has been mainly affected by declining productivity, according to farmers' opinions (Table 22). According to farmers' responses, the real value of the average farm income from all the crop/ livestock activities has decreased during the periods (Table 23).

Table 21. Percentage of farmers involved in primary occupation and degree of change over the period 1970–2008.

Primary occupation	Percentage of farmers involved			Degree of change (%)				
Agriculture	1970	1990	2008	Major decrease	Minor decrease	No change	Minor increase	Major increase
Fine cereal based farming	98	100	98	5	3	12	42	38
Coarse cereal based farming	90	95	97	5	5	7	30	50
Vegetable cultivation	85	82	65	8	35	10	22	15
Pulses cultivation	60	57	47	3	23	8	22	7
Oilseed cultivation	20	17	18	0	0	0	0	0
Fruits	7	5	8	0	5	3	2	0
Dairy	62	40	40	5	15	0	18	28
Goat farming	13	7	7	0	0	0	7	15
Poultry	20	7	5	0	0	0	0	2
Bee keeping	2	0	0	0	0	0	0	2
Labor	35	33	25	0	13	2	18	3
Business	5	7	7	2	3	0	2	3
Service	7	15	25	5	12	7	3	0
Outward migration	3	8	22	2	17	2	0	2

Table 22. Distribution of respondents (%) by reasons for choosing farm occupations.

	Farm occupation (%)				
Reason	Fine Cereal	Vegetable	Pulses	Oilseeds	Fruit
Declining productivity	2	13	18	8	8
High cost of production	2	5	3	2	2
Low return	0	13	7	3	0
Poor land quality	0	0	0	0	0
Better price premium	55	15	15	3	0
High demand	28	15	5	7	7
Low risk	7	0	3	0	0
Low input use	17	7	2	2	2
Environment friendliness	0	3	2	0	0
Custom and tradition	2	0	0	0	0
Died, old age or disabled	0	0	0	0	0
Drought	0	2	2	0	0
Labor scarcity	0	3	2	0	0
Wild animal attacks	0	2	2	0	0
Higher return	30	15	7	2	2
Attitude	0	0	0	0	0
Better infrastructure facilities	0	2	5	0	0
Higher yield	10	7	2	0	0
Land fragmentation	5	3	0	0	0

Table 23. Average annual farm income from crop/livestock activities, nominal and real values in 1970 and 2008.

	Average Income (₹/ha)					
	1970			2008		
Crop / Livestock activity	Number of respondents	Nominal	Real	Number of respondents	Nominal	Real
Cereal based farming	48	3,955	2,900	60	142,158	594
Vegetable cultivation	14	6,393	4,700	24	47,840	200
Pulses cultivation	10	2,640	1,940	13	63,135	264
Oilseeds cultivation	3	867	640	4	22,250	93
Dairy farming	3	104	76	17	4,814	20
Goat farming	1	111	82	3	2,367	10
Poultry	4	59	43	2	800	3

Note: Real income is obtained by dividing the nominal income by the Colombo Consumer Price Index in the respective year and multiplied by 100 (ccpi in 1970=136; ccpi in 2008=23,920).

4.1.5 Perception on climatic variability - Current trends in climatic variability

The degree of climate variability can be described by the differences between long-term statistics of data calculated for different periods while the farmer perception on different characteristics can be considered in order to have a generalized idea on the particular issues. In general, farmers are widely sensitive to the changes taking place due to rainfall and temperature. According to the majority of the respondents, all the climatic characteristics have not changed during the Yala and Maha seasons of 1970–2008 (Table 24). For Yala, in 2000-2008, longer dry spells, rainfall outside the rainy season and temperature have increased while quantum of rainfall, intensity of rainfall, distribution of rainfall and number of rainy days have decreased. For Maha, in 2000-2008, rainfall outside the rainy season, longer dry spells and temperature have increased while quantum of rainfall, intensity of rainfall, distribution of rainfall and number of rainy days have decreased.

Table 24. Distribution of respondents (%) by current trends in climatic variability in Yala and Maha seasons over the period 1970–2008.

	Yala season					
	1970-2000			2000-2008		
Characteristics of climatic variability	Increase	Decrease	No change	Increase	Decrease	No change
Quantum of rainfall	3	37	57	3	93	2
Intensity of rainfall	3	37	57	5	87	7
Distribution of rainfall	3	35	58	8	85	5
Number of rainy days	3	35	60	3	92	3
Arrival of monsoons - Northeast	0	37	60	2	93	2
Arrival of monsoons - Southwest	0	37	60	2	92	3
Rainfall outside the rainy season	23	12	62	58	32	7
Onset of rainfall	2	35	60	3	95	0
Withdrawal of rainfall	2	35	60	45	50	3
Longer dry spells	27	5	63	72	17	8
Temperature (hotter or colder)	27	7	63	73	8	17
	Maha season					
	1970-2000			2000-2008		
Characteristics for climatic variability	Increase	Decrease	No change	Increase	Decrease	No change
Quantum of rainfall	5	37	57	2	97	2
Intensity of rainfall	5	37	57	3	88	8
Distribution of rainfall	3	35	60	8	87	5
Number of rainy days	3	35	62	2	92	7
Arrival of monsoons - Northeast	0	38	60	0	97	2
Arrival of monsoons - Southwest	0	38	60	0	97	2
Rainfall outside the rainy season	27	10	62	58	32	8
Onset of rainfall	2	37	60	5	95	0
Withdrawal of rainfall	7	30	62	45	53	2
Longer dry spells	27	7	63	73	17	8
Temperature (hotter or colder)	27	7	63	73	8	17

4.1.6 Status of biodiversity

Change of population of the commonly observed animals and the plants can be used as a measure for considering the status of biodiversity in a particular area. Since the village is partly surrounded by a forest cover, the biodiversity is comparatively high and the changes can be observed for the periods. The majority of the respondents in Galahitiyagama village have said that the status of biodiversity has reduced during the period (Table 25). According to most of the farmers, peacock population has increased while all other animal populations have declined. The peacock is considered to be a religious animal in Sri Lankan society. The population of herbs and other plants has also decreased.

Table 25. Distribution of respondents (%) by degree of change on status of biodiversity (animals) over the period 1970-2008.

	Degree of Change (n=60) (%)					
Status of biodiversity	Major decrease	Minor decrease	No change	Minor increase	Major increase	Farmers cannot explain the change
Deer	28	52	17	3	0	0
Rodents	20	53	12	10	2	3
Jackals	8	67	17	3	0	5
Fox	17	58	20	0	0	5
Wild pigs	8	68	12	12	0	0
Elephant	22	45	15	15	3	0
Other animals (rabbit, wolf)	12	72	17	0	0	0
Peacock	0	2	3	38	57	0
Mainah	17	47	30	3	0	3
Sparrow	27	18	15	0	2	38
Jungle fowl	7	85	7	2	0	0
Other birds (indigenous and migratory)	8	67	18	7	0	0
Herbs and plants	17	62	20	0	2	0

4.1.7 Sources, availability and quality of water

In the Sri Lankan context, wells are the primary sources of water at the village level, used for household needs. In dry zone agriculture, irrigation schemes, village tanks, tube wells and community water supply systems are the main sources of water used by the villagers, depending on the existing capabilities of the village. A village tank and the agro-wells are the main sources of irrigation used in Galahitiyagama village while wells are used for drinking purposes. In 1970, the tank and wells were mostly used as sources of water for catering to local needs (Table 26). Most of the respondents have said that the tank water was partly sufficient to cater to local needs while 28% of farmers indicated that it was quite sufficient. In 2008, most of the farmers have used the tank and wells as sources of water to cater to local needs and 40% have said that the tank water was partly sufficient to cater to local needs. About 40% have said that wells were totally sufficient for catering to local needs.

Table 26. Farmers' perception (%) on availability of sources of water to cater to local needs over the period 1970–2008.

	Whether sufficient for catering to local needs (%)											
	1970						2008					
Sources	Partly in sufficient	Totally in sufficient	No change	Partly sufficient	Totally sufficient	Not practiced	Partly in sufficient	Totally in sufficient	No change	Partly sufficient	Totally sufficient	Not practiced
Tank	20	5	0	47	28	0	30	7	2	48	13	0
Wells	18	3	2	17	20	40	10	0	2	12	40	37
Tube wells	7	7	0	3	2	82	12	8	0	3	2	75
Watersheds/ ponds	2	0	0	0	2	97	5	0	0	0	0	95

4.1.8 Changes in indicators of resource conditions

Overall evidences experienced by the farmers in the village have created the impression that the resource conditions of the village was negatively affected, even though they could not clearly understand the cause for this effect. The majority of the respondents have said that the quality of cultivated lands, soil texture, soil depth, quality of grazing land, quality of other common property resources and also the quality of natural water resources have shown a minor decrease during the period 1970-2008 (Table 27). Soil fertility status had a major decrease during that period. The majority have said that soil erosion problems have increased during the same period.

Table 27. Distribution of respondents (%) by degree of change in indicators of resource conditions over the period 1970–2008.

	Degree of change (n=60) (%)					
Indicators of resource condition	Major decrease	Minor decrease	No change	Minor increase	Major increase	Farmer cannot answer for the change
Quality of cultivated land	42	47	5	5	2	0
Soil texture	8	58	13	7	2	12
Soil depth	8	58	15	8	0	10
Soil fertility status	45	40	7	8	0	0
Soil erosion problems	2	17	15	53	13	0
Quality of grazing land	7	53	23	2	0	15
Quality of other CPRs	17	52	15	5	3	8
Quality of natural water resources	23	35	32	10	0	0
Area degraded through special problems	5	0	23	17	7	48

4.1.9 Perception about change in land use

Change in land use of the village has been mainly affected by the increasing population of the village. The agricultural lands cultivated by the previous generations are used for the construction of houses, roads and other purposes by the present generation. According to the majority of respondents, forest land clearance for agriculture and use of agricultural land for other purposes have shown a minor increase during the period 1970–2008 (Table 28).

Table 28. Distribution of respondents (%) by causes of livelihood impacts changed through land use over the period 1970–2008.

	Degree of change (n=60) (%)					
Land use	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot explain the change
Forest land clearance for agriculture	8	32	2	53	5	0
Agricultural land for other purposes	0	27	7	60	7	0

4.1.10 Common property resources

Common property resources of the village include village tanks, wells, pasture lands and forest lands. The majority have said that the number of wells have increased during the period while 75% said that the forest cover has declined. According to most of the respondents, they have full access to the common property resources over the period (Table 29). Village tanks and wells were managed by the villagers or farmer groups. Collection of drinking water was the main purpose of using wells by the villagers. Village tanks were used for lifting water for irrigation.

Table 29. Distribution of respondents (%) by degree of change in common property resources over the period 1970-2008.

	Degree of change (n=60) (%)					
Common Property Resource	Major decrease	Minor decrease	No change	Minor increase	Major increase	Farmer cannot explain the change
Village/community ponds	3	33	38	18	7	0
Well	0	3	2	35	33	27
Pasture lands	5	17	10	0	0	68
Watersheds/Ponds	7	17	7	0	0	70
Forest	15	60	2	2	2	20

4.1.11 Causes of livelihood impacts

Unsustainable production practices

Most of the traditional farming practices have been altered by the farmers at present. Machines are widely used and sustainable production practices have been minimized. According to the majority of the respondents, extensive frequent cultivations, indiscriminate application of herbicides and pesticides, unbalanced use of inorganic fertilizers, excessive tilling practices and deep ploughing

have a minor increase during the periods (Table 30). The majority said that inappropriate cropping pattern, burning of crop residue, forest fire, no or low additions of organic matter, and humus in soil have a minor decline during the period.

Table 30. Distribution of respondents (%) by causes of livelihood impacts changed through unsustainable production practices over the period 1970–2008.

	Degree of change (n=60) (%)					
Unsustainable production practices	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot explain the change
Inappropriate production technology	23	27	12	27	3	8
Extensive and frequent cultivation	2	10	3	58	23	3
Inappropriate cropping pattern	12	42	10	13	2	22
Burning of crop residues/ forest fire	20	32	27	18	2	2
Inadequate addition of organic matter humus in soil	8	37	8	32	8	7
Indiscriminate application of herbicides/ pesticides	5	3	3	52	37	0
Unbalanced use of inorganic fertilizers	2	7	2	55	35	0
Excessive tillage practices	3	7	5	68	10	7
Deep ploughing	5	8	5	65	15	2

4.1.12 Climate change

According to the majority of the respondents, consecutive drought, moisture stress and change in rainfall pattern and temperature have shown a minor increase during the period. The volume of rainfall has been slightly decreased (Table 31).

Table 31. Distribution of respondents (%) by causes of livelihood impacts changed through climatic change over the period 1970–2008.

	Degree of change (n=60) (%)					
Climatic change	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot explain the change
Consecutive drought	2	15	12	67	5	0
Moisture stress	0	8	7	68	2	15
Change in rainfall pattern	2	5	0	75	18	0
Volume of rainfall	25	63	2	10	0	0
Rising temperature	0	3	15	73	8	0
Soil erosion due to intense wind storms	0	7	25	27	8	33

4.1.13 Deforestation

Deforestation has been identified as a major cause for change in climatic conditions. Majority of the farmers perceived that over grazing, excessive fuel wood collection and indiscriminate land mining persisted during the periods (Table 32). A minor decrease was seen in uncontrolled logging and illegal felling of forest trees, over hunting of wild animals, and excessive collection of plants during these periods.

Table 32. Distribution of respondents (%) by causes of livelihood impacts changed through deforestation over the period 1970–2008.

Deforestation	Degree of change (n=60) (%)					
	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot explain the change
Over grazing	5	10	43	18	0	23
Excessive fuel wood collection	7	20	32	18	0	23
Uncontrolled logging and illegal felling of forest trees	18	35	20	8	0	18
Indiscriminate land mining	20	23	28	10	0	18
Over hunting of wild animals	28	42	10	13	2	5

4.1.14 Poverty and Government policies

In the past, most of the lands cultivated by the villagers were state land owned by the Government, and the ownership of these lands had been legally transferred to the villagers. When compared with their previous generation, they are able to satisfy their primary needs and hence, they believe that poverty has declined. The majority have perceived that poverty has been slightly decreased during the period while there was a slight increase in government intervention, and a minor increase in property rights/law enforcement (Table 33).

Table 33. Distribution of respondents (%) by causes of livelihood and impact changed through Government policies over the period 1970–2008.

Government policies	Degree of change (n=60) (%)					
	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot explain the change
Poverty	17	73	3	2	5	0
Government intervention	3	7	15	60	13	2
Property rights/ law enforcement	0	2	2	80	17	0

4.1.15 Land management practices

Mulching, green manuring, composting crop residue, conservation tillage practices and drainage channels have increased during the period. Contour ridges, zero tillage, wind barriers, planting

grasses, construction of stone walls, and planting of shrubs and trees have not changed during the period. According to the majority of the respondents, awareness on all the land practices have increased from 1970-2008 (Table 34).

Table 34. Distribution of respondents (%) by degree of change in land management practices over the period 1970–2008.

	Degree of change (n=60) (%)					
Land management practices	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot explain the change
Mulching	0	0	43	45	3	8
Green manuring	0	2	40	38	8	12
Composting	0	0	23	65	7	5
Incorporating crop residue	3	0	37	48	8	3
Conservation tillage practices	0	3	32	48	2	15
Bunding	0	7	13	67	10	3
Fallow	10	17	48	7	0	18
Fallow strips	10	13	52	3	0	22
Drainage channels	0	0	33	57	3	7
Contour ridges	0	0	67	12	3	18
Zero tillage	5	12	62	0	2	20
Minimal tillage	2	15	62	0	2	20
Agro-forestry	2	3	32	38	12	13
Wind barriers / alley cropping	0	0	53	17	2	28
Planting grasses / Savanna grasses	0	2	52	17	0	30
Construction of stone walls	0	3	53	18	0	25
Planting of shrubs and trees	2	3	38	35	7	15

4.1.16 Collective actions

The majority have perceived that the initiatives of soil and water conservation measures on lands, planting of trees on common lands and conservation and maintenance of grazing lands have not changed during the period (Table 35). Initiatives for soil and water conservation measures on private

lands, plantation of forests, conservation and maintenance of water resources, construction and maintenance of roads and maintenance of community water supply system have shown a minor increase during the period.

Table 35. Distribution of respondents (%) by degree of change in collective actions over the period 1970–2008.

	Degree of change (n=60) (%)					
Collective action	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot explain the change
Initiatives of soil and water conservation measures on common lands	2	5	48	23	7	15
Initiatives for soil and water conservation measures on private lands	0	3	27	45	10	15
Planting of trees on common lands	3	7	43	30	2	15
Plantation of forests	2	3	27	47	0	22
Conservation and maintenance of grazing land	2	18	57	5	0	18
Conservation and maintenance of water resources	0	2	20	68	8	2
Construction of roads and maintenance of roads	2	5	18	57	18	0
Maintenance of community water supply system	0	2	27	60	8	3

4.2 Mangalapura village

Mangalapura village is situated in Mangalapura Grama Niladhari Division in Wanathavilluwa Divisional Secretariat area in Puttalam District. The primary occupation of the villagers was farming and agriculture related activities. Farmer perception of climate change and the related issues are summarized here, showing the percentages of responses regarding the particular issues.

4.2.1 Demographic features of Mangalapura village

The total population in Mangalapura was 1417 in 2008. According to farmer perceptions, the total human population has increased during the period. Geographical area of Mangalapura village is 1976 ha, since it was established as a separate Grama Niladhari Division. Numbers of small, medium and large households have increased during the same period (Table 36). Migration to the village from other areas of the country has taken place and it has caused direct impact on increasing population.

Table 36. Demographic features of Mangalapura village.

Demographic feature	2008	Degree of change
Geographical area (ha)	1976	No change
Marginal households (0–1 ha)	259	Major increase
Small households (1–2 ha)	35	Minor increase
Medium households (2–4 ha)	50	Minor increase
Large households (>4 ha)	50	Minor increase

4.2.2 Cropping pattern, Livestock activities and Input use

4.2.2.1 Cropping pattern

Based on the responses from majority of the farmers, over the period 1970–2008, cultivated extents, productivity and income in coarse grains (finger millet), root crops (manioc, groundnut) and other field crops (chilies, onion, green gram, cowpea, black gram) have decreased while cultivated extent, productivity and income of hybrid watermelon (eg, Sugar baby) have increased (Table 37) (These findings confirmed the all island statistics). During the period, all the cultivations were mainly done under rain-fed condition mainly in the Maha season and very limited cultivation was done in the Yala season, also under rain-fed conditions.

The cultivated area of most of the seasonal crops has declined, consequent to the negative impacts of climatic conditions and occurrence of pests and diseases. Drought conditions have adversely affected the average yield of the cultivated extents, and most of the farmers were discouraged by that. Over the period 1970-2008, cultivated area, productivity and income increased for all perennial crops such as cashew (161 ha in 2008, 8.15% of the total village extent), coconut (86 ha in 2008, 4.35% of the total village extent), mango, orange and papaya. However, banana cultivation has declined (Table 38). These perennial crops were mainly cultivated under rain-fed conditions. Average yields of banana, cashew and papaya have increased too. Cashew and coconut cultivations were prominent in Mangalapura village after the villagers gave up cultivating seasonal crops. Mango, papaya, orange and other such fruit crops have also been cultivated in the village and most of the farmers have perceived that the average yield of those crops has increased.

4.2.2.2 Input use for crops

Over the period 1970-2008, the majority have said that land preparation using tractors and use of improved seeds have increased, but there is no change in water supply/irrigation. Also, use of organic fertilizers (farmyard manure, compost and cattle penning) and inorganic fertilizers (urea, di-ammonium phosphate and muriate of potash), IPM, pesticides and herbicides have increased. Bullocks were not used for land preparation since most of the land preparation practices were carried out for water melon cultivations (Table 39). Instructions for the preparation of organic fertilizers were given by Agrarian Services Center and the World Vision International and some farmers are involved in producing compost fertilizers following the instructions given. Hence, usages of the inorganic fertilizers for seasonal crops have increased. Water melon cultivation requires higher level of fertilizer usage and almost all the farmers use inorganic fertilizers. Consequently, there has been high usage of herbicides and pesticides for melon cultivations.

Table 37. Average yield and distribution of respondents (%) by degree of change in average yield of crops during Maha season 1970–2008.

	Average yield (kg/ha)		Degree of change (n=50) (%)					
Crop	1970	2008	Major decrease	Minor decrease	No change	Minor increase	Major increase	Farmers cannot explain the change
Onion	6	0	0	0	0	0	0	100
Finger millet	679	401	0	2	0	0	0	98
Green gram	591	140	2	8	0	0	0	90
Cowpea	*	0	4	10	0	0	0	86
Black gram	24765	4834	0	2	0	0	0	98
Manioc	403	235	14	8	2	2	2	72
Groundnut	28817	0	2	0	0	0	0	98
Pumpkin	0	37720	0	0	0	0	0	100
Watermelon	3705	19760	0	0	0	0	0	100
Maize	1853	1853	0	0	0	0	0	100
Brinjal	2470	0	0	0	0	0	0	100

Table 38. Cropping area and distribution of respondents (%) by degree of change in cropping area of perennial crops over the period 1970–2008.

		Cropping area (ha)		Degree of change (n=50)					
Perennial crop	Farmer reported	1970	2008	Major decrease	Minor decrease	No change	Minor increase	Major Iincrease	Farmer cannot answer for the change
Cashew	74	74	161	10	0	14	6	40	4
Banana	44	42	7	18	0	2	4	16	4
Coconut	38	19	86	4	2	0	2	22	8
Mango	12	0	1	0	0	2	0	4	6
Papaya	12	0	1	0	0	0	0	4	8
Orange	4	0	4	0	0	0	0	2	2

Table 39. Distribution of respondents by (%) degree of change in input use over the period 1970–2008.

	Degree of change (n=50)(%)				
Input use	Major decrease	Minor decrease	No change	Minor increase	Major increase
Land preparation					
Tractors	0	2	6	20	50
Bullocks	4	2	0	0	0
Improved seed	2	2	32	32	20
Type of irrigation					
Pump set	8	6	8	20	8
Sprinkler	0	0	0	2	0
Drip	0	0	0	4	0
Others (Pitcher irrigation)	2	2	2	0	0
No. of irrigations	2	12	48	28	10
Fertilizers					
Farmyard manure	0	0	2	18	20
Compost	2	0	8	24	14
Cattle penning	2	2	2	8	10
Urea	4	8	8	20	30
Di Ammonium Phosphate	0	2	0	0	0
Single Super Phosphate	0	2	0	0	0
Muriate of potash	4	4	8	20	28
Complex fertilizer	0	0	0	2	4
Other fertilizers	2	2	0	0	0
Labor usage					
Male	16	28	44	8	4
Female	18	28	34	16	4
Family labor	22	36	36	4	2
Weeding					
Manual	20	22	48	10	0
Mechanical	2	0	6	18	14
Herbicides / weedicides	4	4	20	26	32
Pesticides	4	2	18	36	34
Integrated Pest Management	10	34	48	2	4

4.2.2.3. Livestock population

Livestock activities of the village have declined due to changed livelihood pattern of the villagers. Most of the farmers have given up livestock related activities while a few are engaged in goat farming, which was not practiced in the past (Table 40). Poultry keeping and rearing indigenous cattle were practiced by villagers, but a reducing trend was observed due to lack of interest in livestock keeping.

Table 40. Actual livestock population data for 2008 and farmers' perception on degree of change in livestock population over the period 1970–2008.

Livestock population	2008	Degree of change
Cattle	181	Major decrease
Buffaloes	0	Major decrease
Goat	76	Minor increase
Poultry	1,040	Major decrease
Pig	37	Major decrease

4.2.2.4 Input use for livestock activities

Although farmers are aware of the services such as vaccination, medicines and artificial insemination in the livestock industry, the actual service they received was marginal, which could be one of the reasons to neglect the livestock industry. Most of the farmers who carried out livestock activities in a limited scale have not used the inputs available in markets (Table 41). They have only given them limited variations of cut grasses or these animals were led to grasslands for grazing. Poultry based activities are also on a very small scale, only for household needs of eggs. The animals were also not given any inputs available in the market.

Table 41. Distribution of respondents (%) by degree of change in input use for animals over the period 1970–2008.

	Degree of change (n=50) (%)					
Input use for animals	Major decrease	Minor decrease	No change	Minor increase	Major increase	Did not use inputs
Dry fodder	2	2	8	10	0	78
Cultivated green fodder	2	2	10	4	2	80
Grasses & hand-picked/collected green fodder	4	4	2	12	6	72
Concentrates	0	0	12	8	4	76
Compound cattle feed	0	0	14	4	0	82
Minerals & vitamins	0	0	12	6	0	82
Vaccines	0	2	6	10	8	74
Medicines	0	0	8	12	6	74
Artificial insemination	0	0	2	6	6	86
Improved animal breeds	0	4	0	10	6	80
Poultry feed	0	0	10	0	2	88

4.2.3. Market and Infrastructure

4.2.3.1 Input market

In 1970s, 1990s and 2008, most of the inputs for agricultural activities were bought from Puttalam city, which is located 25 km from the village (Table 42). Some farmers have also prepared seeds for cultivation using the seeds of the previous season.

Table 42. Distribution of respondents (%) by distance from the village to the input market over the period 1970–2008.

	1970				1990				2008			
Input	Within the village	0-10 km	10-30 km	>30 km	Within the village	0-10 km	10-30 km	>30 km	Within the village	0-10 km	10-30 km	>30 km
Seed	28	6	62	2	40	6	52	2	34	28	38	0
Fertilizer	22	6	62	2	32	12	52	2	32	30	38	0
Agro chemicals	20	4	64	2	30	8	56	2	34	30	38	0
Cattle feed	0	0	6	0	2	0	6	0	2	0	8	0
Others (Machineries)	0	0	10	0	12	0	4	0	10	0	6	0

4.2.3.2 Output market

Output markets for agricultural products were not attractive for farmers to earn a reasonable income from crop production. In 1970s, a comparatively large amount of the food grains, pulses and vegetables produced were sold to a wholesale market about 30 km away from the village area (at Puttalam city) (Table 43). In 1990s and 2008, the above productions were relatively small, hence these were sold at the village itself and in the nearby market. However, a wholesale market was created for watermelon in 2008. In 1970s, marketing of cashew was done on a small scale at the village level and in the nearby market, but wholesale dealers came to the village for purchase during 1990s; in 2008, the majority (70%) of the cashew farmers processed their products and added value, and wholesale dealers came and purchased their products at the village itself (Table 44).

Table 43. Distribution of respondents (%) by output market over the period 1970–2008.

	Where sold (%)								
	In village itself			Nearby market			Farmer created institutions		
Items	1970	1990	2008	1970	1990	2008	1970	1990	2008
Food grains & pulses	22	24	2	68	44	16	0	0	0
Oilseeds	0	0	0	0	0	0	0	0	0
Vegetables	22	28	0	36	28	10	0	0	0
Other agricultural commodities	14	16	36	18	12	6	0	0	0
Milk	2	0	22	0	0	2	0	0	0
Live animals	0	6	6	4	2	0	0	0	0
Poultry & eggs	10	10	8	2	2	2	0	0	0
Cashew	24	48	70	24	20	2	2	0	0
Forest products	2	2	0	0	0	0	0	0	0

Table 44. Distribution of respondents (%) by output market over the period 1970–2008.

	To whom sold (%)											
	Fellow farmers			Local agents			Whole sellers			Directly to retailers		
Item	1970	1990	2008	1970	1990	2008	1970	1990	2008	1970	1990	2008
Food grains & pulses	8	2	2	32	28	28	34	24	24	16	12	12
Oilseeds	0	0	0	0	0	0	0	0	0	0	0	0
Vegetables	8	6	6	28	30	30	18	14	14	6	6	6
Other agricultural commodities	6	4	4	8	12	12	10	8	8	8	4	4
Milk	2	0	0	0	0	0	0	0	0	2	0	0
Live animals	0	2	2	2	2	2	2	0	0	0	4	4
Poultry & eggs	6	4	4	4	4	4	0	0	0	2	4	4
Cashew	10	16	16	16	24	24	22	24	24	2	4	4
Forest products	0	0	0	0	0	0	0	0	0	0	0	0

4.2.4. Occupations and livelihood

4.2.4.1 Primary occupation

Fine cereal based farming has been practiced at a considerable level in 1970s and 1990s, but in 2008 it has reduced to 14%, which was a major decline (Table 45). Most of the farmers practiced fine cereal based farming in the area called Villu, which was favorable for paddy farming. In 1970s during the rainy season, a sufficient amount of water was available in Villu and farmers were able to collect water to practice paddy farming. In 2008, however, the water holding capacity of Villu was not sufficient for paddy cultivations. Hence, most of the farmers have given up paddy farming.

Vegetable cultivation was also a major farming activity carried out by the majority of the farmers in Mangalapura village, especially in the area called Wagaawa. Since the vegetable cultivation was adversely affected by unfavorable weather conditions, and most of the land area was occupied by perennial crops as the second choice, farmer involvement in vegetable and pulses cultivations has declined. Cultivation of fruits shows a minor increase, due to farmer involvement in melon cultivation as a cash crop. Cashew and coconut are the major perennial crops cultivated in Mangalapura village. Cashew cultivation has become popular in the village since it has better drought tolerance than other perennials. At present, cashew cultivation is one of the major sources of income for farmers in Mangalapura village. Farmer involvement in coconut cultivation has seen a minor increase and most of the large-scale farmers have been practicing coconut cultivation as their primary income source. Livestock activities are operated at a lower level as a primary occupation.

A considerable number of farmers were involved in labor hiring activities since 1970s. This was mainly after obtaining their harvest during the Maha season. Some of the farmers were engaged in labor hiring activities in large-scale farms, mostly in cashew and coconut cultivations since they couldn't carry out considerable level of farming for their living in the Yala season. Migration of the villagers for primary occupations has shown a significant increase during the period. Some have migrated to suburban areas for employment opportunities in factories and private companies rather than engaging in agriculture related activities. Most of the farmers have perceived that the declining productivity, high cost of production, low return and poor land quality have affected the income generated through fine cereal based farming, coarse cereal based farming, vegetable cultivations and oil seed cultivation (Table 46). Farmers have also perceived that the fruit and cashew based farming have been encouraged by the high demand for output and better price premium.

Table 45. Distribution of respondents (%) by primary occupations.

Primary occupation	Percentage of farmers involved			Degree of change (%)				
Agriculture	1970	1990	2008	Major decrease	Minor decrease	No change	Minor increase	Major increase
Fine cereal based farming	56	38	14	24	32	0	2	2
Coarse cereal based farming	14	2	4	8	4	6	2	0
Vegetable cultivation	92	66	52	42	38	10	2	2
Pulses cultivation	84	54	30	32	42	4	2	2
Oilseed cultivation	16	8	6	4	8	0	2	0
Cotton cultivation	6	2	0	2	4	0	0	0
Fruits	60	62	70	10	20	8	20	22
Coconut cultivation	32	32	40	8	10	4	14	12
Cashew cultivation	46	66	84	2	8	6	34	36
Dairy farming	8	10	10	2	4	0	4	4
Goat farming	12	10	6	4	6	2	4	0
Poultry	22	20	16	14	8	4	6	2
Bee keeping	8	2	2	2	4	0	2	0
Labor	36	36	28	4	14	10	6	4
Business	10	16	18	4	6	2	16	4
Service	34	38	38	2	16	14	18	4
Migration	2	4	30	0	2	0	20	10

Table 46. Distribution of respondents (%) by reasons for choosing farm occupations.

Reason	Farm occupation (%)								
	Fine cereal	Coarse cereal	Vegetable	Pulses	Oil seeds	Cotton	Fruit	Cashew	Coconut
Declining productivity	30	10	36	44	8	0	10	4	16
High cost of production	22	4	24	18	4	0	6	0	8
Low return	26	4	54	34	4	6	8	0	8
Poor land quality	10	6	16	14	2	0	6	0	4
Better price premium	0	0	0	2	0	0	8	16	0
High demand	0	0	0	2	0	0	42	56	0
Low risk	0	0	2	4	0	0	4	6	0
Low input use	0	2	6	4	0	0	2	6	0
Custom and tradition	0	2	0	0	0	0	0	0	0
Died, old or disabled	0	0	2	0	0	0	0	0	0
Drought	4	0	6	10	6	0	8	4	12
Labor scarcity	2	0	2	2	0	0	0	0	0
Wild animal attacks	2	0	0	0	0	0	0	2	0
Higher return	2	0	2	2	2	0	10	12	4
Attitude	2	0	2	2	0	0	4	0	0

4. 2. 5 Average annual farm income

The majority of the farmers have perceived that the income generated through cereal based farming, vegetable cultivations and pulses cultivation has declined over the period 1970–2008 (Table 47).

Table 47. Distribution of respondents (%) by degree of income changed through crop/ livestock activities over the period 1970–2008.

	Degree of change (n=50) (%)					
Crop/Livestock activity	Major decrease	Minor decrease	No change	Minor increase	Major increase	Farmer cannot answer for the change
Cereal based farming	44	6	0	4	4	38
Vegetable	64	16	0	2	10	6
Pulses	66	8	2	2	8	14
Oilseeds	10	4	0	0	0	86
Cotton	2	2	0	0	0	96
Fruits	22	4	2	2	50	20
Cashew	4	2	0	0	76	16
Coconut	8	0	2	2	20	68
Dairy	2	2	2	2	4	88
Goat farming	10	0	0	0	4	86
Poultry	10	0	0	2	8	70
Bee keeping	4	2	2	2	0	90

4.2.6 Perception on climatic variability - Current trends (increasing/ decreasing)

The majority of the respondents felt that characteristics of climatic variability (quantum of rainfall, intensity of rainfall, distribution of rainfall, number of rainy days, arrival of monsoons, onset of rainfall and withdrawal of rainfall) for Yala and Maha seasons during the period 1970–2000 have not changed, but have reduced/extended during the period 2000-2008 (Table 48). Similarly, temperature, longer dry spells and rainfall outside the rainy season have increased both in Yala and Maha seasons during 2000-2008.

Table 48. Distribution of respondents (%) by current trends in climatic variability in Yala and Maha seasons over the period 1970–2008.

Characteristics for climatic variability	Yala season (%)						Maha season (%)					
	1970-2000			2000-2008			1970-2000			2000-2008		
	Increase	Decrease	No change	Increase	Decrease	No change	Increase	Decrease	No change	Increase	Decrease	No change
Quantum of rainfall	2	40	58	4	92	4	8	34	58	8	90	2
Intensity of rainfall	2	36	62	0	88	12	10	32	58	6	86	8
Distribution of rainfall	0	40	60	0	94	6	4	36	60	0	96	4
Number of rainy days	0	42	58	0	98	2	4	36	60	0	98	2
Arrival of monsoons - Northeast	0	42	58	0	98	2	2	40	58	0	98	2
Arrival of monsoons - Southwest	0	42	58	0	96	4	4	38	58	2	96	2
Rainfall outside the rainy season	28	6	66	56	32	12	28	14	58	58	34	8
Onset of rainfall	2	36	62	6	86	8	2	42	56	8	92	0
Withdrawal of rainfall	6	30	64	26	62	12	10	28	62	28	62	10
Longer dry spells	38	4	58	82	10	8	26	8	66	78	10	12
Temperature (hotter or colder)	34	4	62	64	6	30	30	8	62	64	4	32

4.2.7 Status of bio-diversity

In terms of bio-diversity, the majority of farmers (76%) perceived that the peacock population has increased but all the other animals have reduced in numbers. Farmers have also observed that the population of herbs and plants in the village area have also declined. Most of the indigenous and migratory birds' populations have also declined during the period (Table 49). Reduction of the forest cover has destroyed the natural habitat of the wild animals' and plants and it has led to the decline of their population.

Table 49. Distribution of respondents (%) by degree of change on status of bio-diversity (animals) over the period 1970–2008.

	Degree of Change (n=50) (%)					
Status of bio-diversity	Major decrease	Minor decrease	No change	Minor increase	Major increase	Farmer cannot answer for the change
Deer	26	64	4	4	0	2
Rodents	4	30	12	10	2	42
Jackals	6	2	10	0	0	82
Fox	20	68	8	2	0	2
Wild pigs	40	48	12	0	0	0
Elephant	2	78	6	10	0	4
Other animals (rabbits, wolf)	34	56	6	4	0	0
Peacock	4	10	10	54	22	0
Mainah	12	38	28	2	0	20
Sparrow	0	0	6	0	0	94
Jungle fowl	4	62	6	20	0	8
Other birds (indigenous and migratory)	16	52	14	18	0	0
Herbs and plants	28	54	14	4	0	0

4.2.8 Sources, availability and quality of water

Tube well water was available during both Yala and Maha seasons but water was not available in canals and tanks. Over the period, the majority felt that the use of wells as a source of irrigation has decreased (60%) but the use of tube wells has increased (76%) during the period. However, both sources were not quite sufficient to supply the required amount of water (Table 50). Villagers are using tube wells for their local needs and the majority perceived that the quality of water in tube wells has deteriorated. Wells are not used and the total demand for water has been met by the tube wells.

Table 50. Farmers' (%) perception on water quality from different sources of water over the period 1970–2008.

	1970 (%)					
Sources	Major deterioration	Minor deterioration	No change	Minor improvement	Major improvement	Not practiced
Wells	0	4	68	0	0	28
Tube wells	2	2	76	2	2	16
Water sheds/ Villu	0	0	30	0	0	70
	2008 (%)					
Sources	Major deterioration	Minor deterioration	No change	Minor improvement	Major improvement	Not practiced
Wells	20	26	22	2	0	30
Tube wells	14	30	40	4	2	10
Water sheds/ Villu	8	14	10	0	0	68

4.2.9 Changes in indicators of resource conditions

Over the period 1970–2008, more than 90% of the farmers perceived that the quality of cultivated land and the fertility has deteriorated. Also over 50% of the respondents were of the view that soil erosion has aggravated (Table 51). About half of the sample believed that perennial crops affect the cultivation of seasonal crops in terms of soil fertility. The quality of natural water resources has deteriorated due to high salinity. Most of the farmers perceived that the resource conditions have changed, but the majority of them were not aware of any specific reasons for those changes.

Table 51. Distribution of respondents (%) by degree of change in indicators of resource conditions over the period 1970–2008.

Indicators of resource condition	Degree of Change (n=50) (%)					
	Major decrease	Minor decrease	No dhange	Minor increase	Major increase	Farmer cannot answer for the change
Quality of cultivated land	36	56	8	0	0	0
Soil texture	14	44	40	0	0	2
Soil depth	6	28	42	20	2	2
Soil fertility status	38	52	8	2	0	0
Soil erosion problems	6	18	24	34	18	0
Quality of grazing land	12	40	46	2	0	0
Quality of other CPRs	16	40	42	2	0	0
Quality of natural water resources	12	40	46	2	0	0
Area degraded through special problems	2	4	52	22	4	16

4.2.10 Perception about changes in land use

Forest land clearance for agriculture has declined as indicated by 52% of the respondents and there was a slight decrease in agricultural land use for other purposes (Table 52). Forest cover is protected by forest conservation laws and regulations. Hence, most of the villagers have to refrain from the clearance of forest cover for agricultural purposes. The majority of the villagers have changed their livelihoods as infrastructure facilities of the village have changed. Most of the agricultural lands have been used for constructing buildings, roads and for various other purposes.

Table 52. Distribution of respondents (%) by causes of livelihood impacts through land use changed over the period 1970–2008.

Land use	Degree of change (n=50) (%)					
	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot explain the change
Forest land clearance for agriculture	10	42	2	28	16	2
Agricultural land for other purposes	0	18	6	54	22	0

4.2.11 Common property resources

During the period, the majority of the farmers (76%) perceived that cultivated area has increased and the forest cover, common property resources (permanent pasture, grazing lands, Villu) have declined (Table 53). Villagers have full access to common property resources except forests (Table

54). Wells and pasture lands are managed by farmer groups while forests are managed mainly by the Government. The majority of the farmers (84%) have used wells for household chores and collection of drinking water (Table 55).

Table 53. Distribution of respondents (%) by degree of change in common property resources over the period 1970–2008.

	Degree of change (n=50) (%)					
Common property resource	Major decrease	Minor decrease	No change	Minor increase	Major increase	Farmer cannot explain the change
Village/community ponds	0	0	22	0	0	78
Well	40	22	12	10	4	12
Pasture lands	38	6	16	0	0	40
Watersheds/Villu	54	4	24	0	0	18
Forest	50	18	10	0	0	22

Table 54. Distribution of respondents (%) by management of common property resources over the period 1970–2008.

	Managed by (%)			
Common property resource villager/farmer group	Non-Governmental Organizations		Government	Farmer cannot explain the change
Well	50	0	22	28
Pasture lands	28	0	0	72
Watersheds/ Villu	6	2	36	58
Forest	0	0	78	22

Table 55. Distribution of respondents (%) by purpose of using common property resources over the period 1970–2008.

	Purpose (n=50) (%)					
Common property resource	Household chores (Bathing, washing cloths & utensils)	Collection of drinking water	Washing animals	Lifting water for irrigation	Fishing	Grazing of animals
Village/community ponds	6	6	8	0	0	0
Well	34	50	0	0	0	0
Pasture lands	22	2	14	2	20	0
Watersheds/ Villu	12	22	10	2	0	18
Forest	38	36	2	0	0	0

4.2.12 Causes of livelihood impacts

Unsustainable production practices

About 62% have responded regarding the indiscriminate applications of herbicides and pesticides, which have increased over the period 1970–2008. The majority mentioned that unbalanced use of inorganic fertilizers, extensive tillage practices and deep-ploughing had increased over the period (Table 56). Occurrence of pests and diseases, and high competition of weeds resulted in increased application of herbicides and pesticides for their cultivations. The use of inorganic fertilizers was especially high in melon cultivation. Land preparation for the melon crop require deep ploughing and excessive tilling practices.

Table 56. Distribution of respondents (%) by causes of livelihood impacts change through unsustainable production practices over the period 1970–2008.

	Degree of change (n = 50)(%)					
Unsustainable production practices	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot explain the change
Inappropriate production technology	14	34	20	24	0	8
Extensive and frequent cultivation	18	34	16	28	2	2
Inappropriate cropping pattern	10	32	20	28	0	10
Burning of crop residues/ forest fire	4	32	32	28	2	2
No or low addition of organic matter humus in soil	8	28	18	40	6	0
Indiscriminate application of herbicides/pesticides	6	12	20	42	20	0
Unbalanced use of inorganic fertilizers	8	22	20	32	18	0
Excessive tillage practices	12	6	18	44	8	12
Deep ploughing	14	0	22	50	12	2

4.2.13 Climate change

As experienced by the majority of the farmers (over 70%), increase in consecutive droughts, moisture stress, variability of rainfall and temperature were observed while there was a decline in the volume of rainfall (Table 57). Nearly half of the respondents said that soil erosion due to wind storms has increased during the reference period.

Table 57. Distribution of respondents (%) by causes of livelihood impacts change through climatic change over the period 1970–2008.

	Degree of change (n=50)(%)					
Climatic change	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot answer for the change
Consecutive drought	0	6	18	58	18	0
Moisture stress	2	6	8	70	14	0
Change in rainfall pattern	0	6	2	58	32	2
Volume of rainfall	28	54	2	12	4	0
Rising temperature	0	6	34	50	10	0
Soil erosion due to intense wind storms	0	6	32	32	16	14

4.2.14 Deforestation

Over the period, nearly 50% of the respondents felt that uncontrolled logging and illegal felling of forest trees have declined and nearly 80% felt that over-hunting of wild animals and collection of plants have reduced (Table 58). Also, indiscriminate land mining has declined over time. Since the government intervention towards the illegal practices was high, most of the farmers perceived that these illegal practices have declined to a very limited scale.

Table 58. Distribution of respondents (%) by causes of livelihood impacts chang through deforestation over the period 1970–2008.

	Degree of change (n=50) (%)					
Deforestation	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot explain the change
Over-grazing	0	14	40	32	0	7
Excessive fuel wood collection	8	16	38	24	2	14
Uncontrolled logging and illegal felling of forest trees	14	32	8	20	8	12
Indiscriminate land mining	18	18	22	14	4	18
Over-hunting of wild animals and collection of plants	24	54	6	12	2	24

4.2.15 Poverty and the Government policies

Over the period 1970–2008, the majority of the villagers (64%) felt that poverty has slightly declined (Table 59). As a consequence of the development of the infrastructure facilities of the village, living standards have also improved.

Table 59. Distribution of respondents (%) by causes of livelihood and impact change through Government policies over the period 1970–2008.

	Degree of change (n=50) (%)					
Government policies	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot answer for the change
Poverty	22	64	2	10	2	0
Government intervention	0	4	14	60	18	4
Property rights/ laws	0	0	6	66	26	2

Table 60. Distribution of respondents (%) by degree of change in land management practices over the period 1970–2008.

	Degree of change (n=50) (%)					
Land management practices	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot answer for the change
Mulching	4	10	22	42	16	6
Green manuring	4	12	26	44	10	4
Composting	2	16	12	40	24	6
Incorporating crop residue	8	10	22	54	4	2
Conservation tillage practices	4	10	36	30	2	18
Bunding	2	8	44	32	0	14
Fallow	2	18	48	6	0	26
Fallow strips	2	18	50	2	0	28
Drainage channels	6	16	34	30	2	12
Contour ridges	4	2	54	6	0	34
Zero tillage	8	36	40	0	0	16
Minimal tillage	8	30	30	8	0	24
Agro-forestry	0	10	20	52	4	14
Wind barriers/ alley cropping	8	12	42	6	0	32
Planting grasses/Savannah grasses	6	10	44	12	0	28
Construction of stone walls	2	12	50	2	0	34
Plantation of shrubs and trees	2	14	40	30	2	12

4.2.16 Land management practices

Among the land management practices, mulching, green manuring, composting and incorporating crop residue have been slightly increased over the period 1970–2008. However, other land management practices such as conservation in tillage practices, bunding, fallow, fallow strips, drainage channels, contour ridges, zero tillage, minimal tillage, agro-forestry, wind barriers, alley cropping, planting grasses, construction of stone walls, planting of shrubs and trees were new practices that were not adopted in 1970s nor in 2008 (Table 60). However, the degree of awareness on land management practices has increased over the period 1970–2008.

4.2.17 Collective actions

Strong collective action was undertaken to minimize soil degradation, water pollution and deforestation during 1970-2008. Accordingly, the initiative for soil and water conservation measures on private lands, construction of roads and their maintenance, and maintenance of the community water supply system have been improved (Table 61). However, other collective actions such as initiatives of soil and water conservation measures and planting of trees on common lands, plantation of forest, conservation and maintenance of grazing land and conservation of water resources have not changed over the above period.

Table 61. Distribution of respondents (%) by degree of change in collective actions over the period 1970–2008.

	Degree of change (n=50) (%)											
	Major decrease		Minor decrease		No change		Minor increase		Major increase		Cannot explain the change	
Collective action	1970	2008	1970	2008	1970	2008	1970	2008	1970	2008	1970	2008
Initiatives of soil and water conservation measures on common lands	0	12	0	4	4	42	0	22	0	0	96	20
Initiatives of soil and water conservation measures on private lands	0	2	0	4	4	32	0	40	0	6	96	16
Planting of trees on common lands	0	10	0	6	4	48	0	20	0	0	96	16
Plantation of forest	0	10	0	0	4	52	0	16	0	2	96	20
Conservation and maintenance of grazing land	0	10	0	4	4	62	0	6	0	2	96	16
Conservation and maintenance of water resources	0	6	0	8	4	44	0	32	0	6	96	4
Construction of roads and their maintenance	0	6	0	4	4	34	0	40	0	14	96	2
Maintenance of community water supply system	0	4	0	2	4	22	0	48	0	18	96	6

4.3 Mahagalwewa village

Mahagalwewa village is in the Mahagalwewa Grama Niladhari Division at Suriyawewa Divisional Secretariat Area in Hambantota District. The primary occupation of the villagers was mainly based on agriculture related activities. Farmer perception of the climate change and the related issues are summarized here, showing the percentages of responses regarding each particular issue.

4.3.1. Demographic features of Mahagalwewa village

Geographical area of the Mahagalwewa village in the year 2008 was about 460 ha. It has not changed during the period 1970–2008. The numbers of household in all categories have increased in Mahagalwewa village during the period (Table 62).

Table 62. Demographic features of Mahagalwewa village.

Demographic feature	Number in 2008	Perception
Geographical area (acre)	1150	No change
Marginal Households (0–1 ha)	125	Major increase
Small Households (1–2 ha)	100	Major increase
Medium Households (2–4 ha)	20	Minor increase

4.3.2. Cropping pattern, Livestock activities and Input use

4.3.2.1 Cropping pattern

The percentage of farmers involved in fine cereal based farming, coarse cereal based farming, vegetable cultivation, pulses cultivation and oilseed cultivation have not changed during the period 1970–2008 (Table 63). The percentage of farmers involved in cotton cultivation has declined during the period. According to perceptions of the majority of respondents, coarse cereal farming, vegetable cultivation, pulses cultivation and oilseed cultivation have decreased during the period. Cultivated area of cotton, finger millet, green gram, cowpea, sesame and paddy have decreased during the period while cultivated area of manioc and maize have increased during the Yala season (Table 64). The farmers felt that the average yield of finger millet, green gram, cowpea, cashew, manioc, sesame, maize and paddy have declined, while average yield of cotton and tomato have increased (Table 65). In Maha season, the average yield of chilies, finger millet, green gram, manioc, sesame and maize have declined during the period while the average yield of groundnut showed a slight increase (Table 66).

Table 63. Cultivated area and distribution of respondents (%) by crop cultivated during Yala season over the period 1970–2008.

	Cultivated area (ha)		Degree of change (n=50) (%)				
Crop	1970	2008	Major decrease	Minor decrease	No change	Minor increase	Major increase
Cotton	1	0.4	2	2	2	0	0
Finger millet	7	3	8	10	6	4	0
Green gram	3	1	6	4	4	2	0
Cowpea	3	2	6	2	4	8	0
Cashew	0.4	0.4	0	0	0	0	0
Manioc	0.4	1	0	0	2	2	0
Sesame	5	4	2	8	10	2	0
Maize	0.2	1	0	0	0	6	2
Paddy	18	14	4	6	22	0	0
Tomato	1	1	2	2	0	0	0
Other	10	6	8	4	4	2	0

Table 64. Average yield and distribution of respondents (%) by degree of change in average yield of crops during Yala season 1970–2008.

	Average yield (kg/ha)		Degree of change (n=50) (%)				
Crop	1970	2008	Major decrease	Minor decrease	No change	Minor increase	Major increase
Cotton	2128	4940	0	2	0	0	0
Finger millet	3118	1801	6	12	0	2	2
Green gram	1425	1027	2	12	2	2	0
Cowpea	1997	0	2	8	0	6	2
Cashew	7410	6175	0	2	0	0	0
Manioc	405	202	0	2	0	2	0
Sesame	1343	1136	2	6	2	6	4
Maize	1853	1544	0	0	0	4	2
Paddy	2829	2712	0	14	8	14	0
Tomato	3335	4323	0	2	0	2	0
Other	2152	2223	0	8	0	6	0

Table 65. Cultivated area and distribution of respondents (%) by crop cultivated during Maha season over the period 1970–2008.

	Cultivated area (ha)		Degree of change (n=50) (%)				
Crop	1970	2008	Major decrease	Minor decrease	No change	Minor increase	Major increase
Chili	2	1	2	4	6	0	0
Finger millet	11	7.7	8	20	8	8	0
Green gram	9	6	8	12	10	6	2
Manioc	0.2	0.2	0	0	2	0	0
Groundnut	0.5	0.5	0	4	2	2	0
Sesame	12	11	4	26	12	12	0
Maize	4	2	2	8	6	8	0
Papaya	1	1	0	2	2	0	0
Paddy	28	26	4	6	40	2	2
Cotton	16	0	24	2	2	0	0
Other	6	3	2	8	14	0	0

Table 66. Average yield and distribution of respondents (%) by degree of change in average yield during the Maha season over the period 1970–2008.

	Average yield (kg/ha)		Degree of change (n=50) (%)				
Crop	1970	2008	Major decrease	Minor decrease	No change	Minor increase	Major increase
Chili	1004	984	0	6	0	6	0
Finger millet	2817	2499	6	20	4	12	0
Green gram	1690	1054	6	22	2	2	0
Manioc	222	198	0	2	0	0	0
Groundnut	741	823	0	4	2	2	0
Sesame	1888	1288	6	16	4	18	0
Maize	2671	2209	2	10	2	4	2
Paddy	3128	3116	2	16	14	24	0
Cotton	16	0	24	2	2	0	0
Other	1544	1050	0	4	0	4	0

4.3.2.2 Input use for crops

Land preparation using tractors has increased while usage of bullocks has declined during the period (Table 67). Usage of improved seed varieties, usage of farmyard manure, compost, urea and Muriate of Potash (MO) has also been increased. Labor usage and usage of herbicides, weedicides and pesticides has also been increased during the period.

Table 67. Distribution of respondents (%) by degree of change in input use over the period 1970–2008.

	Degree of change (n=50) (%)				
Input use	Major decrease	Minor decrease	No change	Minor increase	Major increase
Land preparation					
Tractors	0	0	10	40	34
Bullocks	24	34	8	2	0
Improved seed	0	0	4	62	10
Type of Irrigation					
Water supplied through pipe lines	0	0	0	26	0
No. of irrigation	0	0	0	28	2
Fertilizers					
Farm Yard Manure	0	0	14	22	4
Compost	0	2	6	28	10
Cattle penning	0	2	12	10	0
Urea	0	0	2	50	26
Muriate of Potash	0	0	8	36	2
Labor usage					
Male	4	18	4	32	16
Female	6	18	6	30	10
Family labor	2	14	26	44	0
Weeding					
Manual	6	8	20	28	10
Mechanical	0	4	8	30	6
Herbicides/weedicides	0	0	2	68	22
Pesticides	0	0	4	68	20
Integrated Pest Management	2	28	34	22	6

Livestock population and input use

The majority of the respondents have not practiced livestock farming during this particular period of time (Table 68). Also, the majority have not purchased inputs (feed items) for animals they reared.

Table 68. Distribution of respondents (%) by degree of change in input use for animals over the period 1970–2008.

	Degree of change (n=50) (%)					
Input use for animals	Major decrease	Minor decrease	No change	Minor increase	Major increase	Did not use inputs
Dry fodder	4	2	0	4	2	88
Cultivated green fodder	0	0	0	2	2	96
Grasses & hand picked/ collected green fodder	0	0	0	2	2	94
Concentrates	0	0	0	0	0	100
Compound Cattle feed	0	0	0	0	4	96
Minerals & vitamins	0	0	0	2	0	98
Vaccines	6	0	0	2	6	86
Medicines	6	0	0	0	6	88
Artificial Insemination	0	0	0	0	6	94
Improved animal breeds	0	0	0	0	2	98

4.3.3. Market and Infrastructure

4.3.3.1 Input market

The majority have said that seeds were available within the village over the period. But cattle feed was not available within the village during the period. The input market for seed was situated within the village itself from 1970s to 2008, while the input market for fertilizer and agrochemicals was located about 15 km away from the village (Table 69).

Table 69. Distribution of respondents (%) by distance from the village to the input market over the period 1970–2008.

	1970(%)			1990(%)			2008(%)		
Input	Within the village	0-15 km	>15 km	Within the village	0-15 km	>15 km	Within the village	0-15 km	>15 km
Seed	56	38	6	58	36	6	58	36	6
Fertilizer	24	74	0	28	70	0	26	72	0
Agro chemicals	8	92	0	8	92	0	8	92	0
Cattle feed	0	2	0	0	2	0	0	2	0

4.3.3.2 Output market

The majority have said that the output market for food grains, pulses and oilseeds has not changed during the period 1990–2008 and 36% have said that output market for cotton cultivation had a major decline during the period 1970–1990. The majority have sold their pulses and oilseeds at a nearby market during the periods 1970, 1990 and 2008 (Table 70). Cotton was sold in the village itself in 1970s to a local agent while the majority has sold food grains, pulses and oilseeds to wholesale dealers during 1970s, 1990 and 2008 (Table 71). The marketing point of food grains, pulses and oilseeds was situated within a distance of about 10 km from the village in 1970s, 1990s and 2008 (Table 72).

Table 70. Distribution of respondents (%) (where sold) by output market over the period 1970–2008.

	Where sold (%)					
	In village itself			Nearby market		
Items	1970	1990	2008	1970	1990	2008
Food grains and pulses	24	18	14	72	78	80
Oilseeds	12	8	8	54	58	58
Vegetables	8	8	8	14	12	14
Other agricultural commodities	0	0	0	4	6	6
Cotton	42	4	2	0	0	0
Sesame	10	6	8	44	48	44
Milk	8	8	8	4	2	0
Animals	0	0	2	0	0	0
Poultry & eggs	2	2	0	0	0	0
Forest products	0	0	0	0	0	0

Table 71. Distribution of respondents (%) (to whom sold) by output market over the period 1970–2008.

	To whom sold (%)								
	Fellow farmers			Local agents			Whole sellers		
Items	1970	1990	2008	1970	1990	2008	1970	1990	2008
Food grains and pulses	6	4	0	32	36	36	58	56	56
Oil seeds	4	2	0	20	24	24	42	40	40
Vegetables	2	2	2	12	12	12	8	6	6
Other agricultural commodities	0	0	0	4	4	4	0	2	2
Cotton	0	0	0	38	4	2	4	0	0
Sesame	2	2	0	14	20	18	38	32	32
Milk	4	6	6	4	4	0	4	0	2
Live animals	0	0	0	0	0	2	0	0	0
Poultry & eggs	0	0	0	2	2	0	0	0	0
Forest products	0	0	0	0	0	0	0	0	0

Table 72. Distribution of respondents (%) by distance from the village to the sales point over the period 1970–2008.

	1970(%)			1990(%)			2008(%)		
Output	Within the village	0-10 km	>10 km	Within the village	0-10 km	>10 km	Within the village	0-10 km	>10 km
Food grains and pulses	20	32	44	16	34	48	12	34	48
Oil seeds	12	24	30	8	26	34	8	26	32
Vegetables	8	10	4	8	10	4	8	12	4
Other agricultural commodities	0	0	4	0	2	4	0	2	4
Cotton	38	0	0	4	0	0	2	0	0
Gingelly	10	22	22	6	22	28	8	20	24
Milk	8	0	2	8	0	0	8	0	0
Live animals	2	0	2	0	0	2	2	0	0
Poultry & eggs	0	0	0	2	0	0	0	0	0

4.3.4. Occupations and livelihood

1.1.1.1 Primary occupation

Percentage of farmers involved in fine cereal based farming, coarse cereal based farming, and cultivation of vegetables, pulses and oilseeds has changed during the period 1970–2008 (Table 73). Percentage of farmers involved in cotton cultivation has declined during the period. According to perceptions of the majority of respondents, coarse cereal based farming, cultivation of vegetables, pulses and oilseeds has declined during the period. The majority (84%) of the farmers have said that the income through cereal based farming has seen a major increase during the period. About 74% have said that income from pulses and 60% have said that income from oilseeds cultivation have shown a major increase during the period. About 36% said that income from cotton cultivation has decreased during that period. Fine cereal, vegetable, pulses and oilseed cultivations gained by better price premium. However, there had been a water scarcity according to the majority of the respondents. Declining productivity has affected the pulses cultivations during the period. Dairy farming has been adversely affected by higher infections of diseases but there had been better price premium.

Table 73. Farmers (%) involved in primary occupation and degree of change over the period 1970–2008.

	Percentage of farmers involved			Degree of change (%)				
Primary occupation Agriculture	1970	1990	2008	Major decrease	Minor decrease	No change	Minor increase	Major increase
Fine cereal based farming	88	88	82	10	26	38	14	0
Coarse cereal based farming	70	70	68	4	42	18	8	0
Vegetable cultivation	48	48	40	2	28	14	6	0
Pulses cultivation	70	80	78	4	46	10	16	2
Oilseed cultivation	58	62	62	2	32	8	24	2
Cotton cultivation	38	8	0	38	0	0	0	0
Fruits	14	14	16	0	0	12	4	0
Dairy farming	16	10	4	14	2	0	2	0
Goat farming	0	0	2	0	0	0	2	0
Labor	0	2	4	0	0	0	4	0
Business	2	6	8	0	0	0	8	0
Service	2	2	2	0	2	0	0	0
Migration	4	6	6	2	0	0	4	2

4.3.5. Perception on climatic variability - Current trends of climatic variability

The majority have said that there has been a decline in the quantum of rainfall, intensity of rainfall, distribution of rainfall, number of rainy days, arrival of monsoon and withdrawal of rainfall during both periods, 1970–2000 and 2000–2008 in both Yala and Maha seasons. According to the perceptions of respondents, rainfall outside the rainy seasons and temperature have increased during both the seasons (Table 74 and 75).

Table 74. Distribution of respondents (%) by current trends in climatic variability in Yala season over the period 1970–2008.

Characteristics of climatic variability	Yala season (%)					
	1970-2000			2000-2008		
	Increase	Decrease	No change	Increase	Decrease	No change
Quantum of rainfall	32	64	4	18	80	2
Intensity of rainfall	12	56	18	2	68	16
Distribution of rainfall	10	70	6	0	80	6
Number of rainy days	32	58	4	38	52	4
Arrival of monsoons - Northeast	2	72	0	2	72	0
Arrival of monsoons - Southwest	2	72	0	2	72	0
Rainfall outside the rainy season	64	24	10	84	6	8
Onset of rainfall	22	72	2	0	94	2
Withdrawal of rainfall	4	80	2	10	74	2
Longer dry spells	38	50	8	48	40	8
Temperature (hotter or colder)	58	26	14	80	6	12

Table 75. Distribution of respondents (%) by current trends in climatic variability in Maha seasons over the period 1970–2008.

Characteristics of climatic variability	Maha season (%)					
	1970-2000			2000-2008		
	Increase	Decrease	No change	Increase	Decrease	No change
Quantum of rainfall	32	64	4	18	78	2
Intensity of rainfall	12	56	18	2	68	16
Distribution of rainfall	10	70	6	0	80	6
Number of rainy days	34	52	6	40	50	4
Arrival of monsoons - Northeast	2	72	0	4	70	0
Arrival of monsoons - Southwest	2	72	0	4	70	0
Rainfall outside the rainy season	66	24	8	84	6	8
Onset of rainfall	22	72	2	2	92	2
Withdrawal of rainfall	4	80	2	12	70	2
Longer dry spells	40	48	8	50	38	8
Temperature (hotter or colder)	60	24	12	78	6	12

4.3.6 Status of bio-diversity

Status of bio-diversity in Mahagalwewa village is also comparatively higher in relation to abundance of forest covers. The majority of the farmers have said that numbers of buffaloes and deer have declined while porcupines, peacock, teetar and mainah have not changed during the period (Table 76).

Table 76. Distribution of respondents (%) by degree of change on status of bio-diversity (animals) over the period 1970–2008.

Status of bio-diversity (Animals)	Degree of change (n=50) (%)				
	Major decrease	Minor decrease	No change	Minor increase	Major increase
Buffaloes	22	30	30	18	0
Deer	38	46	14	2	0
Rodents	0	6	38	48	8
Porcupine	0	6	86	2	2
Fox	20	46	32	2	0
Wild pigs	12	16	32	40	0
Elephant	4	34	56	0	4
Other animals (rabbits, wolf)	0	2	2	56	40
Peacock	0	2	96	2	0
Teetar	0	2	96	0	2
Mainah	0	2	96	0	2
Sparrow	48	24	26	0	0
Jungle fowl	0	2	62	26	10
Other birds (indigenous and migratory)	8	24	48	16	0
Herbs and plants	2	28	66	2	0

4.3.7 Sources, availability and quality of water

The majority have said that the canals, tanks, tube wells and watershed have not changed as sources of irrigation during the periods (Table 77). According to most of the respondents, usage of wells as an irrigation source has declined during the periods. Availability of wells as sources of water supply was totally insufficient in 2008. The majority of the farmers have perceived that the quality of water in canals, tanks, wells, tube wells, watershed and tap water had not changed during 1970s. However, according to them, the quality of water in canals, tanks and wells has deteriorated during the period of study (Table 78 and Table 79).

Table 77. Farmers' perception (%) on sources of irrigation and their degree of change over the period 1970–2008.

	Degree of change (n=50) (%)				
Sources	Major decrease	Minor decrease	No change	Minor increase	Major increase
Canal	2	0	74	14	8
Tank	6	8	58	16	10
Wells	14	52	20	10	2
Tube wells	12	8	60	12	0
Watersheds/Ponds	0	14	82	2	0
Others (Tap water)	0	0	50	8	4

Table 78. Farmers' perception (%) on availability of sources of water to cater to local needs in 1970s.

	Whether sufficient to cater to local needs					
	1970(%)					
Sources	Partly insufficient	Totally insufficient	No Change	Partly sufficient	Totally sufficient	Not practiced
Canal	0	0	70	12	0	2
Tank	0	0	44	22	22	0
Wells	2	2	44	24	14	0
Tube wells	2	2	48	14	2	6
Water sheds/ Ponds	0	0	54	4	0	0
Others (Tap water)	0	0	20	2	0	36

Table 79. Farmers' perception (%) on availability of sources of water to cater to local needs in 2008.

	Whether sufficient to cater to local needs					
	2008 (%)					
Resources	Partly insufficient	Totally insufficient	No change	Partly sufficient	Totally sufficient	Not practiced
Canal	0	8	42	36	0	0
Tank	2	26	32	30	2	0
Wells	22	38	20	12	2	0
Tube wells	8	10	42	0	0	2
Watersheds/ Ponds	0	6	44	0	0	0
Others (Tap water)	0	0	30	6	6	16

4.3.8 Changes in indicators of resource conditions

According to the majority of the respondents, the quality of cultivated land, soil fertility status, quality of other common property resources, and quality of natural water resources have declined during the period. Most of them have perceived that the soil texture, soil depth, quality of grazing land and area degraded through special problems have not changed during the periods. Sizable numbers of farmers have perceived that the soil erosion problems have increased. The majority has said that the soil fertility status has been adversely affected by frequent cultivations (Table 80).

Table 80. Distribution of respondents (%) by degree of change in indicators of resource conditions over the period 1970–2008.

	Degree of change (n=50) (%)					
Indicators of resource condition	Major decrease	Minor decrease	No change	Minor increase	Major increase	Farmer cannot answer for the change
Quality of cultivated land	22	54	22	0	2	0
Soil texture	2	34	48	0	2	14
Soil depth	0	8	50	28	2	12
Soil fertility status	30	66	2	0	2	0
Soil erosion problems	0	0	18	42	36	4
Quality of grazing land	2	10	58	0	0	30
Quality of other CPRs	10	44	36	0	4	6
Quality of natural water resources	22	46	24	2	2	4
Area degraded through special problems	0	0	64	20	0	16

4.3.9 Perception about change in land use

The majority of the respondents have said that clearance of forest land for agriculture and use of agricultural land for other purposes have increased during the period (Table 81).

Table 81. Distribution of respondents (%) by causes of livelihood impacts change through land use over the period 1970–2008.

	Degree of change (n=50) (%)				
Land use	Major decrease	Minor decrease	No change	Minor increase	Major increase
Forest land clearance for agriculture	8	24	6	54	8
Agricultural land for other purposes	0	8	32	44	8

4.3.10 Common property resources

The majority of the villagers said that wells and forests were considered as common property resources. According to them, there had been full access to community ponds, wells, pasture lands, and watersheds, while access to forests was restricted during the periods (Table 82). According to the majority of respondents, village/ community ponds, well and pasture lands were managed by the government. The majority were using the community ponds and wells for household chores while the forest was used for collection of wood and hunting of animals (Table 83).

Table 82. Distribution of respondents (%) by degree of change in common property resources over the period 1970–2008.

	Degree of change (n=50) (%)				
Common Property Resource	Major decrease	Minor decrease	No change	Minor increase	Major increase
Village/community ponds	8	40	8	42	2
Well	36	34	20	10	0
Pasture lands	0	0	28	0	0
Watersheds	0	2	24	0	0
Forest	30	50	4	6	2

Table 83. Distribution of respondents (%) by purpose of using common property resources over the period 1970–2008.

	Purpose (n=50)(%)							
Common Property Resource	Household chores (Bathing, washing clothes & utensils)	Collection of drinking water	Washing animals	Lifting water for irrigation	Fishing	Collection of wood and hunting of animals	Collection of timber and grazing of animals	For cultivat-ion
Village/ community ponds	98	14	10	12	4	0	0	0
Well	52	18	0	42	0	0	0	0
Pasture lands	0	0	0	0	0	0	0	0
Watersheds/ Ponds	0	0	0	16	0	0	0	0
Forest	0	0	0	0	0	54	26	14

4.3.11 Causes of livelihood impacts

Unsustainable production practices

According to the majority of the respondents, unsustainable production practices have increased except burning of crop residues/forest fire (Table 84).

Table 84. Distribution of respondents (%) by causes of change in livelihood impacts through unsustainable production practices over the period 1970–2008.

	Degree of change (n=50) (%)				
Unsustainable production practices	Major decrease	Minor decrease	No change	Minor increase	Major increase
Inappropriate production technology	0	8	22	28	36
Extensive and frequent cultivation	2	4	20	48	24
Inappropriate cropping pattern	0	4	26	30	22
Burning of crop residues/ forest fire	6	46	0	22	24
No or low addition of organic matter humus in soil	10	30	8	30	22
Indiscriminate application of herbicides/ pesticides	2	0	2	64	30
Unbalanced use of inorganic fertilizers	0	0	2	52	44
Excessive tillage practices	0	2	22	44	12
Deep ploughing	2	10	24	34	8

4.3.12 Climate change

According to the majority of the respondents, consecutive drought, moisture stress, changes in rainfall pattern, volume of rainfall, temperature and soil erosion have increased during the periods (Table 85).

Table 85. Distribution of respondents (%) by causes of changes in livelihood through climatic change over the period 1970–2008.

	Degree of change (n=50)(%)				
Climatic change	Major decrease	Minor decrease	No change	Minor increase	Major increase
Consecutive drought	2	10	12	46	28
Moisture stress	0	0	0	82	14
Change in rainfall pattern	2	6	2	48	36
Volume of rainfall	0	34	8	48	6
Rising temperature	0	0	10	56	32
Soil erosion due to intense wind storms	0	0	20	24	8

4.3.13 Deforestation

According to the majority of the respondents, overgrazing, excessive fuel wood collection and indiscriminate land mining have not changed during the period while uncontrolled logging and illegal felling of forest trees, and over hunting of wild animals and collection of plants have been reduced (Table 86).

Table 86. Distribution of respondents (%) by causes of change in livelihood impacts through deforestation over the period 1970–2008.

	Degree of change (n=50) (%)				
Deforestation	Major decrease	Minor decrease	No change	Minor increase	Major increase
Over grazing	2	4	34	12	2
Excessive fuel wood collection	4	20	44	0	6
Uncontrolled logging and illegal felling of forest trees	8	52	20	4	4
Indiscriminate land mining	6	4	34	0	0
Over hunting of wild animals and collection of plants	26	40	14	4	0

4.3.14 Poverty and the Government policies

According to the majority of the respondents, government intervention has increased and there was a minor decrease in poverty during the period (Table 87).

Table 87. Distribution of respondents (%) by causes of change in livelihood impact through Government policies over the period 1970–2008.

	Degree of change (n=50) (%)				
Government policies	Major decrease	Minor decrease	No change	Minor increase	Major increase
Poverty	8	38	16	28	10
Government intervention	2	16	6	48	22
Property rights/ laws	0	0	8	4	0

4.3.15 Land management practices

According to the majority of the respondents, mulching, green manuring, composting, bunding, drainage channels and agro forestry have been slightly increased during the period, while fallow strips and fallows have decreased. Awareness on land management practices have increased during the period 1970–2008 (Table 88).

Table 88. Distribution of respondents (%) by degree of change in land management practices over the period 1970–2008.

	Degree of change (n=50) (%)					
Land management practices	Major decrease	Minor decrease	No change	Minor increase	Major increase	Cannot answer for the change
Mulching	0	0	8	34	16	42
Green manuring	0	0	14	42	8	36
Composting	0	2	2	50	34	12
Incorporating crop residue	2	6	32	24	14	22
Conservation tillage practices	4	0	8	30	4	54
Bunding	2	4	6	40	8	40
Fallow	20	28	28	0	0	24
Fallow strips	20	26	28	2	0	24
Drainage channels	0	2	4	50	10	34
Contour ridges	0	0	0	4	0	96
Zero tillage	0	0	0	0	0	100
Minimal tillage	0	0	0	2	0	98
Agro-forestry	0	0	0	26	0	74
Wind barriers/alley cropping	0	0	0	0	0	100
Planting grasses/Savanna grasses	0	0	0	2	0	98
Construction of stone walls	2	0	0	12	0	86
Plantation of shrubs and trees	2	0	0	4	0	94

4.3.16 Collective actions

Initiatives of soil and water conservation measures on common lands and private lands, planting of trees on common lands, conservation of forests and maintenance of grazing land have not changed during the period, while construction and maintenance of roads and community water supply system have declined (Table 89).

Table 89. Distribution of respondents (%) by degree of change in collective actions over the period 1970–2008.

Collective action	Degree of change (n=50) (%)				
	Major decrease	Minor decrease	No change	Minor increase	Major increase
Initiatives of soil and water conservation measures on common lands	8	34	42	6	2
Initiatives of soil and water conservation measures on private lands	6	20	36	26	2
Plantation of trees on common lands	6	20	56	10	0
Plantation of forest	6	18	52	14	2
Conservation and maintenance of grazing land	6	12	68	4	0
Conservation and maintenance of water resources	14	44	28	8	6
Construction of roads and their maintenance	16	40	28	10	6
Maintenance of community water supply system	16	40	26	16	2

4.4. Bata-Atha village

Bata-Atha village is situated in Bata-Atha South Grama Niladhari Division in Ambalantota Divisional Secretariat area in Hambantota District. The primary occupation of the villagers was mainly based on marine fisheries and part-time farming. Farmer perception of the climate change and related issues are summarized here, showing the percentages of responses regarding the particular issues.

4.4.1. Demographic Features of Bata–Atha village

The current geographical area of the village is about 490 ha as it has increased during the period (Table 90). The number of marginal, small, medium and larger households have increased in the village.

Table 90. Demographic features of Bata-Atha village.

Demographic features	2008	Farmer perception on degrees of change over the period 1970–2008
Geographical area (acre)	1236	Major increase
Marginal households (0 - 1 ha)	269	Major increase
Small households (1 - 2 ha)	121	Major increase
Medium households (2 - 4 ha)	87	Major increase
Large households (>4 ha)	7	Minor increase

4.4.2. Cropping pattern, Livestock activities and Input use

4.4.2.1. Cropping pattern

The cultivated area of finger millet, green gram, sesame, maize and paddy has declined while the cultivated area of cowpea and cashew has increased in the Yala season (Table 91). Average yields of chili, cowpea, groundnut, sesame and tomato have declined during the Yala season over the period 1970–2008. Average yields of chili, manioc, pumpkin and brinjal have increased while average yields of finger millet, green grams, cowpea, okra, sesame, maize and paddy have decreased in the Maha season. The cultivated area of chili, finger millet, green gram, cowpea, manioc, sesame, brinjal plant and paddy has declined during the Maha season (Table 92).

Table 91. Cultivated area and distribution of respondents (%) by crop cultivated in Yala season over the period 1970–2008.

	Cultivated area (ha)		Degree of change (n=50)(%)				
Crop	1970	2008	Major decrease	Minor decrease	No change	Minor increase	Major increase
Chili	2	2	2	6	0	0	0
Finger millet	1.2	0	2	0	0	0	0
Green gram	0.4	1	0	2	2	0	0
Cowpea	0	0.1	0	0	2	0	0
Cashew	0	0.5	0	0	2	2	0
Manioc	1	1	4	0	0	0	0
Groundnut	0	0	0	0	4	0	0
Sesame	3	1	8	2	4	0	0
Maize	1	0	4	0	2	0	0
Paddy	5	4	4	2	12	2	0
Tomato	1.1	0.6	2	4	0	0	0
Other	1.4	0	4	4	2	2	0

Table 92. Average yield and distribution of respondents (%) by degree of change in average yield of crops during Yala season 1970–2008.

	Average yield (kg/ha)		Degree of change (n=50) (%)				
Crop	1970	2008	Major decrease	Minor decrease	No change	Minor increase	Major increase
Chili	429	464	2	10	0	4	0
Potato	1000	0	0	0	2	0	0
Green gram	500	542	0	0	0	4	0
Cowpea	469	438	0	0	2	0	0
Cashew	250	250	0	2	2	0	0
Manioc	1250	0	0	2	0	0	0
Groundnut	438	406	0	2	2	0	0
Sesame	731	250	6	6	0	0	0
Maize	313	313	0	0	4	0	0
Paddy	2200	2707	4	6	2	4	0
Tomato	329	142	2	2	0	2	0

4.4.2.2 Input use for crops

According to the majority of the farmers, the use of tractors for land preparation and of improved seed varieties as planting material have increased during the period. The number of irrigations has been slightly increased, and the usage of all types of fertilizers has increased over the period. The usage of hired labor has decreased while usage of family labor has increased. Applications of herbicides, weedicides and pesticides for cultivations have also increased from 1970–2008 (Table 93).

Table 93. Distribution of respondents (%) by degree of change in input use over the period 1970 –2008.

	Degree of change (n=50) (%)				
Input use	Major decrease	Minor decrease	No change	Minor increase	Major increase
Land preparation					
Tractors	12	4	4	40	8
Bullocks	2	28	8	2	0
Improved seed	0	0	8	42	10
Type of irrigation					
Pump set	0	0	0	16	2
Sprinkler	0	0	0	0	2
Drip	0	0	0	2	0
No. of irrigations	0	0	4	60	4
Fertilizers					
Farm Yard Manure	0	4	2	32	2
Compost	2	4	2	50	4
Cattle penning	0	10	2	32	2
Urea	0	0	8	48	8
Muriate of Potash	0	0	2	42	0
Complex fertilizer	0	0	0	36	2
Other fertilizers	0	0	2	34	0
Labor usage					
Male	20	32	14	10	6
Female	16	36	24	4	2
Family labor	2	24	8	40	10
Weeding					
Manual	2	24	36	2	10
Mechanical	0	4	12	14	2
Herbicides/ weedicides	0	2	10	42	12
Pesticides	0	2	12	36	20
Integrated Pest Management	2	8	26	24	4

4.4.2.3. Livestock population

Both cattle and buffalo populations have declined over the period 1970 to 2008 in Bata-Atha village (Table 94).

Table 94. Livestock population of Bata-Atha village.

Livestock population	1970s	2008	Perception
Cattle	2500	30	Major decrease
Buffaloes	1750	58	Major decrease

4.4.2.4 Input use for livestock activities

Since livestock farming was carried on at a very small scale of operations, villagers have not used the inputs available at outside markets. Practices such as vaccination and artificial Insemination were not popular in the village (Table 95). The percentage distribution of respondents by degree of change in inward migration and outward migration of animals over the period 1970–2008 is highlighted in Table 96.

Table 95. Distribution of respondents (%) by degree of change in input use for animals over the period 1970–2008.

	Degree of change (n = 50)(%)					
Input use for animals	Major decrease	Minor decrease	No change	Minor increase	Major increase	Did not use inputs
Dry fodder	4	0	2	0	2	94
Cultivated green fodder	4	0	2	0	2	94
Grasses & hand-picked/ collected green fodder	6	2	2	0	2	90
Concentrates	4	0	4	0	2	92
Compound cattle feed	0	4	2	2	2	92
Minerals & vitamins	6	0	4	0	2	90
Vaccines	10	0	2	2	2	86
Medicines	12	0	4	0	2	84
Artificial Insemination	0	0	2	0	2	98
Improved animal breeds	0	0	2	0	2	98
Poultry feed	0	2	2	2	2	94

Table 96. Distribution of respondents (%) by degree of change in inward migration and outward migration of animals over the period 1970–2008.

	Degree of change – Inward migration (%)					
Animal type	Major decrease	Minor decrease	No change	Minor increase	Major increase	Not practiced
Local cattle	6	2	0	0	2	92
Cross-bred cattle	0	0	0	0	2	100
Bulls	0	0	0	0	2	100
Goat	0	0	0	0	2	100
Poultry	4	2	0	0	2	94
Pigs	4	0	0	0	2	96
Bee hives	6	0	0	0	2	94
	Degree of change - Outward migration (%)					
Animal type	Major decrease	Minor decrease	No change	Minor increase	Major increase	Not practiced
Local cattle	0	0	0	0	2	92
Cross-bred cattle	0	0	0	0	2	100
Bulls	0	0	0	0	2	100
Goat	0	0	0	0	2	100
Poultry	0	0	0	0	2	94
Pigs	0	0	0	0	2	98

4.4.3 Markets and Infrastructure

4.4.3.1 Input market

The distance from the village to the input market ranged between 0 and 1 km from the village in 1970s, 1990s and 2008 (Table 97). The distance from the village to the marketing point ranged between 0 and 10 km to sell food grains and pulses in 1970s, 1990s and 2008.

Table 97. Distribution of respondents (%) by distance from the village to the input market over the period 1970–2008.

	1970(%)			1990(%)			2008(%)		
Input	Within the village	0-10 km	>10 km	Within the village	0-10 km	>10 km	Within the village	0-10 km	>10 km
Seed	56	96	2	60	96	2	52	88	2
Fertilizer	6	66	2	6	66	2	8	66	2
Agro chemicals	2	54	2	2	56	2	2	56	2
Cattle feed	0	6	2	0	6	2	0	6	2

4.4.3.2 Output market

The output market for food grains, oil seeds, vegetables and sesame have not changed during both periods, 1970–1990 and 1990–2008. In 1970s, 1990s and 2008, food grains, pulses and oil seeds were sold inside the village itself and in nearby markets (Table 98). Most of the agricultural commodities have been sold to wholesale dealers in 1970s, 1990s and 2008. Percentage distribution of respondents by distance from the village to the sales point over the period 1970–2008 is shown in Table 99.

Table 98. Distribution of respondents (%) by degree of change in output market over the period 1970–2008.

	1970–1990 (%)					1990–2008 (%)				
Items	Major decre-ase	Minor decre-ase	No change	Minor incre-ase	Major incre-ase	Major decre-ase	Minor decre-ase	No change	Minor incre-ase	Major incre-ase
Food grains & pulses	2	8	78	4	0	18	12	58	0	0
Oilseeds	2	10	64	6	0	22	16	38	2	0
Vegetables	0	0	34	2	0	14	2	20	0	0
Other agri. comm.	0	6	26	0	0	10	2	16	4	0
Gingelly	4	2	58	6	0	16	10	40	0	2
Milk	0	0	2	0	0	0	0	2	0	0
Animals	0	0	2	0	0	0	2	0	0	0
Poultry & eggs	2	4	8	0	0	4	0	8	0	0

Table 99. Distribution of respondents (%) by distance from the village to the sales point over the period 1970–2008.

	1970 (%)			1990 (%)			2008 (%)		
Output	Within the village	0-10 km	>10 km	Within the village	0-10 km	>10 km	Within the village	0-10 km	>10 km
Food grains & pulses	38	50	2	34	50	2	10	48	2
Oilseeds	34	42	0	28	48	0	8	40	0
Vegetables	18	12	2	20	12	2	8	10	4
Other agri. comm.	10	14	4	6	18	4	4	14	4
Gingelly	26	40	0	20	46	0	8	34	0
Milk	2	0	0	2	0	0	2	0	0
Live animals	2	0	0	2	0	0	0	0	0
Poultry & eggs	14	0	0	8	0	0	4	0	0

4.4.4 Occupations and livelihood

4.4.4.1 Occupation

Most of the farmers were involved in fine cereal based farming, coarse cereal based farming, cultivation of vegetable, pulses, oilseed and fruits (Table 100). The percentage of farmers involved in agriculture based occupations has declined during the period.

Table 100. Percentage of farmers involved in primary occupation and degree of change over the period 1970–2008.

Primary occupation	Percentage of farmers involved			Degree of change (%)				
Agriculture	1970	1990	2008	Major decrease	Minor decrease	No change	Minor increase	Major increase
Fine cereal based farming	40	40	30	6	10	4	16	4
Coarse cereal based farming	60	58	36	14	18	2	20	6
Vegetable cultivation	60	62	50	8	30	6	18	6
Pulses cultivation	70	66	38	12	32	0	20	6
Oilseed cultivation	82	84	46	16	42	2	18	6
Cotton cultivation	0	0	0	0	0	0	0	0
Fruits	30	38	42	2	6	12	16	10
Others	2	2	2	0	0	0	0	2
Dairy farming	10	6	0	4	6	0	0	0
Goat farming	6	4	0	4	2	0	0	0
Poultry	14	8	2	6	6	0	0	2
Bee keeping	2	2	2	2	0	0	0	2
Labor	10	36	46	0	6	2	22	16
Business	12	24	24	2	8	2	18	2
Service	0	4	6	0	2	0	2	4
Outward Migration	4	8	8	2	2	0	2	6

4.4.5 Indicators of weather/climate variability, impacts, causes and practices

Perception on climatic variability - Current trends of climatic variability

The majority of the respondents have perceived that the quantum of rainfall, intensity of rainfall, distributions of rainfall, number of rainy days and rainfall outside the rainy seasons has declined during both Yala and Maha seasons over the period 1970-2000 and 2000-2008. Arrival of monsoons and onset of rainfall have been delayed during both periods. According to the majority of the respondents, longer dry spells and temperature have increased during the Yala and Maha seasons in 1970–2000 and 2000–2008 (Table 101 and Table 102).

Table 101. Distribution of respondents (%) by current trends in climatic variability in Yala seasons over the period 1970–2008.

Characteristics of climatic variability	Yala season (%)					
	1970–2000			2000–2008		
	Increase	Decrease	No change	Increase	Decrease	No change
Quantum of rainfall	40	54	4	12	82	4
Intensity of rainfall	38	54	6	2	90	6
Distribution of rainfall	28	50	20	0	78	20
Number of rainy days	36	54	8	10	84	4
Arrival of monsoons - Northeast	26	72	0	4	94	0
Arrival of monsoons - Southwest	26	72	0	16	80	2
Rainfall outside the rainy season	12	62	18	56	32	6
Onset of rainfall	18	74	6	18	80	0
Withdrawal of rainfall	40	50	6	50	34	12
Longer dry spells	54	32	10	74	16	8
Temperature (hotter or colder)	54	28	14	78	8	12

Table 102. Distribution of respondents (%) by current trends in climatic variability in Maha seasons over the period 1970–2008.

Characteristics for climatic variability	Maha season (%)					
	1970–2000			2000–2008		
	Increase	Decrease	No change	Increase	Decrease	No change
Quantum of rainfall	34	62	4	14	82	4
Intensity of rainfall	34	58	8	4	88	8
Distribution of rainfall	24	54	22	2	76	22
Number of rainy days	24	70	6	14	82	4
Arrival of monsoons - Northeast	26	74	0	8	92	0
Arrival of monsoons - Southwest	26	74	0	16	84	0
Rainfall outside the rainy season	8	78	8	44	46	6
Onset of rainfall	16	78	6	16	84	0
Withdrawal of rainfall	28	66	4	48	50	0
Longer dry spells	60	30	8	60	32	8
Temperature (hotter or colder)	62	24	12	72	16	12

4.4.6 Status of bio-diversity

The percentage distribution of respondents by degree of change on status of bio-diversity (animals) over the period 1970–2008 is highlighted in Table 103. It was evident that buffaloes, deer, rodents, porcupine, fox, elephant, and herbs and plant populations have shown a major decrease while jackal, peacock and jungle fowl populations have shown a major increase mainly because the jungle fowl has been declared the national bird, and the peacock is a religious bird. However, villagers have perceived that wild pig attacks on the cultivation had increased over the period of time probably because of twin reasons, that of clearing of jungles and converting them into cultivation lands, and population increase due to large litter sizes.

Table 103. Distribution of respondents (%) by degree of change on status of bio-diversity (animals) over the period 1970–2008.

	Degree of change (n=50) (%)				
Status of bio-diversity (Animals)	Major decrease	Minor decrease	No change	Minor increase	Major increase
Buffaloes	30	26	30	4	10
Deer	34	26	40	0	0
Rodents	62	32	6	0	0
Jackals	2	10	24	34	30
Porcupine	14	24	28	28	6
Fox	44	18	34	4	0
Wild pigs	2	34	14	20	30
Other animals (rabbits, wolf)	6	54	22	16	2
Peacock	0	8	8	38	46
Teetar	0	0	100	0	0
Mainah	4	14	68	8	6
Sparrow	6	8	68	10	8
Elephant	92	6	0	0	2
Jungle fowl	4	22	34	16	24
Other birds (indigenous and migratory)	2	50	38	6	4
Herbs and plants	18	34	38	8	2

4.4.7 Sources, availability and quality of water

Usage of tanks, wells and tube wells as sources of irrigation have declined during the periods while usage of canals has not changed (Table 104). In 1970s and 2008 the quality of water in canal, tank, tube wells and watershed has not changed. According to the majority of the respondents they have full access to village pond, well, pasture lands and watersheds. Most of the respondents said that access to forests have been restricted. The farmers' perception (%) on water quality from different sources of water over the period 1970–2008 is highlighted in Table 105.

Table 104. Farmers' perception (%) on sources of irrigation and their degree of change over the period 1970–2008.

	Degree of change (n=50) (%)				
Sources	Major decrease	Minor decrease	No change	Minor increase	Major increase
Canal	2	20	76	2	0
Tank	38	28	32	0	0
Wells	52	34	12	0	0
Tube wells	48	30	12	8	0
Watersheds/ponds	34	16	46	2	0

Table 105. Farmers' perception (%) on water quality from different sources of water over the period 1970–2008.

	1970 (%)					2008 (%)				
Sources	Major deterio-ration	Minor deterio-ration	No change	Minor improve-ment	Major improve-ment	Major deterio-ration	Minor deterio-ration	No change	Minor improve-ment	Major improve-ment
Canal	0	0	94	6	0	2	8	86	2	0
Tank	0	2	46	8	40	36	16	46	0	0
Wells	10	16	24	14	32	2	20	76	2	0
Tube wells	6	30	46	14	2	26	26	42	4	0
Watersheds /Ponds	0	6	46	28	16	12	34	48	0	0

4.4.8 Changes in indicators of resource conditions

Percentage distribution of respondents by indicators of resource conditions over the period 1970–2008 is detailed in Table 106.

Table 106. Distribution of respondents (%) by indicators of resource conditions over the period 1970–2008.

Indicators of resource condition	Degree of change (n=50) (%)				
	Major decrease	Minor decrease	No change	Minor increase	Major increase
Quality of cultivated land	28	58	10	2	2
Soil texture	4	20	74	2	0
Soil depth	4	6	68	22	0
Soil fertility status	52	36	8	2	2
Soil erosion problems	2	14	22	18	44
Quality of grazing land	4	60	30	0	0
Quality of other CPRs	14	36	30	6	2
Quality of natural water resources	16	42	38	2	2
Area degraded through special problems	2	2	60	26	6

4.4.9 Common property resources

According to the majority of the respondents, most of the common property resources have declined during the period (Table 107). The majority have perceived that the access to forest area has been restricted while the access to other common property resources has remained unrestricted (Table 108).

Table 107. Distribution of respondents (%) by degree of change in common property resources over the period 1970–2008.

Common property resource	Degree of change (n=50) (%)				
	Major decrease	Minor decrease	No change	Minor increase	Major increase
Village/community ponds	54	22	24	0	0
Well	44	44	12	0	0
Pasture lands	16	58	24	2	0
Watersheds/ponds	4	44	52	0	0
Forest	42	50	6	0	0

Table 108. Distribution of respondents (%) by access to common property resources over the period 1970–2008.

Common property resource	Access (%)		
	Full	Partial	Restricted
Village/community ponds	98	0	2
Well	78	2	20
Pasture lands	74	12	2
Watersheds/ponds	72	0	6
Forest	6	36	58

4.4.10 Causes of livelihood impacts

4.4.10.1 Unsustainable production practices

According to the majority of the respondents, inappropriate production technology, extensive and frequent cultivations, inappropriate cropping pattern, addition of organic matter /humus in soil, indiscriminate applications of herbicides, pesticides, unbalanced use of inorganic fertilizers, excessive tillage practices and deep ploughing have not changed during the period while burning of crop residues/ forest fires has declined (Table 109).

Table 109. Distribution of respondents (%) by causes of change in livelihood impacts through unsustainable production practices over the period 1970–2008.

	Degree of change (n=50) (%)				
Unsustainable production practices	Major decrease	Minor decrease	No change	Minor increase	Major increase
Inappropriate production technology	0	16	60	6	4
Extensive and frequent cultivation	0	4	52	26	8
Inappropriate cropping pattern	2	10	40	18	6
Burning of crop residues / forest fire	28	28	22	2	12
No or low addition of organic matter/ humus in soil	4	24	42	10	10
Indiscriminate application of herbicides/ pesticides	2	8	54	14	16
Unbalanced use of inorganic fertilizers	0	8	60	8	18
Excessive tillage practices	2	4	62	10	14
Deep ploughing	2	2	60	10	16

4.4.10.2 Climate Change

The majority of the respondents have said that consecutive drought, moisture stress, change in rainfall pattern and rising temperature have been observed during this period; while volume of rainfall has declined. Soli erosions due to intense wind storms have not changed during the periods (Table 110).

Table 110. Distribution of respondents (%) by causes of change in livelihood impacts through climatic change over the period 1970–2008.

	Degree of change (n=50) (%)				
Climatic change	Major decrease	Minor decrease	No change	Minor increase	Major increase
Consecutive drought	0	16	18	20	44
Moisture stress	2	12	14	26	28
Change in rainfall pattern	0	20	12	44	22
Volume of rainfall	8	36	18	10	26
Rising temperature	0	8	24	20	40
Soil erosion due to intense wind storms	2	6	48	6	6

4.4.10.3 Deforestation

According to the majority of the respondents, over grazing, excessive fuel wood collection, and indiscriminate land mining has not changed while over hunting of wild animals and cutting of plants have decreased during the periods (Table 111).

Table 111. Distribution of respondents (%) by causes of change in livelihood impacts through deforestation over the period 1970–2008.

	Degree of change (n=50) (%)				
Deforestation	Major decrease	Minor decrease	No change	Minor increase	Major increase
Over grazing	0	10	34	4	20
Excessive fuel wood collection	4	16	34	2	4
Uncontrolled logging and illegal felling of forest trees	6	30	32	18	4
Indiscriminate land mining	0	14	46	2	0
Over hunting of wild animals and collection of plants	8	40	24	6	10

4.4.10.4 Poverty and the Government policies

The majority have perceived that poverty has declined while property rights have slightly increased during the period (Table 112).

Table 112. Distribution of respondents (%) by changes in livelihood and impact through Government policies over the period 1970–2008.

	Degree of change (n=50) (%)				
Government policies	Major decrease	Minor decrease	No change	Minor increase	Major increase
Poverty	10	56	6	6	16
Government intervention	2	28	14	24	2
Property rights/ laws	0	4	12	28	2

4.4.10.5 Land management practices

The majority of the villagers have perceived that mulching, green manuring, composting, bunding, drainage channels and agro forestry have increased during the periods 1970–2008 (Table 113). Incorporating crop residues have not changed while fallow and fallow strips have decreased. Awareness on land management practices have also increased during the period.

Table 113. Distribution of respondents (%) by degree of change in land management practices over the period 1970–2008.

	Degree of change (n=50)				
Land management practices	Major decrease	Minor decrease	No change	Minor increase	Major increase
Mulching	0	4	18	28	16
Green manuring	0	8	14	50	12
Composting	0	10	4	38	34
Incorporating crop residue	0	16	44	16	6
Conservation tillage practices	0	2	12	22	6
Bunding	0	4	22	44	8
Fallow	30	28	16	6	0
Fallow strips	32	28	16	4	0
Drainage channels	2	4	14	42	6
Contour ridges	0	0	6	20	0
Zero tillage	0	0	4	0	0
Minimal tillage	0	0	4	2	0
Agro-forestry	0	2	2	34	0
Wind barriers / alley cropping	0	0	4	4	0
Planting grasses / Savanna grasses	0	0	2	2	0
Construction of stone walls	0	2	2	10	0
Plantation of shrubs and trees	0	0	2	4	0

5.Adaptations Strategies

5.1 Adaptation strategies for Galahitiyagama village in Anuradhapura District

Changing the seasonal crop cultivation to short term cash crop cultivation was the main adaptation strategy at the farm level (Table 114). Specifically, the farmers have adopted the cultivation of a hybrid maize variety called pacific as a short term cash crop. At the institutional level, the main adaptation strategy was providing subsidies during peak requirements. At the technological level, use of new machineries and hybrid crop varieties were the adaptation strategies. At the social level, most of the farmers have established kinship ties to aid in difficult situations.

Table 114. Adaptation strategies practiced at different levels of intervention at Galahitiyagama.

Intervention level	Adaptation strategy
Farm level	They did not get any adaptation for the crop cultivations
Institution level	Providing subsidies during peak requirements
Technological level	They did not get any adaptation for the use of technology
Social level	Resorted to help from kinship ties

The major motivational factors for farmers for participation in the local groups were convenience to obtain subsidies in the event of disasters, supplement agricultural inputs, tools/ machineries, assistance in social events at the village level and importing knowledge and instructions for agricultural operations (Table 115). Coping mechanisms undertaken by farmers, ranked according to the scale of preferences among farmer categories, are summarized in Table 116.

Table 115. Distribution of respondents (%) by motivational factors for being part of the local groups among farmer categories at Galahitiyagama.

Farmer category	Number of participants	Participator		Motivational factor				
		Male	Female	Easy to obtain loans	Easy to obtain subsidies in events like disasters	Supplement of agricultural inputs, tools/ machineries	Giving knowledge and instructions for agricultural operations	Assist in social events of the village
Small households (1-2 ha) (n=17)	100	71	6	53	29	29	24	47
Medium households (2-4 ha) (n=27)	100	78	19	56	30	30	19	52
Large households (2-4 ha) (n=16)	100	81	19	75	31	38	31	56

Table 116. Coping mechanisms undertaken by farmers ranked according to the scale of preferences among farmer categories at Galahitiyagama.

Scale of preference	Marginal households (0-1 ha)	Small households (1-2 ha)	Medium households (2-4 ha)
1	Improvement of access to water availability through watersheds / Digging of deeper wells	Diversification of means of livelihoods	Use of previously collected resources
2	Use of previously collected resources	Obtain loans	Reduced consumption and expenditure
3	Resort to non-farm activities	Improvement of access to water availability through watersheds / Digging of deeper wells	Improvement of access to water availability through watersheds / Digging of deeper wells
4	Reduced consumption expenditure	Reduced consumption expenditure	Obtain loans
5	Selling of assets	Selling of assets	Migration for non-farm activities
6	Diversification of means of livelihoods	Use of previously collected resources	Diversification of means of livelihoods
7	Obtain loans	Migration for non-farm activities	Selling of assets
8	Selling of livestock	Selling of livestock	Selling of livestock

5.2 Adaptation strategies in Mangalapura village in Puttalam District

When considering the adaptation strategies at farm level, it was indicated that the desirable step is to change the seasonal crop cultivations to perennial crop cultivations. Providing subsidy requirements was considered as the main adaptation strategy. Use of hybrids, short duration varieties and resistant varieties were the adaptation strategies practiced at the technological level. Establishment of better kinship ties was the strategy adapted at the social level. The mostly preferred coping mechanism by marginal and larger householders was diversification of means of their livelihoods. Most of the villagers have been occupied in different occupations other than engaging in agriculture based activities. Changing the seasonal crop cultivations to perennial crop cultivations is the main coping strategy of marginal, medium and large householders. The main coping strategy of small householders is changing the occupation (Table 117). Adaptation strategies practiced at different levels of intervention in Mangalapura village are highlighted in Table 118.

Table 117. Adaptation strategy at household level in Mangalapura village.

Farmer category	Main coping strategy
Marginal households (0-1 ha)	Change the seasonal crop cultivations to perennial crop cultivations
Small households (1-2 ha)	Change the occupation
Medium households (2-4 ha)	Change the seasonal crop cultivations to perennial crop cultivations
Large households (>4 ha)	Change the seasonal crop cultivations to perennial crop cultivations

Table 118. Adaptation strategies practiced at different levels of intervention at Mangalapura.

Intervention level	Adaptation strategy
Farm level	Change the seasonal crop cultivations to perennial crop cultivations
Institution level	Receiving subsidies during peak requirements
Technological level	Use of hybrids, short duration varieties, resistant varieties
Social level	Establish better kinship ties

5.3 Adaptation strategies in Mahagalwewa village in Hambantota District

Ownership of sources of water was considered as the major factor that determines the capacity to adapt to climatic change, according to the majority of respondents in marginal and small households (Table 119). For medium households, the major factors were ownership of sources of water and the attitudes of the people to determine the capacity to adapt to climatic change. Financial assets, ownership of sources of water were the major factors for larger households according to the majority of the respondents.

Table 119. Distribution of farmer categories (%) by factors determining the capacity of households to adapt to climatic changes at Mahagalwewa.

	Factors determining the capacity to adapt to climatic change						
Farmer category	Financial assets	Ownership of sources of water	Good health	Occupation	Water storage capability	Attitudes	Age
Marginal households (0-1 ha) (n=14)	0	29	0	7	0	0	0
Small households (1-2 ha) (n=4)	0	50	0	25	0	0	0
Medium households (2-4 ha) (n=12)	8	17	0	8	0	17	0
Large households (>4 ha) (n=20)	10	10	5	0	5	0	5

Institutional Capacities

Government institutions were the main institutions approached by the marginal, medium and larger households in the event of a drought (Table 120). Most of the farmers in the small household category said that the political affiliations, kinship and relatives are the major institutions approached by them.

Table 120. Frequency distribution of respondents among farmer categories that can be approached in the event of a drought at Mahagalwewa.

Scale of preference	Marginal households (>1)	Small households (1-2 ha) (n=17)	Medium households (2-4 ha) (n=27)	Large households (2-4 ha) (n=16)
1	Governmental organizations	Governmental organizations	Governmental organizations	Governmental organizations
2	Kinship and relatives	Kinship and relatives	Non-governmental organizations	Kinship and relatives
3	Non-governmental organizations	Villagers	Kinship and relatives	Non-governmental organizations
4	Villagers	Non-governmental organizations	Political affiliations	One person
5	One person	Political affiliations	Villagers	Villagers
6	Political affiliations	School	One person	Private organization
7	Private Organization	One person	Private organization	Political affiliations

5.4 Adaptation strategies in Bata-Atha village in Hambantota District

At farm and technological levels, farmers have not practiced any adaptation strategies to climatic changes. At interventions level, providing subsidies during peak requirement was the main adaptations strategy while development of kinship ties was the main strategy at the social level (Table 121).

Table 121. Adaptation strategies practiced at different levels of intervention at Bata-Atha.

Intervention level	Adaptation strategy
Farm level	They did not get any adaptation for the crop cultivations
Institution level	Providing subsidies during peak requirements
Technological level	They did not resort to any adaptation for the use of technology
Social level	Development of kinship ties

Major coping mechanisms undertaken by marginal householders were the diversification of means of livelihoods followed by reduced consumptions and expenditure and digging of deeper wells. According to the majority of the respondents in the small households category, improvement of access to water availability through watersheds, digging of deeper wells, reduced consumptions and expenditure and diversifications of means of livelihoods were the major coping mechanisms (Table 122).

Table 122. Coping mechanisms undertaken by farmers ranked according to the scale of preference among farmer categories at Bata-Atha.

Scale of preference	Marginal households (0-1 ha)	Small households (1-2 ha)
1	Diversification of means of livelihoods	Improvement of access to water availability through watersheds/ Digging of deeper wells
2	Reduced consumption expenditure	Reduced consumption expenditure
3	Improvement of access to water resources availability through watersheds/ Digging of deeper wells	Diversification of means of livelihoods
4	Buying foods	Selling of assets
5	Selling of assets	Buying foods
6	Mobilization and use of collected resources that are held collective	Migration
7	Migration	Obtain loans
8	Obtain loans	Mobilization and use of collected resources that are held collective

Scale of ranking: 1=most preferred, 8=least preferred

Annex 1

List of Participants

SLCARP - ICRISAT Stakeholder Consultation and Policy Dialogue
on
Vulnerability to Climate Change: Adaptation Strategies and Layers of Resilience

held at *"The Sovereign", Colombo, Sri Lanka, 5 April 2011*

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Continued

Annex-1 *continued*

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Continued

Annex-1 *continued*

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Sri Lanka Council for Agricultural Research Policy

Sri Lanka Council for Agricultural Research Policy (SLCARP) is an umbrella organization of the National Agricultural Research System (NARS) that operates within the Ministry of Agriculture. SLCARP came into existence on 22 December 1987 to create an environment for more productive agricultural research.

With the Secretariat in Colombo, SLCARP serves as an organization in an advisory capacity for co-ordinating and consolidating research efforts within Sri Lankan NARS, funding research projects/ programs and promoting scientific research linkages in prioritized areas both nationally and internationally. SLCARP has been instrumental in promoting and facilitating research by improving and enhancing agricultural research through documentation and communicating latest advances in research to the NARS scientists. SLCARP has identified its own perspective, plans and programs for the future in keeping with the aspirations and National goals proclaimed in Mahinda Chinthana to meet the future challenges in enhancing food security and poverty reduction.

Vision

A vibrant and sustainable agricultural research, development and innovation system assuring socio-economic development of Sri Lanka

Mission

To ensure agricultural research, development and innovations are directed towards national development goals through policy formulation, facilitation, coordination, monitoring and evaluation and impact assessment

About ICRISAT

International Crops Research Institute for the Semi-Arid Tropics

ICRISAT is a member of the CGIAR Consortium

The **International Crops Research Institute for the Semi-Arid Tropics** (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in Asia and sub-Saharan Africa with a wide array of partners throughout the world. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid tropics have over 2 billion people, of whom 644 million are the poorest of the poor. ICRISAT innovations help the dryland poor move from poverty to prosperity by harnessing markets while managing risks – a strategy called Inclusive Market-Oriented Development (IMOD).

ICRISAT is headquartered in Patancheru, Telangana, India, with two regional hubs and six country offices in sub-Saharan Africa. It is a member of the CGIAR Consortium. CGIAR is a global research partnership for a food secure future.

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