LINKAGE OF AQUACULTURE WITHIN WATERSHEDS AND CONCURRENT DESIGN OF HILLSIDE PONDS

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Abstract

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ABSTRACT

Hillsides in Latin America cover about one million square kilometers and provide livelihood for some 200 million people. Farming on the hillside has resulted in progressive deterioration of natural resources due to a combination of overgrazing, poor farming practices, deforestation, and poor water management. The introduction of tilapia production could improve the nutrition of farm families and local communities and provide a means of additional earning for improving economic status. However, improper pond designs and construction and maintenance methods can result in failed attempts to introduce tilapia. An important design aspect for the successful introduction of tilapia in Honduras and the adjoining regions is to have all stakeholders identify needs that include technical requirements as well as social and environmental issues important in the design of ponds and the production of tilapia.

The fundamental method of pond design is based on the principles of concurrent engineering design methodology. Our stakeholder list included Honduran farmers, extension agents, government agencies, nongovernmental organizations, builders, and design engineers. To insure that pond design meets the identified needs, specific measurable requirements for each need were listed and quantitative targets set.

The hillside pond was defined as a pond that is built on land slopes ranging from 2 to 15%. Two types of hillside ponds were considered in this study: 1) a watershed pond in which water availability is entirely dependent on rainfall in the watershed catchment area; and 2) a spring-fed pond in which water supply is entirely dependent on springs. Critical analysis of water balance considering water source, availability, distribution over time, and losses is important in the design of ponds. Thus, water balance models are being constructed for both pond types. For the watershed pond both runoff and evapotranspiration were modeled whereas for spring-fed ponds only the evapotranspiration and rate of water exchange were used for modeling.

Climate plays an important role in estimating water balance. Based on monthly average temperature and monthly rainfall, we selected six geographic locations distributed across Honduras. Selection was also based on number of years of available records for the candidate locations and on the results of in-depth analysis of rainfall to estimate water availability for watershed ponds. These locations are Comayagua, Choluteca, Santa Rosa, Catacamas, La Ceiba, and Sico. Rainfall data from these locations were used to estimate 90% probability distribution.

Thus, conditions for pond design are as follows:

a) Two pond types: watershed and spring-fed ponds.
b) Three pond sizes: small = 0.05 ha, medium = 0.05 to 0.5 ha, and large = 0.5 ha.
   The three sizes of pond were selected based on current farm sizes in Honduras and on meeting the needs at the following three levels: tilapia production for meeting needs of the farm family only, the farm family plus the immediate neighbors, and the farm family and the local market on a consistent basis.
c) Three slopes: low = 2 to 5%, medium = 5 to 10%, and high = 10 to 15%.
d) Three ground covers: forest, pasture, and mix of forest and pasture.
e) Selection of regions in Honduras based on adequate rainfall, appropriate slopes, and soil with greater than 20% clay content (to seal the pond).

To address diverse design needs of various communities, we have decided to identify modules in the design of ponds and develop concepts that will likely meet a range of anticipated conditions in Honduras. This approach will enable users to receive design information for a customized pond based on their own constraints and needs.

At this time we have selected nine conditions to provide the design for. They include a combination of three sizes of pond (small, medium, and large) and three levels of land slope (low, medium, and high), giving the nine alternatives. The following structural features will be included in the design recommendations: shape of pond, dimensions of pond, outlet pipe, spillway, diversion ditch, pond sealing, drainage outlet, construction methods, materials, cost, labor requirements, and maintenance.

In summary, we are using a design approach that concurrently considers the needs of all individuals and entities that can impact the construction, operation, and maintenance of a pond. Market considerations relevant to the pond design are also being considered. Furthermore, we are developing models for estimating the water balance to make a more informed decision when selecting pond size and type. Although many specifics of pond dimensions and design features have been reported earlier, this approach provides a means for the user to interactively input his/her needs and select a design for the conditions unique to his/her environment and constraints. Finally, concurrently considering needs of all "customers" in the design and selection of construction methods provides a powerful method to have users educated and invested in the design. This approach presents an increased possibility of introducing acceptable pond design and tilapia production as economic enterprises in Honduras and Central America.

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