ADAPTATION STRATEGIES TO DROUGHT AMONG SMALLHOLDER FARMERS IN SOUTHERN LEYTE, PHILIPPINES

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Abstract

Small-scale farmers faced numerous risks related to the adverse impact of climate change, particularly prolonged periods of drought. Although farmers use various risk-coping strategies, these are insufficient to prevent them from remaining food insecure. This study aimed to identify the determinants of farmer's adaptation strategies to drought in selected municipalities of Southern Leyte, Philippines. Logistic regression analysis was employed to identify the determinants. The results show that participation in agricultural training, awareness of drought and total farm income have positive and significant relationships with adaptation strategies. The result of the logistic regression implies that when farmers are aware, well-trained and equipped, they are more inclined to employ adaptation strategies to drought. The result also indicates that farmers who have experienced and are knowledgeable about dry spells have more tendencies to adapt and adjust during the actual occurrence of drought. More effort may also be made to older farmers as they are less likely to employ adaptation strategies. In addition, information and training about using drought-tolerant crop varieties is of the feasible options to consider in responding to drought.

Key words*: *drought, adaptation strategies, extreme weather events, rural Philippines

INTRODUCTION

Climate change threatens agriculture production's stability and productivity. In many areas of the world climate change is expected to reduce productivity to even lower levels and make production more erratic [5, 6, 10]. Long-term changes in temperature and precipitation patterns are expected to shift production seasons, pest and disease patterns and modify the set of feasible crops affecting production, prices, incomes, and ultimately, livelihoods and lives [6].
Climate change impacts include increased incidence of floods and droughts, soil degradation, water shortages and possible increases in destructive pests and diseases [6]. The main goal of climate change adaptation is to reduce vulnerability to climate change [2]. Agriculture is one of the sectors greatly affected by climate change and extreme weather events. Agriculture plays a crucial role in economic, social, and cultural activities. Climate change is expected to profoundly modify conditions related to agricultural production [8]. Physical damages, crop loss and drop in productivity are some of the examples of direct and indirect effects of extreme weather events [1]. The capacity to adapt varies considerably among regions, countries, and socioeconomic groups. The most vulnerable regions and communities are highly exposed to hazardous climate change effects and have limited adaptive capacity.
Across the tropics, farmers already face numerous risks to agricultural production. Extreme weather events are expected to disproportionately affect the farmers and make their livelihoods even more precarious [8]. In the Philippines, smallholder farmers with low levels of technology, inadequate information and skills, poor infrastructure, weak institutions, inequitable empowerment and access to resources have limited the capacity to adapt. Farmers in the Philippines are under significant threat from climate

change, being situated in a naturally vulnerable location [4, 13, 19]. Farmers are frequently exposed to climate change hazards or extreme weather events like drought, which cause significant crop and income losses and exacerbating food insecurity issues. Few farmers have adjusted their farming strategies in response to climate change, owing to limited resources and capacity.

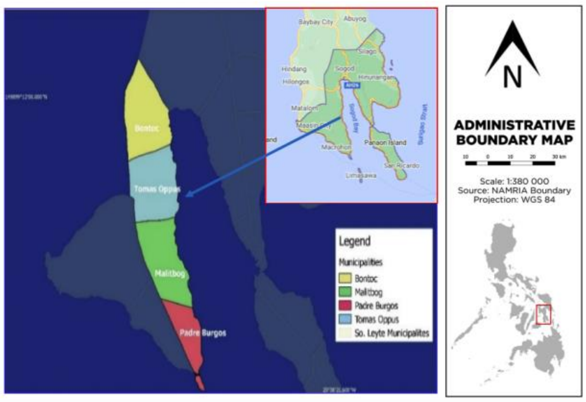
Adaptation and coping practices are necessary to reduce vulnerability to drought stresses and prepare for possible future extreme drought events. The reports of the Intergovernmental Panel on Climate Change (IPCC) define adaptation as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities [9, 10, 11]. Adaptation involves adjustments in reducing the vulnerability of households to climatic variability and change [23]. Smallholder farmers in the Philippines have long been exposed to climate variability. They have been implementing adjustments in farm management practices in response to climatic changes. One of the most commonly used adaptation techniques involves changes in the cropping patterns and cropping calendar, improved farm management, and utilization of climate-resilient crop varieties [7, 17, 18, 21].

Adaptation strategies are important to keep agricultural growth and resiliency. Growth in agriculture can be sustained through technological development [22] and adoption of climate smart practices [18]. In particular, adaptation strategies are needed to cope with the impact of extreme weather events such as drought [16]. Farmers are particularly vulnerable to drought because it could reduce their farm productivity and negatively affect their livelihood [12]. Farmers' adaptation strategies depend on several factors [3, 20, 24]. This study focuses on identifying the farmer's adaptation strategies, particularly to drought and investigate their determinants. Answers to these questions are essential to formulate tailored policy directions and programs that can contribute to farmers' resiliency and capacity to adapt to a changing climate.

MATERIALS AND METHODS

Study Site

The island of Leyte is divided into two provinces, namely, Leyte and Southern Leyte. The study sites are located in the municipalities of Southern Leyte, namely, Bontoc, Tomas Oppus, and Padre Burgos. All municipalities lie along the western side of Sogod Bay (Map 1).



Map 1. Map showing the study sites
Source: [15].

Sampling Procedure and Size of Sample

The sampling procedure used in the study is probabilistic in nature. The following formula was used to determine the sample size obtained using simple random sampling:

$$n_o = (Z^2_{\alpha/2})(\sigma^2)/(e^2) \qquad (1)$$

where n_o refers to the sample size to be determined, $Z_{\alpha/2}$ is the confidence interval, σ^2 is the population variance and e refers to the margin of error.

The study used a 99% confidence interval and 8% margin of error. The established Z-value for the 99% confidence interval is 2.585. Since there was no prior information with regards to the population variance (σ^2), it was estimated using proportion of 0.5. With these assumptions, the sample size (n_o) was determined as follows:

$$n_o = (Z^2_{\alpha/2})(p)(1-p)/(e^2)$$
$$n_o = (2.585^2)(0.5)(0.5)/(0.08^2) = 261$$

However, since the population of the study is finite, it was necessary to adjust the computed sample size. To adjust the computed sample size, the following formula was used:

$$n = n_o /[1+ n_o/N] \quad (2)$$

where: n is the adjusted sample size, n_o refers to the initial sample size computed using equation 1 and N is the population under study. The population in the study is the total number of farmers for each of the municipality under study. Using equation 2, the estimated sample size for the study area is computed as follows:

$$n = 261 /[1+ 261/4000] = 245$$

Based on the computation, a total of 245 respondents were randomly interviewed for this study.

Data analysis

There are four major factor groups that are hypothesized to affect farmers' decision to adapt to the various adaptation strategies to drought. These include the social, economic, physical and institutional/entitlement factor (Figure 1). The social factors include the individual characteristics of the household, such as household size, gender, age, educational attainment, and marital status. On the other hand, economic factors include income level, cost of production, occupation, social capital such as access to financial and credit assistance in the locality, and off-farm work. The physical factors such as farm area and number of parcels cultivated are also considered as contributing factors. Lastly, institutional factors like knowledge and information, innovation, organization, decision-making and governance were also included.

The logistic regression model was used to identify the factors that significantly affect farmers' adaptation strategies to drought.

The dependent variable indicates whether or not a household has adopted drought adaptation strategies.

A value of one was assigned to households adopting at least one adaptation strategy (adopter) and zero was assigned to households that did not practice adaptation strategies (non-adopter).

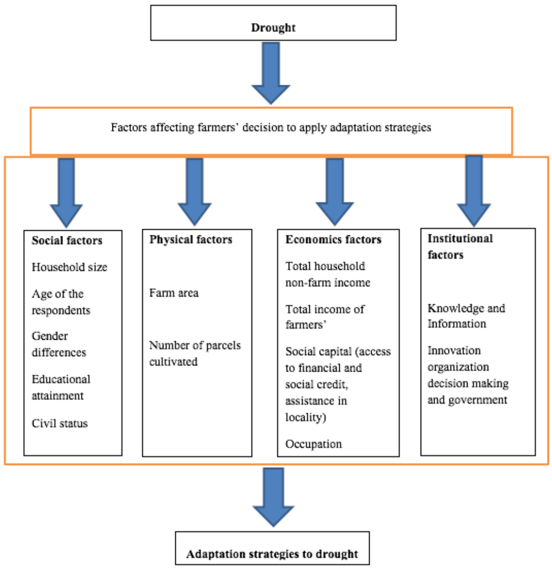


Fig. 1. Schematic diagram showing the factors affecting farmers' adaptation to drought.
Source: [14, 25].

The farmer's decision to adopt or not to adopt any adaptation strategies is influenced by social, physical, economic and institutional factors. The econometric model is postulated as follows:

$$\begin{aligned} drght\_adapt = {} & \beta_0 + \beta_1 age + \beta_2 married + \beta_3 male \\ & + \beta_4 education + \beta_5 frm\_inc + \beta_6 nonfrm\_inc \\ & + \beta_7 hhsize + \beta_8 othr\_occu + \beta_9 ten\_stat \\ & + \beta_{10} acredit + \beta_{11} notif + \beta_{12} farm\_expr \\ & + \beta_{13} crop\_subsidy + \beta_{14} crop\_insrnce \\ & + \beta_{15} totfarm\_area + \beta_{16} drghtaware \\ & + \beta_{17} training + \mu \end{aligned}$$

where:

drght_adapt = is a dummy variable, assigning a value of 1 for farmers who indicated that they had taken adaptation strategies in response to drought and a value of 0 if otherwise.
age = age of the respondents
married = 1 for married and 0 otherwise
male = 1 for male and 0 if female
education = actual years in formal schooling
frm_inc = total annual farm income of farmers
nonfrm_inc = total annual income of other occupation
hhsize = actual number of the household members
othr_occu = other occupation of the farmer respondents
ten_stat = dummy variable for tenure status, 1 if owner -operator and 0 if

otherwise

crd_access = dummy variable for access to credit, 1 if with access and 0 if otherwise

notif = dummy variable for notification on drought, 1 if notified, and 0 if otherwise

farm_expr = farming experience (years in farming)

cropsubsidy = dummy variable, 1 if with access to crop subsidy program and 0 if otherwise

cropinsrnce = dummy variable for the crop insurance, 1 if farmers have access and 0 if otherwise

totfarmarea = cultivated farm area (hectare)

drghtaware = dummy variable for awareness to drought, 1 if aware and 0 if otherwise

agri_train = number of agricultural training attended by farmers

μ = the usual remaining error term

RESULTS AND DISCUSSIONS

Distribution of Farmer Respondents by Adaptation Classification

In this study, a farmer is considered an adopter if the farmer employs at least one adaptation or coping strategy to abate the negative effects of drought. The non-adopter refers to farmers who have not taken adaptive measures in response to the negative effect of drought. Table 1 shows the distribution of farmer respondents who employed adaptation strategies to drought in the selected municipalities of Southern Leyte.

Table 1. Distribution of farmer respondents by adaptation classification in Southern Leyte

Municipality	Classification				Total	
	Non-adopter		Adopter			
	n	%	n	%	n	%
Bontoc	84	67.2	41	32.8	125	100
Tomas Oppus	58	66.7	29	33.3	87	100
Padre Burgos	24	72.3	9	27.3	33	100
Total	166	67.8	79	32.2	245	100

Source: Authors' own calculation and analysis (2021).

It can be noted that less than one-third (32.2%) of the total number of farmers interviewed were adopters of drought adaptation strategies while a bigger proportion (67.8%) were not. This proportion can be consistently observed in the three municipalities covered by the study (Table 1).

Socio-Demographic Profile of the Farmer Respondents

The socio-demographic characteristics of the farmers are presented in Table 2. Majority of the adopter and non-adopter farmers were male and married (87.8% and 81.2%, respectively).

Table 2. Socio-demographic characteristic of farmer respondents in Southern Leyte

Socio-Demographic Characteristics	Types of Respondent				Total	
	Adopter		Non- Adopter			
	n	%	n	%	n	%
Gender						
Male	73	92.4	142	85.7	215	87.8
Female	6	7.6	24	14.5	30	12.2
Total	79	100	166	100	245	100
Civil Status						
Married	67	84.8	132	79.5	199	81.2
Single	4	5.1	10	6.0	14	5.7
Widowed	5	6.3	19	11.4	24	9.8
Separated	1	0.6	0	0.0	1	0.4
Cohabitation	3	3.8	4	2.4	7	2.9
Total	79	100	166	100	245	100
Age						
21-40 years old	10	12.7	13	7.8	23	9.4
41- 60 years old	39	49.4	79	47.6	118	48.2
61-80 years old	30	38.0	72	43.4	102	41.6
80 Above	0	0.0	2	1.2	2	0.8
Total	166	100	79	100	245	100
Mean	55.49		57.75		57.02	
Educational Attainment						
No formal schooling	0	0.0	1	0.6	1	0.4
Elementary Level	13	16.5	33	19.9	46	18.8
Elementary Graduate	31	39.2	58	34.9	89	36.3
High school Level	13	16.5	13	7.8	26	10.6
High school Graduate	14	17.7	38	22.9	52	21.2
College Level	2	2.5	14	8.4	16	6.5
College Graduate	6	7.6	9	5.4	15	6.1
Total	79	100	166	100	245	100
Mean	7.57		7.72		7.67	
Household size						
1 to 3	22	27.8	56	33.7	78	31.8
4 to 6	42	53.2	81	48.8	123	50.2
7 to 9	11	13.9	25	15.1	36	14.7
10 to 13	4	5.1	4	2.4	8	3.3
Total	79	100	166	100	245	100
Mean	4.77		4.61		4.66	

Source: Authors' own calculation and analysis (2021).

The average age was about 57 years, with the adopters being slightly younger (55.49 years old) than the non-adopter (57.75 years old). The two farmer groups were similar in terms of number of years spent in school, which was about seven years or high school level. The biggest percentage of adopter and non-adopter farmers (39.2% and 34.9%, respectively) were elementary graduates. The two farmer groups were also similar in terms of average household size (5), with most households having 4- 6 members. Only a few of them (3.3%) have a relatively big household size of 10-13 members.

Farmer and Farm-Related Characteristics

The characteristics of the farm and the farmer respondents in Southern Leyte are presented in Table 3. The tenure status of the farmers shows that there were more tenant farmers (52.2%) than owner-cultivators (47.8%) in the study area. Among the adopter farmers, the proportion of tenants was higher (55.7%) compared to the non-adopter farmers (50.6%).

Table 3. Characteristics of smallholder farms in Southern Leyte, Philippines

Characteristics	Types of Respondents				Total	
	Adopter		Non-Adopter			
	N	%	n	%	n	%
Tenure Status						
Tenant	44	55.7	84	50.6	128	52.2
Owner-Cultivator	35	44.3	82	49.4	117	47.8
Total	79	100	166	100	245	100
Number of year in farming						
1 to 10 Years	30	38.0	36	21.7	66	26.6
11 to 20 Years	11	13.9	36	21.7	47	19.2
21 to 30 Years	12	15.2	27	16.3	39	15.9
31 to 40 Years	12	15.2	30	18.1	42	17.1
41 to 50 Years	10	12.7	22	13.3	32	13.1
51 Years	4	5.1	15	9.0	19	7.9
Total	79	100	166	100	245	100
Mean	22.36		27.57		25.89	
Total area Cultivated (hectares)						
Below 1 hectare	33	41.8	76	45.8	109	44.5
1 to 3 hectares	41	51.9	74	44.6	115	46.9
4 to 6 hectares	4	5.1	12	7.2	16	6.5
6 to 8 hectares	1	1.3	2	1.2	3	1.2
Above 9 hectares	0	0.0	2	1.2	2	0.8
Total	79	100	166	100	245	100
Mean	1.28		1.57		1.47	

Source: Authors' own calculation and analysis (2021).

In terms of years in farming, the adopter farmers appeared to have a longer farming experience of about 28 years compared to the non-adopter farmers with about 22 years. It was observed that many of the adopter farming (38%) had a relatively short farming experience at 1 to 10 years. The average area cultivated by the farmers was less than one and a half hectare (1.47 ha.). Very few farmers owned big farm area. The biggest farm area reported by the adopters was around 6-8 hectares, while for the non-adopters the biggest farm area was reported to be above 9 hectares. The non-adopter farmers had a bigger average farm area of 1.57 hectares compared to the adopters with an average farm area of 1.28 hectares (Table 3).

Adaptation Strategies to Drought

The occurrence of drought is detrimental to agricultural production. Every time drought occurs in Southern Leyte, smallholder farmers are the most vulnerable as since they have very low adaptive capacity. However, they can still minimize agricultural losses through localized adaptation strategies. Among the adaptation strategies reported by many farmers to lessen the negative effects of drought was to plant drought tolerant crops (35%). With this, they require less water than others once they are established. Some farmers (27.2%) also built/bought water impounding facilities (Table 4).

Water impounding facilities or small water impounding is a structure constructed across a narrow depression or valley to hold back water. It develops a reservoir that will store rainfall and run-off during the rainy season for immediate or future use.

Other farmer respondents (14.6%) availed of loan programs as one of their adaptation strategies. A loan program for the farmers provides access to credit and they can have additional resources in their production. A small proportion of farmer respondents (7.8%) availed of small-scale irrigation programs. Irrigation usually on small plots in which farmers have the controlling influence using a level of technology that they can operate and maintain effectively. On the other hand, about 6.8% of the farmer respondents availed themselves of crop insurance for protection against crop losses. For them, it is another adaptation strategy to recover their losses from extreme weather events such as drought. Other adaptation strategies like mulching, participating in training programs, cleaning the planted crops area, hiring a laborer to water the planted crops, buying a water pump, and watering the planted area were also practiced.

Table 4. Adaptation strategies to drought employed by farmer respondents

Adaptation Strategies	n	%
Planted drought tolerant crop	36	35.0
Built/bought water impounding facilities	28	27.2
Availed loan program	15	14.6
Availed small-scale irrigation program	8	7.8
Availed crop insurance	7	6.8
Availed weeding planted area	3	2.9
Mulching	1	1.0
Availed training program	1	1.0
Cleaning the planted crops area	1	1.0
Hired a laborer to water the crops	1	1.0
Bought water pump	1	1.0
Watering the planted	1	1.0

Source: Authors' own calculation and analysis (2021).

Determinants of Farmers' Adaptation Strategies to Drought

In identifying the determinants affecting the adoption of adaptation strategy during drought, logistic regression was employed (Table 5). Logistic regression is used to determine the relationship between the limited dependent or outcome variable and one or more categorical or continuous explanatory variables. The outcome variable is a binary variable with a value of 1 if the farmer is employing adaptation strategy and 0 if not.

Based on the results of the analysis, it was found out that farmers' attendance or participation in agricultural training, awareness of drought, and total farm income has a positive and significant relationship to adaptation. In contrast, total area cultivated and years in farming have a negative and significant relationship to adaptation strategies to drought.

The results imply that farmers who have participated in agricultural training are more likely to employ adaptation strategies than those who have not undergone agricultural training. The result validates the importance of training the farmers in order to improve their farming capabilities. Trainings regarding agriculture ensure that farmers are equipped with the relevant knowledge concerning farming. Those farmers who are aware of drought are more likely to employ adaptation strategies to drought than those who are not aware. This suggests that farmers who are knowledgeable about dry spells can adapt and adjust during the actual occurrence. This is due to the fact that prior knowledge allows the farmers to estimate possible effects and damages; therefore, they know what to do in times of drought.

As with income, the result implies that an increase in income is associated with an increase in the likelihood that farmers have adaptation strategies to drought. With an increase in income, the farmers will have higher adaptive capacity and mitigate the adverse effect of drought on production.

The association between years in farming and adaptation strategy to drought is negative. Farmers are relatively old and are not keen to pursue innovative approaches in farming. In terms of land area, the association with farm size and adaptation is not as expected because the coefficient is negative. This may indicate that farmers with bigger farms were less likely to employ adaptation strategies. Large farms require larger investment to implement adaptive strategies to drought. This maybe one of the reasons why farmers with bigger farm did not employ adaptive strategies.

Table 5. Logistic regression model

Variables	Coefficient	Std. Error
Age	-0.0019	0.0164
Married	0.5268	0.4659
Male	0.8808	0.5728
Education	-0.7969	0.0547
Farm income	0.000015***	0.000005
Non-farm income	0.0000004	0.0000003
Household size	0.3283	0.0826
Other Occupation	0.4383	0.6878
Tenure_ owner	-0.01024	0.3480
Access to credit	-0.2287	0.3711
Notification	-0.2989	0.5133
Years in farming	-0.0310***	0.0118
Crop Subsidy	0.3956	0.3660
Crop Insurance	-0.8560	0.9315
Total farm area	-0.1426*	0.0842
Awareness to drought	2.8047***	0.4816
Agriculture training	0.7970**	0.3659
Constant	-3.9892**	0.1612
Observations	245	

Note: LR $chi^2(17) = 81.41$; Prob > $chi^2 = 0.0000$; Pseudo R-square = 0.2643; ***significant at 1%, **significant at 5% , *significant at 10%.

Source: Authors' own calculation and analysis (2021).

CONCLUSIONS

The study aimed to analyze the adaptation strategies of farmers to drought in selected municipalities of Southern Leyte, Philippines. Specifically, it aimed to describe the socio-economic characteristics of the farmers in Southern Leyte; identify the farmer's adaptation strategies to drought; and identify the factors that influence farmer's decision to apply adaptation strategies to drought. Results showed that, among the 245 sample farmer respondents, only 79 farmers, or 32.2%, had employed an adaptation strategy to drought.

Among the adaptation strategies to abate the adverse effects of drought, many farmers (35%) planted drought-tolerant crops. Some farmers (27.2%) also built/bought water impounding facilities. Other farmer respondents (14.6%) availed of loan programs as one of their adaptation strategies. A small proportion of farmer respondents (7.8%) availed of small-scale irrigation programs. Irrigation usually on small plots in which farmers have the controlling influence using a level of technology that they can operate and maintain effectively. Moreover, about 6.8% of the farmer respondents availed themselves of crop insurance for protection against crop losses.

Results show that agricultural training programs provide opportunities for the smallholder farmers to develop their skills and acquire knowledge in dealing with climate change. However, this study found that only a little over half (55.9%) of the farmer respondents were involved in agricultural training programs. They have attended training programs 1 to 5 times. With this, agricultural training programs for the farmers concerning extreme weather events such as drought are essential to improve smallholder farmers' resiliency.

Organizations and local government units (LGUs) may consider disseminating information regarding climate change and its impacts so that farmers will be more aware and minimize the possible losses and impact of extreme weather events, especially drought. More effort may also be made to older farmers as they are less likely to employ adaptation strategies. Farmers will also need to be informed on adaptation strategies that are not too costly, like using drought-tolerant varieties. Results imply that the costs associated with employing adaptation strategies hinder many farmers from employing them.

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