Factors Affecting On-farm Water Management for Sustainable Agriculturein Savannakhet Province, Laos People's Democratic Republic

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Abstract

The objectives of this research were to study 1) characteristics of basic personal, economic, and social information of farmers and their level of knowledge and understanding of farmers in on-farm water management; 2) factors affecting the success of on-farm water management; and 3) problems, obstacles, and suggestions about factors affecting the success of on-farm water management for sustainable agriculture ofThe sample group used in the study was 282 farmers which used irrigation water at Ban Wen Tonhaen, in Xayboury District, Savannakhet Province. Data were collected through interviews and questionnaires. Data were analyzed using descriptive statistics to find percentage, mean, and standard deviation; and inferential statistics, namely multiple regression analysis, to find factors affecting the success of on-farm water management.

The study indicates that most of the farmers live at Ban Wen Tonhaen (44.3%), 14.5% were farmers of the Khao Phon Water Users Group, 71.3% were male, with an average age of 49.94 years old, 42.6% had secondary education, 82.3% marital status, an average income 543,000 kip/ month, Agriculture area capacity more than 5,001 square meters 57.4% were no land ownership, 71.6% of the land was inherited by inheritance, 45.7% had been a member of the water user association for 31-40 years, and 53.2% Irrigation Canalscross thought their production land. In terms of the farmer's level of knowledge and understanding ofon-farm water management, it revealed that 72.77% had a moderate level since the farmers lack knowledge of the on-farm water management model, academic technical training isn't thorough; study tours are discontinuous or less.Therefore, the level of knowledge onon-farm water management was not pretty good as expected. Farmers have customary practices for on-farm water management which may be practiced from generation to generation, thus affecting the current level of knowledge. While analyzing the factors affecting the success of on-farm water management, it showed that there were three factors: income, farmers' knowledge and understanding of on-farm water management of rice cultivation, and the water management model of rice cultivation. In

terms of Issues and obstacles, it resultsthat farmers had the most problems with officials and on-farm water management. The farmers suggested that officials should prioritizeon-farm water management. Whether it is planning, implementation, inspection, and evaluation, the establishment of regulations between officials and water user groups for participation, acceptance and compliance because it is a brainstorming rule for water management. Farmers within the group should have a discussion and exchange ideas on fair water allocation with leaders of water user groups taking part as main participants in the meeting. It should be clear in pointing out issues including listening to the problems of farmers who use water.

Keywords: On-farm water management, Sustainable agriculture, Laos People's Democratic Republic, Irrigation, Water resource management

Introduction

Water is an essential resource for production in industry, agriculture, tourism, and living. Many developing countries have recognized the importance of water resource management and national development from the past to the present. Development in many countries has caused economic and social growth both in metropolitan and rural areas. It also includes efforts to create water resource security and protection against the effects of droughts and floods. Therefore, water resource management is linked in many dimensions to development and poverty, especially in the agricultural sector, which depends on water resources as a fundamental factor in production. The aforementioned problem remains the main problem in each country and is linked to many other relevant factors (SathitSueaprasertsukchana and WatcharaArunrat, 2015). Lao People's Democratic Republic (Lao PDR) is a country in Southeast Asia located in the center of the Indochina Peninsula. The total area is about 23,680,000 hectares, divided into 23,080,000 hectares of land and 600,000 hectares of water. Lao PDR is a landlocked country since the entire border of Lao PDR has a total length of 508,300 hectares, surrounded by the borders of five neighboring countries, namely China in the north, Thailand in the south and west, Cambodia in the south, Vietnam in the east and Burma in the west. Lao PDR can be regarded as a mainly agricultural society and is currently one of the countries with the smallest expansion in Asia-Pacific (Epprecht et al., 2018), with a population of about 7.57 million and an annual average increase of 1.48% (Basic International Data, 2021). About 66% of the population lives in rural areas and most of the people depend on agriculture for their subsistence. Lao PDR attaches great importance to the agricultural sector, especially rice, which accounts for 40% of the country's GDP. Employment for rice production accounts for 80 percent of the total number of workers. The total agricultural area is about 2,000,000 hectares. The area for rice cultivation

accounts for 60-70 percent of the total agricultural land (Vongmany et al, 2018). Important rice fields are Vientiane Capital, Khammouane Province, Bolikhamsai Province, Savannakhet Province, Salavan Province, and Champasak Province which are areas where the Mekong River flows through.

The annual water supply in Lao PDR is approximately 270 billion cubic meters, accounting for 35% of the Mekong River Basin's average annual water supply. The distribution of river flows in Lao PDR for each month follows a rainfall pattern, approximately 80% during the rainy season (May- October) and 20% in the dry season from November- April. Most of the water consumption is in the agricultural sector, accounting for 82%, followed by the industrial sector, 10%, and domestic 8% (Water Environment Partnership in Asia, 2021). Currently, water is mainly used in agricultural sectors such as irrigation, fisheries, cultivation, and animal husbandry. The abundant amount of water in Lao PDR, especially in the rainy season, makes it a good condition for water transportation for Industrial Development and Water Supply. 60% of the urban population and 51% of the rural population have access to clean water. Currently, there are problems related to wastewater and polluted water in large metropolitan areas from various community uses. There is also water pollution from agriculture and industry as well as mineral exploitation. This may cause a shortage of water in the future (Water Environment Partnership in Asia, 2023). At present, the water situation in Lao PDR is in critical condition both in terms of quantity and quality found that many areas in the country are experiencing imbalance problems in the demand and supply of water due to the rate of population increase. Production in the agricultural and industrial sectors includes inefficient water management. This causes many problems from the use of water resources, such as water shortage, flooding, deforestation, and damaged and shallow water sources. Shallow reservoirs and weirs make the water flow inconvenient. In addition, there were problems in community water management that still lacks efficiency because the community lacks knowledge and understanding about the management of existing water resources in the community. This causes water competition problems for both consumption water and agricultural water. Savannakhet is located in the middle of the country. The area is 9.2 percent of the country's total land area, divided into 366,000 hectares of arable land. The main agricultural products of the province are rice, corn, taro, all types of potatoes, soybeans, vegetables and other beans, and tobacco. The area for livestock is 500,000 hectares, and forests are 1,066,900 hectares, the remaining area is rivers, streams, and brooks. Savannakhet has twelve rivers and many brooks that can build an irrigation system beneficial to agriculture.Savannakhet Province has a total of 326 irrigation sites of various sizes covering an area of 58,980 hectares in the rainy season and over 37,000 hectares in the dry season (Supachai Wannalertsakul, 2007). Association of Irrigation Use Leaders in Ban

Wen Tonhaen, Xayboury, Savannakhet Province, Lao PDR can be considered as a group of water users who are strong and successful in on-farm water management.

Therefore, the researcher realized the problem of on-farm water management to increase the efficiency of sustainable rice cultivation, in Savannakhet Province, Lao People's Democratic Republic. The researcher would like to study factors affecting on-farm water management for sustainable agriculture of farmers from the Water User Group in Ban Wen Tonhaen, Xayboury District, Savannakhet Province, Lao PDR. It includes studying problems and obstacles about factors affecting success in on-farm water management to use the information as a guideline for relevant government agencies or private sectors in on-farm water management.

Equipment and Methods/ Research Methods

This research uses a quantitative research model to study the factors affecting the success of on-farm water management for sustainable agriculture of farmers from the Water User Group at Ban Wen Tonhaen, Xayboury District, Savannakhet Province, Lao PDR with the research methods as follows:

Population and Sample

The population in the study was farmers who used irrigation water at Ban Wen Tonhaen. The sample group was calculated by using a multi-stage sampling method (Sawathee, 1998) as follows: 1) Farmers were selected from the Association of Irrigation User Group Leaders at Ban Wen Tonhaen, Xayboury District, Savannakhet Province, (from BanTonhaen, Ban Wen Tai, and Ban Wen Nua) which can be divided into ten groups with a total of 952 cases due to being groups that are strong and successful in on-farm water management. Then, the sample size was determined according to the formula of Yamane (1973) at the confidence level of 95 percent, the error was 0.05, and the sample size was 282 cases. 2). Determine the proportion of the population in each water user group by the comparison method. A sample of farmers was also selected to be interviewed from each group of water users by a simple random sampling method that is to draw numbers from the list of farmers and not take back the numbers of the farmers' names who have already been drawn. This research was carried out from January 2022 to December 2022.

Data Collection

Data sources collected for use in research can be divided into two types: 1) Secondary data which is a compilation of information from documents, research reports, the study of concepts, theories, and related research; and 2) primary data: the questionnaire was used as a

tool for collecting research data, which consisted of 282 sets, collected from individual water user groups.

Data Analysis

This research used a ready-made statistical program for the analysis of social science research. The analysis of statistical data was divided as follows: 1) Characteristics of basic personal, economic, and social information of farmers, and farmers' knowledge and understanding level of on-farm water management using descriptive statistics including Percentage, Mean, and Standard Deviation. 2) Data analysis on factors affecting the success of on-farm water management, a total of 7 aspects, 45 issues, was used to assess the success level of on-farm water management applied from Likert's estimation scale by defining the scores as follows: most agree with a score of 5, highly agree with a score of 4, moderately agree with a score of 3, less agree with a score of 2, and the least agree with a score of 1. Then, interpret the meaning by comparing each issue with the interpretation criteria. The average score is used as a criterion for interpreting the meaning as follows: A mean score between 4.21- 5.00 means having the most success. A mean score between 3.41-4.20 means very successful. A mean score between 2.61-3.40 means moderate success. A mean score between 1.81-2.60 means less success and a mean score between 1.00-1.80 means the least success. As for the analysis of factors affecting the success of on-farm water management for sustainable agriculture, using inferential statistics is a Multiple Regression Analysis to find the relationship between the independent variables and the dependent variables, and how much each independent variable affects the dependent variables. Fifteen independent variables were selected, namely gender, age, education level, status, occupation, income, occupation of agriculture, farming area, holding area, membership in the Association of Irrigation Use Leaders, catchment area, utilization of water resources for agriculture, and receiving sources of knowledge on water management. Parameters include the farmer's knowledge and understanding of the farmer's on-farm water management model (mean from five aspects). The dependent variable is the factor affecting the success of farmers' on-farm water management (Mean of total success).

Research Results and Discussions

Characteristics of basic personal, economic, and social information of farmers

The study found that most of the farmers lived in Ban Wen Tonhaen (44.3%),14.5% were farmers who used water in the Khao Phon group, 71.3% were mostly male, with an average age of 49.94 years old, 42.6% had secondary education, 82.3% marital status, average income is 543,000 kip/ month with an agricultural area of more than 5,001 square meters, 57.4% were no land ownership, 71.6% of the land was inherited by inheritance, 45.7% had been a member of the water user group for 31-40 years, and 53.2% Irrigation Canals cross thought their production land.

Level of knowledge and understanding of farmers in on-farm water management

The results of the knowledge level test revealed that farmers have knowledge about on-farm water management that affects the success of on-farm water management for sustainable agriculture in Savannakhet, Lao People's Democratic Republic at a moderate level (72.77%), and 27.23% of farmers had a less knowledge without finding farmers who know a very high level. While averaging a total of 10 knowledge scores, it showed that farmers had moderate knowledge with an average score of 1.13, with the lowest score being 10 and the highest being 20 points (Table 1). This indicates that most farmers knew a moderate to low level since the farmers lack knowledge of the on-farm water management model, academic technical training isn't thorough; study tours are discontinuous or less. Therefore, the level of knowledge on on-farm water management was not pretty good as expected. Farmers have habitual on-farm water management practices which may be practiced from generation to generation, thus affecting the current level of knowledge. Moreover, Farmers rarely accept learning from water users' association officials and related government agencies. All of these affect the level of knowledge of on-farm water management of farmers. It is consistent with TheinthongChandarasan, et al. (2014), who studied "The participation of farmers water user group on irrigation water management of Thintiengtay irrigation project, Pakngum district, Vientiane capital, Lao People Democracy Republic".The results showed that 99.6 percent of the water sources used by farmers were irrigation water. The most commonly grown crop was rice at 66.7 percent. Farmers had a high level of knowledge and understanding of irrigation water management. Participation in water management for overall agriculture was at a moderate level with an average of 2.98% and moderate participation in all aspects, namely, gaining advantage from irrigation water distribution, irrigation water utilization planning, and participation in irrigation system maintenance. Factors that affected farmers' participation in irrigation water management were as follows; level of their education, major occupation, minor occupation, household labor, water distribution, location of cultivated area, household income, and in debt.

Table 1: Number and percentage of farmers classified by knowledge of on-farm water management that affects the success of on-farm water management for sustainable agriculture

Level of knowledge of on-farm water management	**Number of Farmers(persons)**	**Percentage**
Farmershave good knowledge.	-	-
Farmers have moderate knowledge.	205	72.77
Farmers have less knowledge.	77	27.23
$\bar{X}$ = 1.13	**Min-Max =10-20**	**SD.=.180**

Note: The good knowledge level is between 8-10 scores (more than 75 percent).
The moderate knowledge level is between 5-7 scores (50-75 percent).
The less knowledge level is between 1-4 scores (less than 50 percent).

Factors Affecting the Success of Farmers in On-farm Water Management for Sustainable Agriculture in Savannakhet Province, Lao People's Democratic Republic

The results of Multiple Regression Analysis by adding all 15 independent variables into the equation and calculating with the normal method (Enter) found that the F-value = 8.426, Sig of F-value = 0.000. This indicates that there is at least one independent variable that is a statistically significant correlation with the dependent variable (Factors affecting success in on-farm water management of farmers) and when considering the coefficient value of decision making was found that R^2 = 0.568 means that all independent variables explained 56.8% of the variation of the dependent variables. Of the 15 independent variables, three variables had statistically significant effects on the dependent variables at the 0.05 level including income, knowledge and understanding of farmers in on-farm water management of rice cultivation, and the farmer's water management model at the farm level (Table 2). They could explain the independent variables that were significantly significant relationships with the dependent variables as follows: 1. Farmer's income found that most farmers will use water to grow crops, primarily for rice cultivation. On-farm water management is a matter in that water user groups have to share responsibility, if water is allocated thoroughly, rice production will flourish, and the income will increase by rice selling. However, if the water allocation is not efficient, it will cause a water shortage, therefore farmers cannot cultivate. This is consistent with the study of SukittiyaBoonlai and SiwachSripokangkul (2017) on "Guideline for water management system impacts from the water management sustainable agriculture Tha Khraserm Sub-district, NamPhong District, KhonKaen Province."There are two water management systems: 1) water

along the irrigation canal and 2) the electricity pumping station project was affected by the results of the water management in 4 aspects: 1) economic, 2) social, 3) culture, and 4) environment. These issues directly affect farmers' incomes which Most are engaged in agriculture only. The refrain from supplying water prevents farmers from cultivating crops; therefore, lacking the income to support their families and the budget that the government compensates is not enough to cover household expenses. In addition, it affects people who are employed in general agriculture, such as plowing (land preparation), rice harvesting (rice harvesters), and lack of income. 2. Knowledge and understanding of farmers in on-farm water management of rice cultivation is when farmers have knowledge and understanding of the various processes related to rice cultivation, such as wet and dry rotation farming in the area of the irrigation area that controls the water supply and drainage, preparation of the plot, an important period for water allocation, fertilizers using, water control, etc., allows farmers to learn and utilize water in full efficiency, and 3. The on-farm water management model consists of five aspects, namely 1) problem exploration and causes of problems, 2) planning and decision making, 3) operation, 4) receiving benefits, and 5) evaluation and conclusion. It revealed that all affect the factors affecting the success of farmers' on-farm water management. It is consistent with Padsawan and Bancha (2013), who studied "The participation of water user groups in irrigation management: a case study of Nong Daeng Project, Mueang District, Salavan Province, Lao People's Democratic Republic." The study found that Nong Daeng Irrigation Project uses water in agriculture to grow rice only and hundred percent glutinous rice. The management system is collaboration management between water user groups and the government agencies, but the water user group will have more responsibility, whether issuing regulations that are legal within the group, the irrigation system management and maintenance, water distribution planning, water expansion bill collection, punishment the offenders, various solutions arise in projects, etc. The government part must provide education and assistance in terms of concepts, academics, and evaluation at the end of the production season. For almost fifteen years, the project has had a good feedback management model at the provincial level, however in reality, in the past operation process, it can be seen that this management system lacks an academic model.

Table 2 Analysis of factors affecting the success of farmers' on-farm water management

IndependentVariables	DependentVariables		
	The success of farmers'on-farm water management		
	Coefficient (B)	**t**	**Sig.**
1. Gender	-0.021	-0.424	0.672
2. Age	0.011	0.467	0.641
3. Education level	-0.003	-0.145	0.884
4. Status	0.041	1.063	0.289
5. Occupation	0.041	1.154	0.250
6. Income	-0.046	-3.303	0.001**
7. Agricultural occupation	0.017	0.615	0.539
8.Production Area	-0.007	-0.436	0.663
9. Landownership	0.008	0.289	0.773
10. Membership in the Water User Group	-0.039	-1.331	0.184
11. Irrigated areas	0.047	1.769	0.078
12. Utilization of Water Resources forAgriculture	0.361	1.870	0.063
13. Receiving sources of knowledge on water management	-0.140	-1.336	0.183
14.Knowledge and understanding of farmers in on-farm water management of rice cultivation	0.432	3.011	0.003*
15. Farmer's on-farm water management model	0.295	7.923	0.000**
R^2= 0.568 (56.80%) **F= 8.426** **Sig. F= 0.000****			

Note:* There was a significant relationship at the 0.05 level.

** There was a significant relationship at the 0.01 level.

Problems, obstacles, and suggestions of respondents about factors affecting the success of on-farm water management for sustainable agriculture

1. Officers

1.1 Problems of Officers in Farmers' on-farm water Management

The study indicated that most farmers have problems with the on-farm water management system, for example, officers did not pay attention to checking the water supply, and as a result, members of the water user group did not receive water on time. The officers did not follow up during the distribution of water to the rice fields. The officers were not strict on regulations against members of certain water user groups for offenses, and there were no records ofviolators. The officers do not provide continuous training for their members, leaving farmers with no upgraded new knowledge of on-farm water management. Currently, there has been a

change in the position of head of the Water Users Group, which has little experience in on-farm water management and also rarely participated in the activities of water user group members.

In suchproblems, farmers suggested thatofficers should stick with every aspect of on-farm water management. Whether it is planning, operation, inspection, or evaluation. Officers should make rules, and regulations for the water user group resulting from the participation of all farmers, which will lead to acceptance and compliance because it is a rule for everyone. Officers should participate in various activities, which are currently produced, and change the position of the head of the water user group, a person who intends to visit the farmers.

1.2 Obstacles of Officers in Farmers' on-farm water Management

The study results that most farmers have problems with insufficient officers for on-farm water management resulting in no person monitoring water distribution. As a result, there are various problems such as the distribution of water is not evenly distributed and not following the plan. This causes the rice to lack water and be badly damaged. Relevant agencies do not have budget support for repairs when there are various events such as power outages, no backup power system, water pumps being small, insufficient capacity to pump water into the fields, lack of transportation and irrigation facilities,budget management is not clarified, etc.

In such problems, farmers suggested that officers should inform the relevant government agencies and coordinate purposesfor assistance if there was a problem that could not be resolved by a single agency. Withinthe water users group, therehelped each other and had internal discussion meetings to solve the initial phase problem. A water user group also collects maintenance fees for repairs to the pumping stations without relying solely on government agencies.

1.3 Suggestions of Officers in Farmers' on-farm water Management

The study showed that most of the farmers wanted the officers involved in the water user group to pay more attention to the group. Relationships areestablishedwitheachother. Whetheritisaboutmonitoringthewatersupply to beconsistentandfairtoeveryone.Providingtrainingtofarmers, and groups of waterusersequally and fairly, and everyone gainsknowledge.Officershaveset water usemeasuresfor water-use farmerstoprevent a laterconflict.Farmerswanthigh-rankingofficialstoparticipateinimportantactivities.

In such problems, farmers suggested that officers should participate in various activities between farmers and water users and officials, such as organizing training on irrigating plants, water delivery, and maintenance including capacity buildingneeded for the farmer equally and fairly.

2. On-farm Water Management

2.1 Problems of Farmers' on-farm water Management

The study found that most farmers have problems with facilities of on-farm water management, for example, the pressure of the water pump is low, causing delayed delivery of water. The turnout gatesare not safe to store, resulting in water being stolen. The electricity system is not stable causing the water distribution not to go as planned. In addition, farmers encountered environmental problems which are as shallow canals due to not being operative for many years. As a result, water delivery is not distributed regularly. Farmers have to face trouble. The last problem is farmers don'trespect the rules and regulations of the wateruser group. There is a scramble for the resources of water for their production causing insufficient water to be distributedto other farmers.

From such problems, farmers suggested that regular meetings should be held to know the damage or needs of farmers within the group. There must be discussion and brainstorming ideas on fair water allocation to reduce each other's water being stolen. Leaders of water user groups took part in the meeting toclarify the issues and listen to the problems of the members. In addition, all members of the water user group must review the rules and regulations of the group to clarify themself. Penalties are imposed on offenders, which must be the result of everyone's involvement to be accepted and followed.

2.2 Obstacles to Farmers' on-farm water Management

The study found that most of the farmers have obstacles to the water supply to members of the water user groups. Whether is an adverse environmental aspect such as the main canals being shallow, old, and earthen causing the water not to spread atfull capacity, it is insufficient for some farmers. Also, the roads along the canal are narrow, so transportation was difficult. Regulations are another obstacle. Some farmers have filled canals without notifyingthe Group and dug holes to block waterwaysat many points. Therefore, there was no water at the end of the canal. Another affected is not receiving the water at the right time because the cycle took many days and then the water evaporates before receiving the cycle, or another reason for not receiving water on time is the drainage system, the gate is old, and not in good condition, not able to press the water and sometimes objections. Other obstacles are expense cost issues, such as higher electricity rates, etc.

In such problems, farmers have suggested that environmental problems should be something everyone has to concern and solve. If the problem is not can be solved by themselves, it requires assistance from various agencies, with the leader of the water user group as an

intermediary in coordinating for help, while some farmers who do not respect the rules and regulations must be punished according to the rules and regulations to prevent that from happening again.

2.3 Suggestions for Farmers' on-farm water Management

The study found that most of the farmers suggested distributing water to water user group members. It is proposed to improve the structure in various aspects such as the environment. Most of the farmers suggested that the irrigation canal should upgrade to the concrete type with the standard size and full sets of turnout gates to irrigate easily. It includes suggestions forimprovementof the accessroads for the transportation the agriculture products. Regarding the irrigation facilities, most farmers suggested installing watergatesin every canal to the highly effective on-farm water management andprevent water from being stolen and proposed improving the irrigationpump station to easily distribute water. In terms of information dissemination, there should be a meeting to plan and clarify the water distribution rules which will reduce internal conflicts of the Water User Group.

Of such problems, farmers should be supported by various agencies to upgrade the environment to have more efficiency. Farmers' water user groups should also participate in this development. There will be discussions and plans for operations of on-farm water management in the future with various agencies that will be integrated and will continue to manage on-farm water to be more effective.

Most of the farmers had suggestions for organizing training for farmers' water user groups with the desire to study to apply knowledge to solve problems encountered by farmers, such as training on pest and weed control management, etc. Farmers want to improve in terms of materials and equipment because they are not as effective as they should be, such as organizing a new canal system to facilitate and the ability to deliver better waterways, improving the water pump system, and farmers proposed using solar energy instead of electricity to help reduce production costs and make it easier to manage. In terms of the officials concerned, farmers have a proposal to supervise and monitor the plans that have been laid out together and relevant officials should have a visit to the area to encourage farmers to discuss and exchange problems and obstacles together.

that farmers know on-farm water management that affects the success of on-farm water management for sustainable agriculture in Savannakhet, Lao People's Democratic Republic at a moderate level (62.27%)

Conclusion

The results of the study on "Factors Affecting On-farm Water Management for Sustainable Agriculture in Savannakhet Province, Lao People's Democratic Republic. In terms of knowledge

about on-farm water management, it showed that most of the farmers who used water had a moderate level of knowledge (72.77%). To find factors affecting the success of on-farm water management in a total of seven aspects, namely water user group officers, leader of the water user group, water user groups, principles of morality, and good governance. In terms of rules, regulations, and attitudes towards on-farm water management, it revealed that the independent variables affecting the success factors in on-farm water management were income, farmers' knowledge and understanding of farmers in on-farm water management of rice cultivation, and farmers' on-farm water management model. In terms of problems, obstacles, and suggestions of the respondents about the factors affecting the success of on-farm water management for sustainable agriculture, there were problems with the staff that could not manage the water management system, such as monitoring the water distribution. Regarding on-farm water management, it showed that most of them had problems with materials, equipment, and other suggestions that there should be training for farmers and in other solutions such as pest control, weed control, etc.

Recommendation

This study, it is known that the knowledge and understanding of farmers in on-farm water management and factors affecting on-farm water management for sustainable agriculture in Savannakhet, Lao People's Democratic Republic can be used as information for those in charge involved in on-farm water management planning. The research results revealed that the government has focused on the economic growth of the country by relying mainly on existing natural resources, especially water resource development, but the government still lacks water management policies understanding and does not continuously monitor the results of water management. In addition, to heal farmers who are affected by flooding or without water to use in the dry season, no agency seriously takes care of it. There is no adaptation of farmers in water resource management at the local level, making them unable to adapt to the highly volatile climate. Therefore, the researcher proposed ideas for solving water resource management problems of farmers as follows: 1) Promote short-term crops and vegetables to increase income for farmers in addition to growing rice, 2) Researching the planting system after harvest, 3) Provide capacity building to farmers on disaster risk management and climate change adaptation, and 4) watershed management to improve irrigation water sources to store water for use in the dry season.

Acknowledgment

The researcher would like to thank farmers' irrigation water users' groups at Ban Wen Tonhaen, key informants, and thanks to the teachers and personnel in Resource Management and Development, Faculty of Agricultural Production, Maejo University who provided information, advice, and support in this research.

References

Basic information about Foreign countries. 2021. Lao People's Democratic Republic. [Online]. https:// www.nia.go.th/ media/ almanac/ 2022/01/ Lao_2022.pdf. (30 June 2023)

Epprecht, M., Bosoni, N. and Hayward, D. 2018. Urbanization processes in the Lao PDR. Centre forDevelopment and Environment. The University of Bern. [Online]. Available https://www.shareweb.ch/site/PovertyWellbeing/currentpovertyissues/Documents/Lao_Urbanization_Study_CDE_final.pdf (19 June 2023).

PatsawanChaiyawong and Bancha Kwanyuen. 2013. Participation of water user groups in irrigation management, a case study of Nong Daeng Project, Muang District, Salavan Province, Lao People's Democratic Republic. Journal of Science and Technology, 2(1): 27-38.

SatitSueaprasertsukchana and WatcharaArunrat. 2015. Water resources management and drought. [Online]. https://dwr.go.th/uploads/file/article/2015/article_th-16082015- 104440-394136.pdf. (19 June 2023)

Sawathee, P. 1998. Sampling method forresearch. NIDA Development Journal 38(3): 103-130

SukittiyaBoonlai and SiwatSripokankul. 2017. Guidelines for developing water management systems for sustainable agriculture: A case study of Tha Kraserm Subdistrict, Nam Phong District, KhonKaen Province. Veridian Electronic Journal, Silpakorn University. (Humanities, Social Sciences and Arts), 10(2): 1771-1784.

Supachai Wanlertsakul. 2007. Savan-Seno Special Economic Zone: Opportunities and Threats for Thailand. Faculty of Law Thesis, UbonRatchathani University.

TheinthongChandarasan, et al. 2014. The participation of farmers' water user group on irrigation water management of Thintiengtay irrigation project, Pakngum district, Vientiane capital, Lao People's Democracy Republic, Journal of Forest Management, 8(15): 53-67.

Vongmany, O., Watanabe, K.N., Mizunoya, T., Kawase, M., Kikuchi, A., Yabar, H., Higano, Y., Sombounsack, N and Phounpakon, O. 2018. Sustainable Water Management under Variable Rainfall Conditions in River Communities of Champhone District, Savannakhet Province, Lao PDR. Journal of Sustainable Development 11(3): 108-122.

Water Environment Partnership in Asia. 2021. Outlook on Water Environmental Management in Asia. [Online]. Available https://wepa-db.net/wp-content/uploads/2023/02/WEPA_outlook 2021_e.pdf. (30 June 2023).

Water Environment Partnership in Asia. 2023. Water Environment in Asia. [Online]. Available https://www.env.go.jp/en/water/wq/wepa_broc.pdf. (19 June 2023)

Yamane, T. 1973. Statistics: An IntroductoryAnalysis. New York: 3.S.l. HarperInternational. 886 p.