(Additional form 3)

Summary of Doctoral Dissertation

Name: Masato ODA

Title: Study of a Water-Saving Cultivation Method for Vegetables by Using Soil Moisture in Northeast Thailand

---

Vegetable production during the dry season by using water from farm ponds is recommended for improving the livelihood of farmers in Northeast Thailand. However, the quantity of water in farm ponds is low, and the amount of labor required for watering plants is high. In Japan, there is a farming technique for the production of high quality vegetables; using this technique, it is possible to grow tomatoes with one-hundredth the amount of water currently used. It is possible to improve the farmers' situation if this technique is found to be useful in Northeast Thailand. It was necessary to evaluate the applicability of this technique under drought conditions. We were unable to find any papers that described this cultivation method. Therefore, the applicability of this method under different circumstances was not clear.

In this study, we investigated the applicability of the water-saving cultivation method in an experimental field plot in Northeast Thailand. Second, we attempted to develop a practical method for vegetable cultivation through the participation of farmers. Next, we reconstructed the water balance changes in the field through simulations and determined the applicability of the cultivation method for different soil types. Finally, we monitored the soil moisture movement in the entire mini-watershed, determined the quantity of soil moisture, and analyzed the cause of soil moisture movement.

The summary of the results is as follows.

Chapter 1: Applicability of Japanese farmers' method in Northeast Thailand

Water-saving cultivation of tomato was conducted in the dry season in Northeast Thailand by using plastic mulch film (mulched plot) and without using plastic mulch film (unmulched plot). The conventionally cultivated plot was watered 3 times a week. The results were as follows.

1. At flowering time, the root systems of the unmulched plants extended deep into the soil, whereas those of the other plants exhibited a large root mass near the soil surface. The root zone area of the mulched plants was especially large. The differences in the root systems corresponded to the differences in soil moisture distribution. The soil moisture was distributed in the deep part of the soil in the unmulched plot, near the surface in the conventional plot, and widely spread under the mulch film in the mulched plot because of condensation of vapor.

2. The best plant growth was observed in the mulched plot, followed by that in the conventional and unmulched plots. The best yield observed in the mulched plot was similar to the average local yield. Some plants were dead but not because of water shortage. The differences in growth seem to be caused by shortage of nutrition.

3. Water-saving cultivation seems to be based on the soil moisture because the amount of water used was far larger than the total amount of irrigated water (750 mL per plant). Result no. 1 also supported this inference.

Chapter 2: Development of a water-saving cultivation method for vegetables through the participation of farmers

Farmers were shown a model of the water-saving cultivation method; this model consisted of a plastic much film, plastic water jar, drip irrigation tape, plant seedling, and watering with liquid fertilizer for 5 times. Subsequently, the farmers modified the materials, improved water management, and established practical techniques. The results were as follows.

1. The farmers achieved a local average yield with 10 mm of total watering by using rice straw mulch instead of plastic mulch.

2. It is almost obvious that the water-saving cultivation method is based on soil moisture. This is because tomato growth was uniform when the plants were sufficiently watered before transplantation. Water-saving cultivation was unsuccessful when the sandy soil layer of the field was thin. Not only tomatoes but also chili peppers were successfully cultivated using this method.

3. At an evaluation meeting, on the basis of the results mentioned above, the farmers concluded that water-saving cultivation is possible by using locally available materials.

Chapter 3: Evaluation of the applicability of water-saving cultivation of vegetables by using a soil moisture simulation

We determined the mechanisms involved in water-saving cultivation by using a soil moisture simulation. Further, we evaluated the applicability of this technique in other soil types in Northeast Thailand.

1. A large part of the soil moisture that is charged by rainfall in the rainy season is maintained through the dry season because of the effect of the dry sand layer in the sandy soil of Northeast Thailand.

2. The simulation could replicated the actual tendency of soil moisture movement during water-saving cultivation.

3. The water supply capacity of typical soil types in Northeast Thailand was larger in Roi-Et and Phimai than in Nam Phong (where the technique was developed) and Ubon. Therefore, water-saving cultivation can be used in a large area of Northeast Thailand.

Chapter 4: Soil moisture movement during the dry season in the sandy soil area of Northeast Thailand

The soil layer from the surface to a depth of 1 m was monitored in the dry season from 2005 to 2006 in 2 neighboring small watersheds in the Khon Kaen province of Northeast Thailand. The results were as follows.

1. A nominal decrease of 23 mm was observed in the soil moisture. This was much less than the potential evaporation of 324 mm during this period.

2. The effects of the topographical level of the watersheds on the decrease of soil moisture were not clear for both the talweg and cross line. However, the type of vegetation affected the soil moisture. The moisture level in December was 25 mm in forests, 79 mm in fallow uplands (weeds), 96 mm in cassava fields, 131 mm in sugarcane fields, 147 mm in fallow paddy fields (weeds), and 163 mm in after rice harvested (little vegetation) fields.

3. In December, the available water in the after-rice harvested (little vegetation) fields was estimated to be 141 mm. This amount of water can yield a maximum dry matter of 1.4 kg·m^{-2} in corn cultivation and 0.3~0.7 kg·m^{-2} in the cultivation of general crops.

On the basis of the results mentioned above, we developed a water-saving vegetable cultivation method that requires almost no irrigation. We determined that this method is based on soil moisture; therefore, no special equipments are required, and this method is widely suitable for farmers in northeast Thailand.