Available online at www.sciencedirect.com

ScienceDirect

Procedia Food Science 6 (2016) 288 – 292

Procedia Food Science

International Conference of Sabaragamuwa University of Sri Lanka 2015 (ICSUSL 2015)

Adaptation to climate change by smallholder farmers in rural communities: Evidence from Sri Lanka

L.M.C.S.Menike[a], K.A.G.P. Keeragala Arachchi[b]

[a]*Senior Lecturer, Department of Accountancy & Finance, Sabaragamuwa University of Sri Lanka, P.O. Box 02, Belihuloya, Sri Lanka*
[b]*Department of Natural Resources, Sabaragamuwa University of Sri Lanka, P.B. Box 02, Belihuloya, Sri Lanka*

Abstract

The agricultural sector plays a key role in Sri Lankan economy, whose major source of livelihoods is smallholder farming in paddy and vegetable cultivation which is highly vulnerable to climate changes having negative impact on food security. To overcome the welfare losses, the smallholder farmers need to identify the changes in climatic variables and adjust to their farming practices to cope up with the climate change. Thus, this study examines how rural smallholder farmers in different agro-ecological zones in Sri Lanka perceive climate change and accordingly adapt to it in their agricultural practices. A questionnaire survey was conducted with a random sample of 125 farmer households distributed in most vulnerable four agro-ecological zones namely, Belihuloya, Ihala Galagama, Mulgama and Kosgama in up country inter mediate zone. The study shows that all the respondents have observed rising trends in temperature and winds and lack of adequate rainfall during last twenty years and in response they have grown short season crops as the main farming practice to adapt to minimize the potential losses on their yields. The results of the logistic regression revealed that social economic factors, environmental factors, institutional factors and the economic structure influence farmers' choice of adaptation methods to climate change. The size of the household, income, education, accessibility to climate information through television and radio, being a member in farmers' group, location of the land, crop variety, access to formal loans and distance to input markets had significantly affected adaptation. For instance the farmers who grow beans as the major crop to adapt to climate change has 94% probability with compared to those farmers who do not grow other crops whereas the farmers who come to know the changing patterns of the climate through television and radio have a higher probability (94%) of adaptation to the climate change than those who use other media. Sri Lankan government requires facilitating the smallholder farmers to overcome the constraints in which they face in using adaptation methods to climate change so that the welfare of the farmers and growth of the agricultural sector can be ensured.

Peer-review under responsibility of International Conference of Sabaragamuwa University of Sri Lanka 2015 (ICSUSL 2015).

Peer-review under responsibility of International Conference of Sabaragamuwa University of Sri Lanka 2015 (ICSUSL 2015).
doi:10.1016/j.profoo.2016.02.057

Keywords: Adaptation methods; climate change; logistic regression;smallholder farmers;Sri Lanka

1. Introduction

Climate change is one of the crucial factors which threaten the agricultural sector for decades and the sector is more sensitive to climatic conditions. The agricultural sector contributes 10.9% to the GDP and 31% of the population is employed and remained as the main source of livelihood for rural communities in Sri Lanka. The majority of the population (77.4%) lives in rural sector where farming is extensively practised. Sri Lanka, a tropical nation, is highly vulnerable to impacts of climate change and the climate of Sri Lanka is undergoing three major types of changes, gradual increase in air temperature, changes in pattern of rainfall and increase in frequency and severity of extreme weather events such as floods, droughts and winds. The impact of climate change on agriculture production differs from one country to another and several studies confirm that climate changes negatively impact on agriculture [1&2]. The rural level smallholder farmers are severely influenced by climate change as they have the low adaptive capacity to climatic change.

Adaptation to particular climate changes seem to be the most appropriate and responsive way for farmers to lower the negative impacts of climate change as it is the mean of transmitting the outcome of the farmers perception on climate change[3]. In Sri Lanka, some scholars point out that adverse impact of climate change on agricultural production could be minimized by applying suitable adaptation strategies such as introduction of micro irrigation, changing planting dates, reduction of irrigation depth and crop diversification[4]. Few studies propose that changing planting time to suit rainfall variability[6] and introduction of micro irrigation[5] are the best adaptive methods to minimize the negative impact of climate change.

The agricultural measures such as the use of improved crop varieties, planting trees, soil conservation, changing planting dates, and irrigation are the most widely used adaptation strategies whereas several socio-economic, environmental and institutional factors and the economic structure are key drivers influencing farmers to choose specific adaptation methods[7]. However, in Sri Lanka, such studies in different ecological zones are lacking and need a rise to recognize the capacity and drivers of adaptation to climate change predominantly amongst smallholder farmers in rural community in Sri Lanka in order to implement appropriate policy measures to strengthen the accessibility of the different adaptation methods. Thus, this study will address to the research question "How do smallholder farmers in Sri Lanka perceive climate change and adjust their farming practices to cope with the changes in climate?"

2. Methodology

2.1 Materials and Methods

A cross sectional household survey was carried out using a semi structured questionnaire and face-to-face interviews. The questionnaire consists of five parts one each for demographic characteristics, environmental factors, institutional factors, and the economic structure and methods of adaptation to climate change and constraints for implementing any adaptations strategies by smallholder farmers. Most prominently, the farmers were asked to compare the climate conditions of past twenty years with respect to mean and variance precipitation and temperature. If they had observed changes they were later inquired with reference to ways in which they had taken actions to the perceived climate changes. The questionnaire was pre-tested with ten farmers in Belihuloya and Mulgama agro-ecological zones.

From the up-country inter mediate zone, four agro-ecological zones were selected namely, Belihuloya and Ihala Galagama from Imbulpe Divisional Secretariats, Mulgama, from Balangoda Divisional Secretariats and Kosgama from Haldulmulla Divisional Secretariats. The study first adopted the stratified sampling technique based on agro-ecological zones and selected four zones. Next, the sample was randomly drawn from the selected agro-ecological zones. The number of farmers interviewed was 50 out of 116 from Kosgama, 18 out of 60 from Mulgama, 26 out of 78 from Ihala Galagama and 31 out of 82 from Belihuloya.

Thus, a total of 125 respondents were selected randomly and questionnaires were administered. Interviews for the selected respondents were conducted individually in their homes or their cultivated lands based on the availability of the head of the household in April 2015. The respondents interviewed include male, female, elderly and young farmers.

The selection of the variables were guided by the relevant literature and a set of variables were selected which might have an impact on undertaking a method of adaptation to climate change and the use of specific adaptation methods to climate change. These include socio-economic factors, environmental factors, institutional factors, and the economic structure.

2.2 Binary Logistic Models: Farmers' decision to undertake any adaptation at all

In order to identify whether or not an adaptation method is undertaken in responsive to perceived climate change among other factors. A logistic regression model is used where the binary dependent variable is a dummy for undertaking any adaptation at all (Where, Yi has only two possible values, 1 or 0, for either adapting or not adapting to climate change). The independent variables took the form of both categorical and continuous.

3 Analysis and Discussions

3.1 Farmers' Perceptions about Changes in Climatic Variables

Almost all the respondents interviewed had observed a change in the climate in the last 20 years and they were in the opinion of increasing temperature and winds and declining precipitation over the past 20 years. Extreme climatic events like floods, drought/prolonged dry seasons, and winds were accounted to have increased in the last 20 years. Perception to climate change was indeed influenced by the agro-ecological zone and farmers in the hilly and windy areas perceive more changes in climate variables than those in other areas. For those farmers undertaking adaptation, the leading methods were planting short season crops (87%), planting crops resistant to drought (7%), changing planting dates (3%) and planting trees (3%).

3.2 Factors affecting farmers' strategies to cope with climate change

Table 1 reports the results of the fitted logit model estimating the probability of a particular farmer undertaking adaptation to climate change in Sri Lanka. The results of the logit model suggest that the probability (29%) of a typical farmer adapting to climate change decreases when the size of the household is three or below. The larger size household offers more technical and manual skills for adapting to climate change.

The farmers whose annual income falls below RS.360,000 have higher probabilities to undertake adaptation to climate change. This contradictory results may be due to the fact that the farmers who earn higher income have generally own large size of lands and cannot be managed their cultivation with the variability of weather conditions to cope up with climate change. The results also reveal that farmers who come to know the changing patterns of the climate through television and radio have a higher probability of adaptation to the climate change. Higher educated framers who know well about climate changes are more likely to adapt to climate change. The probability of farmers who grow beans as the major crop to adapt to climate change is 94% higher than those who do not grow other crops. Farmers located in the alluvial plains and hilly agro-ecological zones tend to do high adaptation as compared to those located in windy and river side agro-ecological zones. The social capital or being a member in a farmers' society is also important in choosing certain adaptation methods and the probability of adapting to climate change is 62%. The farmers who can access to formal loans tend to adapt to climate change with a high probability of 57%. The distance to input market is an influencing factor of choosing the mean of appropriate adaption to climate change and farmers who can easily access to input markets within 10 km have a higher probability of 74% to undertake adaptation.

The results also reveal that almost all farmers in the sample perceive that climate changes are occurring in these areas and they are more likely to voluntarily adopt particular adaptation methods, and the socio economic, environmental, institutional and economic conditions influencing their adoption of particular adaptation methods. However, the results show that undertaking some adaptation to climate change in the right direction by farmers in Sri Lanka is hindered by some constraints namely, lack of appropriate seeds, poor planning, shortage of funds and inadequate irrigation facilities.

Table 1: *Parameter Estimates, Standard Errors, P Values, Exp(B), Probability with logistic regression model for the Factors affecting farmers' strategies to cope with climate change*

Variable	Model Parameter	P Value	Exp(β)	Probability	Reference Category
	$Logit(P_i)= \beta_0 + \beta_1^{<3}{}_{Members} + \beta_2^{4\text{-}6}{}_{Members} + \beta_3^{7\text{-}9}{}_{Members}$				
Family Members	β_0 = 0.838	.364	.180		≥ 10 Members
	$\beta_1^{<3}$ = -1.716	.056	2.034	29	
	$\beta_2^{4\text{-}6}$ = 0.710	.440	1.051	82	
	$\beta_3^{7\text{-}9}$ = 0.049	.952	2.311	71	
	$Logit(P_i)= \beta_0 + \beta_1^{Rs.60000\text{-}120000} + \beta_2^{Rs.120000\text{-}240000} + \beta_3^{Rs.240000\text{-}360000}$				
Income	β_0 = -1.707	.112	.181		> Rs.360,000 Income
	$\beta_1^{<3}$ =2.127	.051	8.393	60	
	$\beta_2^{4\text{-}6}$ =2.601	.017	13.481	71	
	$\beta_3^{7\text{-}9}$ =2.554	.046	12.863	70	
	$Logit(P_i)= \beta_0 + \beta_1^{Televison} + \beta_2^{Radio} + \beta_3^{Newspapers}$				
Media	β_0 =.796	.312	1.257		Other Media
	β_1^{TV} =2.544	.039	2.216	74	
	β_2^{Radio} =-.047	.016	12.727	94	
	$\beta_3^{Newspapers}$ =.229	.943	.955	54	
	$Logit(P_i)= \beta_0 + \beta_1^{Paddy} + \beta_2^{Beans} + \beta_3^{Tomato}$				
Crop	β_0 = .529	0.242	1.698		Other Crops
	β_1^{Paddy} =-.141	.773	.869	60	
	β_2^{Beans} =2.246	.036	9.454	94	
	$\beta_3^{Tomato=}$ 1.358	.239	3.887	87	
	$Logit(P_i)= \beta_0 + \beta_1^{Group\ member}$				
Group Member	$\beta_1^{Group\ member}$ =.762	.100	.467	63	No
	$Logit(P_i)= \beta_0 + \beta_1^{<10km}$				
Distance to Input Acquire	β_0 =.394	.101	1.483		≥ 10 Km
	$\beta_1^{<10km}$ =.475	.156	1.608	70	
	$Logit(P_i)= \beta_0 + \beta_1^{Hill\ areas} + \beta_2^{Plains} + \beta_3^{Windy}$				
Location	β_0 = -.444	.341	.642		River Side Lands
	$\beta_1^{Hill\ areas}$=1.504	.003	4.499	74	
	β_2^{Plains}=.866	.093	2.379	60	
	β_3^{Windy} = .325	.490	1.384	47	
	$Logit(P_i)= \beta_0 + \beta_1^{Loan\ access}$				
Loan Access	β_0 = 1.564	.000	4.478		No
	$\beta_1^{Loan\ access}$ =1.265	.002	.282	57	
	$Logit(P_i)= \beta_0 + \beta_{1Primary} + \beta_2\ O/L + \beta_3\ A/L$				
Education	β_0 = 1.186	.009	3.275		Graduate
	$\beta_1^{Primary}$ =-1.132	.064	.322	51	
	$\beta_2^{O/L}$ =-.441	.404	.643	68	
	$\beta_3^{A/L}$ =- .551	.270	.577	65	

4 Conclusion

The study shows that smallholder farmers in rural community in Sri Lanka seem to be producing perceptions about climate change which are consistent with reality and they tend to take up adaptation strategies to cope up with climate change. The famer's decision to undertake any adaptation to climate change imply that the probability of undertaking any adaptation increases with the size of the family, higher educated farmers, being a member in a farmers' group, access to formal loans, less distance to input market, access to information through electronic media and growing beans as the main crop. The results further suggest that the probability of undertaking adaptation to climate change falls low in the farmers group whose annual farm income is more than RS. 360,000. However, farmers located in the alluvial plains and hilly arrears seem to do most adaptation. Farmers expressed short-season crops, crops which are resistant to drought, irrigation, changing planting dates and planting trees as the means they have employed to cope with the climate change. The smallholder farmers have a high responsiveness of changes in rainfall, temperature and wind and have taken appropriate measures to cope with impacts of a changing climate.

Policy Implications

The government should reform environmental, institutional and economic conditions to promote particular adaptation methods which are the most appropriate for particular circumstances by assisting the farmers to overcome the inherent barriers such as shortage of water, funds, seeds, and poor planning as observed by them in choosing particular adaptation practices.

References

1.Chandrasiri WACK. Farmers' perception and adaptation to climate change: A case study in vulnerable areas in Kurunagala District. *Annals of Sri Lanka Department of Agriculture* 2013; **15**: 13-23.
2.Hassan R, Nhemachena C. Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis. *African Journal of Agricultural and Resource Economics*. 2008; **2**: 83 —104.
3.Füssel HM, Klein RJT. Climate change vulnerability assessments: An evolution of conceptual thinking. *Climate Change*. 2006;**75**: 301-329.
4.Esham M, Garforth C. Agricultural adaptation to climate change: insights from a farming community in Sri Lanka.*Mitigation and Adaptation Strategies for Global Change*. 2013;**18(5):** 535-549.
5.Aheeyar MMM, Kumara SK, Samarasinha GGDe LW. The application of micro irrigation technologies in the small farming sector Sri Lanka. HARTI 2005; Colombo. Sri Lanka.
6.De Silva CS, Weatherhead EK, Knox JW, Rodriguez Diaz JA. Predicting the impacts of climate change- A case study of paddy irrigation water requirements in Sri Lanka. *Agricultural Water Management*.2007; **93**: 19-29. DOI:http://dx.doi.org./10.1016/j.agwat/2007.06.003.
7.Bryan E, Deressa TT, Gbetibouo GA, Ringler C. Adaptation to climate change in Ethiopia and South Africa: Options and constraints. *Environmental Science and Policy* 2013; **12**: 413-426.