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Vulnerability to Climate Change:
Adaptation Strategies and Layers of Resilience

Farmers' Perception of Climate Change in Thailand: Grassroots Level Insights

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Abstract

This report was prepared as part of the ADB funded project "Vulnerability to Climate Change: Adaptation Strategies and Layers of Resilience". The study tried to address the perception of farmers on changes in climate variables, trends in village level institutions and other socio-economic variables such as cropping pattern, natural resources, constraints in effective adaptation. Purposive stratified sampling techniques were adopted in selecting the study area and the households. Four villages from northeast region of Thailand (two villages from Chok Chai district and 2 villages from Chatturat district) were selected for this study. Both quantitative and qualitative data were collected through farmer surveys, group discussions and key informant interviews. The villagers perceived a reduction in rainfall and increase in variability including onset of major rainy season. The villages have been experiencing increased incidence of drought resulting in yield loss, non- availability of water for irrigation, increased pest and diseases attack, and migration. Farmers perceived a minor increase in agriculture over the years; however, there is still a trend of diversification of livelihood among farmers from traditional agriculture to high-value crops and other non-agricultural sectors. Over the years, there have been slow but steady improvements in the human development indicators, village infrastructure and collective initiatives in all the study villages. Increased diversification in cropping pattern, improvement in market access, etc, are seen in these villages. The rural community in the study villages tries to cope with these changes by reducing expenses on food, working as agricultural or non-farm labor, leasing crop land, making changes in cropping pattern and in crop management strategies. The higher degree of impact of these climate-related risks is comparatively on landless and smallholder farmers than on medium and large farmers. They have identified a list of constraints that prevents them from succeeding in efficient adaptation such as lack of sufficient information on climate change and potential adaptation technologies, sufficient support programs, market and other livelihood options.

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1. Introduction

Climate change is expected to have serious environmental, economic and social impacts on Thailand. Rural farmers in particular are likely to be affected as their livelihoods mostly depend upon the use of natural resources. The extent of these impacts depends on farmers' perception and adaptation response to climate change. It has been shown in Report No. 1 on the Thailand climate analysis that there was a notable climate variation during the past 39 years (1970-2008) associated with rainy days and warmer conditions. This situation occurs over Thailand, but its northeast is the most vulnerable region to climate change as shown in the vulnerability analysis in Report No. 2. These reports provide the basis for climate change/variability and the target area for subsequent study.

This research is aimed at examining how farmers' perceptions correspond with climatic analysis and analyze farmers' adaptation responses to climate change/variability. Both qualitative and quantitative data was analyzed based on household surveys and focus group data. It was anticipated from this research that a better understanding on how farmers realize and cope with the impact to climate change/variability will be observed. An institutional involvement that can help reduce the potential impacts will bring about the required policy recommendation.

2. Methodology

Two districts (sub-regions) in the northeast region lying in the hot spot of the lowest rainfall area in Thailand were chosen to be the targeted sites, namely Chatturat District in Chaiyaphum Province and Chok Chai District in Nakhon Ratchasima Province. The village status database (NRD2C) of the Community Development Department was used to classify village level target sites. Lowland to total area ratio for each village in the 2 districts was analyzed to define the main cropping situation. Each district was divided into 2 classes or strata. The first is the more lowland area, of which the ratio is equal or more than 0.6, and the second is the upland or less lowland, of which the ratio is less than 0.6. After that, one village from each class was randomly sampled. This ended up with 4 villages, two from Chok Chai, Nakorn Ratchasima Province, namely Baan Don Plai (DP: ratio =0.7-1.0) and Baan Kudsawai (KS: ratio = 0.4), and the others from Chatturat, Chaiyaphum Province, namely Baan Nong Muang (NM: ratio = 0.5) and Baan Tha Taeng (TT: ratio= 0.6).

The households in each village were classified into 4 clusters according to farm size and nominated 0 (0 - 0.16 ha), 0-2 (0.17 - 1.6 ha), 2-4 (1.61 - 3.2 ha) and more than 4 ha (3.2 ha). Subsequently, 40 households in each village were randomly sampled to the proportion of the clusters. The number of study households in each cluster is shown in Table 1.

Table 1. Number of households from the 4 clusters in 4 targeted villages of 2 sub-regions.

	Chok Chai District, Nakhon Ratchasima		Chatturat District, Chaiyaphum	
Farm Size (hectare)	DP (Don Plai)	KS (Kudsawai)	NM (Nong Muang)	TT (Tha Taeng)
0	6	3	0	1
0-2	16	19	7	1
2-4	5	8	10	7
>4	13	10	23	31
Total	40	40	40	40

2.1 Data collected

1. Quantitative data on agriculture, social and economic matters for the period of 1970-1990 and 1990-2008
2. Source of data in each village: 1 key informant group (village level) and 40 farmer households (household level).
3. Qualitative data on farmers' perception in climate variability, impact, adaptation,
4. Institutional intervention and coping strategies on agriculture, social and economic matters.

The respondents for this were divided into 2 major categories composed of

a. Focus Group Discussion

Six groups of 8-12 people in each village were composed

a. village leader
b. women
c. landless or marginal farm holders (0 ha)
d. small farm holders (0 - 2 ha)
e. medium farm holders (2 - 4 ha)
f. large farm holders (more than 4 ha)

b. Individual farmer

Ten to fifteen individual farmers, ie, 2-3 farmers from each group, were randomly sampled to be the respondents.

2.2. Analytical tool

The socioeconomic data was analyzed using SPSSTM software version of 11.5 and MS Excel. Descriptive statistics; means, maximum, minimum, percentage and frequency were used to explain socioeconomic characteristics.

3. Profile of area under study

3.1 Demographic

Don Plai (DP) and Kud Sawai (KS) villages, Nakhon Ratchasima Province, are mainly lowland areas both with and without irrigation from Lum Chae Dam, whereas Nong Muang (NM) and Tha Taeng (TT), Chaiyaphum Province, are mainly upland with some irrigated areas from small reservoirs, which may not be active in the dry season. These have fewer paddy fields than the first two villages. DP and NM villages have a large number of households (266 and 257 HH, respectively). Proportion of female to male is the same in the 4 villages which is 1:1. Most farmers had finished their primary school. For DP and KS village, most villagers fall into the small farm holder HH group (0-2 ha) of about 45 and 68%, respectively, but NM villagers are in medium landholders HH (2-4 ha) of 77% and TT's landholdings are large (47%) and medium HH (44%). DP has a larger irrigated area than the other villages, and NM has the smallest.

Agricultural areas in KS, NM and TT occupy more than 85% of the total village area, whereas in DP it is 66%. Some areas in DP probably have canal irrigation and other water sources (Table 2).

Livestock is not a major source of livelihood in the villages, but farmers raise them for self- consumption, and to work in farms and as a means of supplementary income when needed. Chicken rearing is very popular and stands first in DP and NM. Rearing cattle ranks second. There are also some buffaloes in DP and swine in NM and TT (Table 3).

Table 2. Demography of the study villages.

		DP	KS	NM	TT
Demographic features	Population	1116	780	916	323
	No. of household	266	176	257	96
	Gender (female : male)	1 : 1	1 : 1	1 : 1	1.3 : 1
	Education	Mostly primary school	Mostly primary school	Mostly primary school	Mostly primary school
Geographic area		lowland	lowland	upland	upland
Landless HH (%)		11	12	3	5
Small HH (0-2 ha) (%)		45	68	0	4
Medium HH (2-4 ha) (%)		26	12	77	44
Large HH (>4 ha) (%)		18	8	20	47
Total area (ha)		1,072	358	800	466
Net cropped area (ha)		707 (66%)	342 (96%)	718 (90%)	405 (87%)
% Irrigated area (of net cropped area)		50	23	3	16

Table 3. Livestock population of the study villages.

Livestock population	DP	KS	NM	TT
Cattle	100	13	300	300
Buffaloes	35	-	-	-
Poultry	2,600	300	1,000	500
Swine	-	-	20	20

3.2 Climatic

The climate analysis in the four targeted villages (Table 4) came from 2 meteorological stations, Chok Chai, Nakhon Ratchasima Province and Chaiyaphum Province. Annual rainfall between 1970 and 2008 in DP and KS showed an average of 1,086 mm. There was an overall increase of 0.29 mm within 39 years, whereas in NM and TT villages it showed an average of 1,114 mm. The overall decrease was 0.023 mm. The wettest month is September. The mean maximum temperature for 39 years was averaged 32.5°C in DP and KS and 32.6°C in NM and TT. The mean minimum temperature for 39 years was 22.1°C in DP and KS and 22.5°C in NM and TT. April is the hottest month in all the 4 villages and the onset of monsoon was mostly around the middle of May. However there are early showers in February, when farmers can prepare the land before cropping, and this is done in all the villages. Finally, the number of annual rainy days in NM and TT are less than in DP and KS (average of 101 days in 39 years, versus 112 days). However, there was more rainfall in NM and TT than in DP and KS.

Table 4. Climatic characteristics of the four study villages.

	Chok Chai Met. Station		Chaiyaphum Met. Station	
Climatic factor	DP	KS	NM	TT
Average annual rainfall 1970-2008 (mm)	1,086 (Average Increase 0.29 mm)	1,086 (Average increase 0.29 mm)	1,114 (Average decrease 0.023 mm)	1,114 (Average decrease 0.023 mm)
Wettest month	September	September	September	September
Max. temperature (°C)	32.5	32.5	32.6	32.6
Min. temperature (°C)	22.1	22.1	22.5	22.5
Hottest month	April	April	April	April
Onset of monsoon	May	May	May	May
Earliest rain (possible start of cropping)	February	February	February	February
End of monsoon	October	October	October	October
Number of rainy days	112	112	101	101

Source: 39 years (1970-2008) climatic analysis

3.3 Livelihood

3.3.1 Primary occupation (farm and non-farm)

More than 80 percent of the villagers are dependent on agriculture in all the study villages. This showed an increase of less than 20% (3-13%) in the last 39 years (Table 5). About 25 percent in DP, 33 percent in KS, 58 percent in NM and 48 percent in TT villages earn their living by working as agricultural laborers. There was a drastic decrease in this figure within 39 years (1970-2008) in all the villages. Some farmers work in two places -- in their own farms and in the neighbor's farms -- at the same time. General labor is mainly for landless or marginal villagers, 5 percent in DP (no change), 10 percent in KS (major increase), 3 percent in NM (minor decrease) and 5 % in TT (major increase). Of late, none of the villagers are turning to factory work in all the villages. There is no change in 3 villages but there is a high decrease in Tha Taeng. Occupation in business is more in KS (13 percent than in the other three villages. Service jobs are more in KS (8 percent), but this figure decreased by 29 percent from 1970. Other occupations such as out migration jobs are 33 percent in DP, KS and NM, but none in TT. The villagers sell forest products, wild vegetables and mushrooms and earn 5% of their incomes from this in DP, 0% in KS, 3% in NM and 15% in TT. This indicates that there is more forest fertility in TT village than in the others.

Table 5. Primary occupations in the study villages.

	DP		KS		NM		TT	
Primary occupation	%	Farmers perception* (%)	%	Farmers perception* (%)	%	Farmers perception* (%)	%	Farmers perception* (%)
Agriculture	83	1(3)	95	1(13)	100	1(3)	90	1(3)
Labor								
- Agricultural Labor	25	-2(60)	33	-2(43)	58	-2(28)	48	-2(32)
- General Labor	5	0(0)	10	2(41)	3	-1(9)	3	2(59)
- Factory Labor	0	0(0)	0	0(0)	0	0(0)	0	-2(50)
Business	8	2(50)	13	2(29)	3	2(50)	5	2(100)
Service	5	2(25)	8	-2(29)	5	2(50)	3	2(50)
Others								
- Out migration	33	2(50)	33	-2(30)	33	0	0	-2(50)
- Sale of fuel wood, forest products	5	-2(25)	0	-2(50)	3	-2(25)	15	1(18)

*{-2 major decrease (>20% decrease),-1 minor decrease (<20% decrease), 0 no change, 1 minor increase (<20% increase), 2 major increase (>20% increase)}

Note: Total percentage exceeded 100 because of multi-occupation households.

Tables 5.1, 5.2, 5.3 and 5.4 show that landless and smallholder farmers occupy themselves more with agricultural labor than medium and large-scale farmers. In KS village, farmers of all classes do several jobs involving farm and non-farm labor, and making of handicraft goods such as baskets. Fishing equipment is a famous Thai One Tambon (or Town) One Product (OTOP) product of this village. Smallholder, medium and large-scale farmers also earn their living by indulging in agricultural labor of 71, 70 and 48%, respectively. In TT village, landless farmers do not work in their own or rented land, as in DP and KS, because there is not much paddy land to rent. Instead, they all join as agricultural labor (100%). Medium (43%) and large farmers (48%) also follow this trend.

Table 5.1. Primary occupations in the study villages (% of studied household in 2008) – Don Plai (DP).

	Landless		Small		Medium		Large	
Primary occupation	%	Farmers perception* (%)	%	Farmers perception* (%)	%	Farmers perception* (%)	%	Farmers perception* (%)
Agriculture	83	1(13)	88	1(4)	60	-1(-13)	85	1(5)
Labor								
- Agricultural Labor	33	-2(30)	31	-1(16)	20	-2(-33)	15	-2(-42)
- General Labor	0	0	13	0(0)	0	0	0	0
- Factory Labor	0	-2(50)	0	0	0	0	0	0
Business	0	0	13	2(50)	0	0	8	2(50)
Service	0	0	6	0(0)	0	0	8	0(0)
Others								
- Handicraft making	0	0	0	0	0	0	0	0
- Out migration	0	0	0	0	0	0	8	2(50)
- Sale of fuel wood, forest products	0	-2(50)	0	0	20	-2(-25)	8	0

*{-2 major decrease (>20% decrease),-1 minor decrease (<20% decrease), 0 no change, 1 minor increase (<20% increase), 2 major increase (>20% increase)}

Table 5.2. Primary occupation of the study villages (% of studied household in 2008) – Kud Sawai (KS).

	Landless		Small		Medium		Large	
Primary occupation	%	Farmers perception* (%)	%	Farmers perception* (%)	%	Farmers perception* (%)	%	Farmers perception* (%)
Agriculture	100	2(25)	95	1(14)	100	1(7)	90	1(17)
Labor								
- Agricultural Labor	33	-2(-25)	42	-1(-11)	25	-1(-9)	20	-1(-8)
- General Labor	33	2(50)	5	0(0)	13	0(0)	10	2(25)
- Factory Labor	0	0	0	0(0)	0	-2(-50)	0	0
Business	0	0	5	-2(-25)	0	0	40	2(100)
Service	0	0	11	-2(-29)	13	-2(-25)	0	0
Others								
- Handicraft goods making	33	2(50)	63	2(73)	38	2(75)	50	-
- Out migration	0	0	5	-2(-25)	13	0	0	2(-50)
- Sale of fuel wood, forest products	0	-2(-50)	0	-2(-50)	0	0	0	0

*{-2 major decrease (>20% decrease),-1 minor decrease (<20% decrease), 0 no change, 1 minor increase (<20% increase), 2 major increase (>20% increase)}

Table 5.3. Primary occupations in the study villages (% of studied household in 2008) – Nong Muang (NM).

	Landless**		Small		Medium		Large	
Primary occupation	%	Farmers perception* (%)	%	Farmers perception* (%)	%	Farmers perception* (%)	%	Farmers perception* (%)
Agriculture			100	1(8)	100	0(0)	100	1(2)
Labor								
- Agricultural Labor			71	-1(-8)	70	-1(-5)	48	-1(-20)
- General Labor			0	0	10	2(25)	0	-2(-50)
- Factory Labor			0	0	0	0	0	0
Business			0	0	0	0	4	2(50)
Service			0	0	0	-2(-50)	9	2(50)
Others								
- Handicraft making			0	0	0	0	0	0
- Out migration			0	-2(-50)	0	0	4	2(50)
- Sale of fuel wood, forest products			14	0	0	0	0	-2(-50)

*{-2 major decrease (>20% decrease), -1 minor decrease (<20% decrease), 0 no change, 1 minor increase (<20% increase), 2 major increase (>20% increase)}

** = no farmer in this class

Table 5.4. Primary occupations in the study villages (% of studied household in 2008) – Tha Taeng (TT).

	Landless		Small		Medium		Large	
Primary occupation	%	Farmers perception* (%)	%	Farmers perception* (%)	%	Farmers perception* (%)	%	Farmers perception* (%)
Agriculture	0	-2(-50)	100	0	86	1(10)	94	1(4)
Labor								
- Agricultural Labor	100	0	0	0	43	-1(-20)	48	-1(-15)
- General Labor	0	-2(-50)	0	0	0	-2(-50)	3	1(13)
- Factory Labor	0	0	0	0	0	0	0	-2(-75)
Business	0	0	0	0	0	0	6	2(100)
Service	0	0	0	0	0	0	3	2(50)
Others								
- Handicraft making	0	0	0	0	0	0	3	0
- Out migration	0	0	0	0	0	0	0	-2(-50)
- Sale of fuel wood, forest products	0	0	0	0	14	-1(-9)	16	2(33)

*{-2 major decrease (>20% decrease),-1 minor decrease (<20% decrease), 0 no change, 1 minor increase (<20% increase), 2 major increase (>20% increase)}

3.3.2 Human Development Indicators

Food supply, housing, infant and mother health care, general health care, availability of drinking water, purchasing capacity, education and information flow show better development in all the study villages over 40 years (Tables 6, 7, 8, 9). In contrast, availability of farm land has been low in the last 20 year period. The possible reasons cited are - selling of land or dividing land into small pieces for children to

Table 6. Livelihood of the study villages – Don Plai (DP).

Human Development Indicators	1970	1990	2008	Perception
% Households unable to get even 2 meals a day	0	3	0	Highly decreased
% Households having wooden huts	40	30	6	Highly decreased
% Households having cement houses	60	70	94	Highly increased
Availability of farm land	yes	yes	lower	Highly decreased
Availability of drinking water	good	good	good	No change
Quality of drinking water	good	good	lower	Slightly decreased
Child nutrition	good	good	good	No change
Infant mortality	high	low	none	Highly decreased
Child mortality	low	little	little	Slightly decreased
Maternal mortality	none	none	none	No change
General health of the people	good	good	better	Highly increased
Ability to cope with drought	low	good	better	Highly increased
Availability of consumer goods	low	good	better	Highly increased
Ownership of durable goods	low	good	better	Highly increased
Availability of energy sources for cooking	low	low	good	Highly increased
Availability of energy sources for lighting	Low	good	better	Highly increased
Education/ Literacy	low	good	better	Highly increased
Information flow	low	good	better	Highly increased

Table 7. Livelihood of the study villages – Kud Sawai (KS).

Human Development Indicators	1970	1990	2008	Perception
% Households unable to get even 2 meals a day	0	0	0	No change
% Households having wooden huts	100	50	0	Highly decreased
% Households having cement houses	0	50	100	Highly increased
Availability of farm land	yes	yes	lower	Slightly decreased
Availability of drinking water	good	good	good	No change
Quality of drinking water	good	good	lower	Slightly decreased
Child nutrition	good	good	good	No change
Infant mortality	none	none	none	No change

Continued

Table 7. Livelihood of the study villages – Kud Sawai (KS) *continued.*

Human Development Indicators	1970	1990	2008	Perception
Child mortality	none	none	none	No change
Maternal mortality	none	none	none	No change
General health of the people	good	good	worse	Slightly decreased
Ability to cope with drought	good	good	better	Highly increased
Availability of consumer goods	lower	low	good	Highly increased
Ownership of durable goods	lower	low	good	Highly increased
Availability of energy sources for cooking	low	low	good	Highly increased
Availability of energy sources for lighting	Low	good	better	Highly increased
Education/ Literacy	low	good	better	Highly increased
Information flow	low	good	lower	Slightly decreased

Table 8. Livelihood of the study villages – Nong Muang (NM).

Human Development Indicators	1970	1990	2008	Perception
% Households unable to get even 2 meals a day	0	0	0	No change
% Households having wooden huts	40	20	2	Highly decreased
% Households having cement houses	60	80	98	Highly increased
Availability of farm land	yes	yes	yes	No change
Availability of drinking water	low	good	good	Slightly increased
Quality of drinking water	low	good	good	Slightly increased
Child nutrition	good	good	better	Highly increased
Infant mortality	low	none	none	Highly decreased
Child mortality	low	none	none	Highly decreased
Maternal mortality	low	none	none	Highly decreased
General health of the people	Very good	good	good	Slightly decreased
Ability to cope with drought	low	low	good	Highly increased
Availability of consumer goods	low	good	better	Highly increased
Ownership of durable goods	low	good	better	Highly increased
Availability of energy sources for cooking	low	low	good	Highly increased
Availability of energy sources for lighting	Lower	low	good	Highly increased
Education/ Literacy	low	good	better	Highly increased
Information flow	low	good	better	Highly increased

Table 9. Livelihood of the study villages – Tha Taeng (TT).

Human Development Indicators	1970	1990	2008	Perception
% Households unable to get even 2 meals a day	0	0	0	No change
% Households having wooden huts	0	0	0	No change
% Households having cement houses	0	0	yes	Highly increased
Availability of farm land	yes	yes	yes	No change
Availability of drinking water	yes	yes	yes	No change
Quality of drinking water	good	good	lower	Decreased
Child nutrition	low	good	better	Highly increased
Infant mortality	none	none	none	No change
Child mortality	none	none	none	No change
Maternal mortality	none	none	none	No change
General health of the people	good	good	good	No change
Ability to cope with drought	lower	good	good	Highly increased
Availability of consumer goods	low	good	better	Highly increased
Ownership of durable goods	low	good	better	Highly increased
Availability of energy sources for cooking	low	good	better	Highly increased
Availability of energy sources for lighting	low	low	better	Highly increased
Education/ Literacy	low	low	better	Highly increased
Information flow	low	good	better	Highly increased

inherit. The villagers are able to afford more for consumer goods and durable goods such as refrigerators, televisions, etc. Energy sources for cooking used to be from firewood collected in the forest, these days natural gas is widely used. Also, electricity has been available in the villages for the last 20 years. Children now have more opportunities to study in the nearby secondary schools than they had in the past.

3.3.3 Other Information on Livelihood

Table 10 shows that formation of groups to improve farmer livelihoods in the village has highly increased. The groups are mostly informal, and have been introduced by the government projects, for example, sufficiency economic group, compost producing group and self-forming such as irrigation water user and vegetable producing group. Some are formed by a joint agreement and cooperation from both sides. Wells and tube wells were dug for household use, and have recently been increased to ensure sufficient water. Women in the village are housewives and help their husbands in farm work. They also help by earning supplementary income in case of crop yield loss. Forming supplementary career groups is a good way to overcome such problems.

Table 10. Some factors concerning livelihood of the study villages.

Factors concerning villagers livelihood	Perception			
	DP	KS	NM	TT
Farmers associations/ groups/ societies in the village	Highly increased (irrigation water user group)	Highly increased	Highly increased (compost producing group, etc.)	Highly increased (sufficiency economic gr., vegetable producing gr., etc)
Co-operative societies in the village	None	None	1	None
Producers organization	None	None	None	Highly increased
Watersheds/ ponds in the village	None	Slightly decreased	No change	Highly increased
Wells in the village	None	Slightly decreased	Highly increased	None
Tube wells in the village	Highly increased	Highly decreased	Slightly increased	Highly increased
Housewives/Women groups	Highly increased	Highly increased	Highly increased	None
Self-help groups (SHGs)	Highly increased	Highly increased	Highly increased	Slightly increased
Type of SHGs (eg, Micro-finance)	Micro-finance, supplementary career	Micro-finance, basket work career	Micro-finance, savings, silk weaving, dressmaker	Poverty solving group, sufficiency economic group, vegetable producing group
Agricultural produce center	1 Fertilizer warehouse	None	1 community rice mill	1 Agricultural Learning Centre
Private	1 Gas station, 1 animal feed mill	Highly decreased	Slightly increased	None
NGOs/ Community based organizations	none	None	None	None

3.4 Cropping pattern

Average size of land holding in TT (4.8 ha) and DP (4.0 ha) are larger than in NM (3.1 ha) and KS (2.0 ha). The village cropping pattern profile of Thailand was completed only in the recent years, which clearly show the difference in crop types. In DP and KS, in the areas which are more lowland, rice is grown more than field crops such as cassava. On the other hand, rice is grown less in NM and TT, which are more upland (Table 11). There are many crops cultivated in each village, both annual and perennial. Fruit crops like mango, bananas, tamarind and guava, and medicinal herbs and vegetables (chilli, basil, etc) are also grown. Other newly introduced crops are eucalyptus and neem trees. Proportion of rice growing area to total area is 65% in DP, 70% in KS, 28% in NM and 20% in TT. While comparing the proportion of rice to the cassava growing area, from 30 years ago to the present day, it was found that DP is now growing

Table 11. Change in cropping pattern for different periods in study villages.

Villages	1975-76			2007-08		
	Average size of landholding (ha)	Proportion of area under food grain production (%)	Proportion of rice: cassava: other crops growing area (%)	Average size of landholding (ha)	Proportion of area under food grain production (%)	Proportion of rice: cassava: other crops growing area (%)
Don Plai	NA*	NA	25 : 75: 00	4.0	65	51 : 28: 21
Kudsawai	NA	NA	70 : 30: 00	2.0	70	60 : 40: 00
Nong Muang	NA	NA	60 : 30: 10	3.1	28	31 : 49: 20
Tha Taeng	NA	NA	20 : 43: 27	4.8	20	23 : 66: 11

*Data not available

more rice (dry season rice) because of the availability of irrigation. KS slightly decreased the growth of rice because of less access to irrigation even though there is water. NM's rice area has highly decreased due to less water sources and drought condition, and farmers are shifting to field crops like cassava. TT's rice area cultivation has not changed much, but the growth of cassava has increased.

In DP village, landless, small and large farm holders grew more rice from 1970-2008 but medium farmers grew less. Most landless or marginal farmers in each village rent land to grow crops and some become farm laborers for supplementary income. Both medium and large farmers have now increased cassava growing because of the higher price it fetches and its drought tolerance. Another change for cassava is the growing season is now all year round. Chilli and vegetables are supplementary cash crops. Mango is another cash crop in this village for any size of farm (Tables 12 and 13).

Table 12. Cropping pattern of villages (%) – Don Plai (DP).

Crops	Landless			Small			Medium			Large		
	1970	1990	2008	1970	1990	2008	1970	1990	2008	1970	1990	2008
Early rainy												
Paddy*	67	83	83	81	81	88	80	60	60	77	85	85
Maize*	0	17	0	6	6	0	0	0	0	8	15	8
Sugarcane	0	0	0	0	0	0	0	0	0	0	15	8
Cassava*	0	0	0	6	19	0	20	60	100	31	62	100
Kenaf / Roselle												
Late rainy												
Maize												
Chilli*	0	0	17	13	13	13	0	0	0	23	23	15
Cassava												
Dry												
Paddy												
Vegetables	17	17	17	13	19	19	0	0	0	31	39	31
Chilli												
Others												

Continued.

Table 12. Cropping pattern of villages (%) – Don Plai (DP) *continued.*

	Landless			Small			Medium			Large		
Crops	1970	1990	2008	1970	1990	2008	1970	1990	2008	1970	1990	2008
Perennial												
Eucalyptus	0	0	0	0	0	0	0	0	0	0	0	15
Mango	17	17	17	13	19	19	20	40	0	8	15	23
Banana	17	17	33	0	0	0	0	0	0	15	15	31
Medicinal herbs	0	0	0	6	13	13	0	0	0	0	0	0
Neem tree	0	0	0	0	6	6	0	0	0	0	0	0
Coconut	0	0	0	0	0	0	0	0	0	0	0	8
Annual												
Sugarcane												
Cassava												
Legumes	0	0	0	6	6	0	0	0	0	15	8	0

* Paddy, maize, cassava and chilli were not separated by growing season.

Table 13. Change in cropping pattern of villages* (%) – Don Plai (DP).

	Landless		Small		Medium		Large	
Crops	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Early rainy								
Paddy	2(25)	0	0	1(8)	-2(-25)	0	1(10)	0
Maize	2(100)	-2(-100)	0	-2(-100)	0	0	2(100)	-2(-50)
Sugarcane	0	0	0	0	0	0	2(100)	-2(-50)
Cassava	0	0	2(200)	-2(-100)	2(200)	2(67)	2(100)	2(63)
Kenaf / Roselle	0	0	0	0	0	0	0	0
Late rainy								
Maize								
Chilli	0	2(100)	0	0	0	0	0	-2(-33)
Cassava								
Dry								
Paddy								
Vegetables	0	0	2(50)	0	0	0	2(25)	-1(-20)
Chilli								
Perennial								
Eucalyptus	0	0	0	0	0	0	0	2(100)
Mango	0	0	2(50)	0	2(100)	-2(-100)	2(100)	2(50)

Continued.

Table 13. Change in cropping pattern of villages* (%) – Don Plai (DP) *continued.*

	Landless		Small		Medium		Large	
Crops	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Banana	0	2(100)	0	0	0	0	0	2(100)
Medicinal herbs	0	0	2(100)	0	0	0	0	0
Neem tree	0	0	2(100)	0	0	0	0	0
Coconut	0	0	0	0	0	0	0	2(100)
Annual								
Sugarcane								
Cassava								
Legumes	0	0	0	-2(-100)	0	0	-2(-50)	-2(-100)

*{-2 major decrease (>20% decrease), -1 minor decrease (<20% decrease), 0 no change, 1 minor increase (<20% increase), 2 major increase (>20% increase)}

In KS village, rice cultivation has highly increased for landless, small and medium farm holders, but for large ones it slightly reduced during the last 20 years as they shifted to cassava. All classes of farmers grow cassava. Chilli and vegetables as well as mango are grown as cash crops by medium and large farm holders (Tables 14 and 15).

Table 14. Cropping pattern of villages (%) – Kud Sawai (KS).

	Landless			Small			Medium			Large		
Crops	1970	1990	2008	1970	1990	2008	1970	1990	2008	1970	1990	2008
Early rainy												
Paddy*	67	100	100	74	90	95	88	100	100	70	100	90
Maize*	0	0	0	11	5	0	0	0	0	10	0	0
Sugarcane	0	0	0	0	0	0	0	0	0	10	0	0
Cassava*	33	33	33	5	16	21	13	13	13	30	70	70
Kenaf / Roselle	0	0	0	5	0	0	0	0	0	10	0	0
Late rainy												
Maize												
Chilli*	0	0	0	0	0	0	25	25	25	10	20	20
Cassava												
Dry												
Vegetables	0	0	0	11	5	16	25	25	38	30	40	50
Others												

Continued.

Table 14. Cropping pattern of villages (%) – Kud Sawai (KS) *continued.*

	Landless			Small			Medium			Large		
Crops	1970	1990	2008	1970	1990	2008	1970	1990	2008	1970	1990	2008
Perennial												
Eucalyptus	0	0	0	0	0	0	0	0	0	0	0	0
Mango	0	0	0	0	0	5	0	13	25	20	20	20
Banana	0	0	0	0	5	16	0	0	0	0	10	10
Medicinal herbs	0	0	0	0	0	0	0	0	0	0	0	0
Neem tree	0	0	0	0	0	0	0	0	0	0	0	0
Coconut	0	0	0	0	0	0	0	0	0	10	20	20
Annual												
Sugarcane												
Cassava												
Legumes	0	0	0	5	5	0	0	0	0	10	0	0

* Paddy, maize, cassava and chilli were not separated by growing season.

Table 15. Change in cropping pattern of villages* (%) – Kud Sawai (KS).

	Landless		Small		Medium		Large	
Crops	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Early rainy								
Paddy	2(50)	0	2(21)	1(6)	1(14)	0	2(43)	-1(-10)
Maize	0	0	-2(-50)	-2(-100)	0	0	-2(-100)	0
Sugarcane	0	0	0	0	0	0	-2(-100)	0
Cassava	0	0	2(200)	2(33)	0	0	2(133)	0
Kenaf/Roselle	0	0	-2(-100)	0	0	0	-2(-100)	0
Late rainy								
Maize								
Chilli	0	0	0	0	0	0	2(100)	0
Cassava								
Dry								
Paddy								
Vegetables	0	0	-2(-50)	2(200)	0	2(50)	2(33)	2(25)
Chilli								
Perennial								
Eucalyptus	0	0	0	0	0	0	0	0

Continued.

Table 15. Change in cropping pattern of villages* (%) – Kud Sawai (KS) *continued.*

	Landless		Small		Medium		Large	
Crops	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Mango	0	0	0	2(100)	2(100)	2(100)	0	0
Banana	0	0	2(100)	2(200)	0	0	2(100)	0
Medicinal herbs	0	0	0	0	0	0	0	0
Neem tree	0	0	0	0	0	0	0	0
Coconut	0	0	0	0	0	0	2(100)	0
Annual								
Sugarcane								
Cassava								
Legumes	0	0	0	-2(-100)	0	0	-2(-100)	0

*{-2 major decrease (>20% decrease),-1 minor decrease (<20% decrease), 0 no change, 1 minor increase (<20% increase), 2 major increase (>20% increase)}

In NM village, small, medium and large farm holders slightly increased rice cultivation from 1970-2008. The cultivation of cassava has increased every period for the 3 classes of farm holders. Roselle or kenaf used to be a cash crop in the village, but its cultivation was decreased and is now given up because it needs a lot of water in the process of retting fibre. Besides, it also causes some pollution. Maize, chilli, vegetables, mango, bananas and legumes are other cash crops (Tables 16 and 17).

Table 16. Cropping pattern of villages (%) – Nong Muang (NM).

	Landless**			Small			Medium			Large		
Crops	1970	1990	2008	1970	1990	2008	1970	1990	2008	1970	1990	2008
Early rainy												
Paddy*				86	100	100	100	100	100	96	96	100
Maize*				29	29	29	0	0	0	4	17	9
Sugarcane				0	0	0	0	0	10	0	0	4
Cassava*				29	57	71	70	90	100	44	74	78
Kenaf / Roselle				43	29	0	50	20	0	57	52	9
Late rainy												
Maize												
Chilli*				0	0	0	30	20	30	22	26	22
Cassava												
Dry												
Paddy												
Vegetables				29	29	29	20	10	10	17	17	17
Chilli												
Others												

Continued.

Table 16. Cropping pattern of villages (%) – Nong Muang (NM) *continued.*

	Landless**			Small			Medium			Large		
Crops	1970	1990	2008	1970	1990	2008	1970	1990	2008	1970	1990	2008
Perennial												
Eucalyptus				0	0	0	0	0	10	0	4	22
Mango				0	0	0	20	30	30	26	30	39
Banana				14	14	14	20	20	20	17	17	22
Medicinal herbs				0	0	0	0	0	0	0	0	4
Neem tree				0	0	0	0	0	0	0	0	0
Coconut				0	0	0	0	0	0	9	9	9
Annual												
Sugarcane												
Cassava												
Legumes				14	14	14	10	10	10	13	13	4

* Paddy, maize, cassava and chilli were not separated by growing season.

** = no farmer in this class

Table 17. Change in cropping pattern of villages* (%) – Nong Muang (NM).

	Landless		Small		Medium		Large	
Crops	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Early rainy								
Paddy			1(17)	0	0	0	0	1(5)
Maize			0	0	0	0	2(300)	-2(-50)
Sugarcane			0	0	0	2(100)	0	2(100)
Cassava			2(100)	2(25)	2(29)	2(11)	2(70)	2(6)
Kenaf / Roselle			-2(-33)	-2(-100)	-2(-60)	-2(-100)	-1(-8)	-2(-83)
Late rainy								
Maize								
Chilli			0	0	-2(-33)	2(50)	1(20)	-1(-17)
Cassava								
Dry								
Paddy								
Vegetables			0	0	-2(-50)	0	0	0
Chilli								

Continued.

Table 17. Change in cropping pattern of villages* (%) – Nong Muang (NM) *continued.*

Crops	Landless		Small		Medium		Large	
	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Perennial								
Eucalyptus			0	0	0	2(100)	2(100)	2(400)
Mango			0	0	2(50)	0	1(17)	2(29)
Banana			0	0	0	0	0	2(25)
Medicinal herbs			0	0	0	0	0	2(100)
Neem tree			0	0	0	0	0	0
Coconut			0	0	0	0	0	0
Annual								
Sugarcane								
Cassava								
Legumes			0	0	0	0	0	-2(-67)

*{-2 major decrease (>20% decrease),-1 minor decrease (<20% decrease), 0 no change, 1 minor increase (<20% increase), 2 major increase (>20% increase)}

In TT village, landless or marginal farms decreased the cultivation of rice in the last 20 years but the smallholder farmers still grow it. Medium and large farms have increased the growth of rice, maize and sugarcane from 1970 to 2008. Cassava is a major cash crop for all farm sizes but smallholder farmers have only recently starting cultivating it. Roselle growing was cancelled from 1990 for landless and smallholder farms, but medium and large farmers cancelled it in the recent years. Chilli, vegetables, mango, coconut and legumes are also cash crops for nearly all farm sizes (Tables 18 and 19).

Table 18. Cropping pattern of villages (%) – Tha Taeng (TT).

Crops	Landless			Small			Medium			Large		
	1970	1990	2008	1970	1990	2008	1970	1990	2008	1970	1990	2008
Early rainy												
Paddy*	100	100	0	100	100	100	71	71	86	87	90	94
Maize*	0	0	0	0	0	0	14	29	71	29	39	52
Sugarcane	0	0	0	0	0	0	0	14	14	13	7	10
Cassava*	100	100	100	0	0	100	57	71	86	61	90	94
Kenaf / Roselle	100	0	0	100	0	0	71	86	0	87	36	3
Late rainy												
Maize												
Chilli*	0	100	100	100	100	100	14	14	29	42	45	48
Cassava												

Continued.

Table 18. Cropping pattern of villages (%) – Tha Taeng (TT) *continued.*

	Landless			Small			Medium			Large		
Crops	1970	1990	2008	1970	1990	2008	1970	1990	2008	1970	1990	2008
Dry												
Paddy												
Vegetables	0	0	100	100	100	100	29	29	71	45	52	68
Chilli												
Others												
Perennial												
Eucalyptus	0	0	0	0	0	0	0	0	0	0	0	16
Mango	0	0	0	100	100	100	29	43	43	61	68	71
Banana	0	0	0	0	0	0	0	0	14	26	29	26
Medicinal herbs	0	0	0	0	0	0	0	0	29	7	10	13
Neem tree	0	0	0	0	0	0	0	0	0	0	3	3
Coconut	0	0	0	100	100	100	14	29	29	36	42	42
Annual												
Sugarcane												
Cassava												
Legumes	0	0	0	100	0	0	29	43	43	58	42	48

* Paddy, maize, cassava and chilli were not separated by growing season.

Table 19. Change in cropping pattern of villages* (%) – Tha Taeng (TT).

	Landless		Small		Medium		Large	
Crops	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Early rainy								
Paddy	0	-2(-100)	0	0	0	1(20)	1(4)	1(4)
Maize	0	0	0	0	2(100)	2(150)	2(33)	2(33)
Sugarcane	0	0	0	0	2(100)	0	-2(-50)	2(50)
Cassava	0	0	0	2(100)	2(25)	1(20)	2(47)	1(4)
Kenaf / Roselle	-2(-100)	0	-2(-100)	0	1(20)	-2(-100)	-2(-59)	-2(-91)
Late rainy								
Maize								
Chilli	2(100)	0	0	0	0	2(100)	1(8)	1(7)
Cassava								

Continued.

Table 19. Change in cropping pattern of villages* (%) – Tha Taeng (TT) *continued.*

	Landless		Small		Medium		Large	
Crops	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Dry								
Paddy								
Vegetables	0	2(100)	0	0	0	2(150)	1(14)	2(31)
Chilli								
Perennial								
Eucalyptus	0	0	0	0	0	0	0	2(100)
Mango	0	0	0	0	2(50)	0	1(11)	1(5)
Banana	0	0	0	0	0	2(100)	1(13)	-1(-11)
Medicinal herbs	0	0	0	0	0	2(100)	2(50)	2(33)
Neem tree	0	0	0	0	0	0	2(100)	0
Coconut	0	0	0	0	2(100)	0	1(18)	0
Annual								
Sugarcane								
Cassava								
Legumes	0	0	2(100)	0	2(50)	0	-1(-11)	-1(-6)

*{-2 major decrease (>20% decrease),-1 minor decrease (<20% decrease), 0 no change, 1 minor increase (<20% increase), 2 major increase (>20% increase)}

3.5 Market and Infrastructure

Agricultural input markets for DP village has increased from none in the village to 3 shops for seed, fertilizers and agrochemicals. To purchase cattle feed, farmers have to travel 7 kilometers. Hence the agricultural input market for this has not increased. The markets for selling agricultural products increased during the last 20 years. Rice is sold in the nearby markets to local agents, and more recently to private rice mill or wholesalers. Cassava has been sold to the flour mill, 25 km from the village, since 1970. Sugarcane has been sown and self-processed by farmers since 1970, but in recent years it is sold to a sugar factory, 40 km away. Cows and chickens have been sold in the village to local agents and fellow farmers for the last 39 years.

KS village has recently acquired a shop selling fertilizers, but farmers still have to buy seed, agrochemicals and cattle feed from some distance.

NM village has been purchasing inputs in the nearby market since 1970.

TT village has shops selling seed and fertilizers.

The output markets in KS, NM and TT for selling rice are quite similar. Farmers have been going to nearby and distant villages or cities and selling to local agents since 1970, and to rice mills or wholesalers since 1990 (Tables 20, 21, 22 and 23).

Table 20. Agricultural input and output markets in Don Plai (DP) village.

Items		Whether in village? Yes/No			Distance from the village (km)			Change
		1970	1990	2008	1970	1990	2008	
Input Market								
Seed		n	n	y	7	7		Slightly increased
Fertilizers		n	n	y	7	7		Highly increased
Agrochemicals		n	n	y	7	7		Highly increased
Cattle feed		n	n	n	7	7	7	No change
Output market								
Rice	Where sold*	No selling	2	2				Highly increased
	To whom sold**	2	2	3				
Cassava	Where sold*	3	3	3	25	12	25	No change
	To whom sold**	3	3	3				
Chilli	Where sold*							
	To whom sold**							
Sugarcane	Where sold*			3			40	No change
	To whom sold**			3				
Maize	Where sold*							
	To whom sold**							
Cow (live animal)	Where sold*	1	1	1				No change
	To whom sold**	2	2	2				
Chicken	Where sold*	1	1	1				No change
	To whom sold**	1	1	1				
Forest products	Where sold*							
	To whom sold**							
Vegetables (specify)	Where sold*							
	To whom sold**							

* Within the village=1, Nearby market=2, Distant village =3, Others (Specify)=4

** Fellow farmers=1, local agents=2, wholesalers=3, directly to retailers=4, others (specify)=5

Table 21. Agricultural input and output markets in Kud Sawai (KS) village.

Items	Whether in village? Yes/No			Distance from the village (km)			Change
	1970	1990	2008	1970	1990	2008	
Input Market							
Seed	n	n	n			28	Highly increased
Fertilizers	n	n	y				Highly increased
Agrochemicals	n	n	n		2	2	Highly increased
Cattle feed	n	n	n			5	Highly increased

Continued.

Table 21. Agricultural input and output markets in Kud Sawai (KS) village *continued.*

Items		Whether in village? Yes/No			Distance from the village (km)			Change
		1970	1990	2008	1970	1990	2008	
Output market								
Rice	Where sold*	2,3	2,3	2,3	3-28	3-28	3-28	Highly increased
	To whom sold**	2,3	2,3	2,3				
Cassava	Where sold*	3	3	3	5-27	5-27	5-27	No change
	To whom sold**	3	3	3				
Chilli	Where sold*							
	To whom sold**							
Sugarcane	Where sold*							
	To whom sold**							
Maize	Where sold*							
	To whom sold**							
Cow (live animal)	Where sold*	1	1	1				No change
	To whom sold**	2	2	2				
Chicken	Where sold*	1	1	1				No change
	To whom sold**	1	1	1				
Forest products	Where sold*							
	To whom sold**							
Vegetables (specify)	Where sold*							
	To whom sold**							

* Within the village=1, Nearby market=2, Distant village =3, Others (Specify)=4

**Fellow farmers=1, local agents=2, wholesalers=3, directly to retailers=4, others (specify)=5

Table 22. Agricultural input and output markets in Nong Muang (NM) village.

Items	Whether in village? Yes/No			Distance from the village (km)			Change
	1970	1990	2008	1970	1990	2008	
Input Market							
Seed	n	n	n	borrow	borrow	21	Highly increased
Fertilizers	n	n	n	No use	No use	9-21	Highly increased
Agrochemicals	n	n	n	No use	No use	9-21	Highly increased
Cattle feed	n	n	n	No use	No use	2	Highly increased

Continued.

Table 22. Agricultural input and output markets in Nong Muang (NM) village *continued.*

Items		Whether in village? Yes/No			Distance from the village (km)			Change
		1970	1990	2008	1970	1990	2008	
Output market								
Rice	Where sold*	1	2,3	2,3	21	21	21	Slightly increased
	To whom sold**	2	3	3				
Cassava	Where sold*	3	3	3	21	21	7	Slightly increased
	To whom sold**	3	3	3				
Chilli	Where sold*	1	1	1				No change
	To whom sold**	2	2	2				
Sugarcane	Where sold*	Self-processed	Self-processed	3			100	Highly increased
	To whom sold**			3				
Maize	Where sold*							
	To whom sold**							
Cow (live animal)	Where sold*	1	1	1,2			7	Highly increased
	To whom sold**	1,2	1,2	1,2				
Chicken	Where sold*	1	1	1,2			7	Highly increased
	To whom sold**	1,2	1,2	1,2				
Wild vegetables and mushroom	Where sold*	1	1	3			21	Highly increased
	To whom sold**	1	1	1,2				
Vegetables (specify)	Where sold*							
	To whom sold**							

* Within the village=1, Nearby market=2, Distant village =3, Others (Specify)=4

**Fellow farmers=1, local agents=2, wholesalers=3, directly to retailers=4, others (specify)=5

Table 23. Agricultural input and output markets in Tha Taeng (TT) village.

Items		Whether in village? Yes/No			Distance from the village (km)			Change
		1970	1990	2008	1970	1990	2008	
Input Market								
Seed		n	n	y	15	15		Highly increased
Fertilizers		n	n	y	15	15		Highly increased
Agrochemicals		n	n	n	15	15	15	No change
Cattle feed		n	n	n	15	15	15	No change
Output market								
Rice	Where sold*	3	3	3	15	15	15	No change
	To whom sold**	3	3	3				

Continued.

Table 23. Agricultural input and output markets in Tha Taeng (TT) village *continued.*

Items		Whether in village? Yes/No			Distance from the village (km)			Change
		1970	1990	2008	1970	1990	2008	
Cassava	Where sold*	3	3	3	20	20	20	Highly increased
	To whom sold**	3	3	3				
Chilli	Where sold*	3	3	3	15	15	15	No change
	To whom sold**	4	4	4				
Sugarcane	Where sold*	3	3	3	60	60	60	No change
	To whom sold**	3	3	3				
Maize	Where sold*	3	3	3	15	15	15	No change
	To whom sold**	3	3	3				
Cow (live animal)	Where sold*	1	1	1				No change
	To whom sold**	2	2	2				
Chicken	Where sold*	1,3	1,3	1,3	15	15	15	No change
	To whom sold**	1,2	1,2	1,2				
Wild vegetables and mushroom	Where sold*	3	3	3	15	15	15	No change
	To whom sold**	2	2	2				
Vegetables (mint basil, brassica)	Where sold*			3			15	Highly increased
	To whom sold**			4				

* Within the village=1, Nearby market=2, Distant village=3, Others (Specify)=4

** Fellow farmers=1, local agents=2, wholesalers=3, directly to retailers=4, others (specify)=5

4. Findings and discussion

The data from farmers' perception study on climate variability was, according to grounded theory, classified into four parts – exposure to climate variability or shock; impact; adaptation; and pest outbreak and intervention for each village. From participatory discussion with farmers, it became known that there were at least three drought years in DP village from 1979 to 2010, in 1979, 1981-1982 (death of chickens, rice yield loss and an increase in out-migration), and in 2010. There were two wet years or periods during the 39 years, the 1989-1990 year (heavy storm and damage of houses) and 2006-2007 (flooding caused rice and cassava yield loss). Adaptation by farmers consisted of cassava being introduced in 1987, shifting cassava area to lower land into paddy fields, which started in 1997, and sugarcane being introduced again in 2006. Government projects provided relief for climatic variation damage, and have given rise to the health care project in 1990, irrigation supply project in 1997 and recent crop insurance in 2010 (Figure 1).

In 1971, there was drought in KS, causing lack of water and rice yield loss. Farmers faced the same situation again in 2006-2007 and in 2010, which was more severe than other times and very hot. Consequently, cultivation of rice was very difficult. There were two periods of flooding (with storm) in 1983 and in 1997, affecting rice yield, and causing loss and the drying up of the dam in 1997. Growing more drought resistant crops such as cassava is the way of adaptation, including changing from transplanted rice to broadcast in 1997. There was an outbreak of pests after the drought, for example, thrips and red mites in rice (2007-2008) and mealy bug attacking cassava in 2010, which happened in

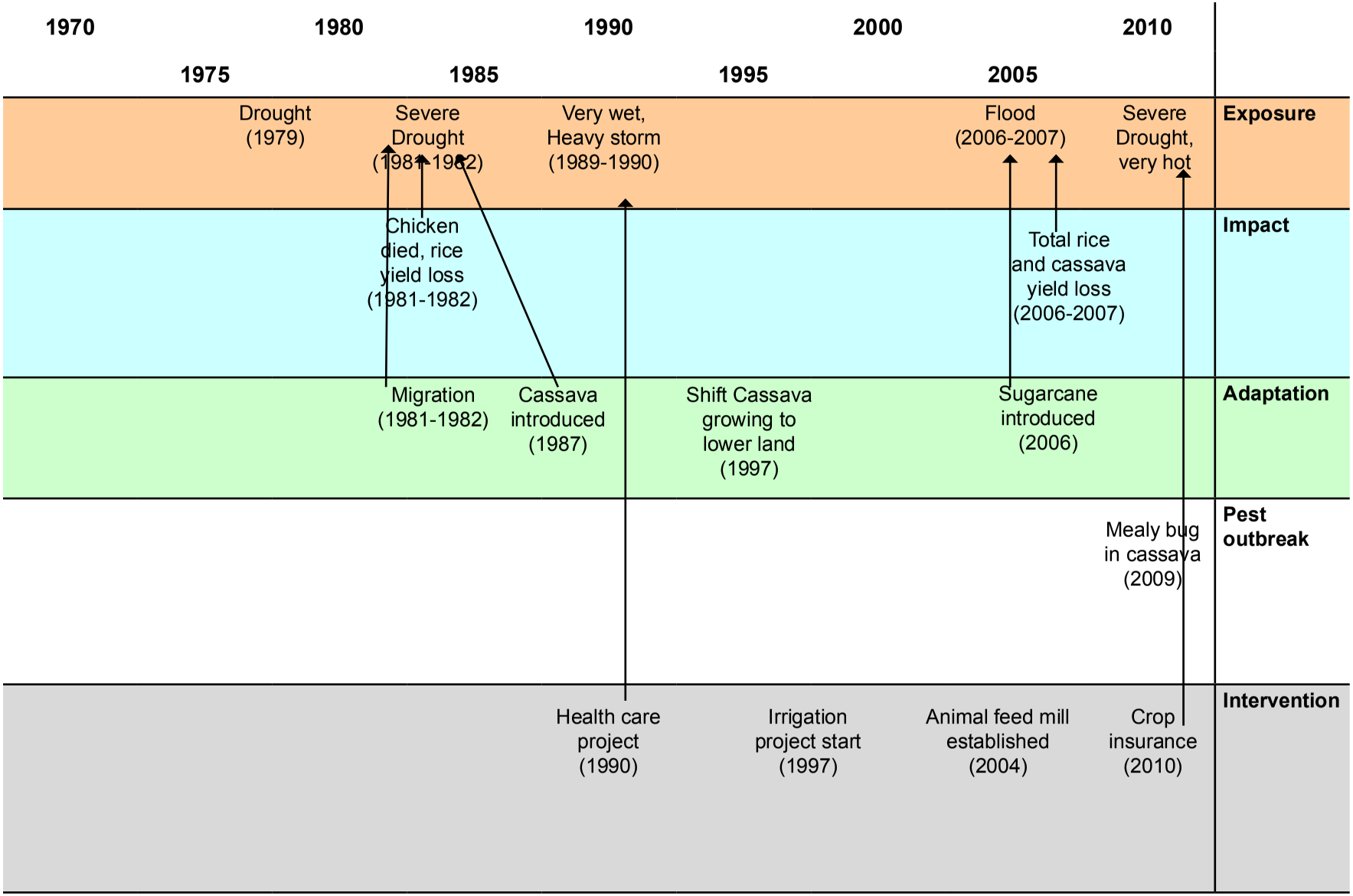

Figure 1. Climate variability perception, impact, adaptation, pest outbreak and intervention in Don Plai (DP) village.

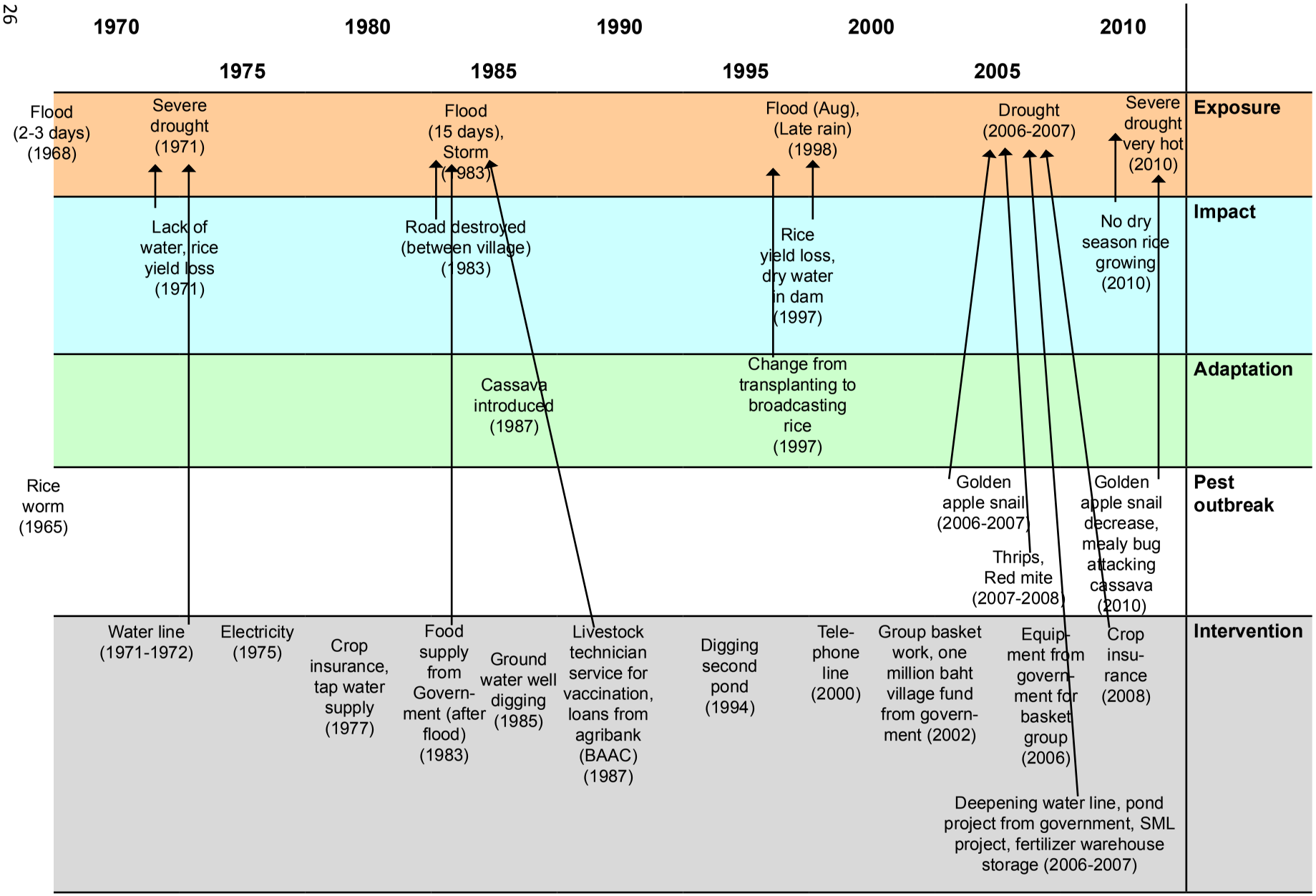

Figure 2. Climate variability perception, impact, adaptation, pest outbreak and intervention in Kud Sawai (KS) village.

several growing areas. Crop insurance policy, groundwater, well digging and deepening, food relief and supply after flood and supplementary occupations were the government interventions (Figure 2).

In NM, which is a more upland area, there were eight droughts from 1970-2008 – in 1972, 1979, 1987, 1993-1995, 1997, 2005, 2009 and 2010. The impact was yield loss, lack of consumption water, and mortgage of land. Floods occurred in 2008 due to excessive rainfall. High air temperatures, wind storm and hail occurred in the same year causing a lot of damage to the houses. The farmer's adaptation to drought was at first temporary migration (in 1972), and later digging of wells, introduction of cassava, use of compost to improve the soil, reforestation, changing from transplantion to broadcast of rice, were followed. Sugarcane cultivation was re-introduced to the village because of the good prices and the fact that sugarcane can be planted once and harvested for 2-3 years. Due to frequent droughts, early maturing rice and crops with low water requirements were introduced. In the meantime other supplementary careers such as silk weaving and dressmaking were promoted. Pest attacks were from roselle worm (1975), golden apple snail (2008), brown hopper, thrip and leaf blight in rice (2009-2010), mealy bug in cassava (2010). As droughts occurred more frequently, immediate aid such as food supply was brought into the village, followed by implementation of water harvesting activities such as deepening wells and ponds, government support for crop loss and supplement job training (Figure 3).

In TT village, floods occurred in 1979 and drought in 1993, 2004 and 2010. Crop cultivation could not go on and a small famine occurred in 2004. Adaptation consisted of reforestation, boring of tube well and sugarcane plantations. Farmers started earning income from growing vegetables in 2005. Pest outbreaks were from rice worm (1984 and 2004) and mealy bug in cassava (2009-2010). Rainwater harvesting was improved by digging new reservoirs, checking dam constructions and the like (Figure 4).

4.1 Farmers' perception on climate change

4.1.1 Rainfall and temperature change

The farmer's views on rainfall pattern changes and possible reasons are recorded in Table 24. Most farmers perceived that the amount of annual rainfall decreased considerably except in 2008, when there was excessive rain, and this is validated with the actual annual rainfall data. Rainfall distribution has not been good or widespread over both time and place. There have been fewer rainy days but no change in the off-season rainfall. The onset of rainfall was perceived to be delayed overall for 39 years. The main reason accepted for the variability was that the forests were destroyed. Table 25 shows that the perceived drought years were more than the flood years in every village, and NM had more drought years than the others.

Actual climatic conditions in 4 villages from 2 weather stations (Chok Chai for DP and KS villages, Chaiyaphum for NM and TT villages) are shown in Table 26. Changes in actual annual rainfall in DP and KS during 1970-90 and 1990-2008 are 3.4% and -3.6 %, respectively and is the opposite of NM and TT. It showed minor increase in perceptual annual rainfall for both the periods (1970-1990 and 1990-2008) in DP (4.5 and 6.0%), but in KS the perception was a minor decrease (1.5 and 2.0%) in rainfall for both the periods. The perception in NM and TT showed the same trend but with different intensity, minor decrease for both the periods (6.0 and 18.0%) in NM, and minor (9.5%) and major decrease (25.0%) in 1970-1990 and 1990-2008, respectively, in TT.

Changes in actual annual temperature shows higher increase in the second period than in the first in all villages ranging from 0.88 to 0.91%, whereas annual temperature in the first one shows a minor decrease from 0.81 to 0.85%. The annual temperature reported by farmers in 4 villages showed different trends in both periods: minor increase in the first one (1970-1990) but major increase in the second one (1990-2008).

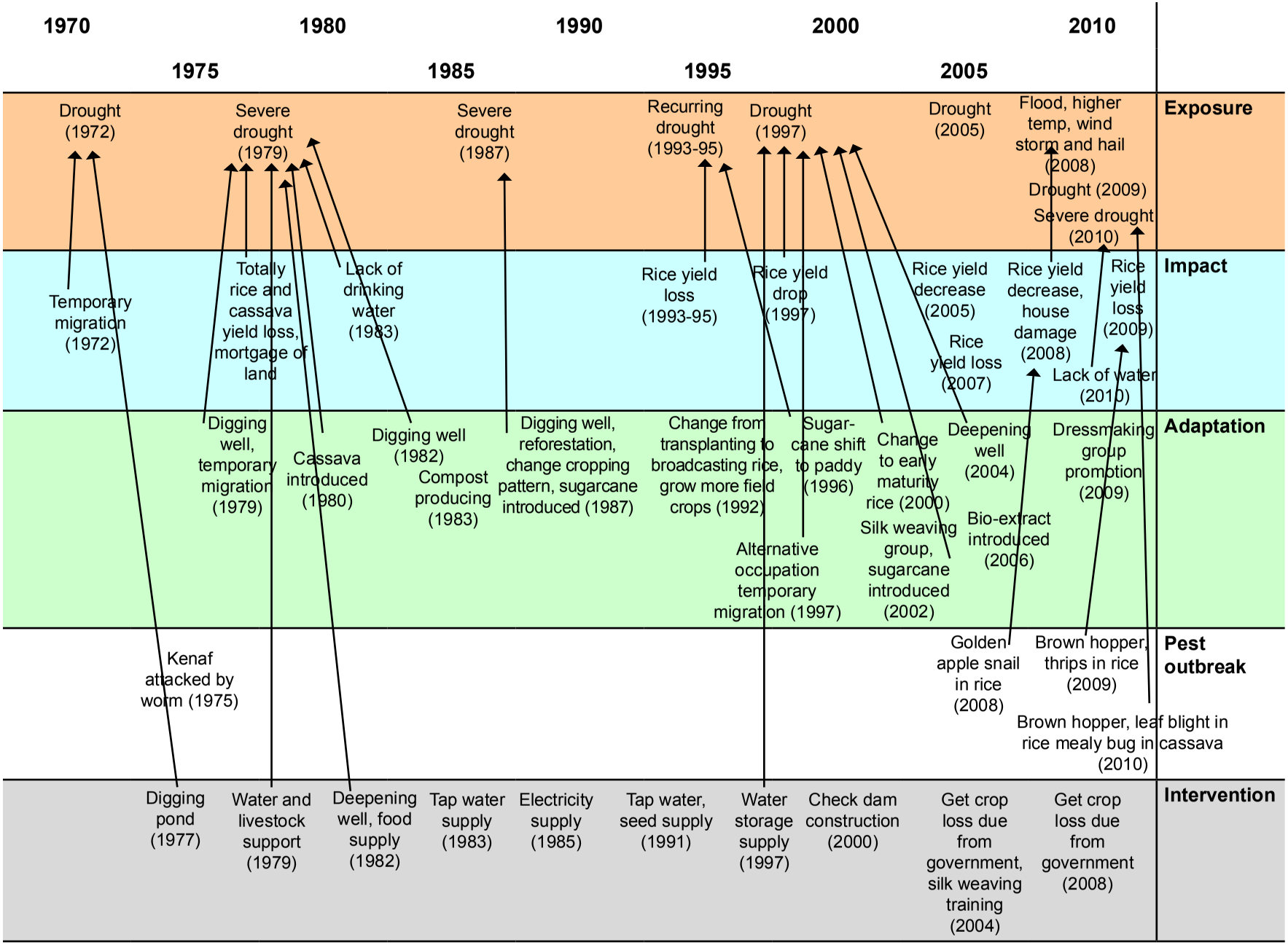

Figure 3. Climate variability perception, impact, adaptation, pest outbreak and intervention in Nong Muang (NM) village.

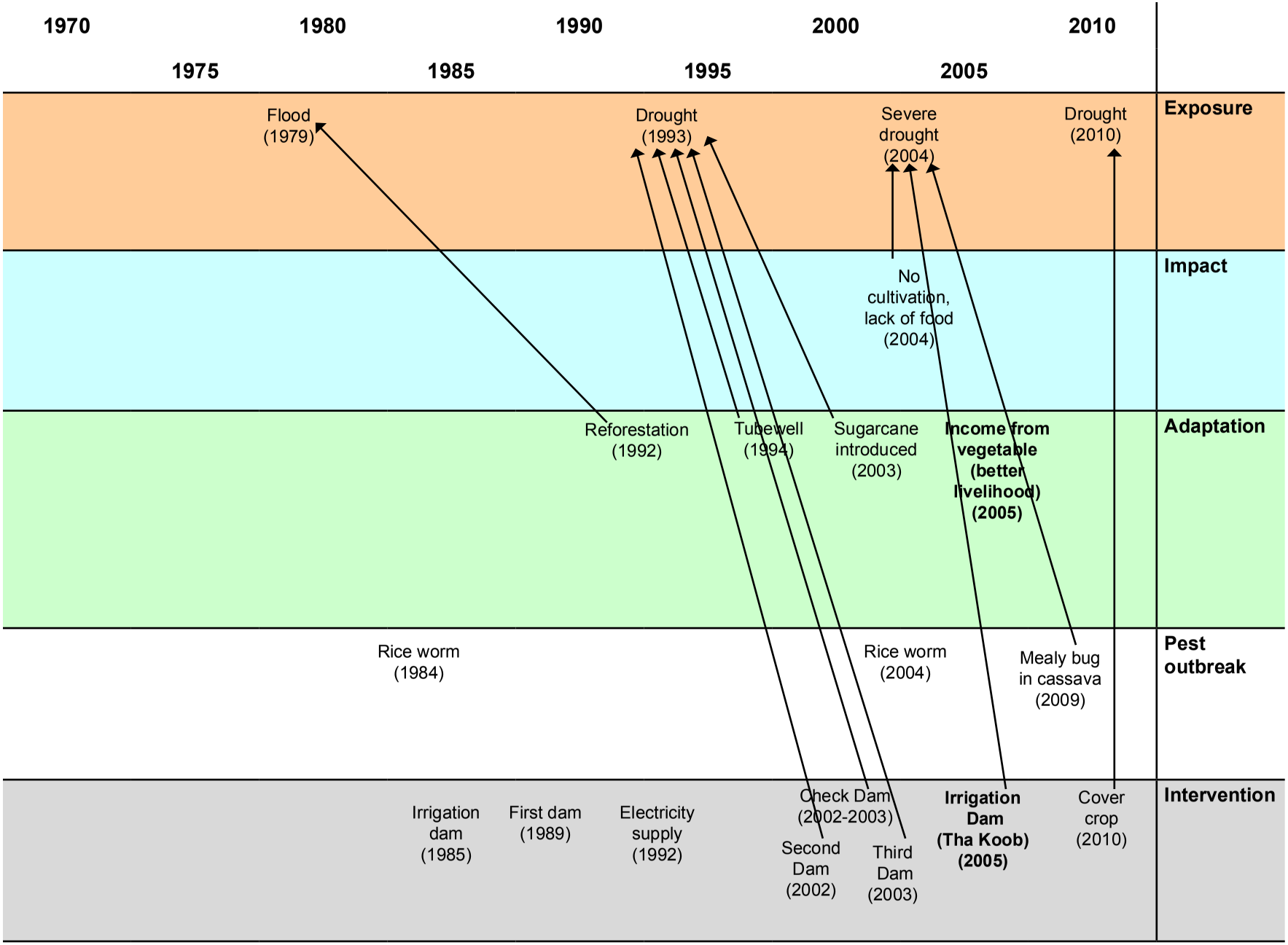

Figure 4. Climate variability perception, impact, adaptation, pest outbreak and intervention in Tha Taeng (TT) village.

Table 24. Farmers' perception, description on rainfall variability and change in 4 villages.

Characteristics	Descriptions	Possible Reasons
Don Plai (DP)		
Quantum of rainfall	Amount was low	Forest was destroyed
Distribution of rainfall	Not good distribution, longer dry spells	Forest was destroyed
Number of rainy days	Less than normal	Forest was destroyed
Rainfall outside rainy season	No change (after October)	Forest was destroyed
Onset of rainfall	Delayed	Forest was destroyed
Kud Sawai (KS)		
Quantum of rainfall	Amount was low	Forest area reduced
Distribution of rainfall	Not good distribution, longer dry spells	More drought condition
Number of rainy days	Less than normal	Forest was destroyed
Rainfall outside rainy season	No change (after October)	Forest was destroyed
Onset of rainfall	Delayed	Forest was destroyed
Nong Muang (NM)		
Quantum of rainfall	Amount was low	Forest area reduced
Distribution of rainfall	Not good distribution	Forest was destroyed
Number of rainy days	Less than normal	Forest was destroyed
Rainfall outside rainy season	No change (after October)	
Onset of rainfall	Delayed	Climate variability
Tha Taeng (TT)		
Quantum of rainfall	Amount was low	Global warming, forest was destroyed
Distribution of rainfall	Not good distribution	Forest was destroyed
Number of rainy days	Less than normal	Forest was destroyed
Rainfall outside rainy season	No change (after October)	
Onset of rainfall	Delayed	Climate variability

Table 25. Drought and flood years in the study villages.

Drought year				Flood year			
DP	KS	NM	TT	DP	KS	NM	TT
1979	1971	1972	1993	1989-90	1983	2008	1979
1981-82	2006-07	1979	2004	(very wet)	1997		
2010	2010	1987	2010	2006-07			
		1993-95					
		1997					
		2005					
		2009					
		2010					

Table 26. Actual and perceptual change in climate.

	Chok Chai Met. Station				Chaiyaphum Met. Station			
	DP		KS		NM		TT	
Change in perception and actual climate	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Change in actual annual rainfall (%)	3.4	-3.6	3.4	-3.6	-3.3	3.5	-3.3	3.5
Change in perceptual annual rainfall (%)*	1(4.5)	1(6.0)	-1(1.5)	-1(2.0)	-1(6.0)	-1(18.0)	-1(9.5)	-2(25.0)
Change in actual annual temperature (%)	-0.81	0.88	-0.81	0.88	-0.85	0.91	-0.85	0.91
Change in perceptual annual temperature (%)*	1(4.5)	2(37.0)	1(7)	2(36.5)	1(10)	2(30.5)	1(8.5)	2(36.5)

*{-2 major decrease (>20% decrease),-1 minor decrease (<20% decrease), 0 no change, 1 minor increase (<20% increase), 2 major increase (>20% increase)}

4.1.2 Monsoon change

Average actual deviation of monsoon shows early monsoons during 1970-90 in all 4 villages (3.1% in DP and KS and 2.4% in NM and TT), but in 1990-2008, DP and KS showed delayed arrival of monsoon, and NM and TT showed a little early arrival of monsoon (Table 27). In view of farmers, perceptual deviation of monsoon showed no change in monsoon in DP during 1970-1990 but major increases or delays in the second period, 1990-2008. In KS, NM and TT, farmers perceived minor increases or delays in the arrival of monsoons in both the periods. The rainfall contribution in each month during the monsoon season, which normally starts in May and lasts till October, sums up to more than 80% of annual rainfall. Average contribution in September is the highest in all the villages for both the periods ranging from 18.8-23.5%. However, the contribution from August and September shows the highest rainfall period in a year.

4.2 Impact of climate change on the village

There seems to be 2 levels of impact of climate variability or shock, which are direct and secondary order impacts. Farmers' perception is that direct impact due to climate shock in the period 1990-2008 was more severe than in the period 1970-1990. Total crop yield loss happened several times, the dam was dryer, there was storm damage, etc, which resulted in non-cultivation of crops and hence lack of food. The lack of drinking water was solved mainly by government intervention and hence this problem didn't occur later again in the second period (Table 28). Pest attacks were more frequent in the second period (1990-2008) in all four villages. Secondary order impact of yield loss was evident through the fact that farmers needed money to buy food, so money saving and loans were needed. Landless or marginal farmers migrate to other jobs for 3-4 months. This is true even among small and medium farm holders. These situations impact on farmers' livelihoods in many ways.

Farmers' livelihood impacts are classified into eight factors with the causes shown in Table 29. Tables 30, 31, 32 and 33 show the perception on majority of the causes by the respondents of different farm sizes in the four villages, DP, KS, NM and TT. There was a little difference in farmers' opinions from different farm sizes.

The change in livelihood impact showed that unsustainable production practices increased more in the second period than in the first for DP and NM, but highly increased in both periods in KS and TT villages.

Table 27. Change in monsoon and monthly contribution.

	DP		KS		NM		TT	
Change in perception and actual monsoon	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Average actual deviation of monsoon (%)	-3.1	1.6	-3.1	1.6	-2.4	-0.5	-2.4	-0.5
Perceptual deviation of monsoon*(%)[1]	0	2(22.5)	1(1)	1(4.5)	1(0.5)	1(3.0)	1(5.5)	1(2)
Average contribution of monsoon during April (%)	7.2	6.7	7.2	6.7	7.5	7.9	7.5	7.9
Average contribution of monsoon during May (%)	13.2	16.1	13.2	16.1	13.1	13.0	13.1	13.0
Average contribution of monsoon during June (%)	10.1	10.9	10.1	10.9	13.6	12.4	13.6	12.4
Average contribution of monsoon during July (%)	11.3	10.9	11.3	10.9	10.6	9.1	10.6	9.1
Average contribution of monsoon during August (%)	12.6	15.3	12.6	15.3	11.3	19.1	11.3	19.1
Average contribution of monsoon during September (%)	21.6	18.8	21.6	18.8	23.5	19.5	23.5	19.5
Average contribution of monsoon during October (%)	15.3	13.1	15.3	13.1	12.9	10.4	12.9	10.4

*{-2 major decrease (>20% decrease),-1 minor decrease (<20% decrease), 0 no change, 1 minor increase (<20% increase), 2 major increase (>20% increase)}

[1] – plus (+) means delay of monsoon : minus (-) means earlier onset of monsoon

Farmers accepted climate variability as the cause of livelihood impacts, which was more than 20% for both the periods in all the villages. Unsustainable water management was a more serious cause in period 1 (1970-1990) than in period 2 for all four villages. Deforestation was perceived to have less impact on livelihoods in the second period than in the first in DP, KS and NM, but it was perceived to be the cause for more than 20% impact in TT for both the periods. Change in land use was accepted to be the cause of more than 20% impact for both periods in DP, but it was negatively perceived in the second period than the first one in KS, NM and TT. This is because DP has more access to irrigation, and thus more agricultural activities. Demographic pressure was perceived to be more serious a cause of impact in the second period for all the villages. Poverty has certainly been the cause of livelihood impact, which was accepted as more than 20% for both periods in all villages. For policy, title, government intervention and property rights or law were perceived to be more than 20% for both periods in DP, KS and NM, and in the second period for TT (Table 34).

Table 28. Direct impact and pest outbreak to climate variability during 1970-2008 in 4 study villages.

	DP	KS	NM	TT
1970-1990	- Chicken deaths - Rice yield loss	- Lack of water - Rice yield loss	- Total rice and cassava yield loss - mortgage of land - lack of drinking water	-
Pest outbreak	-	Rice worm (1965)	Roselle worm attack (1975)	Rice worm (1984)
1990-2008	- Total rice and cassava yield loss	- Rice yield loss - Dry water dam - No dry season rice growing	- Rice yield loss and drop - Houses damaged from storm	- No cultivation - Lack of food
Pest outbreak	Mealy bug in cassava (2009)	- Golden apple snail in rice (2006-07) - Thrip, red mite in rice (2007-08) - Mealy bug in cassava (2010)	- Golden apple snail in rice (2008) - Brown hopper and thrip in rice (2009) - Brown hopper and leaf blight in rice (2010) - Mealy bug in cassava (2010)	Rice worm (2004) Mealy bug in cassava (2009-10)

Table 29. Cause of Livelihood Impact.

Livelihood impact	Causes
1. Unsustainable production practices	- Inappropriate production technology - Extensive and frequent cultivation - Inappropriate cropping pattern - Burning of crop residues/ forest fire - No or low addition of organic matter/ humus in soil - Indiscriminate application of herbicides / pesticides - Unbalanced use of inorganic fertilizers - Excessive tillage practices
2. Climate change	- Consecutive droughts - Moisture stress - Change in rainfall pattern - Volume of rainfall - Rising temperature - Soil erosion due to intense storms
3. Unsustainable water management	- Depleting groundwater table - Faulty surface irrigation system - High water runoff

Continued.

Table 29. *Continued.*

Livelihood impact	Causes
4. Deforestation	- Over grazing - Excessive fuel wood collection - Uncontrolled logging and illegal felling of forest trees - Over hunting of wild plants and animals
5. Change in land use	- Forest land clearance for agriculture - Agricultural land for other purposes
6. Demographic pressure	Human Population / Livestock Population
7. Poverty	- Indebtedness - Land tenure or landlessness - Duration of settlement (migration) - Education level
8. Policy	- Government intervention - Property rights/ laws

4.3 Adaptation measures taken by the farmer

4.3.1 Adaptation strategies

In DP, an adaptation measure adopted by landless or marginal farmers after facing climate shock is the renting of land for cropping, especially for rice. Small and medium holder farmers choose to delay growing time a little to avoid possible upcoming drought. Largeholder farmers choose to change their cropping pattern, for example, growing drought tolerant crops (mungbean) alternately with rice, and delay the growing season (Table 35).

Farmer respondents stated that when they face problems such as climate shocks and lose all their crops, they go to a close neighbor and consult with each other, then form a small group to solve the problem. They say that just unburdening oneself by sharing with someone brings relief.

In KS village, landless farmers become agricultural labor, migrate to non-farm jobs and have supplementary careers in fishing equipment making, basket weaving, or the most famous OTOP product of the village. Smallholder and medium farmers are likely to grow more crops or grow them more frequently after they were damaged from drought, but there is a decrease in the growth of rice and basket weaving in the dry season. Largeholder farmers choose to invest more in growing crops, but decrease dry season rice growing and concentrate more on rainwater harvesting during the monsoons by digging wells (Table 36).

In NM village, landless farmers take up agricultural labor and cut down on expenses to save for buying rice for food when they face climate shocks. In a good crop year, they save rice for their own consumption as the first priority, and sell only when they need cash. Out migration for general labor for 3-4 months is another choice for the landless to adapt to climate shock. Smallholder farmers grow more crops or grow them more frequently, apply for loans, take up employment in factories, and decrease their own expenditure. Medium farmers grow more crops or grow them more frequently, especially higher priced crops such as cassava, get loans, take up employment in factories, decrease expenses and dig new farm ponds. Largeholder ones are likely to grow more crops or grow them more frequently, use their savings, decrease expenses and dig new ponds (Table 37).

Table 30. Cause of livelihood impact at different farm sizes in Don Plai (DP).

	Landless/Marginal		Small		Medium		Large	
Livelihood impact	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Unsustainable production practices	Burning of crop residues	Excessive and frequent cultivation	Burning of crop residues	Excessive and frequent cultivation	Excessive tillage practices	Excessive and frequent cultivation	Burning of crop residues	Inappropriate production technology and indiscriminate application of herbicides and pesticides
Climate change	Volume of rainfall	Rising temperature	Change in rainfall pattern	Rising temperature	Volume of rainfall	Consecutive drought	Consecutive drought	Rising temperature
Unsustain-able water management	Depleting ground-water table	High water runoff	Depleting ground-water table	Faulty surface irrigation system	Faulty surface irrigation system	High water runoff	Faulty surface irrigation system	High water runoff
Deforestation	Excessive fuel wood collection	Uncontrolled logging and illegal felling of forest trees	Excessive fuel wood collection	Excessive fuel wood collection	Over hunting of wild plants and animals	Excessive fuel wood collection	Over grazing	Excessive fuel wood collection
Change in land use	Forest land clearance for agriculture	Forest land clearance for agriculture	Forest land clearance for agriculture	Agricultural land for other purposes	Forest land clearance for agriculture	Agricultural land for other purposes	Forest land clearance for agriculture	Agricultural land for other purposes
Demographic pressure	Livestock population	Human population	Livestock population	Human population	Livestock population	Human population	Livestock population	Human population
Poverty	Land tenure or landless	Indebtedness	Land tenure or landless	Indebtedness	Land tenure or landless	Indebtedness	Indebtedness	Indebtedness
Policy	Property rights/laws	Govt. intervention	Govt. intervention	Govt. intervention	Property rights/laws and Govt. intervention	Govt. intervention	Govt. intervention	Property rights/laws

Table 31. Cause of livelihood impact at different farm sizes in Kud Sawai (KS).

Livelihood impact	Landless/Marginal		Small		Medium		Large	
	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Unsustainable production practices	Burning of crop residues	No or low addition of organic matter/ humus in soil	Burning of crop residues	Indiscriminate application of herbicides and pesticides and unbalanced use of inorganic fertilizers	Excessive tillage practices	Burning of crop residues	Burning of crop residues	No or low addition of organic matter/ humus in soil
Climate change	Consecutive droughts	Rising temperature	Consecutive droughts	Rising temperature	Consecutive droughts	Change in rainfall pattern	Consecutive droughts	Rising temperature
Unsustainable water management	Depleting groundwater table	Faulty surface irrigation system	High water runoff	Faulty surface irrigation system	Faulty surface irrigation system	Faulty surface irrigation system	Depleting groundwater table	Depleting groundwater table
Deforestation	Over hunting of wild plants and animals	Excessive fuel wood collection	Over grazing	Over grazing	Excessive fuel wood collection	Over grazing	Excessive fuel wood collection	Excessive fuel wood collection
Change in land use	Agricultural land for other purposes	Agricultural land for other purposes	Forest land clearance for agriculture	Forest land clearance for agriculture	Forest land clearance for agriculture	Agricultural land for other purposes	Forest land clearance for agriculture	Agricultural land for other purposes
Demographic pressure	Human population	Livestock population	Livestock population	Human population	Livestock population	Human population	Livestock population	Human population
Poverty	Land tenure or landless	Indebted-ness	Land tenure or landless	Indebtedness	Education level	Indebtedness	Education level	Indebtedness
Policy	-	Property rights/laws	Property rights/laws	Property rights/laws	Govt. intervention	Property rights/laws	Property rights/laws	Govt. intervention

Table 32. Cause of livelihood impact at different farm sizes in Nong Muang (NM).

Livelihood impact	Landless/Marginal*		Small		Medium		Large	
	1970-90	1990- 2008	1970-90	1990-2008	1970- 90	1990- 2008	1970-90	1990-2008
Unsustainable production practices			Burning of crop residues	Unbalanced use of inorganic fertilizers	Inappropriate production technology	Unbalanced use of inorganic fertilizers	No or low addition of organic matter/ humus in soil	Unbalanced use of inorganic fertilizers
Climate change			Consecutive droughts	Rising temperature	Consecutive drought	Rising temperature and volume of rainfall	Consecutive droughts	Rising temperature
Unsustainable water management			Faulty surface irrigation system	Faulty surface irrigation system	Depleting groundwater table	Depleting groundwater table	Faulty surface irrigation system	Faulty surface irrigation system
Deforestation			Excessive fuel wood collection	Over grazing	Excessive fuel wood collection	Over grazing	Excessive fuel wood collection	Over grazing and Excessive fuel wood collection
Change in land use			Forest land clearance for agriculture	Forest land clearance for agriculture	Forest land clearance for agriculture	Forest land clearance for agriculture	Forest land clearance for agriculture	Forest land clearance for agriculture
Demographic pressure			Livestock population	Human population	Livestock population	Human population	Livestock population	Human population
Poverty			Indebtedness	Indebtedness	Indebtedness	Indebtedness	Land tenure or landless	Education level
Policy			Property rights/laws	Property rights/laws	Property rights/ laws	Property rights/laws	Property rights/laws	Property rights/laws

* - no farmer in this class

Table 33. Cause of livelihood impact at different farm sizes in Tha Taeng (TT).

Livelihood impact	Landless/Marginal		Small		Medium		Large	
	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Unsustainable production practices	-	Indiscriminate application of herbicides/ pesticides and unbalanced use of inorganic fertilizers	Inappropriate production technology	Inappropriate cropping pattern and Indiscriminate application of herbicides/ pesticides	Burning of crop residues	Extensive and frequent cultivation / Inappropriate cropping pattern/ Excessive tillage practices	Burning of crop residues	Excessive tillage practices
Climate change	-	Volume of rainfall / rising temperature	Volume of rainfall / rising temperature	Change in rainfall pattern	Consecutive droughts/ Change in rainfall pattern/ Volume of rainfall/ Rising temperature	Consecutive droughts	Rising temperature	Rising temperature
Unsustainable water management	Faulty surface irrigation system	Faulty surface irrigation system	-	High water runoff	Faulty surface irrigation system	Depleting groundwater table	Faulty surface irrigation system	Faulty surface irrigation system
Deforestation	-	Over grazing and Uncontrolled logging and illegal felling of forest trees	Uncontrolled logging and illegal felling of forest trees	Uncontrolled logging and illegal felling of forest trees	Uncontrolled logging and illegal felling of forest trees	Excessive fuel wood collection	Uncontrolled logging and illegal felling of forest trees	Uncontrolled logging and illegal felling of forest trees
Change in land use	-	Forest land clearance for agriculture	-	Forest land clearance for agriculture	Forest land clearance for agriculture	Forest land clearance for agriculture	Forest land clearance for agriculture	Agricultural land for other purposes
Demographic pressure	-	-	-	-	Livestock population	Livestock population	Livestock population	Human population
Poverty	Land tenure or landless	Land tenure or landless / Indebtedness	Education level	Indebtedness	Education level	Indebtedness	Duration of settlement (migration)	Indebtedness
Policy	-	-	-	Property rights/ laws	Property rights/laws	Property rights/ laws	Property rights/laws	Govt. intervention

Table 34. Change in factors impacting livelihoods in the study villages* (%).

	Lowland				Upland			
	DP		KS		NM		TT	
Livelihood impact	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Unsustainable production practices	1(16)	2(104)	2(23)	2(71)	1(16)	2(60)	2(35)	2(99)
Climate variability	2(36)	2(51)	2(34)	2(73)	2(34)	2(104)	2(41)	2(135)
Unsustainable water management	-2(-30)	1(8)	1(17)	2(26)	1(14)	2(25)	2(25)	2(92)
Deforestation	2(24)	-2(-68)	1(11)	-2(-30)	2(30)	-1(-12)	2(70)	2(26)
Change in land use	2(40)	2(45)	1(10)	-1(-5)	2(27)	-1(-14)	2(52)	-1(-19)
Demographic pressure	1(7)	2(68)	1(8)	2(37)	1(14)	2(69)	1(19)	2(69)
Poverty	2(33)	2(130)	2(42)	2(105)	2(39)	2(116)	2(49)	2(86)
Policy	2(25)	2(174)	2(24)	2(99)	2(30)	2(93)	1(8)	2(157)

*{-2 major decrease (>20% decrease),-1 minor decrease (<20% decrease), 0 no change, 1 minor increase (<20% increase), 2 major increase (>20% increase)}

Table 35. Adaptation strategies of farmers at different farm sizes (DP).

Household	Main coping strategy
Landless	Rent land for cropping
Small	Delay growing season to avoid drought (in mid rainy season)
Medium	Delay growing season to avoid drought (in mid rainy season)
Large	Change cropping pattern, delay growing season

Table 36. Adaptation strategies of farmers at different farm sizes (KS).

Household	Main coping strategy
Landless	- Taking up agricultural labor and migrating to alternative occupations - earning through supplementary careers such as fishing equipment, basket weaving (OTOP products).
Small	Grow more crops or grow them more frequently, decrease dry season rice growing, taking up supplementary career (basket work).
Medium	Grow more crops or grow them more frequently, decrease dry season rice growing, more harvesting during monsoons.
Large	Increase cost to grow more efficiently, decrease dry season rice growing, more harvesting during monsoons.

Table 37. Adaptation strategies of farmers at different farm sizes (NM).

Household	Main coping strategy
Landless	Taking up agricultural labor, decrease expense, out migration for 3-4 months.
Small	Grow more crops or grow them more frequently, apply for loans, take up employment in factories, decrease expense.
Medium	Grow more crops or grow them more frequently, especially higher priced crop such as cassava, apply for loans, take up employment in factories, decrease expenses, dig new farm ponds.
Large	Grow more crops or grow them more frequently, use saved money, decrease expenses, dig new ponds.

The respondents showed the same attitude as in DP and formed a small group to solve the problems.

In TT village, landless farmers choose to rent land for cropping, take up agricultural and general labor, and get loans for agricultural activities. Smallholder farmers decrease dry season rice growing, take up agricultural labor, grow more integrated crops to avoid climate risk and change from crop cultivation to vegetable cultivation, which generates income on a daily basis. Large farmers adapt by growing more integrated crops to avoid climate risk and growing near water sources, changing from crop cultivation to vegetable cultivation, getting more loans for agricultural input investment and finally decreasing the dry season rice growing (Table 38).

Table 38. Adaptation strategies of farmers at different farm sizes (TT).

Household	Main coping strategy
Landless	Rent land for cropping, taking up agricultural and general labor, get loans for agricultural activities.
Small	Decrease dry season rice growing, taking up agricultural labor, grow more integrated crops to avoid climate risk (women's opinion)
Medium	Decrease dry season rice growing, grow more integrated crops to avoid climate risk, change crop type to vegetable cultivation.
Large	- grow more integrated crops to avoid climate risk and change crop type - cultivate near water source area to avoid climate risk - more loans for agricultural input investment - decrease dry season rice growing

4.3.2 Natural Resource Management

Because of the observation that decrease in forest and wild plants and animals are the cause of climate variability, and after experiencing several climatic shocks such as droughts and floods, natural resource management in the village has taken up measures to combat these. As is shown in Table 39, the respondents in the four study villages, in general know about land management practices quite well, except for mulching and green manure. Soil improvement using compost or manure, incorporating crop residue and conservation tillage practices were increasingly practiced by farmers in all villages. Zero tillage used to be the norm a long time ago, but has not been practiced during the last 39 years, whereas now, minimal tillage practice has been brought to all villages and increasingly in DP and NM. Agro-forestry has been increasingly practiced in KS, NM and TT but decreasingly in DP.

Table 39. Land management practices in four villages.

Practices	Whether aware of (Yes=1/ No=0)				Household practicing (%)							
					1970-1990				1990-2008			
	DP	KS	NM	TT	DP	KS	NM	TT	DP	KS	NM	TT
Mulching	0.7	0.4	0.5	0.8	6	11	4	34	16	17	9	40
Green manuring	0.7	0.6	0.7	0.8	10	2	4	9	18	8	7	25
Composting/manuring	0.9	0.9	0.9	1.0	26	43	21	52	42	16	50	59
Incorporating crop residue	0.7	0.7	0.8	1.0	19	18	33	34	42	31	46	64
Conservation tillage practices	0.6	0.7	0.9	0.9	18	34	41	46	31	40	47	60
Bunding	1.0	0.9	0.9	1.0	74	62	74	66	80	67	74	74
Fallow	0.9	1.0	1.0	1.0	44	66	60	60	38	60	60	65
Drainage channels	1.0	0.8	0.9	1.0	53	53	59	70	71	65	59	80
Contour ridges	0.5	0.6	0.6	0.5	11	7	2	11	12	6	3	13
Zero tillage	0.5	0.6	0.7	0.6	5	13	5	5	3	5	4	0
Minimal tillage	0.6	0.7	0.7	0.7	22	36	27	38	32	32	29	27
Agro-forestry	0.6	0.7	0.7	0.8	17	5	8	24	14	8	9	28
Wind barriers/ alley cropping	0.3	0.6	0.6	0.6	3	1	5	15	4	2	9	14
Planting grasses/ savanna grasses	0.4	0.7	0.6	0.7	0	8	7	19	2	5	9	20
Constructing stone walls	0.3	0.7	0.7	0.6	0.3	0.7	0.7	0.6	1	10	3	8
Plantation of shrubs and trees	0.7	0.8	0.7	0.8	23	24	22	27	19	25	26	23

Practices	Perception*			
	DP	KS	NM	TT
Mulching	2(181)	2(52)	2(140)	1(17)
Green manuring	2(84)	2(288)	2(79)	2(162)
Composting/manuring	2(61)	-2(63)	2(145)	1(13)
Incorporating crop residue	2(126)	2(71)	2(41)	2(86)
Conservation tillage practices	2(65)	1(17)	1(15)	2(31)
Bunding	1(7)	1(9)	1(0.3)	1(12)
Fallow	-1(14)	-1(9)	0	1(8)
Drainage channels	2(33)	2(23)	0	1(14)
Contour ridges	1(8)	-2(25)	2(71)	2(23)
Zero tillage	-2(51)	-2(57)	-2(29)	-2(100)
Minimal tillage	2(46)	-1(11)	1(6)	-2(30)
Agro-forestry	-1(18)	2(79)	1(11)	1(16)
Wind barriers/ alley cropping	2(46)	2(133)	2(100)	-1(8)
Planting grasses/ savanna grasses	2(100)	-2(31)	2(25)	1(4)
Constructing stone walls	2(100)	2(43)	2(500)	1(7)
Plantation of shrubs and trees	-1(20)	1(4)	1(19)	-1(13)

* -2 major decrease, -1 minor decrease, 0 no change, +1 minor increase, +2 major increase

Water management practices have been well known in all villages, for example, water harvesting, development and maintenance of watersheds, in-situ moisture conservation. Farmers know a little about extracting groundwater and drip irrigation. The type of practice used depends on the difference in crop types and extensive or intensive cultivation such as field crops (which are mainly rainfed), and vegetables (which have short growing seasons and bring more income). Water harvesting, development and maintenance of watersheds and in-situ moisture conservation practices were increased during the 39 years (1970-2008) in all four villages. KS and TT villages have sparingly used groundwater, whereas groundwater use has been on the rise in DP and NM. Nong Muang (NM) has not used sprinkler or drip irrigation because of lack of water sources in the dry season, whereas the other three villages use these systems frequently (Table 40).

Nong Muang (NM) village is about 10 km from the Chee river, but it lacks water in the dry season because the topography of the growing areas and village are at higher levels.

Collective action in soil and water conservation of the village was lower in the first period (1970-1990) and increased in the second (1990-2008) in all the villages. The change was more than 20%. This shows a greater concern of farmers or respondents for collective actions in natural resource conservation for the village. It was seen in KS that conservation and maintenance of grazing lands has not changed in comparison to other areas. During early period NM, DP and TT have had more forest plantations than KS and the forest cover has increased over the years in all the study villages. Maintenance of community water supply system has highly increased in all villages (Table 41). Construction of roads and their maintenance has also increased in all the villages, but it has mostly been managed by the government.

Table 40. Water management practices in four villages.

	Whether aware of (Yes=1/No=0)				Household practicing (%)							
					1970-1990				1990-2008			
Practices	DP	KS	NM	TT	DP	KS	NM	TT	DP	KS	NM	TT
Water harvesting	0.8	0.9	0.9	0.9	57	43	52	48	65	65	75	63
Development and maintenance of watersheds	0.8	0.8	0.8	0.9	39	46	46	49	51	56	57	56
In-situ moisture conservation	0.5	0.7	0.8	0.7	17	19	20	32	18	23	22	49
Extraction of groundwater	0.3	0.6	0.5	0.6	7	15	0	10	8	13	0	8
Drainage management	0.9	0.8	0.8	0.9	55	51	50	45	69	52	54	61
Use of sprinklers	0.6	0.7	0.6	0.7	1	1	0	4	7	3	0	8
Use of drip irrigation	0.5	0.6	0.6	0.7	0	0	0	1	5	1	0	6
Construction of check dams	0.6	0.9	0.5	0.7	23	16	3	14	22	20	10	21

	Perception*			
Practices	DP	KS	NM	TT
Water harvesting	1(12)	2(52)	2(44)	2(32)
Development and maintenance of watersheds	2(29)	2(22)	2(25)	1(15)
In-situ moisture conservation	1(4)	2(23)	1(12)	2(54)
Extraction of groundwater	1(12)	-1(12)	2(900)	-2(23)
Drainage management	2(24)	1(1.5)	1(8)	2(34)
Use of sprinklers	2(464)	2(490)	0	2(113)
Use of drip irrigation	2(100)	2(100)	0	2(310)
Construction of check dams	-1(5)	2(28)	2(251)	2(48)

Table 41. Collective action in soil and water conservation in four villages.

	Yes=1/no=0											
	1970-1990				1990-2008				Response*			
Practices	DP	KS	NM	TT	DP	KS	NM	TT	DP	KS	NM	TT
Initiatives of soil & water conservation measures on common lands	0.1	0.2	0.2	0.2	0.7	0.7	0.9	0.8	2(123)	2(61)	2(70)	2(68)
Initiatives of soil & water conservation measures on private lands	0.4	0.5	0.4	0.6	0.7	0.6	0.5	0.8	2(73)	1(20)	2(23)	2(36)
Plantation of trees on common lands	0.4	0.4	0.6	0.6	0.9	0.5	0.9	0.9	2(106)	2(31)	2(68)	2(55)
Plantation Forest	0.4	0.3	0.5	0.4	0.9	0.4	1.0	0.8	2(119)	2(60)	2(117)	2(82)
Conservation and maintenance of grazing lands	0.4	0.0	0.4	0.5	0.5	0.0	0.6	0.6	1(6)	0	2(84)	2(25)
Conservation and maintenance of water resources	0.5	0.5	0.5	0.7	0.9	0.8	0.9	0.9	2(62)	2(69)	2(62)	2(37)
Construction of roads and their maintenance	0.5	0.6	0.8	0.7	0.9	1.0	0.9	1.0	2(95)	2(63)	1(2)	2(36)
Maintenance of community water supply system	0.4	0.4	0.4	0.4	0.9	0.8	0.7	0.8	2(129)	2(92)	2(73)	2(107)

* -2 major decrease, -1 minor decrease, 0 no change, +1 minor increase, +2 major increase

4.3.3 Institutional involvement

There have been many institutional involvement patterns from 1970-2008 (Table 42). In the first period (1970-1990) the village head, local trade market both inside and close to the village, banks and primary school participated more in the village activities, but in the second period (1990-2008) more self-help groups formed, and infrastructure facilities like electricity and telephone had been developed in all the villages. NM and TT villages have had farmers cooperatives involved in terms of loans, but this was not so in DP and KS. The local trade market is involved in setting market prices. Self-help groups have been formed both formally and informally in terms of savings, supplementary occupation and microfinance loans for agricultural activities and other livelihoods. Tumbon, or district administration has had a much more important role to play with its involvement in the second period regarding information on health care, agriculture, infrastructure, climate shock relief and natural resource management. Banks also get involved in agriculture, and livelihood and natural resource management campaigns and loans.

Institutional involvement in different types of services or help is shown in Tables 43, 44, 45 and 46 for DP, KS, NM and TT villages, respectively.

After looking at the institutional involvement in each village, adaptation strategies can be categorized into various relevant levels, which are farm, institution, technological and social levels. In the farm

Table 42. Institutional involvement patterns in four villages.

Institutional involvement	DP		KS		NM		TT	
	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Farmers cooperative	None	None	None	None	None	Loans	None	Loans
Local trade market	- Cassava mill trade - Set market price	- Cassava mill trade - Set market price	- Set market price	- Set market price	- Cassava mill trade - set market price	- Set market price	Cassava mill trade	- Cassava and vegetables trade - Set market price
Savings/SHGs	none	- Savings group - Irrigation water user group	Basket work activities	- Fishing equipment, basket work group (OTOP) - Microfinance group - Sufficiency economic community setting	None	- Microfinance group - Weaving silk and dressmaker group - Savings group	No	- Supplementary occupation - Microfinance
Tambon (district) Administration	Village head	- Information for agricultural technology and market - School milk distribution	- Infrastructure	- Infrastructure - Crop insurance	Village head	- River overflow protection - Food relief - Supplementary career support - Information for agricultural technology and market	No	- Infrastructure - Natural resource management - Relief food/ childrens' lunch subsidies

Continued.

Table 42. Institutional involvement patterns in four villages *continued.*

Institutional involvement	DP		KS		NM		TT	
	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008	1970-90	1990-2008
Primary and Secondary School	No	- Childrens' lunch subsidies (primary school)	Primary school	- Alternative occupation for children (Primary school)	Primary school	- Childrens' lunch subsidies	No	- Childrens' lunch subsidies (primary school)
Health center	- Health care	- Health and mental care				- Health awareness information		- Health awareness information
Livestock technician			Vaccination and animal health	Less action	Animal health care when in shock	Vaccination and animal health	No	Vaccination and animal health
Banks (Regional, rural, cooperative and private)	Savings	- Loans for agricultural input and technology - Crop and income insurance	- Loans for agricultural occupation	- Loans for agri-cultural occupa-tion	Savings	- Loans for agricultural input and soil and water conservation	Settled near the village in 1992	- Reforestation loan - Debt - Agricultural input: major elements fertilizer support
Electricity	No	- Power supply - Electric savings strategy	Power supply since 1975		Power supply since 1985	- Power supply	No	- Power supply - Electrical instrument installation training
Telephone	No	Telephone and mobile phone network supply	No	Telephone and mobile phone network supply	No	Telephone and mobile phone network supply (since 1999)	No	Telephone and mobile phone network supply

Institutional involvement in different types of services or help is shown in Tables 43, 44, 45 and 46 for DP, KS, NM and TT villages, respectively.

Table 43. Institutional involvement in Don Plai (DP) village.

Services		Local Government	Health Centers	Govt. Programs	School	MFIs*	Co-operatives	Banks	SHGs	Development Agencies/ NGOs	Private Companies	Others
Infrastructure	Irrigation	√			√				√			
	Storage							√				
	Communication			√	√							
	Transport	√		√								
Natural Resource Management	Afforestation	√	√	√	√							√ military
	Soil and Water Conservation			√							√	
Alternative Livelihood	Inside the village			√				√				
	Outside the village										√	
Technology, Markets and Inputs	Alternative forms			√				√				
	Market prices			√				√			√	√ middle man
	Marketing Strategies			√				√				
Financial Assistance	Credit					√	√	√				
	Grants			√								
	Chit funds											
Food	Subsidies	√		√								
	Relief Food			√								√ politician
Insurance	Crop			√				√				
	Weather											

Continued.

Table 43. Institutional involvement in Don Plai (DP) village *continued.*

Services		Local Government	Health Centers	Govt. Programs	School	MFIs*	Co-operatives	Banks	SHGs	Development Agencies / NGOs	Private Companies	Others
Information	Weather forecasting	√		√								√ head of village, TV, radio
	Health Awareness		√									
	Market conditions			√								√ neighbor
	Schemes and Benefits	√										
	Counseling	√										
Education	Vocational and Skills training	√										
	Disaster Preparedness											No prepared-ness
Legal	Water Permits			√					√			
	Conflict Resolution			√								
Other Relief Measures		√ municipa-lity (water)		√ water transport								

Table 44. Institutional involvement in Kud Sawai (KS) village.

Services		Local Government	Health Centers	Govt. Programs	School	MFIs*	Co-operatives	Banks	SHGs	Development Agencies/ NGOs	Private Companies	Others
Infra-structure	Irrigation			√								
	Storage								√			Farmer's own
	Communication										√	
	Transport	√										
Natural Resource Manage-ment	Afforestation	√			√				√			
	Soil and Water Conservation										√	
Alternative Livelihood	Inside the village	√		√								
	Outside the village										√	
Technology, Markets and Inputs	Alternative forms			√							√	
	Market prices	√							√		√	
	Marketing Strategies										√	
Financial Assistance	Credit								√			Village lender
	Grants			√								
	Chit funds											Villagers
Food	Subsidies											
	Food Relief											
Insurance	Crop			√			√	√				
	Weather			√								

Continued.

Table 44. Institutional involvement in Kud Sawai (KS) village *continued.*

Services		Local Government	Health Centers	Govt. Programs	School	MFIs*	Co-operatives	Banks	SHGs	Development Agencies/ NGOs	Private Companies	Others
Information	Weather forecasting			√								
	Health Awareness	√	√									
	Market conditions										√	
	Schemes and Benefits			√								√TV
	Counseling			√								
Education	Vocational and Skills training			√								√TV
	Disaster Preparedness			√								√TV
Legal	Water Permits			√								
	Conflict Resolution			√								
Other Relief Measures												

*Village Microfinance Fund

Table 45. Institutional involvement in Nong Muang (NM) village.

Services		Local Government	Health Centers	Govt. Programs	School	MFIs*	Co-operatives	Banks	SHGs	Development Agencies / NGOs	Private Companies	Others
Infrastructure	Irrigation			√								
	Storage											
	Communication										√	
	Transport			√								
Natural Resource Management	Afforestation	√		√								
	Soil and Water Conservation			√								
Alternative Livelihood	Inside the village			√		√					√	
	Outside the village										√	
Technology, Markets and Inputs	Alternative forms			√		√		√				
	Market prices										√	
	Marketing Strategies										√	
Financial Assistance	Credit						√					√ Village lender
	Grants	√										
	Chit funds											
Food	Subsidies	√										
	Food Relief	√										
Insurance	Crop			√								
	Weather											

Continued.

Table 45. Institutional involvement in Nong Muang (NM) village *continued.*

Services		Local Government	Health Centers	Govt. Programs	School	MFIs*	Co-operatives	Banks	SHGs	Development Agencies / NGOs	Private Companies	Others
Information	Weather forecasting											√ TV, radio
	Health Awareness		√									
	Market conditions											
	Schemes and Benefits			√								√ TV, village head
	Counseling	√		√								√ Village head
Education	Vocational and Skills training			√								
	Disaster Preparedness	√										
Legal	Water Permits											
	Conflict Resolution	√										√ Village head
Other Relief Measures												

*Village Microfinance Fund

Table 46. Institutional involvement in Tha Taeng (TT) village.

Services		Local Government	Health Centers	Govt. Programs	School	MFIs*	Co-operatives	Banks	SHGs	Development Agencies / NGOs	Private Companies	Others
Infrastructure	Irrigation	2		2								
	Storage			1								
	Communication	2										
	Transport	1										
Natural Resource Management	Afforestation			2								
	Soil and Water Conservation	1		1								
Alternative Livelihood	Inside the village											
	Outside the village	2		1								
Technology, Markets and Inputs	Alternative forms											
	Market prices											
	Marketing Strategies											
Financial Assistance	Credit					1	1	1				
	Grants											
	Chit funds											
Food	Subsidies	1										
	Relief Food	1										

Continued.

Table 46. Institutional involvement in Tha Taeng (TT) village *continued.*

Services		Local Government	Health Centers	Govt. Programs	School	MFIs*	Co-operatives	Banks	SHGs	Development Agencies / NGOs	Private Companies	Others
Insurance	Crop											
	Weather											
Information	Weather forecasting											Television 2 / village head 2
	Health Awareness		1									Village head 1
	Market conditions											Village head 1
	Schemes and Benefits											Village head 1
	Counseling											Village head 1
Education	Vocational and Skills training			1				1				
	Disaster Preparedness			1				1				
Legal	Water Permits											
	Conflict Resolution											Village head 2
Other Relief Measures												

*Village Microfinance Fund

Score: 1 = very satisfied ; 2 = satisfied ; 3 = unsatisfied

level, the farmers or respondents talked about changing the cropping pattern, for example, introducing drought tolerant crops before growing rice, broadcasting rice instead of transplanting, growing other crops repeatedly after previous crop was damaged, growing less duration crops using available water. Some of them were interested in increased use of organic fertilizer such as compost, animal manure and green manure in soil improvement to make it hold more moisture, but this has to connect with the institutional and technological levels in training or in the introduction of knowledge. The respondents also concentrate on decreasing expense, earning through supplementary occupations in villages, and on temporary migration for 3-4 months.

At the institutional level, the other requirements are development of new water sources for irrigation (the most needed in farmers' adaptation to climate variability), information on agricultural knowledge, weather forecasts and immediate relief from shock. Crop insurance is a medium term adaptation strategy. In TT village, organic farming is more adopted than the other villages because of the presence of a learning center that provided sufficient knowledge on organic farming technology. Furthermore, promotion of supplementary occupation and natural resource management in the village should be continuous.

At the technological level, development of water sources and effective irrigation systems are needed. Concentration should be on agricultural knowledge such as water holding capacity, improvement and alternative cropping systems. Crop varieties tolerant to drought, floods, stress or specific problems should also be developed and introduced.

At the social level, the respondents informally form a group after facing climate shock to talk to each other about the damage and to release their mental stress. This may lead to negotiations to ask for help, or in setting up of village committees for solving problems. There have been many forms of self-help groups for irrigation management within the village and neighboring villages, which address microfinance (village fund), savings, supplementary careers, vegetables production and economic sufficiency. Adaptation strategies on different intervention levels in the four study villages are shown in Tables 47, 48, 49 and 50.

Table 47. Adaptation strategies of farmers on different intervention levels (DP).

Farm level	Change cropping pattern; delay the growing season.
Institutional level	Infrastructure development: irrigation system; Introduction of, and training in organic fertilizer, weather forecasting and immediate relief from shock, crop insurance and natural resource management.
Technological level	Providing more water resources; Organic fertilizer knowledge, drought and flood resistant varieties; Change cropping pattern.
Social level	SHGs, irrigation management within the village and the neighboring villages.

Table 48. Adaptation strategies of farmers on different intervention levels (KS).

Farm level	Grow more crops frequently; supplementary careers, eg, basket work, jobs in factory; get loans.
Institution level	Providing more water resources; promotion of supplementary occupation, information in knowledge, weather forecasting and immediate relief from shock; crop insurance and natural resource management.
Technological level	Rice variety for specific conditions, ie, low flood plain (have to drain out water from paddy before harvesting rainy season rice) and in market needs at the same time.
Social level	SHGs: Handicraft producing, housewives group, microfinance.

Table 49. Adaptation strategies of farmers on different intervention levels (NM).

Farm level	Adoption of compost and organic fertilizer application for soil improvement; decrease expenses and get loans; supplementary careers in village, temporary migration to other careers.
Institutional level	Optimum irrigation system budgeting; organic fertilizer knowledge and training, information in knowledge, weather forecasting and immediate relief from shock; crop insurance and natural resource management.
Technological level	Organic fertilizer knowledge and training; drought tolerant crop types and varieties.
Social level	Self-Help Groups: microfinance, savings, supplementary career groups; form problem solving member group when the need arises and ask for help via village head.

Table 50. Adaptation strategies of farmers on different intervention levels (TT).

Farm level	Change cropping pattern, methods (both broadcasting and transplanting rice), crop type, change to organic farming.
Institutional level	Introduction of green manure cropping (seed supply and recommendation); Organic fertilizer knowledge and training, knowledge of economic sufficiency; access to information about climate shocks; weather forecasting and immediate relief from shock; crop insurance; natural resource management.
Technological level	Change cropping pattern, Organic fertilizer knowledge and training, knowledge of economic sufficiency.
Social level	SHGs, irrigation management within the village and neighboring villages, economic sufficiency group.

To face the next climate shock, which might be more severe than earlier ones, the coping mechanism of farmers showed that shifting to cultivation of new crops that are suitable to climate pattern, was the first choice in DP, NM and TT. Changing the cropping pattern was the second choice. Reducing consumption expenditure was the one chosen by NM male farmers. Migration for non-farm activity and loans were the last choices (Table 51).

Table 51. Coping mechanism of farmers.

			NM		
Coping mechanism	DP	KS	female	male	TT
Loans	7	9	9	8	7
Migration for non-farm activity	9	9	7	9	9
Shift to new crop suitable to new climate pattern	1	1	1	2	1
Partial sale of assets	8	9	8	7	8
Change in the cropping pattern	2	3	2	3	3
Change in the date of operation	3	2	6	5	6
Making use of previous cash saving	5	6	4	6	5
Reduction in the consumption expenditure	4	5	5	1	2
Sale of livestock	6	4	3	4	4

Ranking in 1 to 10 scale: 1= most preferred, 10=least preferred

The villagers changing practices were ranked based on their preferences. They prefer to dig bore wells to overcome the changes in rainfall. Deepening of the existing well and adoption of sprinkler or drip set are also because of changes in rainfall. Change in the cropping pattern will be practiced if there is significant changes in temperature and market situations. Changes in the number of irrigation methods will be done due to changes in temperature and rainfall. Change in livestock rearing will be done due to the change in market situation and rainfall. Change in growing rain fed crop was due to change in rainfall. Changing from annual to perennial crops was due to a change in the market situation. Farmers go to alternative occupations mainly due to changes in rainfall (Tables 52 and 53). It seems that changes in rainfall determine several adaptation strategies.

Table 52. Causes of changing practice of Don Plai (DP) and Kud Sawai (KS) villages.

	DP				KS			
	Rank according to preference				Rank according to preference			
Changing practice	Due to change in RF	Due to change in temp	Due to change in GWL	Due to change in market situation	Due to change in RF	Due to change in temp	Due to change in GWL	Due to change in market situation
New bore well	1	2	3	4	1	3	4	2
Deepening of the existing well	1	3	2	4	2	1	3	4
Adoption of sprinkler/ drip set	1	2	3	4	2	1	4	3
Change in cropping pattern	2	1	3	4	3	4	2	1
Changes in the irrigation methods	2	1	3	4	4	1	2	3
Change in livestock rearing	1	2	3	4	2	3	4	1
Change in growing rain fed crop	1	2	3	4	1	2	3	4
Change from annual crop to perennial crop	1	4	2	3	4	2	3	1
Alternate occupations (migration)	1	3	4	2	2	3	4	1

The ranking is done on a 1-4 scale. 1= most important and 4= least important
RF – Rainfall, GWL – Groundwater level

Table 53. Causes of changing practice of Nong Muang (NM) and Tha Taeng (TT) villages.

	NM				TT				
	Rank according to preference				Rank according to preference				
Changing practice	Due to change in RF	Due to change in temp	Due to change in GWL	Due to change in market situation	Due to change in RF	Due to change in temp	Due to change in GWL	Due to change in market situation	Others
New bore well	1	2	4	3	1	4	3	2	
Deepening of the existing well	1	2	3	4	1	4	3	2	
Adoption of sprinkler/drip set	1	2	4	3	4	2	4	3	1 (Lack of labor)
Change in cropping pattern	1	3	4	2	2	3	4	1	
Change in number of irrigations	1	2	3	4	1	2	4	3	5 (Lack of labor)
Change in livestock rearing	2	3	4	1	2	3	4	4	1 (Lack of grazing area)
Change in growing rain fed crop	1	3	4	2	1	3	4	2	
Change from annual crop to perennial crop	2	3	4	1	2	3	4	1	
Alternate occupation (migration)	1	3	4	2	4	4	4	4	1 (cannot adapt to agricultural work)

The ranking is done on a 1-4 scale, 1= most important and 4= least important

RF – Rainfall, GWL – Groundwater level.

4.4 Barriers to adaptations

Barriers to adaptations from group discussions in each village are shown in Tables 54, 55, 56 and 57.

Table 54. Barriers to adaptation (DP).

Barriers to adaptation	Reasons
1) Recommended adaptation strategies not within priority needs, eg, compost producing	Income generation activities are most important
2) Little understanding of climate change impacts	Few initiatives on climate change information and dissemination
3) Small landholding farmers	Fewer opportunities to change cropping pattern.

Table 55. Barriers to adaptation (KS).

Barriers to adaptation	Reasons
1) Little understanding of climate change impacts	Few initiatives on climate change information and dissemination
2) Many small landholding farmers	Fewer opportunities to change cropping pattern and cost limitation
3) Most cropping areas are in very low lands prone to floods.	Availability of a few varieties of rice suitable for both area and market needs
4) Hard to adopt new methods or recommendation in improving soil fertility, eg, compost and bio-fertilizer production and usage	Lack of knowledge regarding the importance of soil improvement.

Table 56. Barriers to adaptation (NM).

Barriers to adaptation	Reasons
1) Lack of water sources in the dry season	- The village and growing areas are on a higher level than the natural river (Chee River) and the existing water sources have not improved/filled up after the rainy season
	- Deep underground water level
2) Lack of better crop production technologies, especially for rice, which needs more water, eg, drought resistant variety	- No access to seed supply and technology
3) Few innovations in other supplementary careers in the village	- Temporary migration is easy as there are roads in the village
	- Hard to find local market needs responding to the products.

Table 57. Barriers to adaptation (TT).

Barriers to adaptation	Reasons
1) Hard to adopt new methods or recommendations in agriculture until they have had a first-hand (personal) experience.	- Too risky to lose income
	- Have gotten used to the former practice
2) Little understanding of climate change and its impacts	Fewer initiatives on climate change information and dissemination
3) Large farm holders ignore the onset of rainfall in planning to grow crops but more consideration in crop types and land suitability	Having large areas provides easy decision making in growing various types of crops without awareness of climate variability

5. Conclusion

Farmers' perception to climate change was expressed in terms of lower amount of annual rainfall with uneven distribution, fewer annual rainy days with high intensity rain in a day, higher temperatures and delay in the onset of monsoon. These matched actual climatic analysis, except for annual rainfall that shows an increase. From the discussion, we conclude that there were more droughts and severe drought years than flood years in each village, and drought occurred more frequently in the second period (1990-2008). NM village has faced more drought than the other three villages. Storms and pest outbreaks also occurred more in this period. The direct impacts from drought were lack of drinking water, rice and cassava yield decrease and loss and lack of food. Road and house damage occurred due to storms and floods. Secondary order impact of yield loss is the fact that farmers have to spend some money to buy rice as food, so money savings and loans are needed. Landless or marginal farmers migrate to other jobs. These are all livelihood impacts.

However, experiencing climate shocks from time to time forced farmers to adapt themselves to some extent. Delay in the growing period, growing more integrated crops to avoid risk and to grow them repeatedly after damage, are some types of adaptation. Landless farmers rent land to grow rice for food, take up agricultural and general labor, get loans or temporarily migrate. Smallholder and mediumholder farmers decrease dry season rice growing, change the cropping pattern and take up supplementary occupational earnings. Largeholder farmers grow more crops and grow them more frequently, cultivate crops near the water sources and dig more wells or farm ponds. In terms of changes in cropping pattern, there have been both gradual and immediate changes. Crops that need much water to cultivate, like roselle, disappeared, and drought tolerant, less water demanding and higher price crops were substituted in the study areas, for example, cassava, maize and sugarcane. Growing dry season rice where there are irrigation sources and then decreasing the growth after facing several drought years, is another change in agriculture.

Government aided projects, and lately local governments (including village head), are involved in relieving damage from climate variability, and even more during 1990-2008. A dam was built 20 years ago in Chok Chai district and a medium-sized irrigation water reservoir was developed in Chatturat district. Natural resource management, technology and markets, financial assistance, crop and weather insurance, information on weather forecast and health awareness are needed by farmers for adaptation to climate variability. Apart from the external institutional intervention, self-help groups in the village are important, especially immediately after a climate shock.

These lead to mainstreaming adaptation in policy or programs, which are as follows:

1. Agricultural sector

It is clear that drought or flood tolerant crops or varieties is the answer to adapt to climate risk. Improvement in water holding capacity of soils using organic fertilizers such as compost, animal manure and green manure should be introduced. A cropping system with environmentally friendly crops rather than a sole crop should be recommended to achieve economic sufficiency. The information on agricultural knowledge, inputs and awareness of climate disaster are to be provided for easy access.

2. Water resources sector

Water and rainfall harvesting including effective irrigation systems and management is the first priority to establish and improve.

3. Natural resource management

Reforestation and conservation of land and water should be continuously promoted to improve the environment. This will also help in improving farmers' livelihoods.

4. Institutional innovation

There should be proper understanding of climate variability and climate change; formation of self-help groups; promotion of supplementary occupation, micro financing system, weather and crop insurance, and village weather change warning and monitoring system. Public awareness on climate change or variability and impacts on agriculture and livelihood should be continuously promoted.

About ICRISAT

International Crops Research Institute for the Semi-Arid Tropics

ICRISAT is a member of the CGIAR Consortium

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

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

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