CHAPTER 5

Farmers' Perception and Adaptation to Drought in Maize Production

This chapter mentions the awareness of farmer groups basing on their ability in defining drought, their memory about the last severe drought years, the experience in recognizing and coping with drought and farmer's expectation about the variability of this climate phenomenon. The perception levels of farmers on drought is presented in this chapter will show fully understanding of farmers about one of severe climate hazards in the study area. The chapter also focuses on illustration farmer practicing in maize production to cope with drought in the area. This is the main heading of the second content of the chapter. For the last content, it analyzes the factors impact on adaptation practices in maize production of household. The analyzed results will be the basis for giving the improvement solutions in maize production under impact of drought in the area.

5.1 Farmers' perception on drought

5.1.1 Farmers' perception on characteristics of drought

Perception on releasing the characteristics of drought will contribute to evaluate farmer's ability in defining this phenomenon. In this research, the ideas and knowledge of meteorological experts (through key informant interviews) and local people (group discussion) were encouraged to give accurate judgments about the characteristics of drought. According to farmers and key informants' opinion, the average daily temperature in drought years often fluctuated from 36^{o}C – 40^{o}C and it took place in a long time, this situation some years lasted during 2 months. Drought years rarely rained in the summer (one or two times from April to July with the rainfall was very limited). It was very hot and dry (low moisture).

From the illustrations as above, drought in the area was realized with 5 major characteristics, including: high temperature, shortage of rainfall, long dryness, strong sunshine and low moisture (Table 5.1).

The results indicated that, “high temperature” and “shortage of rainfall” were two most popular choice by farmers in the area, with around 67% and 50% in average for each choice, correspondingly. The characteristics of “long dryness” and “strong sunshine” were chosen by over 30% of the farmer. “Low moisture” was a characteristic that hard to observe, hence, the percentage of farmers know this characteristic was quite low, only 5% in the whole.

Table 5.1 Farmers perception on characteristics of drought (%)

Farmer groups	N	Characteristics of drought					
		Do not know	Shortage of rainfall	High temperature	Long dryness	Low moisture	Strong sunshine
1. Commune							
Dakrong	60	11.67	65.00	55.00	20.00	1.67	33.33
Mo O	60	3.33	31.67	68.33	38.33	5.00	20.00
Ba Long	60	0.00	53.33	78.33	48.33	8.33	38.33
2. Age group							
<31	25	12.00	40.00	60.00	28.00	0.00	36.00
31-50	95	3.16	50.53	73.68	32.63	3.16	29.47
>50	60	5.00	53.33	60.00	43.33	10.00	30.00
3. Gender							
Female	72	5.56	54.17	63.89	29.17	2.78	25.00
Male	108	4.63	47.22	69.44	39.81	6.48	34.26
4. Ethnicity							
Minority	105	8.57	47.62	59.05	25.71	1.90	29.52
Majority	75	0.00	53.33	78.67	49.33	9.33	32.00
5. Household type							
Poverty	56	12.50	44.64	55.36	23.21	3.57	25.00
No poverty	124	1.61	52.42	72.58	41.13	5.65	33.06
Total	180	5.00	50.00	67.22	35.56	5.00	30.56

Source: Household survey, 2013.

In comparison among communes, it can be seen that people in Ba Long commune had a better understanding about drought when about 100% farmers in Ba Long commune recognized the characteristics of drought, whilst this percentage was 88.33% and 96.67% in Dakrong and Mo O commune, respectively. The remarkable point in perception of farmers among these communes was that the most choice about drought characteristics of farmers in Ba Long and Mo O commune was high temperature (78.33% and 68.33%, respectively) while, 65% farmers in Dakrong commune faced shortage of rainfall. This difference found in the result of group discussions when almost people in Dakrong commune thought that “rainfall is the most important factor, following by high temperature and strong sunshine, if it has not rain meaning that drought occurring” whilst, farmers in Mo O, especially in Ba Long commune considered high temperature as first factor, following by rainfall, etc. The results also showed the significant relevant at 5% level in each characteristic choosing with commune variable (Table 5.2).

Table 5.2 Chi-square test of farmers’ perception on drought characteristics among farmers groups

Farmer groups	Test	Characteristics of drought					
		Do not know	Shortage of rainfall	High temperature	Long dryness	Low moisture	Strong sunshine
Commune	Chi-square	9.12	13.73	7.46	10.81	2.81	5.08
	df	2	2	2	2	2	2
	Sig.	0.01***	0.00***	0.02**	0.00***	0.25	0.08*
Age group	Chi-square	3.26	1.28	3.81	2.56	5.15	0.41
	df	2	2	2	2	2	2
	Sig.	0 .2	0.53	0.15	0.28	0.08*	0.81
Gender	Chi-square	0.08	0.83	0.61	2.14	1.25	1.75
	df	1	1	1	1	1	1
	Sig.	0.78	0.36	0.44	0.14	0.26	0.19
Ethnicity	Chi-square	6.77	0.57	7.64	10.65	5.08	0.13
	df	1	1	1	1	1	1
	Sig.	0.01***	0.45	0.01***	0.00***	0.02**	0.72
Household type	Chi-square	9.63	0.93	5.19	5.40	0.35	1.18
	df	1	1	1	1	1	1
	Sig.	0.00***	0.33	0.02**	0.02**	0.55	0.28

Note: (*), (**), (***) the significant level at 0.1, 0.05 and 0.01, respectively.

By age group, the middle age farmers seemed to be better understanding about drought than the old and young farmer group. Only 3.16% (of 90 farmers) in middle age group said “do not know” when answering about drought characteristics, while this answer was found in 5% and 12% of old and young farmer group. It can be explained that, almost farmers in Dakrong district were middle age farmers who had less farming experience but higher climate knowledge (they had better approach new information, new knowledge) than old farmers. They also had better experience and not much different in climate knowledge comparing with young farmers. Thus, middle age group farmer in the area had more advantage in capturing climate knowledge. However, the relation between choosing characteristic variables and age group variable was not significant (P value > 0.05).

In comparison by gender, there is no doubt that male farmers had better understanding in drought. Only 4.63% of 108 male farmers answered "do not know" when they was asked "do you know characteristics of drought?". While, this ratio in female group was 5.56% (in 72 samples). Similarly with age group variable, there was not significant related between gender variable and drought characteristic choices (P value > 0.05).

The difference in awareness level and economic life level between ethnic majority (Kinh people who had higher education level) and ethnic minority (Van Kieu, Pa Ko, Pa Hi) was often mentioned when we were working with the local authorities. The results, one again, reflected this difference when ethnic majority and no poor farmers had better understanding about drought characteristic than others. There were 100% ethnic majority and 98.39 no poor farmers knew at least one characteristic of drought whilst, this number in ethnic minority and poor farmers was lower, 91.43% and 87.5%, respectively. The relation between ethnicity variable and "do not know" answer or the answers in recognizing some characteristics such as high temperature, long dryness were significant at 5% level (P value < 0.05).

5.1.2 Farmers' perception on effects of drought

The effects of drought were discussed carefully in key informant interviews and especially, in group discussions. In these kinds of collection data tools, the effects of drought were given focusing on maize production. The results indicated that there were six main effects of drought which had been being impacted on surrounding environment and different stages of maize production in the area, including: no germination (on the sowing stage), diseases increased and crop wilt (on the growth stage), poor harvesting (harvesting stage) land degradation, lack of water (surrounding environment of maize) (Table 5.3).

The household survey results reflected that perception on each type of drought effects was quite different. In the whole, almost farmers (82.87%) were aware that crop burned was the main consequence of drought, following by choosing in seed no geminate (41.67%), lack of water (32.22%), poor harvesting (22.78%) and land degradation (14.44%).

Table 5.3 Farmers' perception on effects of drought (%)

Farmer groups	N	Effects of drought							
		Do not know	Lack of water	Land degra-dation	Seed no germi-nate	Crop burned	Diseases increase-ed	Poor harves-ting	Others
1. Commune									
Dakrong	60	11.67	26.67	21.67	48.33	81.67	1.67	11.67	1.67
Mo O	60	6.67	35.00	10.00	36.67	81.67	5.00	26.67	0.00
Ba Long	60	0.00	35.00	11.67	40.00	85.00	18.33	30.00	0.00
2. Age group									
<31	25	8.00	32.00	20.00	36.00	76.00	0.00	20.00	0.00
31-50	95	3.16	31.58	11.58	41.05	86.32	8.42	26.32	0.00
>50	60	10.00	33.33	16.67	45.00	80.00	11.67	18.33	1.67
3. Gender									
Female	72	6.94	29.17	9.72	38.89	81.94	6.94	15.28	0.00
Male	108	5.56	34.26	17.59	43.52	83.33	9.26	27.78	0.93
4. Ethnicity									
Minority	105	9.52	31.43	17.14	42.86	80.00	1.90	19.05	0.95
Majority	75	1.33	33.33	10.67	40.00	86.67	17.33	28.00	0.00
5. Household type									
Poverty	56	16.07	19.64	10.71	39.29	75.00	1.79	17.86	1.79
No poverty	124	1.61	37.9	16.13	42.74	86.29	11.29	25.00	0.00
Total	180	6.11	32.22	14.44	41.67	82.78	8.33	22.78	0.56

Source: Household survey, 2013.

The difference in perception on effect of drought among farmers in communes was not much different from perception on characteristics of drought. There were 100% farmers in Ba Long knew at least one effect of drought, whilst in Mo O and Ba Long were 92.33% 88.33%, respectively. Chi-square test showed the significant relationships between commune variable and perception on cause variables, at 0.05 level. The significant relevant with commune variable was also found in perceiving on diseases increased effect and poor harvesting effect (P value < 0.05).

Table 5.4 Chi-square test of farmers' perception on drought effects among farmer groups

Farmer groups	Test	Effects of drought							
		Do not know	Lack of water	Land de-gradation	Seed no germinate	Crops burned	Diseases increased	Poor harvesting	Others
Com-mune	Chi-square	7.17	1.27	3.87	1.78	0.31	12.22	6.51	2.01
	df	2	2	2	2	2	2	2	2
	Sig.	0.03**	0.53	0.14	0.41	0.86	0.00***	0.04**	0.37
Age Group	Chi-square	3.18	0.05	1.5	0.62	1.96	3.15	1.46	2.01
	df	2	2	2	2	2	2	2	2
	Sig.	0.2	0.97	0.47	0.73	0.37	0.21	0.48	0.37
Gender	Chi-square	0.15	0.51	2.17	0.38	0.06	0.3	3.84	0.67
	df	1	1	1	1	1	1	1	1
	Sig.	0.7	0.47	0.14	0.54	0.81	0.58	0.05**	0.41
Ethnicity	Chi-square	5.12	0.07	1.48	0.15	1.36	13.63	1.99	0.72
	df	1	1	1	1	1	1	1	1
	Sig.	0.02**	0.79	0.22	0.7	0.24	0.00***	0.16	0.4
HH Type	Chi-square	14.06	5.89	0.92	0.19	3.45	4.56	1.12	2.23
	df	1	1	1	1	1	1	1	1
	Sig.	0.00***	0.02**	0.34	0.66	0.06*	0.03**	0.29	0.14

Note: (*), (**), (***) the significant level at 0.1, 0.05 and 0.01, respectively.

Especially, in comparison among age groups, the old farmers group seemed to be better aware on effects of drought than younger groups. This can be explained that, almost the effects of drought can be easy to observe, thus, by experience the old farmers, who had ever witnessed many drought years in the area, could realize their effects. However, the relationship between age group and perception on drought effect was not significant (P value > 0.05).

Gender and ethnic group showed the similar result with perception on drought characteristics when female and minority farmers had more people answer "do not know" the effects of drought than the rest groups. In which, 6.94% and 9.52% of female and minority farmers had the same answer with 5.56% and 1.33% of male and majority farmers, respectively.

Finally, the difference in perception from household types showed by 16.67% head of poor households did not know the effect of drought, while this rate in no poor group was only 1.61% (P value < 0.05). It can be explained that no poor households often had higher experience, higher knowledge and better economic condition (TV, radio, etc.) to access information as well as perceiving the effects of climatic phenomena.

5.1.3 Farmers' perception on causes of drought

Perception on causes of drought is very important. It may impact on farmer behaviors to prevent or cope with this climate phenomenon. In this research, we referenced the drought causes given by Selvaraju (2007) and Umma (2012) in their researches in Bangladesh. These causes were discussed with key informants and in group discussions before putting in the questionnaire to test the understanding of maize farmers.

The results indicated that, causes of drought in Dakrong district had the general characteristics being mentioned in the previous researches, it also contained the specific characteristics. In which, climate change, over exploiting water resource, no grass for grazing, deforestation, sedimentation of rivers and hydropower system development were the main causes of drought occurring in the area (Table 5.5).

For the first cause "climate change", according to farmers and key informants' opinion, climate phenomena occurred more uncertainly and unpredictable in recent ten to fifteen years in the area. As their understanding, this change had made it hotter and drought occurred more frequently. "Over exploiting water resource" cause was explained by experts and farmers that the increasing of population and development of industry had strongly impacted on water environment, made groundwater resources being depleted increasingly. Whilst, "no grass for grazing" and "deforestation" were directly relate to agricultural development, according to the farmer ideas. Slash and burn farming, the expansion of cultivated area had reduced the forest cover and natural grasslands, leading to water holding capacity of the soil limited.

For "river shallow", this cause came from the idea of people in the flat area. Under impacts of floods and heavy rains, land erosion occurred and made rivers shallow that reduced the water storing capacity of the river. As a consequence, the river at the downstream segment was often lack of water for irrigation in the summer season. This impact also found when "hydropower system" was developed in the area. Hydropower dams hindered the flow of the river and restricted ability to provide water for downstream in the area.

Table 5.5 Farmers' perception on causes of drought (%)

Farmer groups	N	Causes of drought							
		Do not know	Climate change	Over exploiting water resource	No grass for grazing	Defore-station	River shallow	Hydro-power system develop-ment	Others
1.Commune									
Dakrong	60	63.33	16.67	1.67	15	18.33	0	15	0
Mo O	60	31.67	40	1.67	8.33	48.33	10	3.33	1.67
Ba Long	60	28.33	46.67	5	10	31.67	18.33	28.33	3.33
2. Age group									
<31	25	40	28	8	0	44	4	12	0
31-50	95	44.21	30.53	1.05	10.53	30.53	9.47	18.95	1.05
>50	60	36.67	43.33	3.33	16.67	31.67	11.67	11.67	3.33
3.Gender									
Female	72	48.61	26.39	2.78	8.33	30.56	8.33	16.67	0
Male	108	36.11	39.81	2.78	12.96	34.26	10.19	14.81	2.78
4. Ethnicity									
Minority	105	53.33	22.86	1.9	10.48	28.57	1.9	9.52	0
Majority	75	24	50.67	4	12	38.67	20	24	4
5. Household type									
Poverty	56	64.29	14.29	1.79	10.71	19.64	3.57	7.14	0
No poverty	124	30.65	43.55	3.23	11.29	38.71	12.1	19.35	2.42
Total	180	44.11	34.44	2.78	11.11	32.78	9.44	15.56	1.67

Source: Household survey, 2013.

As from the results, there was a high percentage of farmers (over 45% in average) did not know "why drought occur". This proportion was really high in Dakrong commune (63.33%), minority group (53.33%), poverty group (51.79%), female group (49.3%) and middle-aged group (44.68%). Accepting age groups, there were significant relationships between the rest groups with "do not know" response. It was significant at 10% level with gender group and 5% level with commune, ethnic and household type group (Table 5.6).

Table 5.6 Chi-square test of farmers' perception on drought causes among farmer groups

Farmer groups	Test	Causes of drought							
		Do not know	Climate change	Over exploiting water resource	No grass for grazing	Defore-station	River shallow	Hydro-power system development	Others
Commune	Chi-square	18.5	13.19	1.65	1.46	12.3	11.82	14.3	2.03
	df	2	2	2	2	2	2	2	2
	Sig.		0.00^{***}	0.44	0.48	0.00^{***}	0.00^{***}	0.00^{***}	0.36
Age Group	Chi-square	0.88	3.21	3.64	5.03	1.68	1.21	1.76	1.66
	df	2	2	2	2	2	2	2	2
	Sig.	0.64	0.2	0.16	0.08	0.43	0.55	0.41	0.44
Gender	Chi-square	2.79	3.45	0.00^{***}	0.94	0.27	0.17	0.11	2.03
	df	1	1	1	1	1	1	1	1
	Sig.	0.09^{*}	0.06^{*}	1	0.33	0.6	0.68	0.74	0.15
Ethnicity	Chi-square	15.55	14.98	0.71	0.1	2.02	16.75	6.98	4.27
	df	1	1	1	1	1	1	1	1
	Sig.	0.00^{***}	0.00^{***}	0.4	0.75	0.15	0.00^{***}	0.01^{***}	0.04^{**}
HH Type	Chi-square	18.03	14.63	0.3	0.01	6.37	3.28	4.38	1.38
	df	1	1	1	1	1	1	1	1
	Sig.	0.00^{***}	0.00^{***}	0.59	0.91	0.01^{***}	0.07^{*}	0.04^{**}	0.24

Note: $^{(*), (**), (***)}$ the significant level at 0.1, 0.05 and 0.01, respectively.

Next, it seems to be "climate change" and "deforestation" were two major causes of drought according to farmers' idea in Dakrong district with 34.44% and 32.80% of farmer choices, respectively. There were the significant relations between these choices and commune, ethnicity group, and household type group (with choosing in climate change cause), and commune level and household type group (with choosing in deforestation cause), (P value < 0.05). Farmers explained for their idea that, the variability of weather today were very uncertain, its occurring did not follow a constant cycle. For instance, in 2010 it was very hot, whilst it was very cool and much rain in 2011. Besides, the life of farmers in the area tied to forest, thus they witnessed and knew the huge damage of losing forest land area. The forest cover had decreased in recent years were the main causes of poor soil water retention. It also reduced water supply ability of rivers in the summer, causing drought in the area.

5.1.4 Farmers' perception on coping measures in maize production

Coping measures to cope with drought were cited in researches on drought adaptation in crop production of Sleger (2008), Ekpoh (2010) and Umma (2012). However, with different crops which may have difference from coping measures. Therefore, this research had combination in referencing the previous research results and discussing with experts in maize production field who came from Hue University of Agricultural and Forestry, Agricultural and Rural development Department, and Agricultural Extension Station. The results indicated nine popular coping measures which can help farmers cope with drought such as store water for dry season, change sowing day, water for maize, change to another crops, apply drought tolerant varieties, reduce amount of land, cultivate one season, moving to another plots, inter-cropping (Table 5.7).

The mentioned coping measures were defined as follows. For "store water for dry season" measure, the participants said they observed farmers in other areas had built the large tank to hold water for the summer. However, this method often requires a very high cost and only in accordance with the small field. While, "changing sowing day" method is known as the movement of seasonality either later or earlier than usual. "Water for maize" is a popular method to cope with drought by using river water or well water to irrigate for maize. "Change to another crop", "cultivate one season" and "reduce amount of land" were defined as the reducing maize cultivated land area method to cope with drought throughout replacing all or a part of maize land area by other drought tolerant crops (cassava, peanut, etc.,), or cultivating maize on only spring season (summer season is abandoned or switched to other crops). "Moving to another plots" aims at finding out better plots to produce maize where can support more water source for maize in the summer season. Finally, "intercropping" is a multiple cropping practice involving growing maize with other crops, such as upland rice, peanut, green bean, etc. The goal of intercropping is to produce a greater yield on a given piece of land by making use of resources that would otherwise not be utilized by only maize under the impact of drought.

The results showed that there were 48.33% and 41.67%, respectively farmers in Dakrong commune and Mo O commune answered "do not know" when was asked "do you know measures to cope with drought?", whilst this rate in Ba Long commune was only 11.67%. Almost these farmers said that they had grown maize year after year in accordance with the experience of their predecessors, thus they had not cared much about the so-call "coping measures". Some others had not known coping measures despite they was applying them, such as: applying drought tolerant varieties, change to another crop or inter-cropping, etc. The reason given that they practiced following their neighbors or Kinh people (with ethnic minority people).

Table 5.7 Farmers' perception on coping measures in maize production (%)

Characteristics	Mean (N=180)	Commune			df	Sig.
		Dakrong (N=60)	Mo O (N=60)	Ba Long (N=60)		
Do not know	33.89	48.33	41.67	11.67	2	0.00***
Store water for dry season	15.56	18.33	16.67	11.67	2	0.58
Change sowing day	15.56	18.33	6.67	21.67	2	0.06*
Water for maize	51.11	33.33	48.33	71.67	2	0.00***
Change to another crops	25.56	10.00	16.67	50.00	2	0.00***
Apply drought tolerant varieties	20.00	11.67	6.67	41.67	2	0.00***
Reduce amount of land	1.67	0.00	1.67	3.33	2	0.36
Cultivate one season	32.78	15.00	20.00	63.33	2	0.00***
Move to another plots	1.67	0.00	1.67	3.33	2	0.36
Inter-cropping	13.89	20.00	6.67	15.00	2	0.10
Another measures	3.89	0.00	11.67	0.00	2	0.00***

Note: (*), (**), (***) the significant level at 0.1, 0.05 and 0.01, respectively.

Source: Household survey, 2013.

The results also indicated that, the adaptation measures were known by most farmers were "water for maize", by 71.67% farmers in Ba Long commune, 48.33% in Mo O commune and 33.33% in Dakrong commune; "cultivate one season", by 63.33% farmers in Ba Long, 20% in Mo O and 15% in Dakrong commune. The chi-square test results showed the significant relations between these choices with commune variable (P value < 0.05). The awareness on measures such as "change to another crops" and "applying drought tolerant varieties" were found in around 20% to 25% farmers in the area. These measure options also had highly significant relationships with commune variable (P value < 0.01).

5.1.5 Farmers' perception on drought happenings

The farmers were required to reminisce all drought events had occurred from 2000 to 2013. This request was applied not only for group discussions but also for individual interview. The results indicated that farmers had good memory about drought happenings in the area (Table 5.8).

Table 5.8 Farmer's memory about drought happenings (%), (N = 180)

Farmer's memory	Total	Dakrong	Mo O	Ba Long	df	Sig.
1. Remember drought years	65.56	48.33	36.67	70	2	0.00***
2. Remember drought's characteristics	67.22	68.33	49.15	85	2	0.00***
3. Remember productivity losses due to drought	82.22	83.33	77.19	84.75	2	0.54

Note: *** the difference among groups is significant at 0.01

Source: Household survey, 2013.

As can be seen the results, there were 65.56% interviewed farmers could remember exactly severe drought years and 67.22% and more than 82% farmers could remember those droughts' characteristics and their impact on maize productivity. In which, farmers in Ba Long commune always had better memory about drought than farmers in Dakrong commune and Mo O commune.

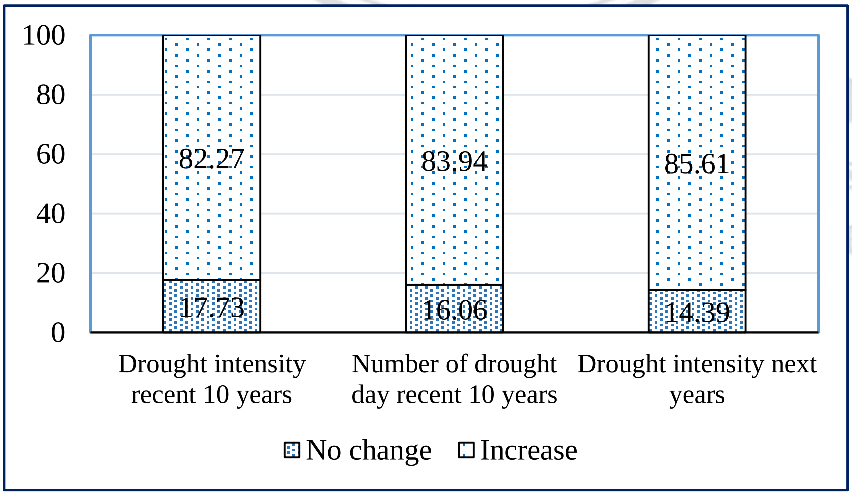

Figure 5.1 Farmers' perception on drought happenings (%), N=180

Source: Household survey, 2013.

Besides, farmers also evaluated the drought intensity and length of droughts in recent 10 years as well as the prediction about drought intensity next years (Figure 5.1). From the results, almost farmers (over 80%) agreed that drought intensity and number of drought day increased significantly recent 10 years. Additionally, there were 85.61% farmers predicted that temperature continue growing up and drought intensity will be more severe next years.

5.1.6 Farmer' perception score

Perception score contribute to evaluate comprehensively farmers' perception about drought in the area. In the research, perception was compared between groups to see the difference in farmer's drought perception in a more multi-dimensional view (Table 5.9 and Figure 5.2).

The results showed the majority of farmers' drought perception were medium level with average score was from 16 to 20 (score), accounted from 50 to 60% for each group of farmers. The one way ANOVA analysis also showed the significant differences in perception score among groups of farmers.

In comparison between communes, it can be seen that farmers in Ba Long had better understanding about drought when their average perception score was 23.17, higher than farmers' in Mo O and Dakrong commune (around 17 score, P value < 0.01). Forty percent of farmers from Ba Long were ranked at the high level, almost three times higher than that in other communes. These differences were explained by almost all farmers in Ba Long, Kinh ethnic majorities, who had higher education level than Mo O and Dakrong farmers (almost Bru Van Kieu and Pako people – ethnic minorities). The comparison between ethnic groups in this figure also proved for this explanation.

Gender and household type were considered as factors that can affect the difference in farmer perception. The evidence was that, male heads of household had higher score perception than female ones (20.22 compared with 18.17 score, P value < 0.05) and 88% male farmers were in medium and high of level perception compared to 78% of female group. Similarly, the poor farmers had lower score as well as perception level than no poor farmers in the study area (P value < 0.01). The difference in perception between these groups came from the inequality in approaching information resources. Another results showed that, percentage of female and poor farmers participated in training course were only 38.9% and 35.7%, correspondingly which lower than male farmers'

(43.5%) and no poor farmers' (44.4%). Besides, female and the poor also had less opportunity to participate in training or access to media such as TV, radio, etc. to expand their knowledge as well as their awareness, (Household survey, 2013).

Table 5.9 Average drought perception score of farmers in the study area

Characteristics of perception by different groups	N	Mean	Standard Deviation	Significant level
1. Commune				
Dakrong	60	17.18^{b}	7.505	
Mo O	60	17.85^{b}	6.262	0.000^{***}
Ba Long	60	23.17^{a}	6.415	
2. Age group				
<31	25	16.56^{b}	7.321	
31-50	95	19.21^{ab}	6.548	0.039^{**}
>50	60	20.88^{a}	7.921	
3. Gender				
Female	72	18.17	6.78	0.061^{*}
Male	108	20.22	7.431	
4. Ethnicity				
Minority	105	16.78	6.72	0.000^{***}
Majority	75	23.07	6.293	
5. Household type				
Poor	56	16.45	6.364	0.000^{***}
No poor	124	20.73	7.224	
Total	180	19.4	7.229	

Note: $^{(*), (**), (***)}$ the difference among groups is significant at 0.1, 0.05 and 0.01 level, respectively.

$^{a, b, c}$ the different letters show the significant difference between two groups at the 0.05 level.

Source: Household survey, 2013.

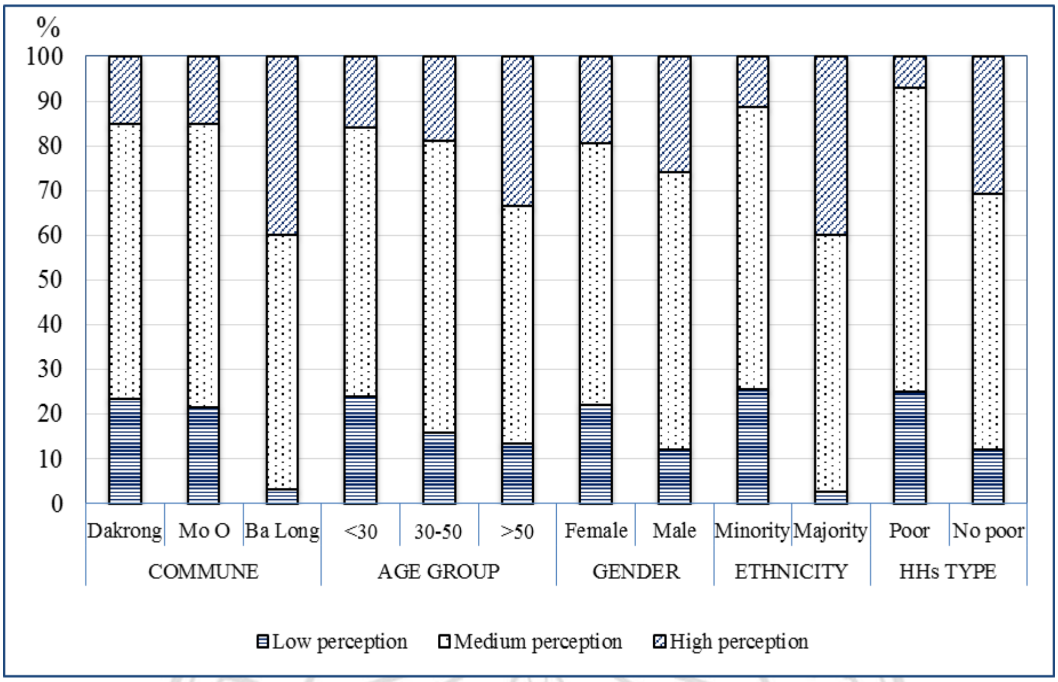

Figure 5.2 Farmers' perception on drought in the study area (%) (N=180)

Source: Household survey, 2013.

One interested point in comparison drought perception between farmer groups that was the quite significant difference in age groups (P value < 0.05). It seemed that, awareness increased quite markedly with age. Thus, in a certain aspect of the relationship between age and perception might find that when farmers get older they had more experience and knowledge, and their perception could be accumulated from their own experience.

5.2 Farmers' adaptation to drought in maize production

In the focus group discussions, farmers gave 5 popular adaptation practices in the study area, which were: (1) changing showing day, (2) cultivating one season, (3) change to another crops, (4) planting the drought tolerant varieties and (5) inter-cropping. These measures were confirmed by the local professional staff, extension officers and agricultural officers before using to evaluate the adaptation level of surveyed households.

As from the results, a significance of farmers had never applied any practice measures in maize production to cope with drought (25.56%). Almost the rest of farmers chose one adaption (29.44%) or two adaptation (35.55%) measures in their farm practice to cope with drought (Figure 5.3).

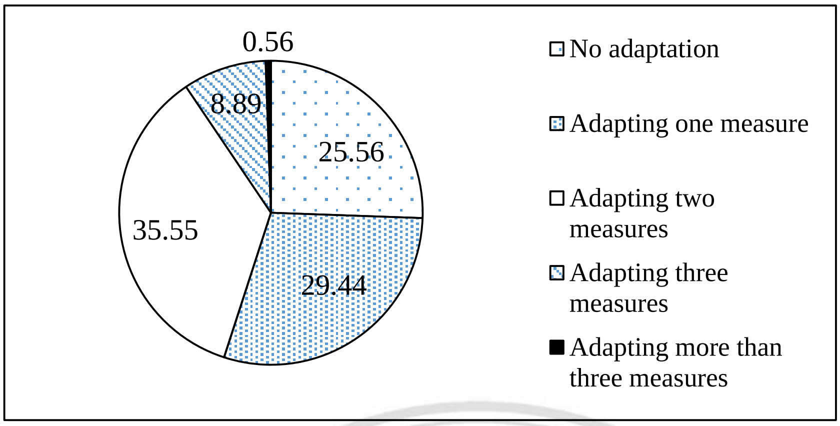

Figure 5.3 Farmer adaptation practice levels in the study area (%) (N=180)

Source: Household survey, 2013.

More remarkably, these options usually focused on "cultivating one season" solution (in Ba Long and Mo O commune) and "inter-cropping" solution (in Dakrong commune). Other options only applied by a small percentage of households (Table 5.10).

Table 5.10 Farmer adaptation practices in maize production (%)

Adaptation practices	COMMUNE Dakrong (N = 60)	Mo O (N = 60)	Ba Long (N = 60)	Mean (N = 180)	Significant level
By changing sowing day	10.00	11.67	21.67	14.44	0.145
By cultivating one season	25.00	58.33	88.33	57.22	0.000***
By changing to another crops	10.00	21.67	40.00	23.89	0.001***
By planting the drought tolerant varieties	8.33	6.67	26.67	13.89	0.002***
By inter-cropping	43.33	11.67	16.67	23.89	0.000***
By other measures	0.00	1.67	0.00	0.56	0.366

Note: (***) the difference between communes is significant at Chi-square 0.01 level.

Source: Household survey, 2013.

5.2.1 Adaptation by changing sowing day

"Changing sowing day" was an autonomous adaptation when the farmers had independently decided the sowing day depending upon their awareness about climate trends, temperature and rainfall at the beginning of each season.

As the results from group discussions, the popular time for sowing maize was quite similar in whole district. Sowing time in the spring season was from the fourth week of December to the second week of January. For the summer season, maize sowing day was from the fourth week of April to the first week of May. This result was confirmed by survey results of farmers' sowing calendar (2011-2012) in Dakrong district (Figure 5.4 and Figure 5.5).

According to farmer experience, in the normal weather condition if they grow maize on those periods, it can give high productivity. Therefore, for the year without cool spell and severe drought (2012), almost farmers especially in spring season, grew maize on time of crop calendar. However, there was some households grew maize earlier, from the fourth week of November to the third week of December (on the spring season), and from the first to the third week of April (on the summer season). The early growing farmers explained that they had grown maize early on the spring season to prevent droughts may occur but for the summer season, early growing maize aimed at coping with flood and heavy rain. Some of them sowed maize early but not to cope with climate risks because that was only an imitation from other farmers.

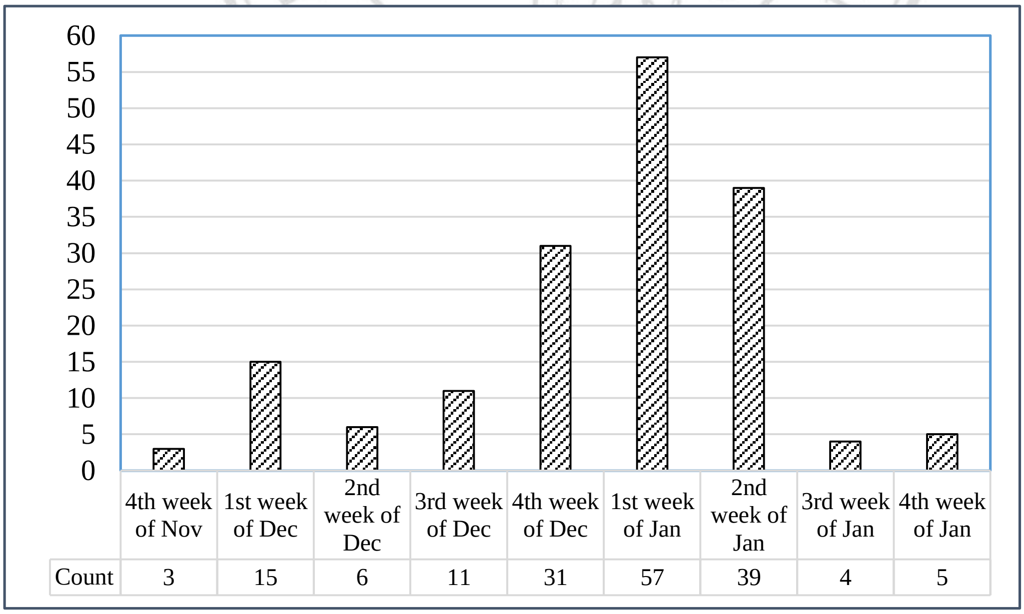

Figure 5.4 Maize sowing calendar of farmer in the spring season (2011-2012)

Source: Household survey, 2013.

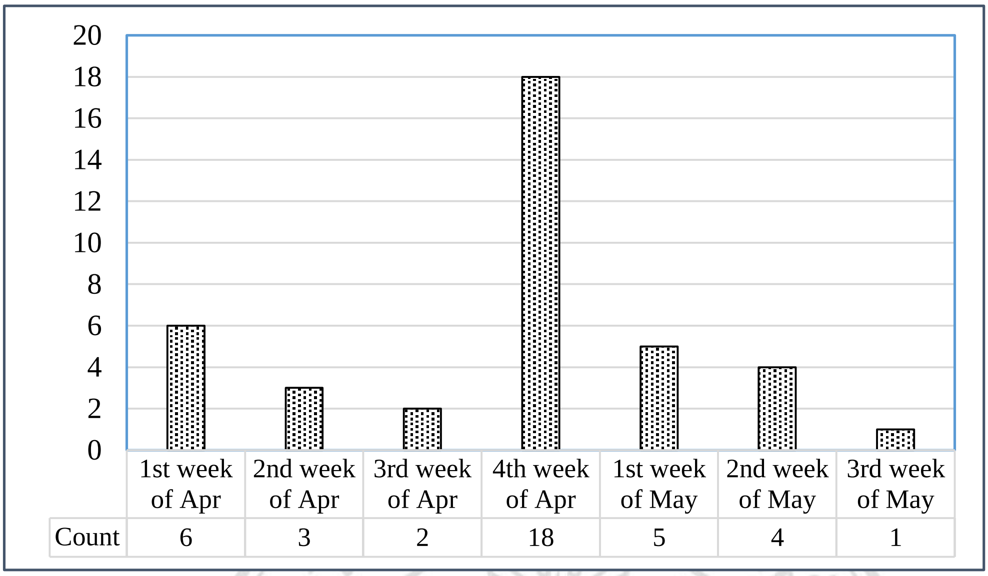

Figure 5.5 Maize sowing calendar of farmer in the summer season (2012)

Source: Household survey, 2013.

The farmers' experience also indicated that the movement of season calendar should be considered by the effect of another climate phenomena on maize's growth periods. For instance, early sowing can help maize prevent the impact of drought but it will be impacted of cool spells at the starting time. Thus, this adaptation option was not widely applied in the study area (14.44%), highest applying portion was in Ba Long commune (21.67%). The chi-square value for the association between changing sowing day and commune was not significant (P value > 0.05). Thus, there was no relation between these variables in the population.

5.2.2 Adaptation by cultivating one season

"Cultivating one season" seemed to be an important measure to cope with drought in the study area. There was a significant relationship between this adaptation and commune variable (P value < 0.01). It had become the first option with farmers in Ba Long (88.33% farmers were applying) and Mo O (58.33%), being the second option in Dakrong commune (25%). This practice was applied for around ten years in Ba Long commune, seven years in Mo O commune and five years in Dakrong commune from group discussions.

Farmers in Ba Long commune and a part of farmers in Mo O commune, under the encouragement of extension staff, had changed from maize to green bean in the summer season. By this planned adaptation, the farmers reduced risks when green bean – a shorter growth day crop was replaced for maize. Green bean was grown after harvesting maize or peanut, its seasonality lasts 90 days (whilst maize is 120 days), might avoid the severe drought in July and August. According to farmer opinion, this changing brought higher benefit because they can get maize product for human food and livestock whilst green bean can give cash after harvesting. Especially, the green bean seeds' price was quite high and stable, made farmers in Ba Long commune more likely to apply this coping measure.

However, there were still many households, especially, in Dakrong and Mo O commune, farmers did not apply this measure. The non-adoption farmers explained that they had not known any suitable crops for next season (after maize) and they also wanted to grow maize two seasons to ensure their human food demand during the year. Besides, farmers in these communes seemed to be cannot apply green bean in the summer season because almost agricultural land area in this area located on the hills. Green bean only grow well in flat area where silt deposited by the river every year.

5.2.3 Adaptation by changing to another crops

"Changing to another crops" was assessed as a new efficient option of farmers in the study area. This adaptation was the result of autonomous and planned adaptation when some of changes came from the farmers. Some others came from the consultant and the guidance from Agricultural and Rural development (ARDD).

Since 2001, farmers in Ba Long commune started converted some ineffective maize land area to chili. However, chili price dropped down two years later and chili was replaced by sesame (2004). The changing was continued until they received the consultant of ARDD in 2007. After a severe drought year (2006), ARDD realized the preoccupation of farmers about maize production, they had consulted and encouraged farmers shift some maize land area to peanut and cassava and it attracted the concern of a part of farmers in Ba Long commune and some other communes.

Whilst, this adaptation in Dakrong and Mo O commune came later, being after the severe drought year, 2010. Farmers who had grown maize on the hills were encouraged to shift to cassava and to peanut in the less slope area. However, this change did not receive the positive respond from farmers, especially the ethnic minority farmers because they need to grow maize to ensure food security. Besides, peanut and cassava required higher investment (high fertilizer requirement than maize) and their soil was not totally suitable for growing peanut similar other communes whilst cassava could be grown in the slope area but the transportation faced much difficult. Additionally, some farmers worried that cassava and peanut cannot be consumed by households themselves if their products are not consumed by the market. Thus, until now there were around 40% and 21.67% of farmers in Ba Long and Mo O commune shifted a part of their farm from maize to peanut and cassava whilst only 10.00% farmers in Dakrong changed to cassava (P value < 0.01).

5.2.4 Adaptation by planning the drought tolerant varieties

"Planning the drought tolerant varieties" was a new measure which applied by farmers since 2010 under Seeds Subsidy program. This program aimed to support maize seed with low price for poor households (subsidized 80% seed price for 2 kilogram per household per year). By this way, farmers could buy new maize variety, C919, LVN 10, LNS222, DK888, etc., from Seed subsidy Program or seed companies which had high or medium drought tolerance and partly replaced the local varieties (Table 5.11).

However, the percentage of farmers using hybrid seeds was not high, almost of them used maize seeds by self-selection (using seeds from hybrid plants) or self-collected from local varieties. In fact, yield and quality of F1 or F2 generation was lower than pure seeds but farmers in the area were likely to apply. The main reason of using self-collection seeds came from farmers' production habit. Self-collecting and storing seeds helped them more proactively in seed preparation and saving money. Besides, this practice also came from the limitation in seed market which was not available and high price in a highland area. Whilst, seeds subsidy program did not catch the seed demand of farmers, they had to pay full price if want to buy more. Not to mention that some poor households sold this amount of seeds to get money instead of using for production in their farm. This was the reason why farmers in the area applying new varieties extensively (only 13.89% applied farmers in the whole).

Table 5.11 Maize varieties growing in Dakrong district

Varieties	Start growing	Characteristics	Production situation
C919	2010	Offered by seed companies in Seeds subsidy Program, high productivity, high drought tolerant, long growing time.	Being grown mainly in Dakrong district. However, a lot of farmers using seeds by self-selection.
LNS 222	2009	Offered by seed companies, high productivity, short growing time, medium drought tolerance.	
LVN 10	2009		
DK 888	2010	Offered by seed companies, productivity is relatively high, medium drought tolerance.	A few farmer was growing in summer season because it was hard to buy seeds.
G 49	2009		
Nu	2005	Offered by seeds companies or selected by farmers, good quality but low productivity, low drought tolerant	Farmers were growing in spring season.
Da Do	Long time ago	Local variety, long growing time, low productivity, low drought tolerant	Few farmers (ethnic minority) was growing on the hills.
Da Trang			
Nep Trang			

Source: Focus group discussion, 2013.

5.2.5 Adaptation by inter-cropping

The last but not less important in the main drought adaptation in the study area was “inter-cropping”. This measure was very important in Dakrong commune where had 43.33% of farmers applied it as autonomous adaption to cope with drought. The fact that, this measure was adapted by many years ago, since the farmers perceiving that the combination of maize and upland rice can cope with drought’s effects and ensuring food security. In this inter-cropping formula, maize and upland rice were grown at the same time on spring season (December or January). Upland rice was a long day crop, flowering in July or August, being harvested in

September or October. Whilst, growing time of maize was shorter. It was harvested in May (flowering in March or early of April). According to farmers' experience, the difference in growing time of maize and upland rice was an advantage to cope with drought. Drought often strongly influences on crop yield if the high intensity dry spell occurs on flowering period. In normally, if strongly dry spell occurs early, it may impact on maize and upland rice still give good productivity. On the other hand, later dry spell may influence on upland rice and maize can be safe. This was the reason why a significant percentage of farmers in Dakrong commune and a part of farmers in Mo O commune liked to apply this copping measure.

For farmers in Ba Long commune and the rest of farmers in Mo O commune, the inter-cropping formula was different from the ones in Dakrong commune. Especially, all of 23.89% farmers in Ba Long commune was experimenting "maize and peanut" or "maize and green bean" as the main inter-cropping formulas to cope with drought. For the first inter-cropping formula (maize and peanut), it can be seen as a planted adaptation type because it was the results of the empirical model and directing the production of Agricultural and Rural development department and Extension station since 2011. This experiment was evaluated as a good measure when both maize and peanut gave stable productivity under impacts of drought. According to district agricultural staffs, peanut is a better drought tolerant while maize can take advantage of the nutrients are created from peanut roots to grow faster and overcomes the influence of drought. Whilst, for the second formula, some farmers adapted by themselves when combing green bean and maize. According to farmers, because green bean was a shorter growing crop, it could be harvest in July or August, thus they wanted to take advance by inter-cropping maize to increase land use efficiency.

5.2.6 Adaptation by other measures

In the study area, farmers' adaptation mainly focused on five above measures, with other coping measures such as: shading or watering for maize was only applied by 1.67% of farmers in Mo O commune. Farmers in Dakrong commune and Ba Long commune did not use these measures in their maize production.

5.3 Factors impact on farmers’ adaptation to drought in maize production

5.3.1 The results of factor analysis

It was found that there were many multi-correlations among the independent variables themselves (Appendix B) and it made complications in developing the model. Therefore, using factor analysis to extract the main factors with an eigenvalue more than one and overcome the multicollinearity problem was necessary.

In order to understand if the set of variables is linearly related, the Kaiser-Meyer-Olkin (KMO) measure was computed (Hair *et al.*, 1998, cited by Babu and Sanyal, 2009). This measure was used to measure strength of the relationship among variables. The KMO values for individual variables were checked, in which, the variables with low value (< 0.5) in the diagonal elements of the anti--image correlation matrix were ignored. With the rest variables, the results indicated that we had a not too high KMO value (mediocre), 0.674 (Table 5.12), however Bartlett’s test of sphericity with an associated p value of <0.001 indicated that we can proceed factor analysis.

Table 5.12 KMO and Bartlett’s Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.676
Bartlett's Test of Sphericity	Approx. Chi-Square	1068.970
	df	153
	Sig.	0.000

By result of extraction method, six components with eigenvalues greater than one were found and they explained 65.298% as cumulative. It was also found that the percentage of variance of factor (1) was 20.5945%, factor (2) was 13.734%, factor (3) was 10.234%, factor (4) was 8.078%, factor (5) was 6.982% and factor (6) was 5.677%.

The first factor was termed as “household’s capitals” consists of ethnicity (x_3), education (x_4), household type (x_6), access to information (x_{15}), access to credit (x_{16}) and drought perception level (x_{17}). The second factor appeared to be “experience”, including two variables with high loading value: age (x_1) and maize experience (x_5). The third factor was composed of distance from market (x_9), maize land area (x_{10}) and maize income (x_{12}). This factor was named as accordingly to its common meaning, termed as “maize production scale” (Table 5.13).

Table 5.13 Components extracted by Principle component analysis and their variables

Factors	Name	Independent variables included
Factor 1	Household's capitals	Ethnicity, education, household type, access to information, access to credit, drought perception level.
Factor 2	Experience	Age, maize experience.
Factor 3	Maize production scale	Maize land area, maize income, distance from market.
Factor 4	Maize productivity	Maize productivity in the normal years, maize productivity in the drought years.
Factor 5	Labor resource	Household size, total labor.
Factor 6	Gender and non-farm income	Gender of household head and non-farm income.

The forth factor represented the maize productivity, including maize productivity in the normal years (x_{13}), maize productivity in the drought years (x_{14}). Whilst, factor five represented the labor force of household which was combined by household size (x_7) and total household labors (x_8). The last factor was the combination of gender (x_2) and non-farm income (x_{11}). The factor scores of the six factors were used as independent variables in the Multinomial Logit model.

5.3.2 Multinomial Logit model

1) Description of dependent variable and independent variables

Response variable:

The result of adaptation section showed that there were six kinds of adaptation practices which farmers applying to cope with drought in the study area. However, it also indicated that, the percentage of farmers using these adaptation measures was very different (in each adaptation option) and some farmers no applied or applied only one measure, others practiced two or three measures, leading more difficulty in evaluating factors impact on adaptation capacity to drought in maize production of farmers. Grouping adaptation farmers basing on characteristics of their adaptation practices seemed to be the good way to analyze the impacting of internal and external factors on farmers' adaptation in the study area. Therefore, the adaptation farmers were divided as follows:

Table 5.14 Frequencies of the response variable categories (ADP)

Adaptation option	Frequency	Percent
ADP_0	46	25.56
ADP_1	28	15.56
ADP_2	53	29.44
ADP_3	53	29.44
Total	**180**	**100.00**

Source: Household survey, 2013.

- ADP_0: farmers no adapt any coping measure in maize production to cope with drought. In this case farmers grow maize without consideration about the impact of drought as well as other climate phenomena.

- ADP_1: farmers adapted by improving in cultivation techniques. In this practice, farmers were more likely to keep the amount of maize land area and they apply cultivation techniques under their understanding or consultant of extension workers such as: *changing sowing day or planting the drought tolerant varieties or practicing inter-cropping*. By this way, the farmer could maintain maize land area to get product for selling, human food or livestock, however, this was not an optimal adaptation measure because according to farmers' idea, the changing in technical practices was not total suitable with all land area. For instance, growing maize on the hilltop area still faced strong influence of drought even though they had applied the technical measures because the intensity of the drought in this area had beyond the tolerance of maize.

- ADP_2: farmers adapted by reducing in cultivated area. This group of farmers did not want to get risk from maize production under drought's impact. For safety, they reduced amount of land by *cultivating one season or changing to another crops*. This measure can lead to decrease in maize yield but they can get product or income from other crops (peanut, cassava, green bean). In fact, this adaptation had attracted much attention from the farmers recent time when cassava, peanut and some other drought-tolerant crops were becoming more suitable with dry land parcels or on the hilltops.

- ADP_3: farmers adapt by combining measures in ADP_1 and ADP_2. This farmer group reduced amount of land as the first practice and then they applied cultivation techniques relating to *changing sowing day or planting the drought tolerant varieties or practicing inter-cropping* for the rest land area to cope with drought. By this way, farmers might get lower maize yield but high maize productivity in average. According to head of Agricultural and Rural development Department, this was a higher level of adaptation compare with ADP_1 and ADP_2 because farmers could keep good maize yield (for livestock and human food) by using new techniques and they also get cash from other crops (through conversion of dry land area to cassava or peanut).

The explanatory variables:

As original design, six components of factor analysis was used as explanatory variables, including: Household's capitals (Factor 1), Experience (Factor 2), Maize production scale (Factor 3), Maize productivity (Factor 4), Labor resource (Factor 5), and Gender and non-farm income (Factor 6).

2) Overall test of relationship (Log Likelihood test)

It is hypothesized that:

- Ho = there is no difference between model without independent variables and the model with independent variables.
- Ha = there is a difference between model without independent variables and the model with independent variables (all of the predictor effects are zero).

Table 5.15 Model fitting information

Model	-2LogLikelihood	Chi-square	df	Sig
Intercept only	488.924			
Final	284.433	204.491	18	0.000

In this analysis, the distribution revealed that the probability of the model chi-square (204.491) was 0.000, less than the level of significance of 0.05 ($P<0.05$). The null hypothesis that there is no difference between the model without independent variables and the model with independent variables was rejected. As evidenced in Table 5.15 this suggested that the existence of a relationship between the independent variables and the dependent variable was supported, hence accepting the alternate (Ha) hypothesis.

The Multinomial Logit regression was fitted to analyze the effect of predict variables on the above adaptation options of farmers and in the model, ADP_0 is the reference group.

3) Evaluating usefulness for Logistic models

According to Bayaga (2010), a more useful measure to assess the utility of a multinomial logistic regression model is classification accuracy, which compares predicted group membership based on the logistic model to the actual, known group membership, which is the value for the dependent variable. By this way, the calculation of the proportional by chance accuracy rate was necessary through calculating the proportion of cases for each group based on the number of cases in each group of the response variable.

Table 5.16 Classification table of the model

Observed	Predicted				Percent Correct
	0	1	2	3	
0	39	3	4	0	84.8%
1	4	13	4	7	46.4%
2	4	1	34	14	64.2%
3	1	2	16	34	64.2%
Overall %	26.7%	10.6%	32.2%	30.6%	66.7%

The squaring and summing the proportion of cases (Table 5.14) in each group is: $(0.256^2 + 0.156^2 + 0.294^2 + 0.294^2) = 0.2627$. Bayaga (2010) and El-Habil (2012) also indicated that the benchmark that used to characterize Multinomial Logit model as useful is a 25% improvement over the rate of accuracy achievable by chance alone, so the proportional by chance accuracy criteria is: 1.25 * 0.2627 = 32.84%. The classification overall percentage computed by Limdep was 66.7% while was greater than the proportional by chance accuracy criterion of 32.84% so the criterion for classification accuracy was satisfied (Table 5.16).

4) Results of Multinomial Logit model for adaptation in maize production to drought

The parameter estimates table showed the directions of the effect of the independent variables on the respond variables. As can be seen from the results, Factor 1, Factor 3 and Factor 6 significantly and positively influenced on all adaptation practices of farmers, whilst, Factor 2 had positive and significant impact on ADP_2 and ADP_3. The significant and negative effect of Factor 5 on farmer adaptation was only on ADP_1.

Table 5.17 Parameters estimates of Multinomial Logit model

Factors	**ADP_1**		**ADP_2**		**ADP_3**	
	β(SE)	P[|Z|>z]	β(SE)	P[|Z|>z]	β(SE)	P[|Z|>z]
Intercept	1.987 (0.710)***	0.051	2.546 (0.699)***	0.000	2.159 (0.707)***	0.002
Factor 1	4.204 (0.936)***	0.000	4.543 (0.923)***	0.000	5.805 (0.960)***	0.000
Factor 2	0.568 (0.405)	0.161	0.899 (0.382)**	0.019	1.194 (0.406)***	0.000
Factor 3	2.478 (0.643)***	0.000	0.867 (0.645)*	0.179	2.157 (0.647)***	0.000
Factor 4	0.387 (0.381)	0.310	0.534 (0.353)	0.130	0.612 (0.381)	0.109
Factor 5	-0.718 0.468	0.125	-0.834 (0.434)*	0.055	-0.596 0.451	0.187
Factor 6	1.239 (0.433)***	0.004	1.322 (0.407)***	0.001	1.66 (0.431)***	0.000
Base category:			ADP_0			
Number of observation:			180			
Pseudo-R^2:			0.41			

(*), (**), (***) Significant at 0.1, 0.05, 0.01 probability level, respectively.

B: Coefficient; SE: standard error.

The fact that, the parameter estimates of the MNL model provide only the direction of the effects of the independent variables on the dependent variable, estimates do not represent actual magnitude of change or probabilities (Greene, 2003; Deressa *et al.*, 2009). Marginal effects measure the expect change in probability of adaptation choice with respect to a unit change in components, were discussed. Table 5.18 presented the marginal effects along with the levels of statistical significant.

4.1) No adaptation group (ADP_0)

According to the estimated coefficients of marginal effects, it was observed that when all other independent variables were constant, Factor 1 (ethnicity, education, household type, access to information, access to credit, drought perception level), Factor 3 (maize land area, maize income, distance from market) and Factor 6 (gender of household head and non-farm income) decreased the probability of no adaptation.

Table 5.18 Marginal effects from the Multinomial Logit model

Factors	ADP_0		ADP_1		ADP_2		ADP_3	
	β(SE)	P[|Z|>z]	β(SE)	P[|Z|>z]	β(SE)	P[|Z|>z]	β(SE)	P[|Z|>z]
Intercept	-0.074 (0.025) ***	0.000	-0.055 (0.045)	0.228	0.144 (0.069) **	0.037	-0.149 (0.058)	0.795
Factor 1	-0.157 (0.076) **	0.038	-0.116 (0.074)	0.118	-0.056 (0.085)	0.506	0.329 (0.057) ***	0.000
Factor 2	-0.029 (0.019)	0.127	-0.075 (0.048)	0.122	0.011 (0.05)	0.826	0.093 (0.042) **	0.025
Factor 3	-0.054 (0.026) **	0.040	0.213 (0.05) ***	0.000	-0.319 (0.075) ***	0.000	0.160 (0.053) ***	0.003
Factor 4	-0.017 (0.012)	0.150	-0.028 (0.045)	0.525	0.014 (0.053)	0.798	0.032 (0.043)	0.461
Factor 5	0.024 (0.015)	0.105	-0.002 (0.048)	0.959	-0.054 (0.053)	0.308	0.033 (0.04)	0.417
Factor 6	-0.046 (0.024) *	0.057	-0.029 (0.048)	0.555	-0.014 (0.051)	0.774	0.089 (0.042) **	0.035

(*), (**), (***) Significant at 0.1, 0.05, 0.01 probability level, respectively.

B: Coefficient; SE: standard error.

As from results, one unit change in Factor 1; Factor 3; and Factor 6 negatively declined the probability of no adaptation by 15.7%; 5.4% (significant at 0.05 level); and 4.6% (significant at 0.1 level), respectively. That means households who were ethnic majority, female, high education level, high drought perception, large maize scale production, or high non-farm income, etc., being more likely to adapt at least one adaptation to cope with drought than other households. This result was in line with the previous researches of Deressa *et al.*, (2009), Mudzonga (2011) and Sahu (2013) who had found a positive relationship between education, gender and adaptation to climate change in Ethiopia, Zimbabwe and India. This finding also contributed to confirm the conclusions of Madison (2006) and Hassan *et al.* (2007) that climate phenomena perception had significant influence on adaptation capacity of farmers. Besides, the result partly reflected the elicitation of Deressa *et al.* (2009), Sofoluwe *et al.* (2011), Tazeze *et al.* (2012) and Obayelu (2014) when farmers have higher non-farm incomes, better resources, they can afford the better or higher investment adaptation options for their farm practice.

4.2) Adapt by improving cultivation techniques (ADP_1)

It was found that Factor 3 (maize land area, maize income, the distance from home to market) significantly increased probability to adapt by improving cultivation techniques. One unit change in these variables increased the probability of ADP_1 by 21.3% (significant at 0.01 level). It means that, when the maize land area increased (often accompanied by an increase in maize income), farmers had to apply technical measures such as intercropping, applying drought tolerant varieties or changing sowing day to cope with drought if they did not want to lose the yield. Especially, as results from the observation, the larger own maize land area farmers often lived far from the center. Thus, results from the analysis reflected the real relationship between maize production scale and adaptation practices in the area. Whilst, other factors did not significantly impact on this kind of adaptation in the area.

4.3) Adapt by reducing in cultivated area (ADP_2).

As mentioned earlier, this kind of adaptation was applying by farmers who had not wanted to get risk from maize production under drought's impact. This adaptation option faced negative impact of Factor 3 (maize land area, maize income, distant from home to market) when one unit increased in components of this factor, it decreased the probability of applying ADP_2 by 31.9% (significant at 0.01 level). Obviously, households who wanted to adapt by reducing in amount of cultivated land area had owned less maize land area than others. Besides, the households were living nearly the central market, they had better condition in buying inputs such as drought tolerant seeds, or materials for intercropping (fertilizers, other crop seeds, etc.). Thus, they tended to apply ADP_3 which seem to be the better coping measures comparing with ADP_2.

4.4) Adapt by combining measures in ADP_1 and ADP_2 (ADP_3).

Adapt by combining between improving cultivation techniques and reducing amount of cultivated land area was one of the best choices to cope with drought in the area. This adaptation was significantly and positively impacted by four of six factors in the model.

The estimated coefficients of marginal effects showed that one unit change in Factor 1 increased probability of adapting ADP_3 by 32.9%. It means that ethnic majority household head, high education and drought perception, better approaching credit or information households, etc. were more likely to adapt by combining between "improving cultivation technique measures" and "reducing cultivated land area measures". Because with their capacity (individual and socio-economic potentials), these household realized the increasing impacts of drought on difference land plots of their farm. Therefore, they changed arid land plots to grow cassava (for getting cash) and applied improving cultivation techniques in the rest plots (for keeping food source or livestock) as the most effective measure to cope with drought.

The results also indicated that a unit increase in age and maize experience resulted in a 9.3% increase in the probability of adaptation by combining measures (significant at 0.05 level). This means that when the farmers have high experience they will have better decisions in choosing adaptation practices because as mentioned in the earlier, adaptation by combining measures is a higher level of adaptation than other adaptation practices. The results were in line with Evengelista (2011) and Nhemachena *et al.* (2014) who had found that the farmer's experience increases the probability of uptake of all adaptation options because the experienced farmers have better knowledge and information on changes in climatic conditions.

Whilst, maize production scale (Factor 3) seemed to have a stronger impact on adaptation by combing coping measures (ADP_3). It increased the probability of adapting ADP_3 by 16% (significant at 0.01% level). A long with ADP_1, ADP_3 was one a good adaptation to cope with drought with the households who had larger land area or higher maize income than others. Under the impact of drought, these households firstly, improved cultivation techniques to increase maize productivity and then reduced amount of land if necessary. This kind of households was found in the remote area (far from the central market), who were growing maize as a main crop.

The last factor (Factor 6) gender and non-farm income increased the probability of applying ADP_3 by 8.9%. It can be explained that household with male head household were often more nimble in accessing information and technologies, thus they might easier combine coping measures to cope with drought than the female head households. This finding is in agreement with results obtained by Deressa *et al.* (2009), Legesse *at al.* (2013). These authors had argued that being a male headed household may affect the ability of a household to cope with different climate extreme events. However, this result contradicted with the finding of Nhemachena *et al.* (2007), Shongwe *et al.* (2014) who had argued that female headed households were more likely to take up adaptation options since most of rural farming was done by women. Women therefore, had more farming experience and information on crop management practices than men. Whilst, non-farm income households were often more proactive in investment capital, therefore, they could afford to choose the good adaptation practices in maize production to maintain maize productivity.

Finally, the result found that Factor (4) maize productivity and Factor (5) labor source insignificant influenced on all adaptation practices to cope with drought in the area.