VNU Journal of Science: Earth and Environmental Sciences, Vol. 30, No. 4 (2014) 25-40

Farmer's Perception and Farming Practices in Rice Production under Changing Climate: Case Study in Quảng Nam Province

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Received 20 August 2014
Revised 28 September 2014; Accepted 10 December 2014

Abstract: In the context of observing climate change impacts and their effect on agriculture and rice production, this study intends to assess the farmers' perception through a study case in Quang Nam province. The social approach of climate change vulnerability in this case study includes defining and exploring factors that determine farmers' perception in four districts. Beside collection of primary and second data, key informant interviews, PRA and farm-household interviews were used for data collection. Evaluation of primary and secondary information comprised an appraisal of impacts of climate change on agriculture and livelihood of farmers, and their strategies to adapt climate change. The descriptive statistical methods were adapted, applied and used to analyse the data. The data was analysed at two scales: whole sample-level and household level. The results show the general situation of rice production under climate change conditions and its clear and considerable effects on rice cultivation in the typical regions of Quang Nam Province. Despite growing attempts of local communities and farmers' perception to adapt to climate change and variability, further planned adaptation aimed at a larger scale and longer duration is necessary to sustain the livelihood security of smallholder farmers.

Keywords: Climate change, rice production, farmer's perception, farming practice, adaption

1. Introduction

Quang Nam has tropical monsoon climate which is classified into 2 distinct seasons (rainy and dry seasons). During the year, there are two main types of wind, North-east and South-west monsoon, affecting the climate of Quang Nam. In addition, there is the South-East wind blowing from the sea (active from late March to June) and dry West wind from Laos, causing the hot weather in local area. Climate change and climatic variability present an increasing

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challenge for Quang Nam. In recent years, climate change in Quang Nam is likely to increase in frequency, intensive, fluctuation and extreme of dangerous weather phenomenon such as storms, whirlwind or natural calamities in relations to the temperature and rain such as hot and dry weather, floods, sunk or drought, extremely cold, salt encroachment, pestilent insects, reducing productivity and yield of plants, crops and livestock [1]. Climate change has strong impacts on the growth and productivity of plants, crops and threatens to reduce the agriculture land acreage. It can be said that agriculture, forestry and fisheries suffer the most severe consequences and in a large area. As reported by Quang Nam's Department of Agriculture and Rural Development and the Central Board of Flood and Storm Control (cited by Quang Nam People's Committee) from 1999 to 2010, agricultural production has been strongly influenced by the climate and weather change. Here are some losses of agriculture production in recent years in the province because of heavy rain/storms and drought/saltwater intrusion [2, 3].

Quang Nam is located in Vu Gia-Thu Bon river basin. Natural area of Quang Nam occupies more than 90% of the basin area. This is one of the largest river basins and also the key economic and agricultural region in the South Central region of Vietnam [4]. Agriculture is the mainstay of the Quang Nam economy and accounts for 30 % of gross domestic product [4]. Area of agricultural land is accounting for 220.040 ha, of which 61% is used for rice cultivation. Rice is considered as the most important food crop in Quang Nam with 88,000 ha of planted area standing at the second largest area of paddy rice in South Central [4, 5]. Although 60 % of the totalpopulation depends on agriculture, the subsistence andtraditional farming makes the agricultural sector highlyvulnerable to the effects of climate change and variability [6]. Significant effects of climate changehave already been experienced by local communities where farmers are struggling to cope with increasingadversities associated with the changes. Owing to limited alternatives for livelihood security, impacts are more pronounced in small-holder agriculture where subsistence farming provides the principal source of income [7]. The goal of this study was to investigate and determine impact of climate change and variability on rice production in four districts of Quang Nam and evaluates farmer's perception and farming practices for rice in smallholder.

2. Materials and Methods

2.1. The study areas

The four (4) selected districts that were chosen for a survey to gather information were three typical sites along a topography transect of Quang Nam: (i) hilly midland—Dai Loc District (3 communes), (ii) delta lowland—Duy Xuyen and Dien Ban districts (6 communes), and (iii) coastal area—a part of Duy Xuyen and Hoi An (2 communes). Four districts have intensive paddy farming practices. Dai Loc was chosen since this district is one of the rice seed production zones of Quang Nam and is now one of the first districts to be selected as a pilot site for testing the 3 Reduction – 3 Gain (3R3G) program and Large-Scale Rice Field (LSRF) model. Duy Xuyen and Dien Ban districts were chosen as study sites since these districts are intensive rice cultivation zones in Quang Nam and are now the ones most dramatically pushing the 3R3G and LSRF model. Hoi An is a coastal district, selected as a representative for coastal districts with rice production.

Stratified sampling and investigation method was used to choose the survey sites. We have conducted a series of focus group discussion and key informants' interview about climate change impacts on rice production, adaptation, and mitigation strategies with community representatives (villages or hamlets) and local government officials. The farm-household survey was conducted in 165 individual households from 11 representative communes, with 15 selected households for each commune.

2.2. Data collection and survey method

Figure 1 shows the sequential steps of research used and the overall type of data expected to be obtained. Data collection was divided into five main stages. The data surveys were conducted during September 2012 and October 2013 in collaboration with Hue University of Agriculture and Forestry (HUAF) and local agricultural agencies in four selected districts. These officers helped the survey team identify key informants and farmers to be surveyed.

The first stage involved gathering of bibliographicaldata and non-exhaustive review of academic literature about climate change in Quang Nam, effects of climate and change in agriculture and water demands, similar previouscase studies, and social research methods. Concerning research methods, it was established that forbetter data quality, this study had to include different sources of data, namely key informant interviews, participatory rural appraisal (PRA), and household interviews.

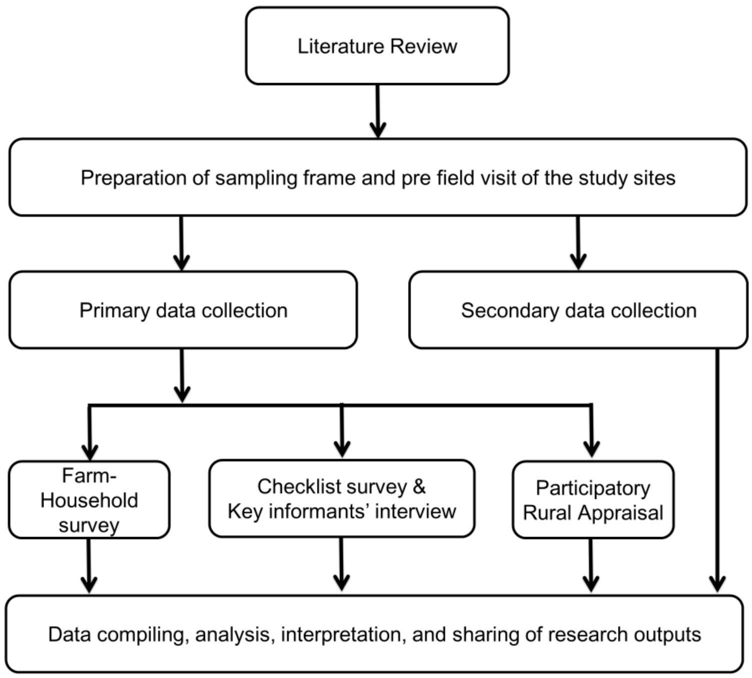

Figure 1. Chronology of data collection.

Primary data collection: Information about rice production, including the implementation of the 3R3G program and LSRF model, in each locality was collected from local authorities such as the local Agriculture and Rural Development Divisions and Agriculture Extension Stations in four districts.

Secondary data collection: Secondary data were drawn from statistical yearbooks, previous studies relating to rice cultivation, input use, and environmental consequences on human health and the environment in Vietnam and Quang Nam, and articles, official reports, and local policies on rice production.

Participatory rural appraisal (PRA): The following tools of PRA can be applied to collect information: mapping of resources, transect diagram, timeline (historical profile), seasonal activity calendar, Venn diagram (organizational linkages diagram), problem tree, priority ranking, pair-wise ranking, wealth ranking, and decision-making matrix.

Farm-household survey (FHS): The interviews with questionnaires were conducted in farmers' houses. Respondent households were selected using a random sampling method. Key informants' surveys were used for a sampling frame, and survey respondents were selected after a pre-field visit. Altogether, sixty households were surveyed from two study locations. Respondents had long-standing experience of local agriculture and climate. Most of the respondents had experiences on local climate and agricultural practices.Data were collected by means of a structured questionnaire containing the following information: rice farming household characteristics, items of rice production costs, input use, output prices, and farmers' perceptions of the impact of pesticides on their health.The time for each interview was 45 minutes to 1 hour.

2.3. Data Analysis

Descriptive statistical tools such as sum, average, etc. were used to analyze and describe farmers' response to the impacts of climate change, and adaptation strategies implemented by local communities. Analysis was carried out using Statistical Package for Social Science (SPSS Inc., version 19) [8].

3. Results and discussions

3.1. Impacts of extreme weather events on rice production in Quang Nam

Natural disasters and extreme weather events usually include a wide variety of phenomena but the survey addressed typhoons, floods, droughts, and sea-water level intrusion by tides as the four major types of natural disasters or severe weather conditions that typically occur in Quang Nam Province and affect rice production there. Because of different geographic conditions, each specific region in the province is affected by certain natural disasters and not by others. In other words, each type of natural disaster will have major impacts in one specific area and at the same time additionalimpacts in surrounding areas.

Results of our PRA survey conducted in August 2013 in 11 local communities demonstrate that local people have a good understanding of the types of natural disasters and extreme weather events, and the typical impacts thereof on their locality and rice production. The responses are summarized below, interpreted as follows: if the percentage of "serious" (S) plus "medium" (M) is 50% or more, it is an important issue. If the combined total is less than 25–49%, it is a minor concern [9].

Table 1. Community perception of the impacts of extreme weather events on rice production

Local community	Typhoon		Floods		Drought		Sea-water surges	
	Level	%	Level	%	Level	%	Level	%
Hilly midland (n=3)	S	65	S	15	S	30	S	0
	M	35	M	30	M	35	M	0
	L	0	L	37	L	26	L	0
	N	0	N	18	N	9	N	100
Delta lowland (n=6)	S	85	S	70	S	52	S	35
	M	15	M	23	M	18	M	26
	L	0	L	7	L	23	L	20
	N	0	N	0	N	7	N	19
Coastal area (n=2)	S	100	S	81	S	55	S	86
	M	0	M	12	M	20	M	9
	L	0	L	7	L	5	L	5
	N	0	N	0	N	20	N	0

Impact: S = serious; M = medium; L = light; N = not occur

Typhoons/storms can have major effects on rice production in delta lowland and coastal areas. In Quang Nam, they usually generate significant adverse impacts on local communities in coastal areas and delta lowland every year [10]. Not surprisingly, typhoons most seriously affect the coastal area of Quang Nam. The data in Table 1 showed that 100% of the coastal communities believed that their rice fields were seriously affected by typhoons on a recurrent basis. However, only 85% of the total lowland delta communities and 65% of the total communities surveyed in mountainous areas believed the same.

Floods can occur in all regions, particularly in the lower basin sections of the Thu Bon and Vu Gia rivers, which are reported to have recently been at their highest recorded levels [10]. In this area, floods occur most often in November. According to information provided by the local authorities responsible for tracking extreme weather and natural disasters, heavy floods typically occur in areas alongside the Thu Bon and Vu Gia rivers, such as Dien Ban, Duy Xuyen District, Hoi An City. Communities surveyed in different regions of Quang Nam had different opinions about the level of intensity of flooding. Serious flood impacts on rice production were observed by 80%, 70%, and 15% of the total coastal communities, total lowland delta communities, and mountainous communities surveyed, respectively. These data collected in each community verified that effect of flood on rice production in lowland delta areas are more seriously than in other areas.

Droughts can occur in most districts in Quang Nam, but the impacts differ. According to experts from Quang Nam's Department for Hydrometeorology Prediction, water often does not reach the low end of the irrigation systems because available irrigation water is insufficient to provide the necessary coverage, due to the limited water supply from inadequately maintained irrigation canals and ditches [10]. In the survey areas, droughts result in reduced access to adequate amounts of good-quality water for daily consumption by people, livestock and agriculture, and small industrial and manufacturing operations. Particularly in lowland coastal areas such as Dien Ban and Duy Xuyen districts, flood-tide surges have exacerbated the impact of drought because fields saturated with saltwater need to be quickly and thoroughly saturated with fresh water to minimize the damage to rice crops. However, since freshwater pumping stations can be damaged by flood surges as well, they often cannot supersaturate the rice fields quickly enough to save the crops. In other geographic areas and socioeconomic situations, drought-affected households experience significant depreciation in household incomes. For example, the data in Table 1 showed that 38% of total coastal communities, 50% of total lowland delta communities, and 57% of total mountainous communities surveyed believed that droughts had seriously affected their local environment and agricultural production, especially rice cultivation.

Flood tides and/or storm surges have caused severe damage to rice crops in coastal areas and delta lowland, including some communes in Hoi Anh, Dien Ban and Duy Xuyen districts [11, 12, 13]. A storm surge is a high flood of water caused by wind and low pressure, most commonly associated with typhoons. Storm surges are different from tidal surges, which are caused exclusively by a tidal shift in sea level. In addition, flood tides affect only the lowland and coastal areas in the summer, resulting in flooding of rice fields with salt water. Spring flood tides are an annual occurrence caused by the relative positioning of the moon, and the effect this positioning has on tidal movement. High tides can be as much as more than 1 meter above normal tide levels. Strong on-shore winds can cause water levels to rise even further. Summer flood tides in coastal areas such as Hoi An and Duy Xuyen can cause significant damage to hundreds of hectares of rice from sea-water.

3.2. Difficulties in rice production in Quang Nam

At community meetings conducted forthis survey, most of the communities surveyed listed the main difficulties in rice production at the community level: new varieties, plant protection chemicals, water shortage, pests/diseases, and market access. The information obtained from meetings of 15 local communities indicated that rice varieties and water shortage were the most serious difficulties for rice production (Table 2).

Table 2. Priority ranking of the main difficulties in rice production

District	Variety selection[a]	Plant protection chemicals	Water shortage	Pests, diseases	Market access
Hilly midland	+++++	++++	++++[b]	+	++
Delta lowland	+++++	+++	++++[c]	++	+
Coastal area	++++	+++	+++++[c]	++	+

[a]*Lack of short-duration and drought-tolerant crop varieties with high yield.*

[b]*Water shortage due to* ***prolonged*** *drought* ***period*** *in dry season (= summer-autumn rice season).*

[c]*Water shortage due to* ***prolonged drought period + saline intrusion*** *in dry season (= summer-autumn rice season).*

Table 3.The problem of water shortage for rice cultivation in Quang Nam

Item		Location (district)		
		Hilly midland	Delta lowland	
		Dai Loc	Dien Ban	DuyXuyen
Gender of farmers	Male	65	68	60
Surveyed (%)	Female	35	32	40
Farmers with water shortage (%)		63	78	82
Duration of water deficit* (days)		33	40–45	40–45
Months of serious water deficit		April, May, June	April, May, June	April, May, June

** The period during the main rice-growing season when water shortage is common.*

In fact, farmers have been mostly using certified varieties but they actually lack short-duration and drought-tolerant rice varieties with high yield in order to adapt to climate change conditions and extreme weather events such as colder weather in winter-spring or warmer weather in summer-autumn. Regarding water shortage, community interviews identified that the impacts of drought and water shortage on rice cultivation were very serious every year (Table 3).

The information collected from the interviews in Table 3 showed that: In the lowland delta communities surveyed, 78–82% of the total interviewees recognized that their fields were affected by water shortage and most seriously during April to June (the summer-autumn season). The drought period usually lasted 40–45 days per year.In the mountainous communities surveyed, 63% of the total interviewees noted that the water shortage and drought had affected their rice fields. The duration of the water deficit was shorter than in the lowland delta areas.

3.3. Farming practice for rice in Quang Nam

Rice planting calendar

Before the period of 2001-2005, Quang Nam's farmer planted 3 rice crops (winter-spring, spring-summer, autumn-winter) per year so that there were climate disadvantages affecting the rice yield and productivity: For winter-spring crop season, farmer has to sow early so that the ear appearance and flowering stage of winter-spring rice coincides with the coldest period of the year (January – February) with very low temperature (18-20^{o}C), low humidity (<55%) and drizzling rain. Accordingly, rice yield earnings could reduce by 30-50% because of empty ears, empty or half-filled. For summer-autumn, prolonged drought occurred (from May to July) and high temperatures of over 37^{o}C during the reproductive stages reduces rice production, especially when the rice plant flowers, causes low seed setting and yield losses (Rice plants are most sensitive at the flowering and ripening stages and both of yield and grain quality are adversely affected by high temperatures. Extremely high temperatures during vegetative growth reduce tiller number and plant height and negatively affect panicle and pollen development, thereby decreasing rice yield potential. High temperature is of particular importance during flowering, which typically occurs at mid-morning. Exposure to high temperatures (>35 °C) can greatly reduce pollen viability and cause irreversible yield loss because of spikelet sterility.

Table 4. Change of rice cultivation calendar

Rice crop season	Before 2001	After 2005
Winter-Spring	10-15 Nov to 10-15 March	20-25 Dec to 20-25 April
Summer-Autumn	01-05 May to 25-30 August	15-20 May to 15-20 Sept
Autumn-Winter	01-05 Sept to 01-05 Dec	uncultivated

(Source: Department of Agriculture and Rural Development of Quang Nam, 2012) [5].

Last crop season (autumn-winter) coincided with the rainy season which typically starts in September and lasts until November. Due to the effects of tropical depression and seasonal storms from the late September to December, the last crop season of the year had low yield and productivity or even was loss completely by flooding.

Thus, from the practical rice production in recent years, Quang Nam province has a large transition area from three rice crops to two crops per year in order to avoid climate disadvantages and climate change effects. Under guidance of province authority, from 2001 farmer began to removed/cancel the spring-summer rice season and re-arranged/changed crop calendar in winter-spring (from 20 December to 20 April instead of from 10-15 Nov to 10-15 March) and summer-autumn (from 20 May to 20 September instead of from 01-05 May to 25-30 August) to be more suitable for abnormal changes of climate. The farmers have been encouraged/asked to grow short-term rice varieties in summer-autumn crop season with duration of less than 105 days, so they can harvest the summer-autumn rice before September 15 to avoid the flooding season.

Thanks to the re-arrangement of the cultivation calendar, new rice varieties and appropriate crop structure, production of two rice crops has been higher than three rice crops, although the cultivated area reduced nearly one third. As a result, the cost of investment reduced by 30% and economic efficiency increased by 30-50%. Cultivation calendar was completely changed to avoid rain and storms in rainy season [14]. In general, the impact of climate change on Quang Nam's agricultural production activities clearly changed the structure of crops.

Rice varieties

Survey statistics showed that rice varieties popular at the study sites were Xi23, Xiec13.2 (long growth duration varieties), QN1, VL20, NhiUu 838, TBR1 (medium growthduration varieties), and HT1, Q5, GL102, IR325 (short growthduration varieties), etc. Today, most farmers in Quang Nam have realized the importance of paddy seed for good results in cultivation. They shifted to growing high-yielding rice varieties, usually nitrogen-responsive varieties. Most of these have medium or short growth duration, ranging from 85 to 110 days. However, long-duration rice still makes up the highest percentage of rice varieties used by farmers here, especially in hilly midland areas, with 45%.

Survey results indicated that the seed quantities used by the farmers at all sites were 10–20% higher than recommended. According to the recommendations given by the DARD and Agricultural Extension Agency, seed quantities necessary for 1 ha are 100–120 kg for hand sowing and 70–90 kg for machine sowing (row seeders) [14]. Traditionally, the rice is sown more densely, usually 150–180 kg of seed per ha. Changing a habitual practice has not been an easy task for agricultural agencies in the locality. However, the seed quantities used by farmers in 3 recent years decreased considerably compared with the rates 5 years ago. These figures could partly reflect the success of the propaganda effect of the programs of advanced farming techniques (such as 3R3G) in various forms on farmers. Farmers absorbed something from these programs and applied it to their fields.

According to technical instructions/ guidelines released by agricultural agencies, to get good yield results, farmers should use row seeders to sow rice seed [15]. This practice empirically helped reduce the seed quantity per ha to recommended rates without reducing rice yield and helped farmers easily take care of their paddy fields. Paddy grown in rows will have enough space for it to develop well and this airy space helps reduce insect density (e.g., brown planthoppers), thus reducing pesticide needs. It may also decrease the nitrogen fertilizer need. In fact, machine sowing takes less sowing time and labor than hand seeding in addition to having a flat land surface. However, because of financial difficulties, it's very difficult for farmers to purchase row seeders although their prices are not so expensive and farmers did know the distinct advantages of row seeding compared with hand sowing. Survey statistics showed that most farmers are still using hand sowing (accounting for more than 90%) rather than a row seeder (less than 10%). That was why surveyed seed quantities did not decline to the expected rates.

The choice of rice varieties for cultivation depends on individual farmers. Table 5 reveals some farmers' reasons for choosing a certain variety. High yield, good adaptability to local conditions, and good pest/disease resistance were the most common reasons for farmers to select a particular rice variety.

Regarding rice varietal type, popular rice varieties in the surveyed districts were conventional pure-line/inbred varieties (*going thuan*) with 60−70% of total cultivated area; hybrid varieties (*going lai*) occupied only 30–40% of total cultivated area. As for sources of seed, the survey data showed that in total more than 65% of the farmers usually tended to buy certified seeds from local seed stations or seed production companies while only 30% of the surveyed farmers had propagated seeds themselves or bought seeds from other local farmers. Farmers in "seed production zones" usually propagated seeds themselves or bought seeds from other local farmers while farmers in other communes tended to buy seeds from a seed production company or local seed production station. The local cooperatives helped farmers a great deal in obtaining new rice varieties and applying new technologies.

Table 5. Reasons for farmers to choose paddy varieties (n=165)

Reason	Percentage of farmers (%)		
	Hilly midland	Delta lowland	Coastal area
High yield	35.1[a]	41.2[b]	42.3[b]
Good pest/disease resistance	23.3[a]	26.4[a]	21.6[a]
Good rice quality	11.0[a]	19.8[b]	16.1[b]
Being suitable to local conditions*	35.8[a]	43.3[b]	45.3[b]
Easy sale after harvesting	9.5[a]	16.3[b]	10.0[a]

(a & b: the significant difference between means by T-test analysis at α=0,05)

** Rice could adapt well to local soil and abnormal changes in climate.*

Table 6. Amount of inorganic fertilizer use for rice cultivation (kg/ha)

Nutrient	Mean (±SD)					
	Hilly midland		Delta lowland		Coastal area	
	WSpr	SA	WSpr	SA	WSpr	SA
N	118 (±45)	99 (±43)	125 (±42)	114 (±38)	126 (±40)	116 (±36)
P_2O_5	81 (±34)	63 (±23)	85 (±32)	72 (±30)	88 (±33)	70 (±30)
K_2O	63 (±22)	46 (±20)	73 (±24)	67 (±25)	75 (±24)	68 (±23)

SD=standard deviation; WSpr = winter-spring season; SA = summer-autumn season.

Table 7. Recommendation of total amount of inorganic fertilizer for rice (kg/ha).

Amount	Winter-spring			Summer-autumn		
	Inbred varieties		Hybrid varieties	Inbred varieties		Hybrid varieties
	SD	LD		SD	LD	
N	88	110	113	107	120	137
P_2O_5	55	58	62	55	55	58
K_2O	76	89	103	88	88	101

(Source: Department of Agriculture and Rural Development of Quang Nam) [15].

Fertilizer use

The kinds of common inorganic fertilizers at the study sites were urea, single phosphate, DAP, KCl, and mixed NPK 5-10-3, 20-20-15, and 16-16-8. These fertilizers have different nutrient contents so the amount of pure nutrients in each kind applied per hectare was calculated to get the nitrogen, phosphorus, and potassium quantity/ha.

Table 6 shows the quantities of N, P_2O_5, and K_2O used by farmers at the three study sites for summer-autumn 2011 and winter-spring 2012. Farmers used 10−15% less fertilizer in summer-autumn rice than in winter-spring rice. A similar trend of fertilizer application was observed at all study sites of the survey for all kinds of fertilizer. There was no significant difference in inorganic fertilizer amount between sites located in delta lowland and coastal areas. The fertilizer quantities applied for rice by farmers at the hilly midland site were much smaller than those of two sites in lower regions.

The inorganic fertilizer rates for the dry (winter-spring) and wet (summer-autumn) seasons recommended by Department of Agriculture and Rural Development (DARD) of Quang Nam appear in Table 7.

As can be seen in Table 7, the rate of K_2O recommended by DARD is always higher than that of P_2O_5 while in contrast potassium used by farmers is lower than nitrogen and phosphorus fertilizer. This means that the effect of the propaganda program of new advanced farming practices is still limited for reducing the amount of nitrogen and phosphorus fertilizer and increasing potassium fertilizer used in growing paddy. In fact, farmers tend to overuse nitrogen fertilizer and phosphorus and use less potassium fertilizer compared with the recommended rates proposed by DARD or the agricultural extension agency. Farmers at surveyed sites tended to use 10−15% more nitrogen and 15−20% more phosphorus fertilizer than the recommendation and they did not reduce N to recommended rates while they used 20–40% less potassium fertilizer than the recommended rates due to the expensive price of K_2O. These data show that rice farmers still use nitrogen and phosphorus fertilizers wastefully. Information from the survey showed that farmers in Quang Nam usually relied on their experience to choose the rates of fertilizer applied on their fields. A considerable number of farmers also decide on the quantity of applied fertilizers according to their family budget.

The choice of types of fertilizer also depends on farmers' experience. The data collected indicate that a great percentage of respondents chose kinds of fertilizer to buy based on the knowledge of fertilizer usage left to them from their parents or combined with what they learned from the media. But, these data also showed that a considerable percentage of 3R3G farmers chose types of inorganic fertilizer through lessons learned from 3R3G training classes organized by local agricultural extension or plant protection stations.

Biocide application

Rice farmers usually apply various kinds of pesticide to cope with pests/diseases. Table 8indicates the quantity of pesticides used in rice cultivation during 2011-12. There was no significant difference in total as well as individual kind of pesticide used among three sites. In fact, farmers in delta lowland could use pesticides much more than farmers in hilly midland since, when interviewing farmers in delta lowland and coastal area, we noticed that, although these people said they had applied many kinds of pesticide, especially insecticides and fungicides, they could not remember some of the names of the kinds of pesticide they had used for rice. Most farmers did not usually keep their records adequately due to low education so they could not fully recall their pesticide use.

Table 8 shows that there was a significant difference in the number of herbicide/ rodenticide/ GAS drug applications and insecticides/fungicides. In this survey, the farmers used insecticides and fungicides more than two to four times per rice season while herbicides and rodenticides/GAS drugs were applied one to almost two times per season only. The data in Table 8 also indicated that at the study site in hilly midland the number of applications of almost all kinds of biocide was significantly lower than that of other sites while the number of fungicide applications was not significantly different between delta lowland and coastal area sites.

Table 8. Biocide applications in 2011-2012 (time per rice season)

Type of biocide	Location		
	Hilly midland	Delta lowland	Coastal area
Herbicide	1.8^a	1.6^a	1.6^a
Insecticide	3.1^a	3.6^b	3.5^b
Fungicide	2.4^a	2.9^a	2.8^a
Rodenticide/GAS drug*	1.5^a	1.8^b	1.8^b

(a & b: the significant difference between means by T-test analysis at α=0,05)

(GAS: Golden Apple Snail)

Table 9. Options for rice residue management in Quang Nam

Option	Percentage of farmers (%)					
	Hilly midland		Delta lowland		Coastal area	
	WSpr	SA	WSpr	SA	WSpr	SA
Open-burning in the field	10	6	8	0	5	0
Left on the field for incorporation	15	62	10	79	8	75
Remove residue from the field for						
Feeding cattle or animal bedding	59	27	62	16	63	20
Cooking at home	8	0	5	0	8	0
Using as mulch for succeeding crops	16	0	18	10	20	12
Using as substrate for composting	23	15	15	0	10	0
Mushroom cultivation	5	0	9	5	6	5

WSpr = winter-spring season; SA = summer-autumn season.

Rice residue management

According to survey data, several kinds of rice residue management exist in Quang Nam (Table 9. In order to manage rice residue in the field, farmers have three options: (1) burn residue in the field, (2) incorporate it into the field, and (3) remove it from the field, either for feeding cattle herds or for animal bedding. Rice residues removed from the field were also used as cooking fuel, as a substrate for composting, or for mushroom cultivation. Individual household conditions will determine the disposal method. Currently in Quang Nam, complete removal of straw from the field is widespread by hand although rice harvesting and threshing are mainly done in the field by machine. Rice straw was mainly collected from the field in the winter-spring season and stored in the farmer's house for alternative uses, especially for fodder and bedding, as more than 60% of the respondents surveyed said that they had great demand and used straw as fodder for cattle (cows) and bedding for animals (pigs) during the year.

The survey data also showed that less than 10% of the farmers burned rice straw after harvesting. This means that open-burning of rice residue in the field is now not a common practice in Quang Nam and greater savings in CO_2 emissions and climate change mitigation can be obtained by removing the straw and using it in alternative ways. Rice residues were burned in the field only because of the ignorance of farmers about their value and lack of proper technology for alternative uses. Burning rice residue in the field could be a cost-effective method of straw disposal for the purpose of preparing fields for the next crop. This also helps to reduce weeds, pests, and diseases, but it causes air pollution by releasing CO_2 and particulates, leading to global warming and health concerns.

An amount of rice straw is left on the field for incorporation or flooding in the summer-autumn season since rice of the summer-autumn season is usually harvested around 5-15 September, at the beginning of the storm season. After flooding in water during the heavy rainy season (Sept.-Nov.), the rice residue is incorporated into the soil as farmers prepare land for the winter-spring season. Also, according to data in Table 9, one acceptable option for rice residue management in Quang Nam is to use the rice straw for mushroom cultivation. Although only less than 10% of the farmer households used rice straw as material in mushroom cultivation, this survey has explored the possibility of using rice straw for environmental rice residue management on a small scale. In sum, these studies explore the possibility of using crop residue in alternative ways after removing it from the field.

The results also indicate that the kind of rice straw management for each season will be decided by farmers based on the difference between the harvesting time of the previous rice season and the planting date of the next season and based on the climatic conditions of each season. For example, a longer fallow time between the harvesting date of the summer-autumn season and the planting date of the next winter-spring season means more time for land preparation given that farmers could leave rice straw to incorporate residue into the field before planting the next crop by the given date.

Applying advanced farming practices for rice

To explore farmers' thoughts about the application of advanced farming practices (e.g., 3R3G, AWD), the questionnaire had a section relating to farmers' behaviour regarding this issue. Table 10 offers some reasons for farmers to adopt or not adopt advanced farming programs such as 3R3G and AWD.

For some farmers adopting advanced farming practices, they first paid attention as they applied a new advanced farming practice for their field to cutting costs and then to increasing their income. A considerable number of respondents also said that they adopted advanced farming practices partly because of encouragement from local authorities and being given materials (fertilizer, seed, etc.) and technical guidance.

As for other farmers who did not apply advanced farming practices, when asked why they did not apply the program, they gave many reasons (Table 10). The most common reason was that they did not receive appropriate help/support from the local government. This help was usually in the form of training classes, technical advice from agricultural extension officers, free leaf colour charts, and subsidized row seeders and seed. In fact, to carry out the advanced farming programs throughout the country, the state agencies and research institutes have provided financial as well as technical support to farmers involved in pilot projects. Only farmers in the project area received special technical and material help from local authorities to engage in the demonstrations. Then, from these key farmers, the outcomes were spread to other farmers outside the testing areas. Because of the budget limitations of each locality and the level of determination of the local government, the impact of the advanced farming programs differed in different districts. It seemed that lowland districts carried out the advanced farming programs more strongly than midland or mountainous ones. This could be due to these lowland districts also being the "main zone of rice production" of the province so that these areas received strong support from the local government such as training, good seed, and guidance and advice from the technical staffs of local agricultural agencies, etc.

Table 10. Farmers' reasons for applying advanced farming practices of rice production (n=63)

Reason	Percentage of surveyed farmers (%)		
	Hilly midland	Delta lowland	Coastal area
To cut/reduce costs	62.5[a]	77.9[b]	75.1[b]
To increase income	91.2[a]	95.8[a]	92.7[a]
Encouragement from local authority	38.6[a]	35.1[a]	33.6[a]
They were given some material and technical guidance	38.6[a]	45.2[b]	44.9[b]
To protect health	10.8[a]	18.5[b]	20.3[b]
To imitate other farmers in the village	13.5[a]	12.6[a]	10.8[a]

(a & b: the significant difference between means by T-test analysis at α=0,05)
Note: This survey was conducted only for farmers who have been adopting/applying/joining advanced farming programs.

Table 11. Farmers' reasons for still applying traditional practices of rice production (n=102)

Reasons	Percentage of surveyed farmers (%)		
	Hilly midland	Delta lowland	Coastal area
No material or financial support from the state or local authority	42.3[b]	35.8[a]	36.8[a]
Lack of family labor	15.3[a]	18.0[a]	16.2[a]
Inappropriate land conditions	16.8[b]	10.0[a]	18.1[a]
Inappropriate irrigation infrastructure	12.9[b]	9.3[a]	15.3[b]
Familiar with old practices	31.1[a]	33.1[a]	29.8[a]
Still not trusting advanced farming practices	3[a]	5[b]	3[a]

(a & b: the significant difference between means by T-test analysis at α=0,05)
Note: This survey was conducted only for farmers who still did not adopt/apply/join advanced farming programs.

Besides these reasons, there were many other reasons for which farmers refused to adopt the new advanced farming techniques for rice cultivation, such as being familiar with old practices, a lack of family labor, inappropriate land conditions, being unable to control irrigation, etc. The lack of family labor explained why some households could not follow the new model because its pursuit required a strong commitment to the field (Table 11)

4. Conclusion

The information gathered from interviews and meetings with local agricultural agencies and from community meetings and interviews with local households reflects the general situation of rice production under climate change conditions and its effects on rice cultivation in the typical regions of Quang Nam Province. Flood, droughts occur in most districts in Quang Nam, but its effect on rice production in lowland delta and coastal areas are more seriously than in hilly midland. Rice varieties and water shortage were the most serious difficulties for rice production. More than 70% interviewed farmers identified that the impacts of drought and water shortage on rice cultivation were very serious every year

The actual investment level for rice production is different at different sites, depending upon the natural and socioeconomic characteristics of that particular site, such as main income of local farmers, level of infrastructure development, educational level, farmers' awareness, support from government and donor agencies (and from beneficiaries themselves).

Acknowledgments

The first author is highly indebted to International Rice Research Institute (IRRI) and the LUCCi project for providing fund for this the study. The author expresses his gratitude to Agronomy Faculty of Hue University of Agriculture and Forestry (HUAF) for giving technical assistance during data collection & survey and Dr Ole Sander (IRRI) for helping edit the manuscript. Thanks goes to colleagues for their constructive comments that improved the manuscript considerably.

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Nhận thức của nông dân và giải pháp thích ứng với biến đổi khí hậu trong canh tác lúa tại tỉnh Quảng Nam

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Tóm tắt: Nghiên cứu này được tiến hành tại các vùng canh tác lúa chính của tỉnh Quảng Nam nhằm đánh giá nhận thức của nông dân về biến đổi khí hậu, tác động của biến đổi khí hậu đối với sản xuất lúa, và các giải pháp thích ứng đang nông dân địa phương áp dụng. Nghiên cứu đã sử dụng các công cụ, phương pháp điều tra (thu thập thông tin thứ cấp, phỏng vấn đại điện, thảo luận nhóm tập trung, điều ra nông hộ...) và các phương pháp phân tích thống kê tiêu chuẩn để thu thập và phân tích dữ liệu. Kết quả điều tra và phân tích cho thấy nông dân có nhận thức khá đầy đủ về tác động thường xuyên của biến đổi khí hậu đối với sản xuất nông nghiệp nói chung và canh tác lúa nói riêng tại Quảng Nam, trong đó vấn đề hạn hán kéo dài hơn trong mùa khô là trở ngại lớn nhất đối với nông dân địa phương. Tuy nhiên, chính quyền và nông dân tại Quảng Nam cũng đã có sự chủ động trong thích ứng với biến đổi khí hậu với các giải pháp thích hợp: chuyển đổi đổi mùa vụ (từ 3 vụ lúa/năm thành 2 vụ lúa/năm, tăng cường sử dụng các giống trung và ngắn ngày, áp dụng các biện pháp tưới nông lộ phơi, 3 giảm – 3 tăng... Để ngày càng nhân rộng các giải pháp thích ứng chủ động trong canh tác lúa, Quảng Nam cần tích cực giải quyết các khó khăn đang gặp phải: thiếu hỗ trợ về kĩ thuật, tập huấn, tuyên truyền; hệ thống tưới tiêu xuống cấp; thói quen sử dụng phân bón, nước tưới lãng phí...

Từ khóa: Biến đổi khí hậu, lúa, thích ứng, nhận thức.