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Research Article

The Study Patterns and Problem Water Management for Agriculture of Durian Production in Chanthaburi, Thailand

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Abstract

The objective of the research is to study patterns and problem water management for agriculture using participatory action research (PAR). Data collection was conducted by entering the area for a survey and interviewing sample groups of farmers from 10 districts in Chanthaburi, Thailand. The sample group consisted of five farmers from each district, constituting 50 farmers. The interview results and statistical data analysis described in detail. The result can be concluded that the farmers mostly encounter water insufficiency and lack of knowledge about the irrigation system. The agricultural costs will increase in terms of the investment of laying out the irrigation system or excessive water usage that is not compatible with the water requirement of the plant. Therefore, the water management system for agriculture should be managed easily with technology, which gives water economically and precisely then farmers can know when to apply the water.

Keywords: *Pattern, Problem, Water management, Durian, Chanthaburi*

1. Introduction

Chanthaburi, the province of Thailand, has the potential to produce and export agricultural products, especially durian. The demand for foreign markets brings then much more income each year. Chanthaburi has the most durian plantation area in Thailand with the area of 192,591 rai and produces 242,686 tons of durian in 2014. (Center of Agricultural Information, Office of Agricultural Economy, 2016).

Nowadays the expansion of the area for durian cultivation has been increased every year due to the high price of this fruit. Many farmers began to change their own areas into durian gardens. Durian plantation needs a large amount of water for its growth. The design of water management systems used during drought is the most important for durian cultivation, especially during climate

change. Durian plantation obtains both quantity and quality under the break-even point is the important thing that farmers should be aware of.

From mention above, the researcher has the concept of studying the condition and the pattern regarding water management systems for agriculture in the durian production of Chanthaburi. The purpose is to develop the concept of water management systems for durian farmers to have the most efficiency based on the data results from the study.

2. Objectives

The objective is to study the state and problem of water management systems for agriculture in the durian production of Chanthaburi province, Thailand.

3. Materials and Methods

Data collection was conducted by entering the area for the survey and interviewing sample groups of durian farmers from 10 districts including Ta Mai, Na Yai Arm, Kao Kitchakoot, Klung, Makham, Kaeng Hang Maew, Pong Nam Ron, Soi Dao, Laem Sing ,and Muang Chanthaburi. The sample group consisted of five farmers from each district, constituting 50 farmers. To explain the interview results, the descriptive data analysis was made. Moreover, the statistical data analysis with percentage was used to describe and show data in detail.

4. Results and Discussion

The result from the survey and interviewing sample groups of farmers can be explained in 5 sections as follows:

4.1 Section 1 Durian farming

The farmers mostly have one year experience (23.1%) in durian farming due to they are taking over the business from the family, and another is 5-year experiences (10.3%). Most farmers had durian plantation areas for 1-2 plots up, and more than 10 rais area (14.6%). Most of the commercial durian varieties cultivated are Monthong variety (85.4%). There are other durian varieties cultivated, including Kradoom variety, Chanee variety, Karn Yao variety, and Puang Manee variety. Some farmers also grow several varieties in the same plot. For the number of durian trees grown in the 1-rai area, is mostly about 25. Most of the farmers use the spacing of 8m x 8m (60%), 10m x 10m (25.7%) and 10m x 5m (14.3%) respectively for durian cultivation in the plot. Most of the farmers use the integrated plantation method in durian cultivation (35.7%), preparing a dug-hold method (33.3%), and sitting on the platform or making the mound (26.2%). Most farmers have management of height control for durian trees by letting them grow naturally (52.4%) and pruning (47.6%). For the number of yields obtained, they mostly get about 10 tons (17.2%), 5 tons (7.7%), and 80-90 tons (5.1%) per year.

Fig 1: Durian-Monthong variety

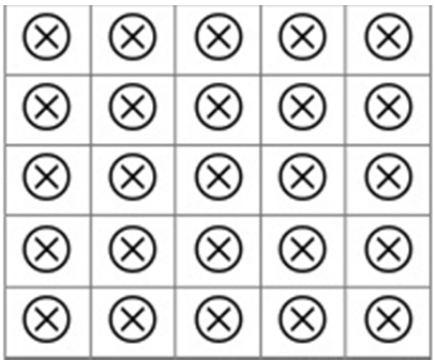

Fig 2: Showing the number of durian trees which farmers grow in the 1-rai area

4.2 Section 2 Area conditions of durian cultivation

For the climate condition of the area used for durian cultivation, the tropical condition is about (26.5%). Most of the areas used for durian cultivation are highlands, about (31%). Most of the soil used in durian cultivation is fertile, about (28.9%). Most of the climate condition of the areas used for durian cultivation is humid and the areas situated on highlands with the fertile soil.

Fig 3: Conditions of highlands

Fig 4: Conditions of loam

4.3 Section 3 Impact on water management systems

The farmers mostly faced the problems of drought since 2002 and from 2014 to 2016, it became more and more severe each year. Most farmers tried to cope with this problem by drilling artesian

wells to get underground water, making new reservoirs or enlarging the old ones transferring water from public canals to reservoirs.

Most farmers face the problems and obstacles in using water for agriculture such as water shortage, electric power failure, water amount, cleanliness of the water, water pumps, damaged water pump motors, oil prices and periods of daytime electric power transmission, water distribution with inappropriate pH values. Moreover, for climate conditions each year, farmers do not know how much water the plants need and when the plants need it during the day. For Highlands, high water pressure is required. Water pumps with large motors consume much electricity, requiring three-phase electric power. It is difficult to find electricians to handle this. In addition to this, water quality cannot be controlled because of using public water.

4.4 Section 4 Water resources and water system management

For types of water resources used in durian production, 50% of farmers use ponds. The qualities of water resources are good qualities (36.8%). Water supplies for sprinkler systems are used mostly for the water supply in durian plantations. However, there are some farmers using the method of drawing hoses and place them at the base of durian trees for letting the water flow out.

In a week, farmers supply durian trees with water 1-4 times up to every day at the extension stage of durian fruits. Water supply for 3 times a week (40.5%). Most farmers distribute water for 30 minutes to 5 hours according to the weather condition. Water distribution that lasts 30 minutes each time (35.7%). Farmers start applying water to durian trees at dawn-all day long and water distribution is conducted according to the weather and the objective of distribution such as fertilizer application. Water supply for newly grown durian can be classified into the following conditions: in the morning (61.9%); in the evening (20.1%); and water distribution, according to the weather and the objective of distribution (18%). Farmers give water to durian trees, starting from September up to May of the following year mostly. The period of water distribution can be classified into: from January to harvesting (13.2%); from December to April (10.5%); and from May to harvesting (7.9%). Most farmers manage water at the flowering stage of durian until the period of harvesting productivity by giving water according to the flowering period, the productivity and supply water every week until the rainy season. Giving water to open up the flower bud lasts 1-2 hours. When all the flowers bloom until durian fruits have the size of a fist, water distribution is reduced to 30 minutes and after that water, distribution is increased to 1 hour. At the flowering stage, water distribution lasts 30-45 minutes. At the blooming stage, the period of water distribution is reduced to about 20-30 minutes. Until the fruiting period, water distribution is increased to about 45-60 minutes all the way up to the time of harvesting productivity. After harvesting durian productivity, farmers have ways to manage water systems for agriculture by supplying water normally, pruning for reducing water losses of the trees after giving yields and nourishing the trees with biological fertilizers. They observe conditions of durian trees. It is between May to November after they finish harvesting the productivity, which starts the period of the rainy season. Water is not needed. Water supply starts again from November to December in order to open up flower buds.

Fig 5: Water supplies for sprinkler systems

4.5 Section 5 Irrigation and characteristics of irrigation systems

Farmers install water-dispensing pipes by having the sprinkler heads at the high level above the soil surface mostly as follows 30 centimeter high. Types of sprinkler heads used currently are Mini sprinklers (20.8%). For the water-dispensing rate of sprinkler heads with their properties, they dispense water in every surrounding direction. Most farmers do not know the information regarding the property of water dispensing of sprinkler heads. Most farmers use the riser pipe of the sprinkler head with the following sizes ¾" (36.4%). For the main pipe size, most farmers use the main pipe with the following sizes 2" (34.4%). Some use lateral pipes with the following sizes 2" (50%). Some use the following spacing between sub-main pipes of 8 meters (11.1%). Most farmers use the following spacing between sprinkler heads 2 meters (30.4%). For water management of durian, most farmers apply water each time as follows 60 minutes (25.8%) Some apply water daily in the period as follows 1 time (43.3%). Some have ways to consider when to apply water to the plant by observing and taking into consideration the conditions of durian leaves, the moisture of soil surface and the weather of the durian plantation.

Problems that farmers face mostly in regard to water application are as follows: Pipes slip out; Sprinklers do not dispense water or are clogged. For the size of the pump, most farmers use the electric motor with 2 horse-powers up for the areas with available electricity and they use the diesel or benzene engine for the areas with no electricity or highlands with slopes which are far away from water resources, requiring the engine with high power and continual pumping. Most farmers use the size of the sucking pipe of the water pump 3 inches (36.55%). Some use the size of the distributing pipe of the water pump 3 inches (33.3%). For the surface of the water level in the pond or the artesian well, there are many levels on average starting from 2 meters up to 10 meters. Most farmers face the problems with the water pump which is the clogging up of the sucking head due to dry leaf debris, blackout, and electrical power brownout. Moreover, there are other problems. For example, lateral pipes and sprinkler heads slip out during water application. Most farmers cannot provide the picture information regarding the dimension of the cultivation plot (width and length), the location of laying the main pipe, the location of laying the sub-main pipe, distances and the location of water resources. This is due to the pipes have already been buried and the location of the pipes cannot be seen.

Fig 6: Farmers install water-dispensing pipes with the height of sprinkler heads measured from the ground

Fig 7: Mini Sprinkler

Fig 8: How to considering when to apply water to the plant by observing the conditions of durian leaves

Fig 9: Problems that farmers face mostly in regard to water application are pipes slipping out, sprinklers not dispensing water or clogging up

5. Discussions

From entering the area to collect the data from the respondents who are farmers, it was found that durian farmers have experiences in doing durian farming for about 1-5 years due to being new-generation farmers to whom the families have passed on the occupation. The farmers have areas for doing durian farming about 10 rai up for 1-2 plots up. This is in line with the report of the research result in the study done by researchers of climatic changes on the pattern of climatic fluctuations having an effect on durian production in Chanthaburi, regarding most farmers had areas of durian cultivation in the range of 1-15 rai (Worakundamrongchai, 2010). The commercial durian variety grown is mostly the Monthong variety. Other varieties are also cultivated including the Kradoom variety, the Chanee variety, the Kanyao variety, the Puangmanee variety and the combination of several varieties grown in the same plot (Radchanui, 2017). Most farmers grow 13-40 durian trees in the 1-rai area-approximately about 25 durian trees per rai. The spacing of the growing durian in the plot is 8 m. x 8 m. (Technical paper Durian, 2004). The system of growing durian trees could be laid out in the direction of north-south whereby the spacing of 8 m. x 8 m. required the total areas of growth for 64 square meters per 1 tree. Therefore, for growing durian trees in the 1-rai area, the rate could be used at 25 durian trees/rai (Center Estate Agent, 2018). Most farmers grew durian with other previously grown fruits (mangosteen, rambutan and southern langsat) or growing more fruits after newly grown durian reaching the age of 3-4 years. According to the principle for durian cultivation, the ground should be corrugated for the height of at least 50-100 centimeters (depending on costs) by taking into consideration water drainage and aeration mainly. Doing this makes durian trees less prone to get diseases. The soil becomes dry faster during the stage of the induction of flowering. The durian tree is stressed and then it slows its growth under stress, making flowering become faster, As a result, off-season production of durian can be made more easily because the structure of the tree is not a problem or an obstacle at all. The root is at the top with good aeration. Therefore, to manage the tree is easier. (Worakundumrongchai, 2017).

Notably, most farmers in areas in the East prefer to use this method of growing durian, namely piling up the soil, sitting on the platform or making the mound. Farmers can pile up the soil on the ground or use a small backhoe to scrape the ground in the plantation to pile the soil up. Using this is a disadvantage because the manage weeds are quite difficult from an uneven elevation of the area. Moreover, to lay out the water system requires more joints, having an effect on water pressure directly. The durian tree has a taproot system consisting of the taproot, subordinate root, lateral root, fibrous root, and radial root which penetrate the soil for nutrient absorption within the limited space. If the method of growing durian by piling up the soil is used, the root cannot spread very far. If flooding or storms occur, chances of losses will occur more than using the high-corrugation pattern of growing durian (Ruamsuk, 2018). It can control the durian trees by letting them grow naturally and pruning to control the height for 5-6 meters (Worakundamrongchai, 2017).

The climate of the area for durian cultivation is mostly tropical. Most areas are plains higher than the sea level and higher than 650 meters (Department of Agricultural Extention, Ministry of Agriculture and Cooperatives, 2018). The soil used for durian cultivation is sandy loam with high fertility and good water drainage.

From the interviewing result, it can be seen that the drought problem became more severe respectively from 2014-2016 whereby in 2016 farmers faced the problem at the most. These problems actually started from 2002 in (Worakundamrongchai, 2010), the pattern of climatic fluctuations having an effect on durian production in Chanthaburi. Most farmers have the way to cope with drought problems by drilling artesian wells to get underground water, drilling reserve ponds or enlarging existing ponds and 3 transferring water from public canals which government agencies have built to reserve ponds.

However, farmers did not calculate the amount of water required for durian trees. It needs the amount of water for 300 liters daily based on the calculation from Crop Coefficient, K_c, x Potential evapotranspiration of the plant, giving out values differently in each area and depending on seasons. Water requirement is annually about 850-900 liters/area approximately under the canopy for 1 square meter or 1,400 cubic meters/rai. For the 1-rai durian plantation, the water source should have the amount of water available for 600-800 cubic meters (Department of Agriculture Extension, Ministry of Agriculture and Cooperatives, 2018).

Most farmers face problems and obstacles in using water for agriculture such as water shortage, power failure, water amount, cleanliness of the water, water pumps, damaged water pump motors, oil prices and periods of daytime electric power transmission, water distribution with inappropriate pH values. The appropriate pH values of the water should be between 6.0-7.5 dS/m (Department of Agriculture Extension, Ministry of Agriculture and Cooperatives, 2018). Moreover, for climate conditions each year, farmers do not know the amount of water for the durian tree need and when they need it during the day. For slopes or highlands, high water pressure is required. Water pumps with large motors consume much electricity, requiring three- phases electric power. It is difficult to find electricians to handle this. The cost of installation is expensive. The water quality cannot be controlled because of using public water. Digging a pond did not follow the correct pattern according to the principle. The pond should have a square shape in order to lose the area at the edge of the pond. To prevent the pond from collapsing, it should have the slope at the rate of 1:1 (Nunthakij, 2018). While most farmers preferred to dig a pond with a shape of a rectangular with the a gradient of 45°C according to the appropriateness and their satisfaction.

Water supplies for sprinkler systems are used mostly for the water supply in durian plantations which Jiracheevee (2014) also report similar information. However, there are some farmers who use the method of drawing hoses and place them at the base of durian trees. In a week period for the irrigation system, most farmers supply durian trees with water 1-4 times up to every day at the extension stage of durian fruits. They apply water 3 times a week. Most farmers apply the water lasts for 30 minutes each time, followed by 60 minutes and 45 minutes each time depends on the weather and observing durian leaves. Farmers start giving water to durian trees at dawn to all day and water distribution is conducted by the weather and the objective of distribution such as fertilizer application and water application for newly grown durian. Also, the Department of Agriculture Extension (2018), the period of water application is when the stomata are open whereby in the morning water application can be started from 6.00-9.00 a.m. and in the evening from 4.00-7.00 p.m.

Farmers apply water to durian trees, starting from September up to May of the following year. The period of water application starts from January to harvesting followed by December to April and from May to harvesting. The beginning water application depends on weather, area conditions and the technique of inducing durian flowering. Most farmers manage water systems at the flowering stage until the period of harvesting productivity by applying water according to the flowering period, the productivity and supply water every week until the rainy season. Giving water to open up the flower bud, takes 1-2 hours. At the flowering stage, water distribution lasts 30-45 minutes. At the blooming stage, it is reduced to about 20-30 minutes. Until the fruiting period, water application is increased to about 45-60 minutes all the way up to the time of harvesting productivity. After harvesting, most farmers supply water normally, pruning for reducing water losses after giving yields and nourishing the trees with biological fertilizers. Between May to November or rainy season, after harvesting the productivity, water is not needed. Water supply starts again from November to December in order to stimulate the plant to open up flower buds. Farmers install water-dispensing pipes by having the sprinkler heads at the average height levels measured from the soil surface about 30-90 centimeters. The types of sprinklers which farmers currently use are mini sprinkler with rotary nozzles, rotators, and fixed spray heads.

The important problems arising from using sprinklers were the cause of the plants having Phythian Root Rot. This occurs especially at the durian plantation where durian trees are grown along the slope of the area. Durian trees with the disease caused by the fungus, *Phytophthora palmivora*, are found dead along the path of water flow. This fungus can be found in the soil depends on the environmental condition that is suitable in the rainy season or high humidity. It will attack the plant at the base, stem, branch, root, making the bark become rotten and causing the plant to have the blast disease (Sangchote, 2018). This disease eventually causes durian trees to die and also infect other nearby durian trees, rapidly. This problem can be solved by calculating the appropriate distance between the sprinkler heads, then the water will not reach the base of the durian tree. Another solution is using fixed spray heads instead and using covering materials such as plastic bags to cover around the base of the durian tree. They dispense water in every surrounding direction.

Most farmers do not know the property of water-dispensing rate of sprinkler heads, this also reported by Jiracheevee (2014). The farmers use the riser pipe of the sprinkler head with the size ¾". For the main pipe size, some use the main pipe with 2 inches. Most farmers use lateral pipes with a size of 2". Some use the following spacing between sub-main pipes of 8 meters. Some use the following spacing between sprinkler heads of 2 meters.

Most farmers manage the durian water application by distributing water for 60 minutes each time. They apply water starting from the water application period of 1 time, followed by 2 times and 3 times. When farmers apply water to the plant, they observe the conditions of durian leaves, the moisture of soil surface (also reported by Masri, 1999), and the weather at the durian plantation. They should use the tensiometer to measure the moisture of the soil appropriately for considering a durian water application. Most farmers use the size of the sucking pipe of the water pump of 3 inches. Some use the size of the distributing pipe of the water pump of 3 inches. Some face the problems with the water pump which is the clogging up of the sucking head due to dry leaf debris. This is because the installation of the foot valve was too low by installing it close to the bottom of the pond, making leaf debris and mud sucked in. The solution is to install the foot valve at the level suitable with the distance of water suction, blackout and electrical power brownout. This is because the farmers used electric motors to pump water for several plantations. Plantations at the starting point received full electric power while the endpoint received lower electric power. This made the electric motor become heated and burn easily. The solution is to install a voltage stabilizer. Other problems, lateral pipes, and sprinkler heads slip out during water application. This is due to the agricultural water filters, valves for draining pressure in water pipes that were not installed or important connecting points were not glued.

Problems that farmers face mostly in regard to water application, which happens often are as follows: Pipes slip out; Sprinklers do not dispense water or are clogged (Thungkorsakul, 2019). For the size of the pump, most farmers use the electric motor with 2 horsepowers up for the area with available electricity and they use the diesel or benzene engine for the area with no electricity or

highlands which are far away from water resources, requiring the engine with high power and continual pumping.

Most farmers cannot provide the dimension of cultivation plot (width and length). Also, the location of laying the main pipe, sub-main pipe, water resources, and distances between pipes have a lack of information. The farmers faced the problem of designing and installing the water system such as the difficulty of selecting the required water system, the selecting of pipe sizes and motor sizes or water pumps, including the technique of installing the water system, which general farmers have lack of this knowledge. They mostly learn all knowledge from the other farmers who have more experience.

Fig 10: Symptoms of rotten rot root disease. The base area has reddish-brown water. When dried, it is brown stains

Fig 11: Condition of the disease with the prevention of fossil diseases-aluminum (80% WP) 50 g per water 20 liters

Fig 12: One-way pinch orientation to supply the water out of the durian tree

6. Conclusion

In fact, agricultural irrigation systems are very important. If farmers lack knowledge about the irrigation system, agricultural costs will increase in terms of the investment of laying out the irrigation system or excessive water usage that is not compatible with the water requirement of the plant. For the suggestion of the concept for a water management system for agriculture in the future, it should be managed easily with the technology, which gives water economically and precisely so that farmers can know when to apply the water. There should be more reserve water resources. For the irrigation system, there should be aqueducts reaching every plantation. Labor force should be used at the maximum. Moreover, water should be managed sufficiently in order to cope with climatic changes in the future.

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