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Risk Management Strategy for Agricultural Production Instability: A Case Study of Paddy Production

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Abstract

While Laos faces more intensive rainfall, frequent severe floods and run-offs from the Mekong river basin, its agriculture sector is likely to be increasingly vulnerable to floods leading to instability of agricultural production especially paddy production. As a result, the instability of agricultural production will affect the Economic Vulnerability Index (EVI) which is regarded as one of the criteria for leaving Laos out from the list of Least Development Countries (LDCs). Therefore, this research seeks to identify the most effective risk management strategies for farmers against floods on paddy farms in the wet season as a case study in order to stabilize the agricultural production from natural disasters and to improve the Economic Vulnerability Index (EVI) of Laos. Data from 369 farming households were collected in vulnerable locations (flood-prone areas) and quantitative analysis via ordinary least square (OLS) estimation was used. The results indicate that calendar adjustment is the only strategy that is able to reduce the risk from floods. Therefore, calendar adjustment should be encouraged. Also, this study suggests that more attention needs to be paid to improving the water or flood control systems such as drainage and embankments in flood prone areas. Lastly, it should be aware that the use of anti-flooded seeds should be depended very much to the nature of floods.

Keywords: Laos, risk management, floods and paddy farm

JEL Classification: Q12, Q15

1. Background

Laos is vulnerable to extremes of weather, Countries relying more on agricultural sector are easily vulnerable to shocks especially natural disasters, making its production unstable. This instability in agricultural production would, then, directly or indirectly have an impact on income, living conditions and livelihood of people as well as economic and human capital development in general. In particular, the annual flood in the Mekong region has caused an immense damage to local communities in vulnerable areas around the river basin in terms of loss of life, properties, infrastructure, and human capital Economic activities are affected particularly the agricultural sector such as fisheries and crops on which the rural people depend the most. An estimated annual catastrophe due to floods in the Lower Mekong Basin region costs up to 70 million dollars[1], or which Cambodia and Vietnam bear two-thirds of total cost. Globally, the numbers of floods has increased considerably from 50 per year in the 1980s to 150 per year in the 2000s which is driven by population growth and climate change (Independent Evaluation, 2012). The population growth leads to poor urbanization, rural land use, deforestation and land erosion facilitating the natural disasters whereas climate change results in an increase in frequency of natural hazards such as storms, drought, flood and fire. According to a report of Lao PDR Resilience Agriculture Sector Climate Change (p. 22), climate change could lead to a longer annual dry season and more intensive rainfall, while at the same time causing more frequent severe droughts and floods. While the acknowledgement of climate change on rice production is well recognizes, desirable policy interventions are still limited and segmented (Chen. Z and Damen. B, 2014, p. 23).

Since Laos is characterized as agricultural economy where the share of agricultural sector accounts for more than ¼ of GDP[2] and majority of population (71 per cent[3]) engaged in agricultural activities such as crop plantation, animal rearing, etc., it is unavoidable for Laos to expose itself to the instability in agricultural production, particularly in recent era where the occurrence of natural disasters has been more frequent due to change in

1 http://www.mrcmekong.org/topics/flood-and-drought/, viewed 7th April 2015
2 Lao Statistics Bureau (2013).
3 Lao Agricultural Census (2010/11)

global climate. Especially, paddy is one of the promising cash crops contributing to national economy substantially which accounts for a quarter of GDP and over half of agricultural GDP (RIMES 2011, p. 1). As a result, there is no doubt that paddy farm is essential for economic growth and indeed for agriculture sector for several years, and either be an important source of incomes for rural people especially in Central and Southern parts of Laos.

The climate in Laos is categorized into two seasons, one is the wet season influenced by the monsoon rain beginning from the mid-May to mid-October and another is the dry season dominating the rest of the year. As a result, paddy farms in the lowland plains are vulnerable to floods during the wet season. According to World Bank 2011, the mean annual rainfall is projected to be increased during the wet season for 10-30 % especially in the eastern and southern parts of Laos. Yet, there is a threat from another way where the annual runoff from the Mekong river basin is also anticipated likely to increase for around 21 percent by 2030. The central and southern provinces of Laos, which are plain-areas with scattered valleys, an abundance of rivers and a long stretch of Mekong River; are regarded as the most vulnerable to heavy floods. As a consequence, paddy production is greatly influenced by the flood. According to National Economic Research Institute (2013), damage due to typhoon and flooding in 2013, for example, have been widespread covering areas of 12 provinces ending up with an estimated economic loss of 2,243 billion kip or 0.27 billion dollars (11 percent of agriculture GDP and 3.2 percent of GDP). The loss of agricultural production such as paddy is the most claimed resulting in the instability of rice production of households.

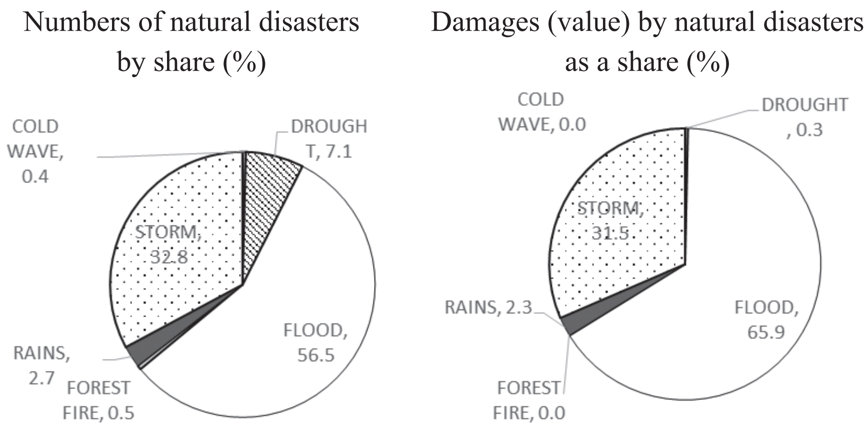
Because the instability in agricultural production affected by natural disasters becomes one of sub-indicative indexes within Economic Vulnerability Index (EVI) that Laos needs to improve in order to graduate from the list of Least Developed Countries (LDCs) along with other criteria such as HAI and GNI (UN 2008). Therefore, improving EVI through enhancing household's agricultural production more resilient to natural disasters is necessary. At the same time, the prevention or risk management strategy against natural disasters is considered as a cost-effective approach. According to Independent Evaluation 2012, disaster risk reduction is regarded as a cost-effective approach rather than post-disaster coping strategies shows that one dollar invested in the risk reduction could save money of four dollars for the cost of a disaster recovery. Therefore, this research concentrates on the study of disaster prevention/risk management strategies as the main research objective. To achieve the objective, two research questions can be identified as (1) Identifying risk management or preventive measures applied by households in the flooded prone areas. (2) Linking the preventive measures and household characteristics with the degree of the impact and identify the most effective measures lessening the impact. Paddy farm in the wet season is given as a case study. Paddy refers to the unpolished rice.

Hence, the study is structured into 7 sections. Background and identified problems are presented in the first section. Information of natural disasters in Laos and literature review are described in sector 2 whereas the methodology and data are presented in section 3 and 4. The statistics from the survey is summarized in section 5 and the quantitative analysis (econometrics result) is in section 6. Therefore, last section is the conclusion.

2. Natural Disaster and Literature Review

It is likely to be that a number of natural disasters has increased substantially during the last two decades. Since 1990 to 2012, Laos had suffered approximately 2,331 natural disasters nationwide; of which over a half was flooding. As shown in Figure 1, a number of floods had covered 56.5 percent of total number disasters over the period of 1990 to 2012 which had caused around 601.9 million US dollars or 65.9 percent of total cost. Storm and drought become the second and the third ranking in term of numbers and damages (value). Over the period, the damages include not only a hug loss of properties, economic activities and infrastructure such as houses, assets, crops, livestock, roads, water and electricity in a value of 938.2 million US dollars or around 40 million US dollars annually; but also involve a death of 191 people, injured 46,896 people and left 38 people still missing. In particular, the storm of Haima or Egay and Nock-ten or Juaning that hit Laos in 2011 had cost 297.3 million US dollars or 0.45 percent of GDP. The storm of Haima had gone through the northern and central provinces (Sayaboury, Xiengkhouang, Vientiane and Bolikhamsay) in the end of June whereas Nock-ten swiped the central and southern provinces (Vientiane, Bolikhamxay, Khammuan, Savannakhet and Champassak) in the late July. The combination cost of both storms includes the damages of vehicles, buildings, bridges, water supply systems, electricity networks, and infrastructure. Moreover, over 63,000 hectares of farmland and 400 irrigations had been damaged or destroyed. At the same time, 25 villages and 15 schools were remained underwater for two days after the storms.

Figure 1. Types and cost of natural disasters in Lao PDR during 1990 to 2012



Source: Disaster Information Management System (Desinventar),

http://www.desinventar.net/DesInventar/profiletab.jsp?countrycode=lao, viewed 15th May 2015.

Regarding to the flood, though the numbers of floods had been fluctuated greatly but its trend had been in an upward as the same as the loss in values. For instance, a number of floods was over 100 times occurring annually since 2008 which jumped from 12 times in 1995 before moving down to 32 in 2012. In terms of damages, the value of loss was more than 200 times in the current price. Under this circumstance, the capital city of Vientiane, Xayaboury, Khammuane and Champasack province were the most sufferers in terms of numbers and losses with an approximately 18 million US dollars and 41.2 thousand hectares of farmland per year. In 2014, according to the latest report from the Department of Disaster Management and Climate Change under Ministry of Natural Resources and Environment (MoNRE), more than 90,000 residents in several provinces (Phongsaly, Luangnamtha, Luangprabang, Hauphane, Xayaboury, Xiengkhuane, Khammoun, Savanhnakhet, Saravan, Xekong, Champasack and Attapue province) were affected by 3 executive floods due to storms generated by soon-moon season during June to October resulting in an extremely loss of 12 million US dollars. The damages include farmland, fisheries, infrastructure (road, water and electricity), and schools.

Based on the literature, a range of household's coping strategies after the shocks of natural disasters can be identified. For instance, World Food Programme (2007) shows that agricultural households in Laos apply the coping strategies of consumption adjustment, borrowing and asking help from relatives and friends and, to extension; their saving is used against shocks of flooding and landslides. Beegle. K, Dehejia. H. R and Gatti. R (2006) found that child labors were used as coping strategies against unexpected crop loss among agricultural households in Tanzania. Moreover, Mukherjee. S & Nayyar. S (2011) identifies that consumption reduction on foods and education are the coping strategies of households in the case of Philippines and Kenya. Lastly, Chen. Z and Damen. B (2014) show very useful information of climate adaptation and risk management carried out by neighbouring countries. Given an example of China, adjusting cropping patterns to expand rice cultivation, breeding new rice varieties with longer growing periods that are tolerant to a wider range of temperatures, improving irrigation and drainage systems, especially promoting alternative wetting-and-dry (AWD) irrigation; pest and disease control; fertilizer application and mechanization are the top priorities. Unlike, Vietnam gives a different approach emphasizing more on participatory community planning and decision-making on adaptation strategies and action plans, development of adaptive livelihood for smallholder rice farmers in the coastal areas such as combined rice-fish, rice-duck farming and alternative rice-vegetable farming, breeding and adoption of early-maturing and salt-tolerant rice varieties; implementation of integrated disaster risk management projects and implementation of irrigation modernization projects.

Nevertheless, previous studies on the issue of preventive measures or risk management against the flood are rarely found especially in the case of Laos. However, there is a document of project proposal[4] on improving the

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[4] More details please see UNDP (2006) in the reference.

resilience of agricultural sector to climate change, which is regarded as a useful literature for this study, the evaluation of such project on the impact of risk management programs or preventive measures on agricultural production stability in particular paddy production against natural disasters reveals that, by providing flood/drought tolerant rice varieties such as TDK1, TDK 1/1, TDK 8 and TDK 11 for 110 hectares in the targeted areas, the average yield is higher than the local seed used before the project for about one ton per hectare[5].

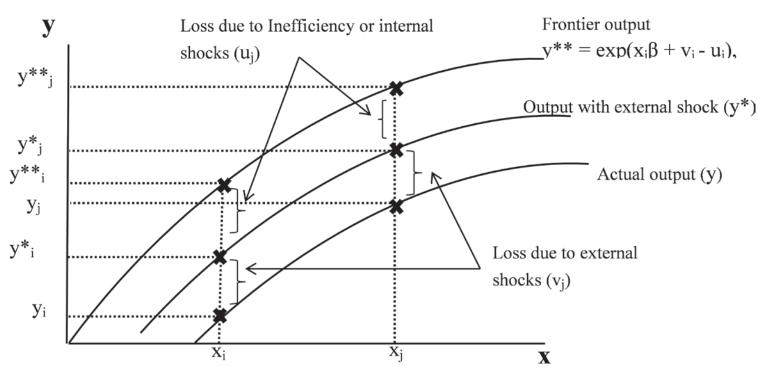
3. Methodology

3.1 Theoretical Concept

This study is based on the theoretical concept of Stochastic Production Frontiers Analysis (SPF) initiated by Aigner, Lovell & Schmidt (1977) and Meeusen & van der Broeck (1977). Despite the main objective of stochastic production frontier is to estimate the technical

inefficiency (internal shocks) grounded on the maximum likelihood estimate (non-linear estimation), the external shocks can also be investigated. The overall concept of the Stochastic Production Frontier is illustrated through the Figure 2.

Figure 2. The Stochastic Frontier Production Function



Source: edited Coelli.T, Rao.P and Battese.G, 2003, p.186

[5] Some achievements and other project interventions can be found on the website of http://www.la.undp.org/content/lao_pdr/en/home/operations/projects/environment_and_energy/IRAS/.

Figure 2 demonstrates the concept of production frontier where the horizon *axis-x* represents the inputs; the vertical *axis-y* is denoted as output and where *i* and *j* refer to the observed farm household *i* and household *j* respectively. The production function of equation (1) is assumed as diminishing return to scale. Household *i*, as the same as household *j*, uses inputs (x) to produce outputs ($y^{**)}$ at the frontier level as in the equation as follows:

$$Y^{**}_{it} = f\,(X_{it}\,,\beta)\; e^{vit\,-uit} \qquad (1)$$

Where, *i* is the number of farm households (i = 1, 2, ……, n), *t* is time (t = 1, 2, …., T), Y^{**}_{it} is the optimal output of paddy, X_{it} is a (1xk) vector of inputs such as capital, labor, seeds and fertilizer and β is a (kx1) vector of parameters to be estimated. However, with the existing of the technical inefficiency and given the amount of inputs, farm household could produce the output only at y^*. At the same time, farm households can produce at y only when the external shocks such as flooding have a negative impact. Technical interpretation on the term of u_{it} and vit are as follows:

The error term *uit* captures farms-specific technical inefficiency in production, specified by

$$uit = z\;it\;\delta + wit \qquad (2)$$

Where, z_{it} is a (1xm) vector of explanatory variables, δ is a (mx1) vector of unknown coefficients and w_{it} is a random variable whereas u_{it} is obtained by a non-negative truncation of N ~ ($z_{it}\delta$, σ^2_u) or N~ (μ, σ^2_u). When $u_{it} \geq 0$ in equation (1), it is conditional to ensure all observations fall under the stochastic production frontier. Input variables can be included in both equation (1) and (2) as long as technical inefficiency effects are stochastic (Battese and Coelli 1995). According to Farrell (1995), the efficiency of farm's production consists of two components (1) technical efficiency and (2) allocative efficiency. The technical efficiency refers to the ability of a farm to gain the optimal (maximal) output given a set of inputs and the allocative efficiency demonstrates the ability of a farm to use the inputs in the optimal proportions given their respective prices. Therefore, the technical inefficiency is sourced from the use of inputs inefficiently and not in the right proportion (an issue of allocation).

Normally, the error term v_{it} is assumed to be independently and identically distributed as N ~ (0, σ^2_v) and captures random variation in output due to factors beyond the control of the farm households such as weather, markets, price and government policies. However, since this study concentrates on the impact of flooding on paddy farms in flood-prone areas as an external shock, the error term *vit* is now assumed to capture the observed variation in output due to the impact of floods as the external shock. Fortunately, there might be some responsive actions against the flood practiced by farmers as well as preventive programs initiated by the government and non-government organizations which can mitigate the potential impact. As a result, equation 3 investigates the preventive program/responsive action that can minimize the effect of floods statistically.

$$v_{it} = \gamma F_{it} + \mathcal{E}_{it} \qquad (3)$$

Where, v_{it} is a (1xm) vector of impact from external shocks (flood) represented by output losses. F_{it} is a (1xm) vector of explanatory variables representing the responsive actions or risk management against floods such as the rice species of flooding resistant, land relocation, adjustment of calendar plantation and building drainage and embankment (water or flood control system), γ is a (mx1) vector of unknown coefficients and $\mathcal{E}_{it}$ is an error term.

3.2 Econometric specification

Since this study seeks to examine the role of risk management mitigating the impact of floods (output losses) on paddy farms, the attention is paid only on equation (3) which is under the theoretical concept of stochastic production frontier analysis. The losses of paddy refer to the impact of floods. The data of paddy losses is collected from farming households in flooded prone areas by the survey. More details on the data collection and the survey are described in the section 3.2.

Equation (3) in the previous section can be seen in a more specific econometrics of equation (4). A list of risk management strategies or preventive programs are examined in equation (4) in order to identify the one that are able to mitigate the paddy losses due to floods. Risk management includes species of flooding resistant, farmland relocation, and reduction of farmland in the flooded areas, calendar plantation adjustment and water/flood control systems (building drainage and embankment). The differences between locations, infrastructures and households' characteristics are also taken into account as control variables. Due to a small number of samples, only relevant control variables are selected to be included into the model. For instance, a dummy variable of Province is used to control the location effects between Savannakhet and Champasack province. Similarly, the variables of Main Road and Irrigation access are considered as infrastructure effects whereas a variable of House-ownership represents the wealth of each farming household. The treatment effects for each household are captured by the variables of Under Development Projects and Rice Bank Membership respectively.

The signs of the coefficients are allowed to be positive or negative based on the effectiveness of risk management strategies or preventive programs. For instance, if water or flood control system (drainage and embankment) in the flooded prone areas is not well designed for controlling the flow of floods, paddy losses as an impact of the floods could be higher than the area with a well design water or flood control system. Similarly, if the risk management of calendar adjustment is practiced inappropriately, the outcome could be costly and vice versa.

Risk Management Model

$$V_{it} = con + \theta RM_{it} + \gamma X_{it} + \Phi_{it} \qquad (4)$$

Where,

- V_{it} is paddy loss for farming household *i* at time t, t = 2014.
- RM_{it} captures all risk management (dummy variables) practiced by farming household *i.* Risk management are (1) Adjusting to early calendar plantation, (2) Adjusting to lately calendar plantation, (3) Farmland relocation, (4) Reducing planted areas, (5) Applying anti-flood seed, (6) Water management system.
- X_{it} are control variables capturing households' characteristics, development projects and geographies. Control variables are (1) House ownership, (2) Access to main road, (3) Ethnic, (4) Off-farm activity (family business),

(5) Access to irrigation, (6) Under development projects, (7) Membership of rice bank, and (8) Province.

- *con* is constant term
- γ and θ are coefficients
- Φ_{it} *is* error term, assuming as normal distribution

4. Data Source

Household survey was carried out in the flood-prone areas where there is plenty of paddy farms. According to statistics from MAF, Champasack province and Savannakhet province (Figure 3) are considered as the largest paddy producers sharing 14 percent and 22 percent of total paddy output respectively in 2013. To what extent, the Lao Agricultural Census 2010/11 indicates that Sukhuma and Pathoumphone districts in Champasack province, and Champhone District in Savannakhet province are among the most paddy plantation intensive areas. At the same time, these three districts suffer at least two times of flooding per year. As a result, they are selected as the targeted locations for the survey. Around 368 households in ten targeted villages[6] in each district in Champasack province and twenty villages in Champhonne district in Savannakhet province are randomly selected as a sample by the provincial statistics centers. The survey was undertaken after the harvest in early December 2014.

Farming households are asked to give a bundle of information particularly related to paddy plantation and floods such as output, paddy losses due to floods, duration and height of the flood, inputs used for plantation and different strategies of risk management adopted by farmers. Household's characteristics such as size, gender, age, education, assets, income, consumption, saving, and infrastructure of main road, electricity, water, school and health center are also taken into account. A summary of the survey is reported in the following section.

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[6] Five targeted villages in Pathoumphone distruct are Ban Khonenoi, Ban Tomo, Ban Moungkhoumtarnpiew, Ban Houybanglieng and Ban Namsaitha. Five villages in Sukhuma district are Ban Korknongboua, Ban Bork, Ban Kodthanou and Ban Houyphai. Ten villages in Champhone district are Ban Lamthean, Ban Lambong, Ban Sakeunneua, Ban Thameung, Ban Nonsithan, Ban Keangphoun, Ban Thamoung, Ban Pheiykar, Ban Dongmeung, and Ban Dongnoi.

Figure 3. Savannakhet and Champasack province in the map of Laos

Source: https://www.google.la/search

5. Survey Locations

The specific information of sampling households' characteristics and their economic structure including occupations along with local infrastructure and geographies in the study locations are presented this section to capture the differences between households. Note that Savannakhet province is referred to the sample in the survey location of Champhone district in Savannakhet province and Champasack province refers to the sample in the survey locations of Phatumphone and Sukhuma district in Champasack province.

5.1 Household's characteristics

It seems to be that sampling households are mainly originated being born in the targeted village rather than recently migrated from other parts of the country and foreign countries. The survey reports that their family has been living in the village as long as 41.6 years as an average. The average size of family's members is 7 persons per household implying a relative large family comparing to the national level and, either; the average age of family's members is around 27 years old illustrating as a young family averagely. More important, the education of sampling households is mostly under the primary level. Only a very small proportion of 1.79 percent of total sample gains higher education. Furthermore, all most of sampling households are Lao-ethic and Buddhism dominantly living in rural area without main road access.

It is apparently seen that the main occupations of the sample are farmers and working in Thailand. There is a small proportion of sample engaged as farm labors, government officials, traders, and workers in manufacturing factories. According to the interview, a shortage of labors is one of the main problems for paddy farms which pushes wages getting higher. It is no doubtful that the sources of income are mainly from farming (livestock and crops) and money transfer. The survey shows that approximately 35 percent of total income is from paddy rice and crop production, about 9 percent is from livestock activity. Money transfer is not only considered as an important source which contributes 17 percent of total income but functions as a credit for farm activities besides borrowing loans from the commercial banks.

5.2 Infrastructure Access

The infrastructure access such as health and education by the sample is varied. The survey reveals that the primary education access is likely to be preferable and accessible as indicated by a short distance of 0.8 Km averagely between the house and the school. However, the distance to access higher education is much longer with approximately 3.5 Km which should advocate some difficulties accessing to education service especially for the poor. Since the longer distance to education service means higher cost to access the service, this might be one of the factors resulting in low education level of the sample. Also, the survey demonstrates that around 25.3 percent of sample is located less than 2 Km far from lower-upper secondary school. The distance to local health center, hospital and administrative office is either long. There is only 19.2 and 2.6 percent of total sample located with a distance of less than 2 Km from local health center and administrative office respectively. In addition, it is shown that less than a quarter of sample has accessed to pipe water and just over a quarter has accessed to electricity. Lastly, a half of sample has toilets. It concludes that a majority of samples have low educations and may have difficulties access to public services such as higher education, health center and administrative office.

5.3 Flood and Paddy Loss

As the main objective research of this study is to identify the most effective strategies of risk management for paddy farmers to be resilient against flooding, Table 1 gives important information related to paddy production and the flood. It illustrates that almost a half of planted areas (1.5 hectares) for both survey locations was flooded resulting in a loss of almost 3 tons of paddy as an average per household. It can be seen that a farming household had suffered the flood for two times in 2014. At the same time, the flood takes about 13 days per time with the maximum case of 25 days. Heavy rain, immediate flood and storm were the sources of floods. More important, paddy fields were flooded in the stages of post-plantation and paddy-grown mainly between July and September in 2014. Also, it is interesting to know that farmers in the survey location in Champasack province seem to suffer more difficulties of flood control because the level of floods is as high as 2.5 meters.

According to the report on natural disasters in 2014 from the Department of Disaster Management and Climate Change under Ministry of Natural Resources and Environment (MoNRE), there were three natural disasters striking Laos in 2014. The first storm had hit Laos between March 20 to April 20 resulting in heavy rain while the second disaster had ran between August 1-25, 2014 due to the noon-soon season and storm leading to floods. The last one had visited in Laos during September 16-22. With this regard, the duration of floods are expected to be more than 20 days although it might be varies in different locations. As a result, the paddy that can't be tolerant during the flood would be damaged. Despite there is an approximated 17 per cent of samples purchasing and receiving anti-flood seeds from a resilience project, it is doubtful for the validity of anti-flood seeds because the duration of the anti-flooding seeds takes about two weeks or 13 days which is likely to be shorter than the duration of the flood. However, the use of anti-flood seeds will be tested statistically in section of econometrics. Around two quarters of the sample in Savannakhet province and a quarter of the sample in Champasack province are treated by development projects. The assistance from the projects includes providing anti-flood seeds, natural disaster preparation training such as preparing to migrate properties and livestock, preparing boats for migration, providing waters and basic foods such as packs of noodle, and training in agriculture such as reducing the impact from diseases, encouraging the use of non-chemical fertilizer.

Table 1: Paddy production in the wet season (per household)

List	Savannakhet	Std. Dev	Champasack	Std. Dev
Planned area	1.6 hectare	(1.13)	1.63 hectare	(1.1)
Actual Output	1.4 Ton	(1.4)	1.6 Ton	(2.08)
Damaged paddy field	1.43 hectare	(1.17)	1.59 hectare	(1.32)
Paddy loss due to floods	2.7 Ton	(6.5)	3.04 Ton	(3.87)
Number of Floods	2.6 times	(3.04)	1.8 times	(0.9)
Duration of a flood	13.38 days	(16.8)	12.19 days	(8.25)
Level of a flood	1.41 meters	(0.7)	2.5 meters	(5.9)
Farmers under development projects	34%		16.8%	

Source: Farming household survey 2014, NERI

5.4 Early Warning

Since an early warning system is considered as one of effective diagnoses in order to enable farm households formulating the effective strategies of risk management, the survey shows that over a half of the sample receiving early warning systems before the appearance of floods dominantly through TV and Radio. Table 2 reports various types of early warning systems taken by farming households in two study locations. It is clearly seen that households were warned before the flood for 4-6 days. The warning via TV news is the most accessible taking for 58.19 per cent of the sample in Savannakhet province and 40.36 percent in Champasack province. However, the sample in Champasack tends to receive more early warnings from village's announcement and local knowledge than the sample in Savannakhet province. Early warnings through radio, village's announcement, local knowledge and other sources share 18 percent, 11 percent, 8.7 percent and 5.9 percent of the sample in both provinces respectively. Nevertheless, this sta tistics implies that a large proportion of households is inaccessible to the systems of early warning. Yet, the time of receiving early warnings seems to be short before the flood. As a consequence, farmers might not be able to find an appropriated strategy and take an action on time to reduce the risk of floods.

Table 2: Early warning systems

List	Savannakhet	Champasack	Days
Early warning via Radio	20.34%	16.87%	4
Early warning via TV	58.19%	40.36%	4
Early warning via SMS	0%	0%	0
Early warning via Village's announcement	9.6%	13.25%	5.5
Early warning via Local knowledge	4.52%	11.45%	5.86
Early warning via Others	6.76%	6.02%	4.86

Note: Early warning through local knowledge includes local fortune tellers grounded on traditional horoscope calendar, observing the level of Mekong river, observing the rain (heavy raining would lead to flooding), observing the behavior of animal such as chicken and past experience. Others include district announcement, calling from sons, friends and daughters.

Source: Farming household survey 2014, NERI

5.5 Risk Management

It is crucial to know that the sample practiced different types of strategies to reduce the impacts or risk of floods such as calendar adjustment for plantation, relocating the planted areas and using anti-flooding seeds provided by resilience projects and self-purchase. Table 3 indicates that less than 10 percent of the sample have carried out various strategies excluding the use of anti-flood seeds against the flood. This suggests that there are many farmers in the survey locations having no ideas of any strategies or preventions to deal with the flood on their paddy farms. Under this circumstance, they have potentially their farms fallen under the risk of being flooded and the consequence is the cost of paddy losses. However, the survey shows that there is a litter higher proportion of the sample (over a quarter) using anti-flood seeds against the flood. Thus, it is interesting to see whether the use of anti-flood seeds could help farmers reducing the risk or impacts of the flood. Regarding to the water/flood control/management systems, the sample in Champasack seem to apply water control systems on their farms such as building drainage and embankment more than the samples in Savannakhet. In contrast, the sample in Savannakhet province seem to prefer the strategies of calendar adjustment and planted areas reduction as risk management. Around 5.7 percent and 4.3 percent of the sample in both provinces had built drainage and embankment on surround their farms whereas about 4.6 percent of the sample had reduced planted areas in the flooded probe areas in order to soften the risk from being flooded. The strategies of calendar adjustment and farmland relocation were practice by a small proportion of sample.

From the view of farmers, it turns out that water/flood control systems via embankment and drainage are the most desirable strategy to lessen the risk from floods on their paddy plantation in the wet season. They claim that water/flood control systems can control the flow of flood and prevent their farms from being flooded. Also, an expansion of the irrigation systems is requested by farmers. They stress that such an expansion of the irrigation would allow farmers to plant more in the dry season by increasing planted areas. With this regard, farmers can avoid the risk and the loss of investment that might be caused by the flood in the wet season. Therefore, as so far, it concludes that water or flood control systems such as embankment and drainage, and an increase of irrigated land in the dry season are considered as the most effective strategies to reduce the risk.

Table 3: Risk management strategies

List	Savannakhet	Champasack	Days
Adjusting to early calendar plantation	1.6%	1.81%	24
Adjusting to lately calendar plantation	3.39%	1.81%	17
Relocating paddy farmland	1.13%	1.81%	1.81
Reducing planned areas	5.08%	3.61%	1.54
Appling anti-flood seeds	24.29%	10.24%	13 (6.55)
Building drainage	5.8%	7.23%	-
Building block (embankment)	0.8%	7.06%	-

Source: Farming household survey 2014, NERI

6. Econometrics Result

This section presents the result of the hypothesis specified in the econometric specification model (equation 4). The main purpose is to examine whether there are any risk management practiced by farm households that would be able to mitigate the effect of floods in order to stabilize the paddy production statistically. Other factors including household's characteristics, geographic and project development are controlled to capture the differences between households that might influence the expected outcomes (paddy loss) indirectly.

The method of ordinary least square (OLS) estimation is employed and the econometric result can be seen in Table 4. Firstly, the model shows that it is overall significant with a high F-value of 7.47. The total observation is 340, which are hopefully sufficient for the statistical estimation. The result indicates that the sign of dependent variables especially the strategies of risk management are expected. Although the variables of risk management have expected signs, most of them are insignificant which implies that these risk management practiced by farmers are not effective sufficiently to deal with the flood in the survey locations. For instance, the result indicates that water management system such as drainage and embankment is insignificant statistically to control the flood out from the paddy fields although the sign is negative as expected. This may explain that the water management systems are not be well designed enough incapable to handle with the flood in the survey where the height and duration of floods is high and takes long days.

Similarly, the variable of anti-flood seeds has also an expected negative sign but are insignificant. Since many farmers about one fifth of the sample in the survey locations had used the anti-flood seeds as a strategy of risk management, it is important to discuss the use of anti-flood seeds. The failure of anti-flood seeds can be explained by the duration and height of the seed that can't be comparable to the duration and height of the flood. Table 1&3 in section 5.3 and 5.5 show that the duration of anti-flood seed takes about 13 days while the duration of the flood is also around 13 days with a maximum of 24 days in some areas. At the same time, the level of floods is also high as high as about 2 meters on average which is higher than the height of paddy (around 1.50 meters). Hence, the anti-flood seeds can't survive during the flood. This suggests that the use of anti-flood seeds should be conditional to the characteristics of floods such as duration and height in flooded prone areas. In other words, the seeds should be given to farmers in the location where the duration and height of floods are short (less than two weeks) and low (less than 1.50 meters). Otherwise, it suggests to develop the anti-flood seeds to be more tolerant with longer days and taller than the height of floods.

Furthermore, the result also shows that the risk management of farm relocation is insignificant. This reflects that farmland relocation by farmers might not be far away enough from the expected floods. As a consequence, farms are still flooded and paddies are lost as the same as other farmers who didn't adopt this method. To what extent, it can be said that the flood is likely unpredictable for farmers to precisely anticipate the coverage and degree of floods. According to the survey, it reports that a small proportion of farmers had relocated their farms far away from the vulnerable areas (expected to be flooded) for 1.8 kilometers. This advises that farmers in the survey locations should have relocate their farms a further distance.

Fortunately, the crucial finding reveals that the strategy of lately calendar plantation adopted by farmers is valid and regarded as the most effective risk management strategy which shines a hope of a way to deal with the flood on paddy farms. It highlights that farmers, who adjust the calendar plantation in a later time after floods, have fewer paddy losses for 50.1 percent than who do not adopt this strategy. Basically, a life circle of paddy plantation in the wet season starts from May to November and December for some areas which is very much depended on the beginning and the nature of the rainfall in fed lowlands. In addition, it takes about 90 days or 3 months before the harvest. Following the survey, paddy fields were flooded in the stages of post-plantation especially the maturity of paddy between July and September subjected to different locations. Since some farmers planted the paddy after floods in August or September respect to different locations, their farms can be avoided of being flooded. Then, they harvested paddies during November and December where there were no events of the flood. This evidence suggests that a strategy of calendar adjustment after the flood can help farmers to reduce the risk of floods. On the contrary, farmers who started plantation early in May or June would probably harvest in August and September which was the period of floods resulting in paddy losses. Similarly, farmers who made an adjustment of early calendar plantation had their farms flooded as well. As a result, the variable of early calendar plantation is tested not significantly.

It is surprised to know that a strategy of farmland reduction has a positive sign significantly meaning that farmers who implements this strategy of risk management have a loss for 33.9 percent larger than who are without. Because farmers are afraid to lose their investment if they still keep paddy plantation in the flooded areas. Thence, by scarifying a certain area of paddy farm that are expected to be flooded would help farmers to save some of the investment. However, the result turns out that these farmers have losses more than other farmers who still keep planting in the flooded prone areas. The reason is that farmers who keep planting may have some survival of paddies. Therefore, a strategy of reducing a certain area of paddy farm in the flooded prone areas would have a larger loss. With this regard, it suggests that this strategy should not be introduced to farmers as risk management against the flood.

For other factors besides the risk management strategies, it can be seen that farmlands with irrigation access are more flooded than farmlands without irrigation access. As a result, farmers who have their farmlands with irrigation access have a larger loss for 22.6 percent than whose are without. This reflects to the characteristics of floods (long duration and high height) in the survey location, the existing irrigation should not help prevent or relieve the floods. On the contrary, the irrigation systems extend the losses due to the land slope of irrigated areas comparing to non-irrigated areas where the farmland is in higher slope. In the same way, Farmers are with main road access and under development projects tend to have their paddy farms more vulnerable than who are without. It is due to the fact that farmers who are living at villages with main road access especially in Sukhuma district in Champasack province have their farms are located along the main road where the drainage is poor. Because of poor drainage, the flood can't be handled and consequently flows into paddy farms resulting in paddy losses. Since the development projects tend to select the vulnerable farmers as targeted groups, farmers who are under the projects are more vulnerable comparing to farmers who are without. Finally, the result shows that the majority of ethnic group has more capabilities or opportunities access to public services of dealing with the flood than the minority.

Table 4: OLS regression

Number of observation: 340

Paddy loss	Coefficient	Robust Std. Err.
Adjusting to early calendar plantation#	0.1034368	0.2640207
Adjusting to lately calendar plantation#	-0.5016118***	0.3015363
Farmland relocation#	-0.0120293	0.1969084
Reducing planted areas#	0.3394376**	0.1620558
Applying anti-flood seed#	-0.1798099	0.130771
Water management system#	-0.3119612	0.3500978
Access to main road#	0.8939148*	0.1282629
Ethnics	-0.6060914**	0.2539453
Access to irrigation	0.2260881*	0.062467
Under development project#	0.3872217*	0.1071151
Constant	8.781043	0.3335458
F (14, 340)	7.47	
Prob > F	0.0000	
R-squared	0.1362	

Note: * is significant at 1 per cent, ** means significant at 5 percent and *** is significant at 10 percent. # refers to dummy variable. Only interested variables and significant controlled variables are presented.

Source: Author's estimations

7. Conclusion

Laos is considered as an agricultural economy which has a majority of population living in rural areas. The main sources of income are predominately from agricultural activities especially paddy production. However, due to natural disasters particularly the flood, the agricultural production such as paddy is easily unstable affecting the stability of farmers' income and the Economic Vulnerability Index (EVI) which is one of the criteria for leaving out from the list of LDCs. Therefore, this research attempts to search and identify the most effective risk management to mitigate the risk from floods in order to stabilize the paddy production in the wet season or to enable farmers be resilient to the flood as a case study through the quantitative research based on ordinary least square (OLS) estimation. Data is collected in the flood-prone areas after the harvest period with a total sample of 369 farming households. The targeted flooded locations as a case study are Champhone district in Savannakhet provice; and Sukhuma and Patumphone district in Champasack province.

The statistics from the survey shows that a large proportion of sampling households didn't receive the systems of early warning. At the same time, it also highlights that only a small proportion of samples had carried out risk management such as changing the calendar plantation adjustment, using anti-flood seeds, building drainage and embankments, and farmland relocation. The econometric result indicates that the lately calendar adjustment is the only risk management that enables farmers to be resilient to the flood. By adjusting the calendar lately after the flood, the losses of paddy due to the flood can be eased relatively to farmers who don't adjust the calendar. Since the result shows that the risk management of farmland reduction is significant with a positive sign coefficient, this measure should not be encouraged. Also, the result shows that using anti-flood seeds is insignificant in the survey locations. This might be due to the short life of anti-flood seeds compared to the duration of floods. In addition, access to irrigation systems and main road can allow paddy farms being flooded due to low slope of irrigated land and poor drainage. Lastly, the result indicates that a variable of ethnic group is significant.

For policy recommendations, the result suggests that the implication should be varied according to the characteristics of floods in flooded prone areas. However, based on this study, a number of areas should be paid attention such as (1) data collection and information of the flood in flooded prone areas should be given up-to-date, (2) based on the evidence of this study, early warning systems should be enhanced particularly from concerned organizations such as the Department of Meteorology and Hydrology in order to make sure that more farmers in the flooded prone areas are accessible to weather forecast and early warnings through various channels such as TV, radio and village's announcement, (3) the feasibility study of calendar plantation adjustment should be carried out in order to identify the appropriated calendar for paddy plantation conditional to the nature of floods in different flooded prone areas. This study should involve the participatory from relevant sectors such as farmer, local and central government agency, development project and agricultural expert. (4) The design of floods or water control systems such as drainage system and embankment in the flooded prone areas including in the areas of irrigated land and main road should be improved. The water/flood control systems should be well designed to be able to handle with the specific characteristics of floods in flooded prone areas at present and in the future. Lastly, (5) The result of this study also suggests that applying the anti-flood seeds would be effective in the flooded prone areas where the nature of floods (duration and height) matched with the application of anti-flood seeds. As a result, using the anti-flood seeds should base on the nature of floods in the flooded prone areas.

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