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Are Homegarden Ecosystems Resilient to Climatic Change? An Analysis of Adaptation Strategies of Homegardeners in Sri Lanka

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ABSTRACT: Homegarden ecosystems are considered to be resilient to climate change partly due to the use of efficient and effective adaptation strategies by the homegardeners. This study documents the strategies adopted by homegardeners in Sri Lanka and investigates the determinants of the choice of such strategies. Data gathered from household surveys conducted in three selected locations were analyzed to achieve the study objectives. About 52% of the homegardeners in all locations were found to be small-scale farmers (<0.5 ha) engaged in semi-subsistence farming over a long period of time. The majority (85%) of them were educated up to the primary (elementary) level. Among the homegardeners, more than 63% in Keeriyagaswewa, 54% in Pethiyagoda and 90% in Siwalakulama have not made any significant changes to the plant, tree and animal composition of homegardens over the past 20 years. A number of adaptation strategies have been used by the homegardeners enabling them to maintain diversity in the homegarden ecosystem. Changes in planting dates (37%), agronomic practices (39%), use of soil and water conservation measures (41%) and technology (55%) such as the use of new varieties and irrigation equipment, were the most commonly-used adaptation strategies. A considerable variation in the type of adaptation strategies across the households was noted. The results of the probit analysis indicate that the type of employment, age, sex, education level of household head, experience in farming, homegarden size, diversity of homegarden measured by the Shannon Weiner Index (SWI) and perceptions towards climate change, significantly influence the decision to adopt a given strategy. The development programmes to promote adaptation to climate change in homegardens should hence be designed taking the above determinants into consideration.

KEYWORDS: *Homegardens, climate change resilience, adaptation strategies*

Introduction

A "homegarden" is a complex sustainable land use system that combines multiple farming components, such as annual and perennial crops, livestock and occasionally fish, of the homestead and provides environmental services, household needs, and employment and income generation opportunities to the households. Homegardens are considered to be well-adapted agroforestry systems in Sri Lanka that cover about 14% of the total land area of the country, and are known to be dynamic and responsive to the changes occurring in their socio-economic and bio-physical environments. In particular, those homegardens characterized by high species diversity are viewed as being resilient to climate change. Climatic changes are predicted to have adverse effects on food production, to varying degrees, in different ecosystems. One of the reasons attributed to such resilience is the adaptation of coping strategies (Rao *et al.,* 2007; Nhemachena and Hassan, 2007). Despite the above claims, there is a dearth of studies, especially in Sri Lanka, quantifying the extent to which homegardens are resilient to climate change.

The objectives of the present study were to investigate (i) the strategies adapted in homegardens, and (ii) the determinants for the choice of such strategies.

Methodology

Site Selection

Sites for the study were selected based on the characteristics of homegardens (i.e. at least 20 years old, presence of tree crops and annual crops, preferably the presence of domesticated animals, having at least a 3-tiered vertical plant structure), access to homegardens, and availability of climate data from the Department of Meteorology, Sri Lanka. The sites were also selected based on the agro-ecological regions and their sensitivity to changes in climate. Further, uninterrupted nature of the homegardens due to other activities such as access roads, construction/establishment of irrigation reservoirs/schemes were also considered. Accordingly, Keeriyagasweva Village (low country dry zone; n=59), Pethiyagoda Village (mid country wet zone, n=59) and Siwalakulama Village (low country dry zone, n=30) were selected as the sites for the study.

Data Collection

Household surveys were carried out from May to December 2010 in the three selected sites of Sri Lanka. A structured questionnaire was used to obtain the information on general household characteristics, structure and composition of the homegarden, changes made during the past 20 years, perception on temperature and rainfall changes, and information on adaptation strategies. Rainfall and temperature data for the period 1960–2009 were obtained from the Department of Meteorology, Sri Lanka.

Data Analysis

The Shannon-Wiener Index (SWI) was used to measure the diversity of homegardens. Frequency tables and cross tabulations were used to assess the type of adaptation strategies used by homegardeners and a probit model was used to analyze factors that influence decisions to adapt to climate changes following Deressa *et al.* (2010). The dependent variable was treated as one (1) if a certain farmer adopted the strategy and zero (0) otherwise. The independent variables included: SWI, number of individuals employed in farming/off-farming, education level of the household-head (variable=1 for primary, =0 otherwise), household size, sex of the household-head (variable=1 for male, =0 for female), age of the household head (number of years), homegarden size, experience in agriculture, perceived change in temperature (variable=1 for perceived change, =0 otherwise), perceived change in rainfall (variable=1 for perceived change, =0 otherwise) and ownership of animals (variable=1 for owned livestock, =0 otherwise). The variability of rainfall and temperatures were calculated to identify the nature of climate change.

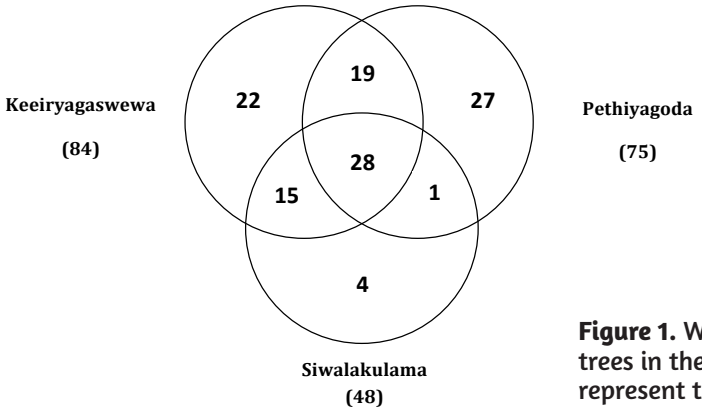


Figure 1. Woody and naturally grown trees in the three study sites (values represent the number of species)

Results of the Analysis and Discussion

General characteristics of the study sites

The analysis of the composition and structure of homegardens revealed that the number of tree species identified in three sites was 116, of which food and timber trees were prominent (Figure 1; Table 1); 28 species were common to all three study sites. Among the domesticated animal species, three livestock species (cattle, goat and buffalo) and poultry were found in homegardens in the two Dry zone sites while no animals were recorded in the Wet zone site at Pethiyagoda (Table 1). The majority of homegardeners, i.e. over 63% in Keeriyagasweva, 54% in Pethiyagoda and 90% in Siwalakulama, indicated that no substantial changes were made to the plant, tree and animal composition of their respective homegardens over the past two decades.

The results of the analysis of household characteristics revealed that the heads of the households were farmers who were educated up to primary level and between 54 and

Table 1. Structure and Composition of Homegardens in Selected villages
Data presented as Mean (range).
* Mean values of the most commonly occurring three species;
KW – Keeriyagasweva Village; PG – Pethiyagoda Village; SK – Siwalakulama Village

Attribute			KW	PG	SK
Number of Homegardens surveyed			59	59	30
Mean Shannon Weiner Index (SWI)			2.133	1.987	1.775
Food Trees	Number of species#		6.43 (5–11)	5.03 (3–8)	4.73 (4–8)
	Number of Trees*				
		Cocos nucifera	4.69	3.62	7.45
		Mangifera indica	3.52	1.46	3.00
		Artocarpus heterophyllus	1.64	2.60	2.42
Timber Trees	Number of species#		3.18 (2–5)	1.98 (0–3)	2.16 (1–2)
	Number of trees*				
		Azadirachta indica	7.40	1.67	4.29
		Tectona grandis	4.10	2.00	3.10
		Berrya cordifolia	5.12	2.60	1.00
Livestock and Poultry	Number of species#		1 (1)	0 (0)	1 (1–2)
	Number of animals*				
		Cattle	8.14	0	3.71
		Poultry	9.0	0	10.0
		Goat	4.0	0	0

58 years of age on average (Table 2). About 52% of the homegardens surveyed, i.e. 46% in Keeriyagasweva, 88% in Pethiyagoda and 23% in Siwalakulama, were less than 0.5 ha. The analysis of climate data indicated that the three sites have experienced increased variability of seasonal rains resulting in more consecutive numbers of dry days with intense droughts and floods. The temperature regime showed an increasing trend in both minimum and maximum temperature (data not presented).

Use of adaptation strategies

The types of adaptation strategies used by the homegardeners in the three locations include changes in planting dates, agronomic practices and technology such as the use of new varieties and irrigation equipment, and use of soil and water conservation measures (Figure 2). Changing technology was the most commonly adapted strategy. During the past 20 years, about 55% of dwellers have changed the technology adopted: 41% have used soils and water conservation measures, while 39% changed their agronomic practices and 37% changed the planting dates of their homegarden crops.

There were differences in the choice of adaptive strategy across sites. In Keeriyagasweva, more than 80% of homegardeners changed planting dates over the past 20 years, while in Siwalakulama, which is also located in the same agro-ecological zone, less than 20% of homegardeners adopted this practice. In both Siwalakulama and Keeriyagasweva, a higher number of dwellers changed their planting dates compared with other adaptive strategies. In Pethiyagoda, soil and water conservation methods were popular compared to other sites and other strategies, where nearly 60% of homegardeners employed soil and water conservation practices in their homegardens.

Determinants of use of adaptation strategies

The results of the probit analysis for surveyed homegardens in the three locations

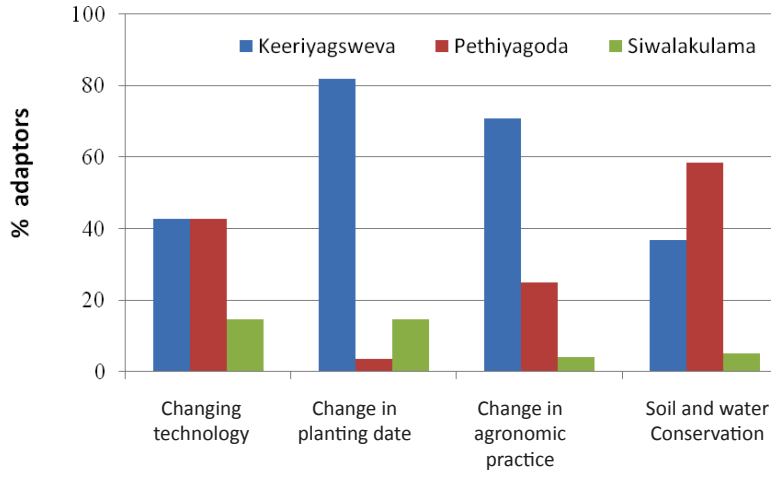
Table 2. Socio-Economic Characteristics of Homegardeners
KW – Keeriyagasweva Village; PG – Pethiyagoda Village; SK – Siwalakulama Village

Attribute		KW	PG	SK
Size of the household	Average	4	4	4
	Range	1–8	1–7	1–5
Age of the household head	Average	55	54	58
	Range	30–83	26–78	30–86
Sex of the household head (% in each category)	Male	86	81	80
	Female	14	19	20
Education level of the household head (% in each category)	No schooling	5.1	1.7	1.3
	Up to primary	84.7	86.4	83.3
	Secondary & above	10.2	11.9	13.3
Occupation of the household head (% in each category)	Housework	0	8	3.3
	Farming	78	28	93.3
	Other	15	50	3.3
	No response	7	14	0
Size of the homegarden (ha)	Average	0.33	0.17	0.4
	Range	0.1–0.6	0.1–0.81	0.04–1.2

Variable	Dependent Variables (Adopted=1; Not adopted=0)				
	Changing planting date	Changing technology	Changing agronomic practice	Soil and water conservation	Any change
Household size		0.12	0.04		-0.05
Employment: Farming=1	0.32**			0.21**	
Employment: Off-farming=1	-0.31**				
Education of the household head	-0.05		-0.93**		-0.61
Shannon Weiner Index (SWI)	0.87**	-0.05		0.23	
Sex of the household head; Male=1		-1.13**	0.39		1.44***
Age of the household head	-0.02**	-0.01	0.001	0.003	0.03**
Experiences in agriculture			0.001		0.02*
Homegarden size	0.42	-0.08	0.82**	-0.30	0.49
Perceived a change in rainfall			-0.64*		-0.36
Perceived a change in temperature		0.72**	0.18	0.38*	0.95**
Ownership of livestock	0.29	-0.01	0.14	0.17	0.18
Natural rate (Constant)	-1.48*	0.84		-1.11*	
Observations	143	143	124	143	124
Pseudo R^2	0.24	0.12	0.13	0.07	0.29

Table 3. Results of the Probit Analysis
*, **, *** statistically significant at the p=0.1, 0.05 and 0.001, respectively

Figure 2. Adaptation strategies reported in the three selected study sites



in Sri Lanka indicated that the number of members in farming and off-farm employment, SWI, as well as age, gender and education level of the household head significantly influenced decision-making on adaptation strategies. It was evident that adaptation has also been influenced by temperature and rainfall change over the past 20 years as perceived by the homegardeners. Interestingly, the specifications that included sites as explanatory variables did not provide satisfactory results indicating that site specific factors do not significantly influence the decision to adopt a strategy (Table 3).

Conclusions

Four main adaptation strategies identified were (i) change in technology; (ii) change in planting date; (iii) change in agronomic practice; and (iv) adopting soil and water conservation strategies. Change

in technology was the adaptive strategy most adopted and change in agronomic practices was the least adopted. The decision to adopt new adaptation strategies is significantly influenced by employment; diversity of the homegarden; age, gender, and education level of the household head; awareness of climate change; and homegarden size. Development programmes to promote adaptation to climate change should, therefore, be designed taking the reported determinants into consideration.

RESEARCH HIGHLIGHTS

- Despite the fact that there is evidence that climate change has taken place in the past 20 years, the composition of homegardens in Sri Lanka has not changed substantially. Strategies adapted by homegardeners over the past 2 decades have enabled them to cope with changes in climate.
- Socio-demographic factors of homegardeners and their perception towards climate determine the type of adaptation strategy adopted.
- Homegardeners who have perceived climate change are more prone to adapt to changes using different techniques and technologies.

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