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# Water management model for sustainable agriculture, Nakhon Ratchasima Province, Thailand

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## ABSTRACT

This research has been carried out to study: 1) the level of public policy; budget; educational institute, public participation, production process and water management for sustainble agriculture; 2) the impacts of government policy, budget, educational institute, public participation and production process on water management for sustainable agriculture; and 3) Water management approach for sustainable agriculture in Nakorn Ratchasima Province. This quantitative research employs the sampling size of400 farmers who irrigate water for their farming; while the qualitative research focuses on the data collection from nine experts on water management at the provincial level, on irrigation experts, and local farmers who are using water for their farming. The research result reveals 1) the impact of the government policy, budget, educational institutes, public participation, production process on water management approach are at the in the medium level; 2) the government policy, public participation, budget and educational institutes directly impacts on water management for the sustainable agriculture; 3) Approach for water management for the sustainable agricuture must be implemented together with the integration of government policy, public participation, allocation of sufficient budget and close cooperation with the educational institutes to train and educate farmers who actually irrigatete water for their agricultures.

**Keywords**
Water Management, Sustainable Agriculture, Participation, Government Policy

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## Introduction

Water management is the important strategy that each country in the world must adopt in order to balance water use and be able to utilize the water with maximum efficiency. It will also help ensuring the food security in the presence of adequate agricultural water. According to the study and review of literature related to water management for agriculture, it was found that agricultural activities resulted in the greatest water use in the world (UN water, 2006).

At present, most of the world's agricultural production relies on rainwater and irrigation. The area is accounted for only 20% of the world's agricultural land while the farmland has expanded 117% since 1961 (FAO, 2011).

Thailand is aware of the water shortage problem in terms of quality, quantity and the appropriateness of the duration of consumption. Such problems become more and more severe every year. Apart from using water for consumption and for living, people also use water for agriculture, industry, hydro power generation, water transport and economic development of the country.

The Northeastern region comprises 20 provinces with a plateau and low slopes towards the southeast. As there are a lot of areas for cultivation, a large amount of rainwater is required mainly for agriculture. Along with the expansion of urban communities and the expansion of industrial sectors, the degradation of water resources is caused making the limited amount of water that can be used in agriculture and consumption must be further reduced. This directly affects the local farmers on the drought. The Royal Irrigation Department has declared Nakhon Ratchasima as a risky area for drought conditions (Royal Irrigation Department, 2020).

Nakhon Ratchasima Province has given importance to water management by defining the strategies in the Nakhon Ratchasima Provincial Development Plan for the 4-year period (2018-2021), 3rd Strategy: Management of natural resources and environment to be sustainable and complete in accordance with the sufficiency economy approaches. The promotion is on water management in both irrigated and non-irrigated zones and the expansion according to the royal initiative projects including the development of flood protection systems in urban areas and adding buildings to reduce the erosion of the banks along the main canals of the province (Nakhon Ratchasima Province, 2018). Nakhon Ratchasima Province has an agricultural area of more than 8.7 million rai or 67.97% of the total area (National Statistical Office, 2018). The province's major economic crops are rice, cassava, and sugar cane, maize, and fruits. The important livestock are cattle, domestic chickens, Chitralada Tilapia fish, etc. It can be seen from all important agricultural activities of Nakhon Ratchasima Province that a lot of water is needed for the production. If there is no concrete water management for agriculture, Nakhon Ratchasima Province possibly encounters the water shortage problems for the consumption and agricultural production in the dry season as same as every past year (Provincial Warehouse Office, Nakhon Ratchasima, 2020).

According to the literature review, it is found that the important factor affecting water management for sustainable agriculture is the government policy related to water management (Masoud et al, 2014). This is consistent with the participation theory of Cohen and Uphoff (1980) used as a participatory process concept that can be used in water management for agriculture. The educational institute factor also plays an important role in water management for agriculture because it is a source of knowledge for the research and development to help providing the advice and

mentor to farmers in the selection of plant varieties, planting, and harvesting. The budgets are provided for the educational institutes to participate in educating more agricultural research (Maru & Rao, 2014). The farmers' production processes are also important factors because farmers have the power to decide where to plant or which kind of plants to produce in their own areas. Each plant has different processes of planting, care, maintenance, and the need for water (Haq & Shafique, 2009).

From the water resource problem in Nakhon Ratchasima Province, it is partly from external factors such as climate change which affects rainfall in the area and partly from internal factors such as the increase in the population and inefficient management of water resources of the relevant departments. Even though the government and the Province have spent huge budgets in solving the problems, there is still a conflict in water management whether the conflict in the demand for water supply, conflict of interests gained from the water sources, and conflict in water quality, etc. The lack of integration in the collaboration of stakeholders is a major problem in water management. The management of water resources for agriculture to achieve sustainability is therefore important to reduce the impact of the problems and the use of water for the maximum benefits as well as being accepted by all parties that are stakeholders. Thus, the researchers are interested in studying the water management model for sustainable agriculture of Nakhon Ratchasima Province for relevant agencies, people, including farmers in the area to use the obtained research results as a solution to the flooding problem in the rainy season and summer drought with concrete results from the integration of all sectors for sustainability.

## Research's objective

To study; 1) the level of public policy; budget; educational institute, public participation, production process and water management for sustainble agriculture of Nakhon Ratchasima Province, 2) the impacts of government policy, budget, educational institute, public participation and production process on water management for sustainable agriculture of Nakhon Ratchasima Province, and 3) Water management approach for sustainable agriculture in Nakorn Ratchasima Province.

## Literature Review

**1. Concepts and theories of management for sustainable agriculture:** The speech of His Majesty King Bhumibol Adulyadej concerning water was, "The main principle is that there must be water for consumption, usage, and cultivation. Because there are lives, if there is water, everyone can survive. If there is no water, no one can live. Without electricity, human can live. But if there is neither electricity nor water, human cannot survive." According to the aforementioned royal speech, it can be seen that water is a resource that is essential and important to all living things in the world. Human needs water as a factor in their lives. From this problem, it is necessary to develop an effective water source. With the sustainable management, the good results will be brought to people such as the increasing income, good quality of life, and sufficient water.

**2. Concepts and theories of public participation:** Public participation is essential to any water management model for sustainable agriculture in Nakhon Ratchasima Province. At present, the government is extremely trying to encourage the people participation in water management for agriculture. This is a lesson from the damage to life and property of many people from flood disasters that frequently occur in Thailand. However, it is mainly involved in water management by the community. It is not an easy thing to do as the water resource problem is more complicated. It can be considered that the same area possibly encounters both drought and flood problems. At the same time, the impact of the area also affects the problems at the river basin level from the upstream area, midstream, to the downstream area. Therefore, granting the opportunities for the local and the public sector to take part in participatory water management will help reducing the damage from experiencing the flood problem and mitigate the damage that occurs. Thus, encouraging people to take part in water management is important. In addition, participatory water management also meets the needs of the community in saving budgets. It also helps reducing the conflicts better than other methods (Royal Irrigation Department, 2020).

## Research methodology

Population and sample group: The population of quantitative research consisted of 24,727 water users in Nakhon Ratchasima Province. The population of qualitative research consisted of the academicians in the fields related to water promotion and management, academicians at the provincial agricultural level, academicians in irrigation, agricultural philosophers, and farmers who use water for their cultivation. The sample groups in the quantitative research were 400 water users in Nakhon Ratchasima Province. The sample size was determined using 20 times the criteria of the observation variable. Sampling was made using a multi-step method on the academicians in the fields related to water promotion and management, academicians at the provincial agricultural level, academicians in irrigation, agricultural philosophers, and farmers who use water for their cultivation totaling 9 persons using the specific sampling method.

Research instruments: The researchers created the questionnaires from reviewing the documents and literature on water management for sustainable agriculture. The questionnaires consist of 3 parts questionnaire and the group discussion record. The questionnaires are as follows; Part 1: Personal factors of the farmers who use water for their cultivation, Part 2: Factors affecting the model of water management for sustainable agriculture in Nakhon Ratchasima Province including the government policy, budgets, educational institutes, public participation, and production process by assigning the 5-level scoring of Likert (1932), Part 3: Questionnaire on water management for sustainable agriculture in Nakhon Ratchasima Province by assigning the 5-level scoring of Likert (1932), Part 4: Open-ended questions on water management for sustainable

agriculture in Nakhon Ratchasima Province to allow the sample group to express further opinions.

The questionnaires used in the research process contain the following quality testing processes:

1. In testing the accuracy of the contents, the researchers appointed 5 qualified persons to check for the content validity and the consistency of the questions to the objectives which gave the content precision of 0.924.
2. In analyzing the confidence of the questionnaires, the researchers brought the questionnaires that passed the content validity test to experiment with farmers who use water in Nakhon Ratchasima Province that were similar to the sample group but not the sample groups of 30 people. From analyzing the confidence, the confidence value of the questionnaires equaled to 0.898.

Statistics used in data analysis: The statistics used by the researchers to analyze the data are mean, standard deviation, and analysis of structural equations.

## Research results

1. Results of the study of opinion level of water user farmers on government policy: From Table 1, it was found that the level of opinion of water user farmers on government policy in the overall and in each aspect was moderate in the implementation of the policy, the clarity of the government, the monitoring and evaluation, respectively. From Table 2, it was found that the level of opinion of farmers who used water on the budget in the overall and in each aspect was moderate in terms of suitability and sufficiency, transparency and responsible persons, respectively. From Table 3, it was found that the level of opinion of farmers who used water on the educational institutes in the overall and in each aspect was moderate in research and development, creation of technology and innovation, and educating, respectively. From Table 4, it was found that the level of opinion of water user farmers on the public participation in the overall and in each aspect was moderate in the recognition of benefits, management, and planning. From Table 5, it was found that the level of opinion of farmers who used water on the production process in the overall and in each aspect was moderate in the selection and management of areas, combined pest management and soil protection, and groundwater refilling. From Table 6, it was found that the level of opinion of farmers who used water on the water management for sustainable agriculture in the overall and in each aspect was moderate in the sufficient water, quality of life, and increasing income.

**Table 1** shows the mean, standard deviation, and opinion levels of water user farmers on government policy

| | Government policy | $\overline{X}$ | S.D. | Levels of opinion |
|---|---|---|---|---|
| 1. | Clarity of the government | 3.04 | 0.82 | Moderate |
| 2. | Implementation of policy into practice | 3.05 | 0.84 | Moderate |
| 3. | Monitoring and evaluation | 2.99 | 0.92 | Moderate |
| | **Total mean** | **3.02** | **0.80** | **Moderate** |

**Table 2** shows the mean, standard deviation, and opinion levels of water user farmers on budgets

| | Budgets | | S.D. | Levels of opinion |
|---|---|---|---|---|
| 1. | Responsible persons | 2.88 | 1.00 | Moderate |
| 2. | Transparency | 2.98 | 1.03 | Moderate |
| 3. | Suitability and sufficiency | 3.13 | 0.90 | Moderate |
| | **Total mean** | **3.00** | **0.93** | **Moderate** |

**Table 3** shows the mean, standard deviation, and opinion levels of water user farmers on educational institutes

| | Educational institutes | | S.D. | Levels of opinion |
|---|---|---|---|---|
| 1. | Educating | 3.01 | 0.90 | Moderate |
| 2. | Research and development | 3.11 | 0.93 | Moderate |
| 3. | Creation of technology and innovation, and, respectively | 3.03 | 0.94 | Moderate |
| | **Total mean** | **3.05** | **0.87** | **Moderate** |

**Table 4** shows the mean, standard deviation, and opinion levels of water user farmers on public participation

| | Public participation | | S.D. | Levels of opinion |
|---|---|---|---|---|
| 1. | Planning | 3.12 | 0.94 | Moderate |
| 2. | Management | 3.13 | 0.87 | Moderate |
| 3. | Recognition of benefits | 3.26 | 0.83 | Moderate |
| | **Total mean** | **3.17** | **0.83** | **Moderate** |

**Table 5** shows the mean, standard deviation, and opinion levels of water user farmers on production process

| | Production process | | S.D. | Levels of opinion |
|---|---|---|---|---|
| 1. | Mixed planting | 3.24 | 0.87 | Moderate |
| 2. | Selection and management of areas | 3.36 | 0.81 | Moderate |
| 3. | Combined pest management | 3.33 | 0.81 | Moderate |
| 4. | Soil protection | 3.33 | 0.85 | Moderate |
| 5. | Groundwater refilling | 3.17 | 0.85 | Moderate |
| | **Total mean** | **3.29** | **0.77** | **Moderate** |

**Table 6** shows the mean, standard deviation, and opinion levels of water user farmers on water management for sustainable agriculture

| | Water management for sustainable agriculture | | S.D. | Levels of opinion |
|---|---|---|---|---|
| 1. | Quality of life | 3.14 | 0.83 | Moderate |
| 2. | Increasing income | 3.07 | 0.90 | Moderate |
| 3. | Sufficient water | 3.34 | 0.79 | Moderate |
| | **Total mean** | **3.18** | **0.76** | **Moderate** |

**2. Analysis on the influence of government policy, budget, educational institute, public participation, and production**

**processes that affect water management for sustainable agriculture, Nakhon Ratchasima Province**
From Figure 1, it is found that policies and public participation directly affect water management for sustainable agriculture. The budgets and educational institutes indirectly affect the water management for sustainable agriculture while the production process does not affect the water management for sustainable agriculture.

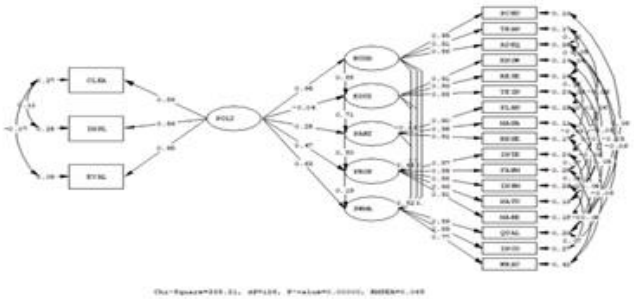

**Figure 1** shows the analysis on structural equations

**3. Model of water management for sustainable agriculture in Nakhon Ratchasima Province:** The model of water management for sustainable agriculture in Nakhon Ratchasima Province consists of 3 elements; quality of life, increasing income, and sufficient water. The factors that have direct and indirect effects are government policy, budgets, educational institutes, and public participation with the guidelines for implementation as follows:
1. For the government policies, all sectors must integrate the government's water management policy in line with the water management area for sustainable agriculture and apply policies at the provincial level, district level, and sub-district level.
2.For the budgets, the relevant government agencies arrange the budgets for water management for agriculture that are sufficient and suitable for each area. The budget allocation process must be transparent allowing the stakeholders to be examined, establish the clear definition of the responsible persons or the agency responsible for the budgets for water management to be clear and to create duplicate work.
3. For educational institutes, the knowledge about water management must be promoted to support farmers who use water such as knowledge of new technology and new innovations in agriculture.
4. For public participation, the participation of people in water management for agriculture must be promoted and encouraged such as taking part in the care, delivery of water, maintenance, repair of irrigation systems, build and cultivate farmers' consciousness to realize the importance of water used in agriculture.

## Research discussion

1. The farmers who used the water had moderate opinions on water management for sustainable agriculture. The case is likely caused by the farmers encountering water shortage in their farming practices which affects the quality of life. In addition, they have income that is not enough to live and they lack adequate land for agriculture. This is because increasing farmers' quality of life depend on income and well-being and a modern agricultural management system is required. The case follows Krener's (2019) idea that empowers farmers through the use of digital technologies such as data acquisition technology, big data, internet of things, etc. to help improving farming in the developed countries to have better income and well-being in living with nature and environmental sustainability.
2. The research results revealed that the policies and public participation have direct impact on water management for sustainable agriculture. The budget and educational institutes indirectly affect the water management for sustainable agriculture. The production process does not affect water management for sustainable agriculture. Such cases are likely to be attributed to water management for sustainable agriculture. Direct and indirect factors are needed to help maximizing the water management for sustainable agriculture for efficiency and modernity. This is the case following the research of Masoud et al (2014) finding that the policy factor was also significantly positive related to the statistical significance. It is also in line with the concept of the theory of participation of Cohen and Uphoff (1980) which is used as a participatory process concept that can be used in water management for agriculture, namely participation in decision making, taking part in the practice, participating in benefits, and participating in assessment. Besides, the educational institute factor plays an important role in water management for agriculture (Maru & Rao, 2014).
3. Water management model for sustainable agriculture by applying government policies in accordance with the characteristics of area for water management can promote the participation of people in water management for agriculture. Budgeting for water management for agriculture must be adequate and suitable for each area. The educational institutes should promote and encourage the dissemination of knowledge about water management for water users. Such cases are likely to come from the reasons the government policy is an important policy that all sectors have to integrate and apply to suit the area. It also relies on the participation of the people to achieve sustainable agricultural water management goals. There is adequate and appropriate budget allocation in each area. The educational institutes are allow to strengthen the knowledge of agriculture to the people. This will make the water management for agriculture the most sustainable.

## Conclusion of results

1. The impacts on the government policy, budget, educational institutes, public participation, and production processes on water management for sustainable agriculture were moderate.
2. The government policy, budget, and educational institutes affect the water management for sustainable agriculture while the production processes does not affect the water management for sustainable agriculture.
3. The model of water management for sustainable agriculture has the guidelines for practice for all sectors to integrate government policies in accordance with the nature of water management areas. This can promote the public participation in water management for agriculture.

Budgeting for water management for agriculture must be adequate and suitable for each area. The educational institutions must promote and support knowledge about water management to water users.

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