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Options for Smallholder Farms: Water Management Design Principles

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The Mound, Reservoir, and Paddy Model of Water Management

At the beginning of last year, Thailand experienced its most severe drought in twenty years. Only four years ago it also experienced its most severe flooding. Natural disasters are occurring with increasing frequency and severity; it is therefore vital to establish defenses against catastrophes like these. One such defence is redesigning areas based on the “mound, reservoir, and paddy” model of water management, which is one way of implementing a concept promoted by His Majesty King Bhumibol Adulyadej. This model is an efficient method of coping with water disasters, whether flooding or drought.

Five Factors to Know Before Designing Your Area

Designing a water management area well first requires gaining an understanding of the relationship between five important factors (represented here by five elements):

1. Fire (the direction of sunshine): Before designing an area, it should be surveyed to determine north, south, east, and west, as well as determining the path of the sun in each season. This will differ on exposure of the area and timing—for example, in the cold season, the nights are long and the days are short, and the sun rises in the southeast and sets in the southwest; in the hot season, the days are long and the nights are short, etc. If a survey is only made at one time, the results will be inaccurate.

2. Earth: The characteristics of the soil and its absorption capability must be understood in order to properly plan the digging of water reservoirs and making appropriate improvements. Methods must be used to rehabilitate the soil— instead of stripping the soil it should be covered with straw, leaves, or grass; it should be supplemented with both liquid and solid organic fertilizers.

3. Water: The direction of the flow of water both into and out of the area should be studied. The water reservoir should be placed in the direction of the warm wind, as this will also help make the house cooler. Reservoirs should be dug so that they wind and twist in order to increase the area that may be cultivated on their banks, as well as creating terraces within the reservoir. The first level of the reservoir should be shallow enough for the sun to reach to the bottom, to provide an ideal space for fish to lay eggs and to foster aquatic life. Aside from this, water plants should be grown to provide further space for egg-laying and habitat. A “fish sandwich” should also be created: stack grass or straw and compost in layers and place it at the water source. This will foster plankton and moina (small crustaceans), food sources for your aquatic life.

4. Air: Investigations should be made to determine which direction the hot wind, cold wind, and wind bringing rain, or monsoon wind, blows from. In general, the monsoon wind blows from the southwest, and the cold wind, or early rice wind, blows from the northeast. The house, rice-drying field, and ricethreshing field, therefore, should not be placed in the path of the cold wind. Aside from this, houses should be designed with ventilation openings in the direction of each season’s wind. This will help reduce energy use in the house, as well as keeping it cool and comfortable.

5. People: This may be considered the most important factor, as the design must principally consider the needs of the people who live there, taking into consideration usefulness, their culture, and what they do for a living.

Natural Water Reservoirs

An important principal of the mound, reservoir, and paddy model of water management is collecting and containing as much rainwater as possible, and keeping it in a natural condition.

Reservoirs

A good water storage reservoir should be dug so that it twists and turns, and has varying levels of depth. This is because if you dig a square hole for a reservoir, fish have no place to lay their eggs, as they like to lay them on terraces. The depth of your reservoir should match the quantity of rainfall in your area—this information should be available through a government office website, such as that of the National Statistical Office of Thailand.

(/resources/d496898c-e293-4f93-9d45-7c746b639783)
Reservoirs should twist and turn, and have different levels of depth so that fish can lay eggs.

(/resources/d68f472f-42aa-4bd2-a840-5339412b4b2b)
Soil dug up for reservoirs should be used to create mounds upon which a forest can be planted.

His Majesty the King Bhumibol Adulyadej has analyzed water in Thailand in great detail, and has discovered that in one year, there are about 300 days without rainfall. On days like this, when no rain falls, water will evaporate from a small reservoir at a rate of approximately one centimeter per day. In one year of 300 days without rain, therefore, three meters of water will be lost to evaporation. Small ponds or reservoirs must therefore be dug more than three meters deep, so that enough water is left over in seasons of drought or when the rain is slow to arrive. *[Eds.' Note: This is an average amount for small retention areas. Determining more precise evaporation rates of your water retention area requires further calculations. For a brief overview, see this civil engineering resource (http://theconstructor.org/water-resources/evaporation-and-its-measurement/4575/). For a more in depth understanding, please see this article at Science Direct (http://infoscience.epfl.ch/record/117489/files/tanny_al.pdf).]*

(/resources/a2f426e1-084f-451e-9f6c-6c9ad2eafee9)
Raise farm dikes at least a meter high, so that water can be stored within the paddy.

Mounds

Take the soil that was dug out for the reservoir and use it to build mounds. On these mounds you will be able to plant a "three kinds four benefits" forest, which refers to planting edible trees, useful trees, and trees that can be used for housing materials, all of which have the additional benefit of helping to provide cool shade and maintain moisture in the area.

When planting a forest on this raised earth, trees of five heights should be planted: tall trees, medium-sized trees, short trees, shrubs, and root or tuber plants, so that their roots may weave together at many levels. The roots of plants are able to absorb rainwater beneath the soil. In addition, vetiver should be planted to help store water and prevent the soil from falling apart.

Such a mound forest, in perfect condition, will store about 50% of rainfall beneath the soil, depending on the type of soil. These mounds should be located to the west, so that they help create shade in the afternoon.

Fields

Earthen dikes surrounding fields should be raised to a height of at least one meter, so that when rain falls onto the field it is able to collect water equal to the height, multiplied by the width and the length of these dikes (height x width x length). For example, an area of one rai, or 1,600 square meters, with a dike raised to the height of one meter, will be able to collect 1,600 cubic meters of water. At least 50% of this collected water will, however, gradually be absorbed into the soil, meaning that the water remaining above the soil will be one half of the amount of rain that fell, or 800 cubic meters *[Eds.' Note: This is a gerneralization; actual amounts lost will be dependent upon many variables]*. The water beneath the soil will not disappear, however—it will help create moisture and be preserved as groundwater.

Dikes should also be built with tops that are wide and large. Not only will they perform their function of containing water within the field like a dam, but the top of this dike can also be used to plant household vegetables, or fruit trees, and other perennials.

"Chicken Guts"

Canals "Chicken guts" canals should be dug so that they twist and turn around your land, in turn feeding water to the entire property without the costly installation of pipes or sprinklers. Moreover, you can plant fruit trees and vegetables all along these canals. Aside from this, settlement ponds should be dug at intervals along the length of these canals, also referred to as "coconut dessert

(/resources/e7450406-def1-436b-ac31-2183ad075fb5)
An area in the foothills: Dig “chicken guts” canals and water catchment holes to help slow the speed of the water.

wells” for water storage *[Eds.’ Note: This term “coconut dessert wells is explained above in the article about Ajarn Yak, to understand this metaphor further please refer to the image at this link (http://importfood.com/media/khanom_krok1.jpg)]*. These settlement ponds will help increase relative moisture in the vicinity, reducing the burden of constant watering.

(/resources/24f75733-39c9-4c52-934a-e1d17883cfd6)
Dig settlement ponds, spaced regularly, for water storage.

Storing Water in Other Forms

Apart from mounds, reservoirs, paddies, and chicken guts canals, all of which are methods of storing water in a natural condition, there remain other forms of possible water storage, such as:

• Large earthen jars, or buckets are appropriate for houses with a small amount of land, where it isn’t possible to dig holes, and which do not have their own rice fields. Just open their lids, place them outside beneath your roof, and connect them to your gutter so that water will run from the roof into your container. Alternatively, sheets of corrugated iron could be used for the same purpose. Or simply place buckets beneath the eaves of yourroof, which will collect the water running off it.

(/resources/54587ef9-c579-4370-8e44-4e29a8a6bb96)

• Water tanks are appropriate for storing water in areas with limited space, or in instances where water needs to be taken to a high elevation. Place the water tank at a high elevation and use a solar powered pump to bring the water up into the tank before releasing it down into the “chicken guts” canal. This will help save energy. Such a water tank can be built using local practices and materials; for example, by using woven bamboo for the structure and then plastering it, or by stacking circular concrete rings on top of each other and plastering them, etc.

• Check dams can be built in waterways or chicken guts canals, which help check the speed of the water flow and perform the function of catching sediment before it enters your reservoir. Farmers are then able to take the sediment and use it to create fertilizer.

(/resources/a5b32437-dd49-48e1-8ee3-24790196bb62)
Water tanks made of woven bamboo and plastered with concrete.

(/resources/46e7f25a-7438-4535-a28b-920ee8046b0e)
Check dams help slow the speed of water flow, as well as storing moisture and catching sediment.

(/resources/cc00ab66-d1dc-4128-82f4-34a33bf6e2bb)Large earthen jars and buckets, useful water-storage containers on small properties.

Method of Calculating Water

Quantities for an Area What a landowner must know in order to calculate the volume of rainfall their land will receive in a given year is the size of the area and the volume of rainfall. For these calculations, an area in meters should be used, as rainfall volumes are measured by a rate of millimeters per year. *Please note the following units of measurement referred to in this article:*

• 1 square wah = 4 square meters

• 400 square meters = 1 ngaan

• 4 ngaan = 1,600 square meters = 1 rai

Example rainfall calculation:

• Area: 1 rai = 1,600 square meters.

• Volume of rainfall in the area: 1,200 mm/ year, or 1.2 meters/year.

• Therefore, the yearly rainfall in this area = 1,600 square meters x 1,200 millimeters = 1,920 cubic meters.

When we know the volume of rainfall, we must then calculate the area required to store it—is what we have sufficient or not?

Example water storage calculation:

• Suppose that in one year, 1,920 cubic meters of rain falls on our land.

• In one year, there may be 300 days without rainfall, and on those days the water will evaporate at a rate of at least 1 centimeter per day. At least 3 meters of the rainwater collected will therefore evaporate in a given year. A reservoir must therefore be dug deeper than 3 meters.

• Water holding capacity of a water storage reservoir = width x length x height (depth).

• If a reservoir is 20 meters wide, 10 meters long, and 6 meters deep = 20 meters x 10 meters x 6 meters = 1,200 cubic meters.

• The earth that is removed to create the reservoir should be piled up to create a raised mound 20 meters wide, 10 meters long, and 6 meters high.

• Upon this mound shall be planted a “three kinds four benefits” forest, which will help store beneath the soil surface approximately 50% of the rainwater, or approximately 600 cubic meters.

If it is necessary to increase the amount of water collected, it is possible to do so in your rice paddies and to dig additional chicken guts canals throughout your property.

Example of calculating additional collection areas:

• Create a rice paddy 1 ngaan in size (400 square meters). Raise the earthen dikes surrounding the paddy to a height of 1 meter. 400 square meters x 1 meter = 400 cubic meters.

• Dig chicken guts canals 1 meter wide x 0.8 meters deep x 30 meters wide = 24 cubic meters.

• Together, the reservoir, mounds, paddies, and chicken guts canals (respectively) are 1,200 cubic meters + 600 cubic meters + 400 cubic meters + 24 cubic meters = 2,224 cubic meters.

Therefore, if land is designed based on this example, on an area of one rai it would be possible to collect 115.83% of rainfall. This water collection process can take place even when the dam gates are closed, simply by collecting additional water whenever it rains. *[Eds.' Note: These calculations are for demonstration only. Actual water retention/evapuration measures are dependent upon many variables (soil type, gradiant level, inflow/outflow, surface area: volume ratio of reservoirs, etc.) There are many good hydogeology books available where readers can learn more].]*

Water Management for Drought and Flooding Resiliency

Designing an area so that it can collect all the rainfall it receives using this mound, reservoir, and paddy model will help provide farmers with water when the rain does not come. At times when there is flooding, these mounds, reservoirs, paddies, and chicken guts canals will act like "coconut dessert wells" and help retain the water, stopping it from overflowing into the neighboring area, and reducing the amount that will ultimately flood into other places.

If we had people take the time to make just a hundred thousand of these "coconut dessert wells", it would use less than 10% of the entire land of the Pa Sak basin. But it would mean being able to mitigate flooding, stop drought. It's an example of how we really can solve this national crisis."

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