Farmer's Seasonal Weather Forecasts Use to Cope with Climate Variability in Central Highland of Vietnam

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ABSTRACT: In face of the increasing variability, traditional farming calendar, existing indigenous knowledge and experience on predicting weather become less reliable to rice farmers. As a result, farmers, particularly poor farmers in highland area, who own mainly rainfed faming land, may have higher risks of failure in agricultural production. In this circumstance, the support from seasonal weather forecasts plays a significant role for farmer in term of making decisions related to adapting with complicated weather conditions which have change trend in Nam Dong district, Thua Thien Hue province, Vietnam. In this research, participatory approach was be adopted to identify how farmers used seasonal weather forecasts to cope with weather variability in their rice production decisions. The results of this research may inform local governments for changes in development plan which better assists farmers in reducing the negative impacts of climatic changes, and meteorological centers and agricultural extension centers for adjustment in production and communication of the weather forecasts to farmers.
Keywords: Rice production decisions making, Nam Dong, Thua Thien Hue

Introduction

Climatic factors are key determinants to crop production processes that account for 15-80% of the variation of inter-annual yield (Oerke et al., 1994). Thus, they were considered as vital factors to farmers who greatly depend on agricultural production, climate condition and rural resources (Oerke et al., 1994; World Meteorological Organization, 1981; Yoshida and Parao, 1976; Sivakumar and Hansen, 2007). Rice production plays a crucial role in Vietnamese economy with nearly 80% Vietnamese farmers cultivate rice (Nguyen and Singh, 2006) and it is also a major food crop for ethnic groups in Nam Dong district, Thua Thien Hue province. High temperature and drought are key factors that had impact on rice yield in Vietnam which was estimated that yield will decline by 0.6 tons per ha per 1°C increase in average temperature (Young et al., 2002). In this case, weather prediction or forecast is one among many sources of information that can be used by decision makers to adapt to weather variability and optimize gains in agriculture (Hammer et al., 2001). Despite the benefits of seasonal weather forecasts, it is argued that the value of the forecasts depends on the knowledge as well as capacity of farmers to access and apply such forecasts into profitable decisions (Marvi and Tupper, 2004). The limited capacity of the local agricultural and extension officers is a problem in delivering and translating the weather forecasts to farmers in proper forms as well as understandable and applicable advisories which can benefit the farmers in decision-making process (Sivakumar and Hansen, 2007) in Vietnam in general and central highland in particular. As a result, one of the main reasons for unsuccessfully application of seasonal weather forecasts by farmers is that

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there is a considerable gap between information needed by farmers and that provided by meteorological services (O'Brien et al., 2000). Given a great amount of effort and investment currently dedicated to developing and improving the seasonal weather forecasts, it is important to investigate and understand how the seasonal weather forecasts using by farmers in their production decisions making (Hu et al., 2006). However, questions place out is that how seasonal weather forecasts are being used by farmers and how they influence on the key rice production decisions; which sources of seasonal weather forecasts that farmers have been accessing and how seasonal weather forecasts limitations influence on farmers' using that have been not yet explored in Nam Dong district, central highland of Vietnam. This research not only plays a significant role for scientist who are working for rural development, but also can assist to inform and improve seasonal weather forecasts to help farmer in term of adapt to weather variability.

Materials and Methods

The monthly maximum temperature, minimum temperature and total rainfall data in the 1986-2012 periods were taken from Thua Thien Hue Hydro-meteorological Station to find out the weather variability over 27 years. Two focus group discussions were conducted by using the participation methods such as matrix ranking and score ranking, in which matrix ranking was applied with 13 participants to explore the key production decisions in rice production that influenced by seasonal weather forecasts and type of seasonal weather forecasts interested by farmer by corresponding scale from the lowest scale of 0 which is "Not applicable" to the highest scale of 6 which is "Great influence". Whereas, the score ranking method was used with 15 participants to understand farmer's perception on seasonal weather forecast limitations by giving score about the degree of importance of each limitation of weather forecasts that influenced on their using by scale at "1" means that 'A little bit important " to "4" means that "Greatly important ". A structure questionnaire was designed and carried out with up to 185 farmers to get information how farmers used seasonal weather forecasts in their rice production to cope with weather variability. The data was analyzed by both qualitative and quantitative manner.

Results and Discussion

Socio economic of Nam Dong district

Nam Dong is the poorest district which lies in a monsoon tropical highland zone in the South-West of Thua Thien Hue province in central Vietnam. The average income per capita in Nam Dong is about 890 US$ per year with total population of 24,015 that divided into 11 communes and 67 villages which is the least population density of any district in Thua Thien Hue Province at 35.9 people/km2. Ninety percent of local habitants are ethnic group, haft of them is Cotu and the rest are Ta Oi, Pa Koh, Ta Hy and Pru-Van Kieu. The main livelihood of the local people depends on agriculture. Total area is 651.95 km2, in which agricultural land and forestland are 59,439.6 ha and 41,799.31 respectively (Nam Dong Statistic Office, 2012).

Paddy rice, cassava and maize are major crops cultivated under rainfed conditions. About 70% of the total cropped area is allocated for rice

production with approximately 741.8 ha, which accounted for 90% of total grain production. Paddy rice is grown in two different seasons. The first season is typically starting in December and harvesting in May on the following year, while the second season is cultivating during May and September. Disease outbreaks that occurs regularly and dry spell are the main causes of low rice yield. Perennial crops such as rubber trees and Acacia hybrids are also grown in this area couple of years ago. Most of communities are subsistence farmers. Diversification of farmer's non-farm incomes is still a challenge because of low educational level, slope area, poor infrastructure and difficult weather condition. (Nam Dong Socio-economic Report, 2013).

The distribution of temperature and rainfall in Nam Dong district

Temperature and its fluctuation are influencing on rice development, growth and yield as well as rice disease and pest outbreaks. The distributions of weather factors including average temperature, maximum and minimum temperature over 28 years period in Nam Dong District, Thua Thien Hue province are showed in **Figure 1**. The temperature was high during April to October, but it was low during November to March. The highest temperature ranged from 30.4^{0}C to 39.8^{0}C, while the average temperature was between 20.2^{0}C to 28.2^{0}C, and the lowest temperature was from 14^{0}C to 22.6^{0}C.

Moreover, the figure shows that the distribution of the average and minimum temperature reached the peak in Jun, but in April for the Maximum temperature. However, the lowest value was in December for average temperature and in January for two the other factors. These extreme distributions occured in times of two rice seasons, so they had direct impact on rice growth and yield.

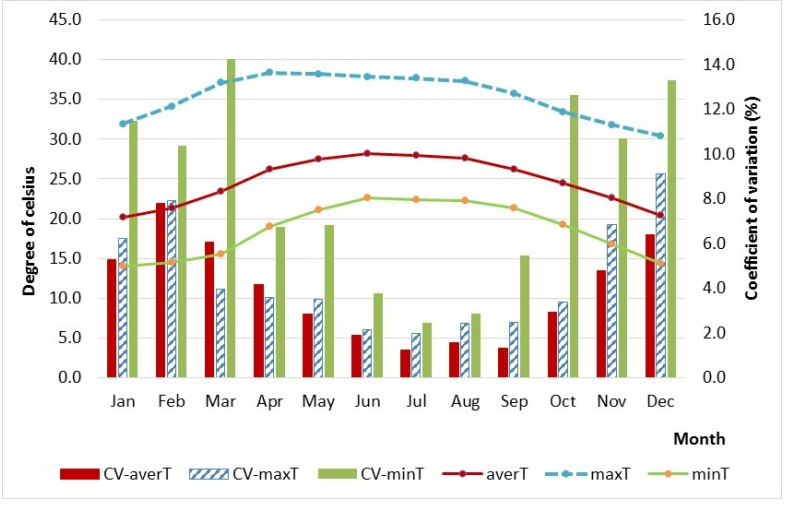

Figure 1 Distribution of average temperature factors and their CVs over 27 years

Note: + The bar shows the coefficient of variation of average temperature (CV-averT), maximum temperature (CV-maxT) and minimum temperature (CV-minT).

+ The line shows the mean of average temperature (averT), maximum temperature (maxT) and minimum temperature (minT)

Opposite with the distribution of temperature, the coefficient of variation (CV) was quite different. It shows that minimum temperature had strong fluctuation from 2.5% to 14.2%, while the maximum temperature and average temperature were the same trend of fluctuation. In addition, from April to September, the CVs of three temperature factors were lowest in whole year, meanwhile, it was sharply down and up from October to March.

Thua Thien Hue is one of the provinces with the largest amount of rainfall in the country with annual average rainfall of 800 – 1500mm. There is less rainfall in first seven month of each year and after that it increased strongly.

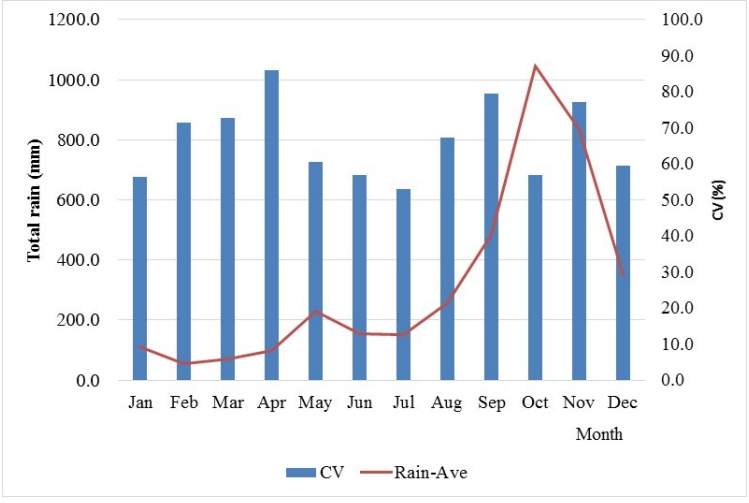

Figure 2 Distribution of average temperature factors and their CVs over 27 year

Note: The bar shows the coefficient of variation rainfall (CV)

The line shows the mean of total rainfall (Rain-Ave)

The most significant change in rainfall patterns is the increase of rainfall during the rainy seasons (especially December to October and to a lesser extent from February to July) and the decrease in rainfall during the drier June-July period. This means that the rainy seasons are becoming wetter and the dry seasons are drier. The drying trend might significantly add to the risk of weather variability and this trend may interrupt the growing season of rice which leads to decrease in rice yield.

The distribution of rainfall was present in **Figure 2**. It's indicates that the highest total rainfall occurred in October with 1044.2 mmm and the lowest total rainfall in March February with 53.8 mm. **Figure 2** shows that there was an increasing trend in total rainfall from September to December and these months made about 77.9% total rainfall in whole year.

The fluctuation of monthly rainfall regime was expressed by the coefficient of variation (CV) in **Figure 2**. It points out that there was a strong fluctuation in the total rainfall in whole year from 53% to 86%. The monthly rainfall was up and down suddenly during September to December.

Influence scale of seasonal weather forecasts on rice production decisions.

The pie chart below explains the awareness of 180 farmers interviewed about the impact of seasonal forecasts on decisions of households in rice production by selecting the scale from 0 means that "no apply seasonal weather forecasts" to 6 is "greatly influence". The chart shows that the majority of farmers indicated that weather forecasts influenced on their rice crop from Moderately to Likely levels occupies around 70%.

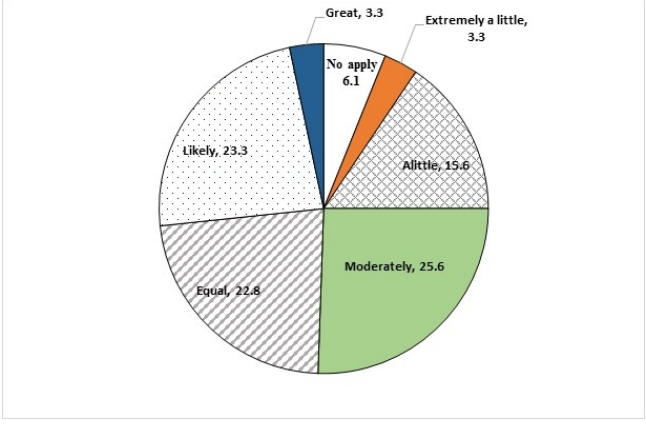

Figure 3 Influence scale of seasonal weather forecasts data on rice production

Result also shows that 25.6% of households said that the weather seasonal forecasts had moderate impact on rice production activities, while only 3.3% (six households) answered that the impact of weather information were extremely a little to their decision-making. In addition, the impacts that were considered at equal and likely on farmers' decisions making accounted of 22.8% (forty-one households) and 23.3 (forty-two households) for each. Only 3.3% (six households) mentioned that their decisions related to rice production activities are greatly affected by weather forecasts. There was 6.1% (eleven households) saying that weather forecasts are not related to their rice cultivation.

Key production decisions in rice production as influence by seasonal weather forecasts

The result of matrix ranking method that used in focus group discussion with 13 was introduced in **Table 1**. Total score and ranking by last two columns shows the influence level of seasonal weather forecasts on each rice production decisions. Whereas, total score and ranking by last two rows indicates which types of weather forecasts were the most interest by farmers in their rice production decisions. Overall, **Table 1** indicates that the degree of influence of seasonal weather forecasts on each rice crop decision is low. The evidence was that most of farmers selected scale 2 (a little bit influence) and 3 (moderately influence) to rank each criteria, so that the

total score of 13 participants raking for each cell was just from 7 to 49 in comparison with highest score should be 78.

Table 1 Key decisions in rice production as influenced by seasonal weather forecasts

Activities	Daily	Weekly	Drought	Storm	Flood	Total	RANKING
Selecting seed varieties	7	11	57	49	47	171	IV
Selecting planting date	23	42	50	47	47	**209**	**I**
Time of brewing seed	39	39	15	14	16	123	V
Herbicides application	42	13	14	10	13	92	VIII
Fertilizers application	32	18	33	20	14	117	VI
Pesticide application	22	35	48	47	32	184	**III**
Irrigation application	24	18	33	20	14	109	VII
Harvesting date	20	53	38	45	34	190	**II**
Total	209	229	288	252	217	1195	
RANKING	V	IV	**I**	**II**	**III**		

Note: The numbers in the table are sum of score that ranked by 13 participants

Regarding to the influence of seasonal weather forecasts on certain rice production operations, three key decisions on ranking were affected which are selecting planting date (209 score), harvesting date (190 score) and pesticide application (184 score). It was explained by the participants that selecting planting date not only affects all subsequent activities particularly on harvesting date, but also shows that farmers could avoid severe weather events such as drought and storm or not. Other decisions also consider the seasonal weather forecasts but at low score such as herbicide application (92 scores), irrigation application (109 scores) and fertilizer application (117 scores).

Table 1 indicates that drought, storm and flood were the seasonal weather forecasts that were the most interest by the farmers in rice production decisions with 288, 252 and 217 scores respectively. Participants pointed out that drought often occurred during rice growth period which caused rice diseases and abandoning land because of water shortage while storm and flood happened unusually in rice harvesting time which indigenous knowledge prediction such as observations of astronomical phenomena and biological behaviors of wild species in order to make decisions for their farming activities was no longer applicable to cope with these events that leaded to bad harvest in some seasons in previous years. That why these seasonal weather forecasts tend to be important consideration of farmers in their farming nowadays.

Source of seasonal weather forecasts among farmers

The chart in **Figure 4** shows the different sources of weather seasonal forecasts that farmers considered in their decision making on rice production activities. It points out that the neighbors and TV are the two significant sources of information that people most often access corresponding to 90.6% and 89.4%, whereas only 54.4% of the interviewed households have accessed to weather seasonal forecasts through radio. Results also indicate that local officers and extension workers accounted for quite high percentage of 80% and 77.2% respectively. These two sources often provide the forecast types such as recommendations on seasonal calendar, pest control and irrigation management which were often discussed in the monthly village meetings or delivered via local loudspeaker system. One participant said *"we follow the seasonal calendar of agricultural officers, it proves we did use weather forecasts, because the seasonal calendar took into account weather factors and therefore we have to follow their instructions".*

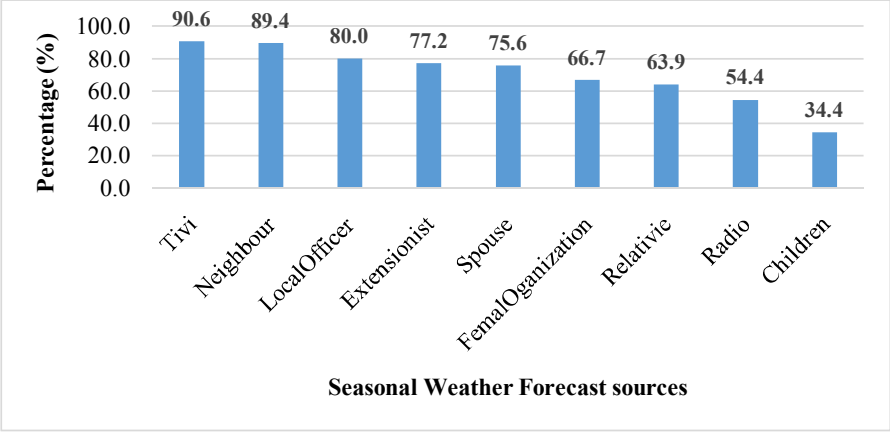

Figure 4 Seasonal weather forecasts data sources (n=180)

The result of the household interviews also indicates that spouse, children, relative and female organization were also the sources of weather seasonal forecasts in term of delivering information to farmers.

Farmers perception on seasonal weather forecasts limitations

The **Table 2** presents the results of a focus group discussion with 15 participants through the use of score ranking method. Ranking column shows the degree of importance of weather seasonal forecasts limitations that influence farmer's use of the forecasts based on their indigenous knowledge and practical experience.

Table 2 The importance ranking of seasonal weather forecasts limitations

Limitations	Total	Rank
Accuracy	40	I
Reliability	34	IV
Timeless	28	VI
Availability	32	V
Easy to understand	35	III
Diversity of channels	25	VII
Localization	37	II

Note: The numbers in table are sum of score of 15 participants by their scoring

The data in total column ranks from 25 to 40 scores in comparison with highest score should be 45 in each cell, so it indicates that seasonal weather forecasts limitations had significant influence on farmer's use of forecasts. Results after scoring and ranking shows that the accuracy, localization and understandable status of the seasonal weather forecasts were the most important factor influence on farmers using with 40, 47 and 43 scores in order. The discussion explained that these three factors have been still weak in this mountainous area, thus that why the farmer's trust on seasonal weather forecasts is still limited. For example, the seasonal weather forecasts on television used formal and general terms such as "mm of rainfall" or "moderate, heavy and very heavy" that make farmer confused and unmeasurable. The reliability which indicate farmer's confidence in the weather forecasts also got quite high score (34) from participants. Other limitations of seasonal weather forecasts also were interested by farmers as limited factors on their using such as timeless, diversity of channels.

Conclusion and Suggestions

The study shows that the fluctuation and variability in weather condition including temperature and rainfall were observed and experienced over period of 27 years in Nam Dong district, Thua Thien Hue province. The seasonal weather forecasts particularly related to drought, flood and storm events were the most concerned on the decisions of rice production activities. Since the scale of influence was still low in specific decisions of farmers, farmer use of seasonal weather forecasts in their faming is still limited. Therefore, it is essential to enhance farmer's capacity to understand and cope with weather variability through training or dissemination weather information on how to access and apply different kind of weather forecasts from the various sources in their daily life in general and in rice cultivation in particular. However, the majority of farmers who has received seasonal weather forecasts directly through television, while this channel is not specific to their locality and not easy to understand by these minority farmers. In general,

farmer's interest of seasonal weather forecasts was influenced by three main factors as the accuracy, localization and understandability. In addition, despite the fact that local officers and extensions were two important sources who communicate regularly with farmers in term of supporting them with weather forecasts, mostly in forms of planning seasonal calendar, disease announcements, disaster early warnings, and technical advisories, but they are not capable to give weather forecasts timely and directly when famers need. Therefore, improving their forecasting and delivering information capabilities directly to farmers are necessary in the mountainous areas with difficult conditions as Nam Dong district.

Moreover, the research also found that each district in Thua Thien Hue province has installed meteorological stations, but no weather forecasts information was being made to local farmers. These stations are only responsible for collecting the raw daily weather data without making weather forecasts in that area. Hence, improving mandates and ability of meteorological staffs at the local level will contribute to create accuracy and localization of weather forecasts and that is easy to understand by local farmers in each area which will help farmers in making a better strategy and approach on using seasonal weather forecasts for their rice production decisions.

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