The WISH pond: Potential for development of aquaculture in northeast Cambodia

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THE WISH POND: POTENTIAL FOR DEVELOPMENT OF AQUACULTURE IN NORTHEAST CAMBODIA

Authors

K. Kwasek, S. Chea, J. Tsatsaros, G. Johnstone and M. Phillips

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BACKGROUND

The Mekong River is one of the world's largest rivers, characterized by its high levels of fish biodiversity. The river contributes to food security in many of the developing countries it runs through, and there is little doubt that the construction of new dams will substantially impact the river's fish population and fisheries (Ferguson et al. 2011).

In Cambodia, fish provide a major source of animal protein for rural households. Capture fisheries have declined and aquaculture has been identified as playing an important role in food and nutritional security and rural income generation. Small-scale aquaculture is prevalent in many countries in Southeast Asia and has been championed by development institutions, governments and nongovernmental organizations (NGOs) for its potential to alleviate poverty, enhance food security, diversify livelihoods and promote economic development (Allison 2011). In Cambodia, aquaculture is one of the fastest-growing food production sectors, contributing approximately 10% of the country's total fish production. In 2011, the actual yield of six main production systems, representing nearly 100% of total aquaculture production in Cambodia, was estimated at 37,000 metric tons (Joffre et al. 2015).

In 2011, WorldFish, in partnership with the Stung Treng Fishery Administration Cantonment and the Culture and Environment Preservation Association, aimed at improving the uptake of small-scale aquaculture by communities with limited experience in fish culture in Stung Treng Province in northeast Cambodia. The system was given the name "WISH ponds," derived from the combination of the words "water" and "fish" to reflect the integration of fish cultivation with water for storage and vegetable growing (Johnstone et al. 2012). The project worked with 15 households and was initially designed to function through collectives like savings groups. It was targeted towards households with limited space to construct large aquaculture ponds, such as peri-urban households. The study focused on how research was used by the community to test and develop aquaculture ponds that meet the needs of households (and women in particular). It developed a learning platform to explore different techniques to improve small-scale aquaculture by understanding costs and benefits and identifying potential sustainable methods for introducing and adopting ponds (Johnstone et al. 2012).

Results from this 2011 study provided important insights into the challenges and constraints for introducing small-scale aquaculture into rural households in Cambodia. The study indicated that WISH ponds can create an important learning platform for communities to address challenges associated with small-scale aquaculture development by using scientific data generated and owned by the participants. The results indicated that more time and analysis were needed to fully assess the business case for investing in WISH pond systems for adoption and scaling out by farmers, as well as identifying appropriate supporting roles for investors, governments, NGOs and development agencies (Johnstone et al. 2012).

In mid-2013, WorldFish won a Feed the Future Partnering for Innovation grant, funded by the United States Agency for International Development, to build upon its successful engagement with communities in northeast Cambodia where WISH ponds had already been introduced and investigate scaling this technology to establish more WISH ponds in these communities. To increase the impact of the WISH pond system, complementary resources from WorldFish were used to expand the objectives of the initiative to focus on the following:

- improving and refining the technological know-how for a small number of villages in the project area to better understand core profitabilities of the WISH pond technology (at the household level) for long-term sustainability

- providing a gender balance and including understanding of whether the technology empowers target groups (i.e. can women successfully implement this form of fish farming?)
- improving our understanding of lessons learned and good practices while continuing to engage existing (and new) local partners
- supporting and strengthening the existing village enterprise networks to improve fish farming techniques, testing and sharing new technologies and ideas, and marketing and bringing new products to markets
- investigating the business dynamics for scaling potential by improving access of households to technical, financial and market services and assessing the ongoing profitability of the franchise.

WorldFish provided financial support to the Cambodian Rural Development Team to implement this phase of the project in collaboration with the Stung Treng Fisheries Administration Cantonment and the Culture and Environment Preservation Association.

WISH POND METHODOLOGY

Farmers living in Koh Khondin, Thmey, Kamphun and Banmai villages in Stung Treng Province volunteered to be involved in the 2013 research into WISH ponds (Figure 1). Farmers were selected for inclusion in the research based on several criteria:

- existing WISH pond farmers;
- women willing to manage household ponds;
- sufficient access to land on which to build ponds and grow vegetables;
- sufficient access to water supplies and nearby supplemental feeds (e.g. termites, red ants and snails);
- willingness of household members to adopt new technologies;
- ability to take care of the ponds (time and labor) while learning and sharing knowledge with others in the community;
- willingness to participate in data collection.

The timeframe for the research was January–June 2014 (cycle 1) and July–December 2014 (cycle 2).

Selected farmers were required to stock their ponds with a maximum of 800 fingerlings per pond, change their pond water at least once every 10 days, weigh the fish once per month, calculate daily feeding rates weekly, and observe and feed the fish on a daily basis. The research involved a total of 38 and 45 farmers in cycles 1 and 2, respectively. A gender balance was established at 52% (n=20) women and 48% (n=18) men farmers in cycle 1, and 48% (n=22) women and 52% (n=23) men farmers in cycle 2.

The WISH systems consisted of concrete tanks (3 meters x 4 meters x 1.2 meters), which were ultimately stocked with 928 ± 359 and 878 ± 503 (average ± standard deviation) fish per pond in cycles 1 and 2, respectively. Each pond was equipped with a water outlet to help drain it when necessary (important for water exchange, harvesting, etc.). Most of the ponds were covered with an ultraviolet-resistant plastic translucent shading frame to protect them from direct sunlight. A small light bulb was also installed above each pond to attract insects at night. African catfish (*Clarias gariepinus*) was chosen for this small and intensive culture system due to its known high resistance to poor water conditions (high temperature, high density, low oxygen, etc.). (See Figure 2.)

The project team designed daily data record books and distributed the books to the selected farmers. Farmers were asked to record data on the amount and type of fish feed used, water exchange, types of vegetables grown by using water from the fish ponds, the amount of vegetable consumption and sales by household, fish mortalities, the amount of fish consumed by farmers, and the amount of fish sold during each farming cycle. The project team provided initial training to the farmers on pond management and feeding techniques and how to record data into their books accurately.

The WISH pond project aimed to achieve economic benefits for rural smallholder farmers through a sustainable business model while facilitating increased income, food security and nutrition for households adopting the WISH pond technology. Enterprise and business development support networks, known as village enterprise networks, were intended to support smallholder adopters and the wider scaling of the WISH pond technology.

Figure 1. Target villages in the WISH pond project.

Figure 2. WISH pond system: ponds with shading (top left); plant cultivation (top right); ponds connected to a garden (bottom left); drainage outlet (bottom right).

Three business models were tested as a prelude to scaling this technology up as a commercial model:

- Model 1: Farmers work together with hatchery owners. Hatchery owners sell fingerlings and fish pellets to farmers at an agreed price. When farmers harvest their catfish, they sell fish to the hatchery owners at a fixed price.

- Model 2: Farmers work together with feed shop owners, fingerling importers and middlemen. These partners supply fish pellets and fingerlings to the farmers, and in turn, they purchase catfish from the farmers at an agreed price.

- Model 3: The loan interest is included as a variable cost on models 1 and 2 to determine how much a variable cost would be for model 3. As a result, profit levels for catfish raising (including interest on the loan) are included.

Key informant interviews were also employed in this study. These were qualitative in-depth interviews with informants within the community, which were intended to record similarities and/or differences among the households, particularly with respect to sources and prices of fish pellets and fingerlings, as well as the selling price of fish. The people who were interviewed included hatchery owners, fish pellet retailers and fingerling importers.

Photo Credit: Michal Wojno/WorldFish

WISH training workshop.

On average, farmers produced 70 ± 39 kilograms (kg; average ± standard deviation) of fish at harvest, from which 61 ± 40 kg was sold and 9 ± 6 kg was consumed by the households. The total cost of fingerlings, feed, water exchange, electricity and other costs in a cycle amounted to USD 132 ± 60, of which feed accounted for 54% of total costs. The average income from the fish sold was estimated as USD 102 ± 63. However, the total income, including value of the fish consumed, was higher: USD 120 ± 66 (Table 1).

WISH system management

During the WISH pond project, several concerns arose that impacted the overall outcome of both cycles.

Lack of data on fish growth

Most farmers did not record monthly weight and length measurements during either cycle and therefore were unable to calculate the amount of feed provided on a daily and weekly basis. This led to both overfeeding and underfeeding of the fish. Not taking measurements also eliminated an opportunity for farmers to evaluate the condition and actual numbers of fish in the ponds.

Lack of feeding rate calculations

Although some of the farmers kept records regarding the biomass weight of fish at harvest, mortalities and amount of feed provided to the fish (by cups or number of feed bags), none of the farmers calculated the feeding rates required for optimal growth, which often led

	Costs (USD)					
	Fingerlings	Feed	Pump	Electricity	Other	Total
Average	43	71	6	3	8	132
Standard deviation	21	42	10	4	11	60

Table 1. Summary of WISH pond expenses from cycles 1 and 2 (USD).

	Revenue			Fish		Vegetables	
	Income from fish sold	Value of fish consumed	Total income	Net income[1]	Actual cash net income[2]	Value of vegetables and crops consumed	Revenue from crops and vegetables sold
Average	102	18	120	-12	-30	11	54
Standard deviation	63	19	65	44	39	26	137

[1] Net income = Total income (including value of fish consumed)–Total production costs
[2] Actual cash net income = Income from sold fish–Total production costs

Table 2. Summary of farmers' income from fish culture and vegetable production (USD).

to overfeeding of the fish and waste of pellets. Most of the farmers did not weigh out the feed but used a condensed milk can or cup to provide it (7 cans of feed = approximately 1 kg).

Increased prevalence of fish diseases after bad weather conditions

Most instances of fish disease occurred after bad weather conditions (strong wind and heavy rains) caused significant drops in the temperature of the pond water. Most of the farmers, however, continued to feed the fish during bad weather and also after disease symptoms and outbreaks were observed, increasing the stress on the fish.

Increased fish mortality after handling

Farmers observed high fish mortalities after harvesting and transportation to the market, a result of feeding fish shortly before harvesting. Farmers also fed fish during water exchange and other activities that may have imposed stress on the fish. Some diseases occurred 2–3 days after stocking the fingerlings, indicating the possibility of inappropriate handling of the fish, as well as transfer of hatchery water to the pond.

Lack of basic knowledge on catfish farming

Although most of the farmers participated in the initial training, they still lacked basic knowledge on catfish farming. Farmers reported that they did not calculate the amount of pellets or sample the fish by weight because they were not familiar with appropriate methodologies. Moreover, many farmers were unable to recognize the overall benefit of the WISH pond concept (use of pond water for vegetable production), as not all the farmers had gardens.

A total of six and eight farmers gained profit from the WISH pond system in cycles 1 and 2, respectively. When the net income was calculated, including the value of consumed fish, the number of profitable households increased to 13 and 15, respectively. However, farmers who finished the first cycle still seemed unsure of catfish culture requirements.

Insufficient daily fish observation

The most outstanding farmers tended to observe their fish on a daily basis, particularly during the feeding. Those farmers paid particular attention to the feeding activity of the fish and stopped the feeding once the fish showed no interest in the feed, ultimately reducing pellet waste. The least performing farmers provided all the feed at once at every meal on a cup basis. These farmers also increased the amount of feed (number of cups), assuming this would significantly improve the weight gain of the fish, but without data or observation of the fish to support this assumption.

Poor water quality

Farmers exchanged the water in their ponds six times on average in both cycles. The water often had a strong odor, characteristic of poor water quality resulting from overfeeding and accumulation of fish metabolites. In addition, the water was opaque and hence the fish could not be seen. It was therefore difficult to determine the condition of the fish, the actual mortality, size distribution, signs of disease, etc.

Overstocking of fingerlings

Some of the farmers increased fingerling density from 800 to 1000–1100 per cycle with the belief that they would obtain better profits. The volume of the pond and infrequent water exchange, however, was insufficient for culturing fish at these increased densities.

Poor fish diet quality

Most farmers used one of three commercial diets available on the Stung Treng market. However, the feed was formulated for tilapia and other herbivorous or omnivorous species and was not optimal to fulfill the nutritional requirements of African catfish. The feed was often too old to be fed to the fish and inappropriately stored. In addition, the feed analysis performed by the International Livestock Research Institute revealed that it lacked several essential nutrients, indicating use of poor raw materials.

A total of 80% of farmers provided supplemental feeds in cycle 1, and 73% did so in cycle 2. The number decreased due to lack of time, particularly for collection of insects. The supplementary feeds included plant (rice bran, rice dust, rice porridge, water hyacinths and water lettuce) and animal (termites, red insects, earthworms, fish waste, snails, small fish such as *Rasbora aurotoenia* and insects attracted by the light bulb) sources. The supplemental feeds, however, were often inappropriately provided (i.e. feed not ground and not mixed with other sources for balance of various nutrients).

Infrequent water exchange also exacerbated the poor culture conditions in the ponds. Farmers that used insects or nutrient-dense kitchen waste (meat or fish waste) as supplementary feed for the catfish observed significant increases in fish production at harvest.

Incomplete mortality data
Farmers were not able to provide accurate numbers regarding fish mortality during the cycles. The mortalities recorded were based on fish floating on the surface of the tank, which did not provide enough information regarding the overall stock performance and welfare.

Inconsistent use of pond water for vegetable gardens
On average, farmers had one pond per household. A total of 19 and 32 farmers had their vegetable gardens established in cycles 1 and 2, respectively, with an average garden size of 124 square meters (m^2). The size range for gardens was extensive: 2–800 m^2 depending on the scope of the land owned and type of vegetables grown. A total of 73% of profitable households had vegetable gardens established as part of the WISH pond system in cycle 2, compared to only 46% in cycle 1. WISH home gardens usually produced morning glory, leek, lemongrass, chili, mint, lettuce, cabbage, cucumber, eggplant and fruit trees. The revenue from vegetables and crops sold varied due to differences in garden size and type of vegetables and crops produced and was estimated to be USD 54 ± 137 (average ± standard deviation).

Not all the farmers used the gardens efficiently in the WISH system. The water for the ponds was obtained from various sources, including the river, rainwater, wells and other sources. Pond water was to be exchanged on a daily basis with small volumes of fresh water. It was intended that farmers were to utilize the exchanged water for the plants in their gardens and then refill the volume used from the pond with fresh water. Using the pond water on a consistent basis would enhance utilization by the plants. Instead, farmers often waited until harvest or until diseases occurred and then drained the whole pond. Farmers often drained the water from the pond by using the lower drainage pipe. This led to high water flow through the garden and waste of water.

Lack of markets for farmed fish
Farmers often reported that people showed little interest in farmed catfish, making it difficult to sell. In addition, there exist a strong competition with the Vietnamese market, which sells the fish at a similar price and whose product is often more appealing to local villagers.

WISH and nutrition

Fish have been promoted as a nutritious food containing high-quality protein, essential fatty acids, and key micronutrients such as vitamin A, iron, calcium, zinc and iodine that can help combat protein and micronutrient deficiencies with better efficiency than nutritional supplements (Kawarazuka and Béné 2010). Resource-poor people in developing countries tend to depend on carbohydrate-based staple foods, including cereals and grains, for their nutritional intake. Therefore, consumption of animal-source foods, and fish in particular, has been encouraged to enhance nutrition, particularly among pregnant women and children (e.g. Ruel 2001).

Small-scale fisheries and aquaculture have been recognized as the main opportunities for improving household nutrition. Many studies indicate an increase in fish consumption in households that invest in pond-based aquaculture or in integrated agriculture-aquaculture systems (Prein and Ahmed 2000),

	Number of fish stocked	% survival	Number of fish at harvest	Fish sold (kg)	Fish consumed (kg)	Total weight at harvest (kg)	Amount of feed used (kg)
Average	903	89	799	61	9	70	87
Standard deviation	431	15	403	40	6	39	53

Table 3. Summary of WISH pond results from cycles 1 and 2.

often linking the improvement of dietary intake to increases in income (Nielsen et al. 2003; Leroy and Frongillo 2007). In the WISH pond project, 18% (7 out of 38) and 17% (8 out of 45) of farmers in cycles 1 and 2, respectively, were profitable based on actual income. However, when the value of consumed fish was included, the percentage of profitable farmers increased to 34% (13 out of 38) and 33% (15 out of 45) in cycles 1 and 2, respectively, indicating that the WISH system has potential not only to contribute to overall income, but also to increase fish consumption.

WISH and gender

Women with improved household income tend to allocate more of their income to food for themselves and their children, leading to improved nutritional outcomes for themselves and their children (Kawazaruka and Béné 2010). One of the major goals of the WISH pond system was to engage women farmers on the premise that their involvement in aquaculture improves economic, nutritional and social outcomes. Out of the farmers who gained net income in the first cycle, 38% (5 out of 13) were women. In cycle 2, the number increased to 60% (9 out of 15). A majority of these women, along with the men farmers, joined various training and capacity-building exercises. They were also encouraged to become committee members in local village enterprise networks.

WISH and business models

Catfish farmers were facilitated to form village enterprise networks to strengthen their catfish farming businesses by equipping the members with resources and giving farmers opportunities to receive small grants to buy fingerlings or pellets and/or invest in building or repairing a concrete tank. Three village enterprise networks were established in Kamphun, Banmai and Koh Khondin villages. The networks helped the farmers by

- providing opportunities to work together and share new knowledge, experience and information regarding farming and marketing practices;
- building strong relationships among the network members and giving them collective voice;
- receiving discounts on the price of fingerlings if buying from two local hatcheries;
- getting recognition and support from authorities and NGOs as a network;
- obtaining loans for network members to invest in catfish farming.

Every month, village enterprise network members met to share progress and challenges on fish culture. They also arranged schedules to harvest fish for sale to middlemen in Kamphon and Banmai, as farmers in these communities prefer to sell fish to middlemen in their villages. Koh Khondin village enterprise network committees helped farmers identify middlemen to buy their members' fish products. According to village enterprise networks' internal regulations, each member had to pay KHR 500 to support network operations.

Farmers who received new ponds were required to return 20% of construction costs (equal to USD 60) to the village enterprise network after 1 year for the sustainability of the network. Farmers who already had WISH ponds (previous to this project) received 800 fingerlings for their first cycle and paid KHR 30,000 (USD 7.5) to the village enterprise network after their first harvest. This money was mostly used for community loans, with some funds allocated to village enterprise network operations, management and marketing. Key stakeholders involved with the village enterprise networks included local authorities (village chiefs and commune counselors), hatchery owners, feed shop owners, middlemen, the Fishery Administration Cantonment and NGO staff.

Three business models were tested to determine the profitability of catfish farming. All the tested models indicated a loss based on each cycle's data. In Model 1, although the total cost dropped by 4.90%, revenue also decreased by 8.94% due to farmers' commitment to sell their fish at cheaper prices when they had a partnership with hatchery owners. Therefore, Model 1 had a 25.71% decrease in net profits compared to current practices.

Likewise, net profits in Model 2 decreased by 33.88% compared to common practice. If the farmers adopted business Model 2, they could reduce their total costs by 10.13%. However, on average they still faced a drop in revenue (15.94%) per tank since they were able to sell their catfish to their partners at only KHR 6000/kg, which is lower than the average price (KHR 7100/kg) of fish sold using common practice.

If farmers adopted Model 3, in which they received a loan from a microfinance institution to invest in their catfish farming, they lost an additional USD 15 per cycle due to loan interest.

If a comparison is made between the current (common) practice and the three business models, the current practice seems to be the most efficient. However, farmers would still benefit from being able to take out loans to invest in catfish farming if they produced fish feed on their own and increased vegetable yields. Building the farmers' capacity in fish feed production, providing them feed-making machines and encouraging them to plant more vegetables could increase their profit margin, which would allow Model 3 to be successfully adopted.

Photo Credit: Karolina Kwasek/WorldFish

One of the Stung Treng hatcheries.

WISH: IMPROVEMENTS IN FISH FARMING PRACTICE

The WISH pond project aimed to increase incomes. Although the WISH system has great potential for income generation, it needs to be tested in circumstances in which farmers follow the pond culture requirements and rules originally provided. The lack of previous experience in aquaculture by all farmers indicates that major improvements must be made to the process and more time is required for farmers to learn and gain confidence in aquaculture farming to avoid bias in the results. Hence, in March 2015, training was provided to 40 farmers on pond management and feeding techniques to improve their catfish culture understanding and awareness. The training included theoretical background, practical exercises and discussion to understand farmer concerns. The following action steps emerged from the training:

- Farmers were instructed to sample at least 30 fish from three different spots in the pond on a regular basis (every 2 weeks). This allows farmers to obtain data on fish weights, screen the fish for potential diseases, evaluate size distribution of fish in the pond, and most importantly, more accurately estimate the feeding rates. Farmers were also presented with and trained on easy techniques for such sampling.

- The feeding rate equations were too complicated for farmers to easily understand, and hence 25% of the training time was dedicated to ensuring an understanding of this critical part of catfish culture.

- Since it seemed easier for the farmers to estimate the amount of feed using a can (cup) as a portion size, the feeding guidelines were adjusted based on the number of cups or volume of one cup to facilitate better feeding practices. In addition, farmers were requested to record the number of meals and the amount of pellets per meal on a daily basis. Amounts using number of cups were easier to record.

- Farmers were provided with basic, fixed feeding rates that could be adjusted according to fish feeding activity in the pond. In this way, fish observation as part of catfish culture was enforced. Observation during feeding allows farmers to evaluate how much feed must be provided based on fish appetite (i.e. continue feeding if fish seem very active in taking up the feed, and stop feeding once fish show no more interest in the feed).

- Since the water quality deteriorates easily in the pond, particularly when higher amounts of feed are used, farmers were instructed to limit the stocking density to 800 fingerlings in a pond. In fact, it was recommended to decrease the density to 500–600 fingerlings in a pond to ensure better survival and growth conditions, particularly if the water could not be exchanged more than two times per month during a cycle (Edward et al. 2010).

- Some of the farmers had animal kitchen waste that could be used as supplementary feed for catfish to reduce the use of pellet. For example, some farmers were fishers and had access to fish waste that could be efficiently utilized as a protein source for catfish. Farmers were provided with detailed guidelines on how to prepare such feeds using easily available and cost-efficient ingredients from the household, how to preserve such feed, and how to store it for more frequent use.

- Farmers were encouraged to cease feeding whenever any stress was imposed on fish or when signs of disease were observed. Farmers were recommended to stop feeding or limit feeding to every other day when a disease outbreak occurred in the pond (Lovell 1998; Sealey et al. 1998).

- Farmers were advised to use more effective methods for water provision in their gardens, either by using simplified irrigation systems (bamboo channels or leaky hoses attached to the drainage pipe to provide pond water at a small flow rate to the plants) or by simply using buckets if the garden was not too large. The farmers were advised that water should also be provided on a more consistent basis to enhance plant growth.
- In order to enhance the quality and palatability of fish flesh, it was recommended to cease feeding the fish for 24–48 hours prior to harvesting (Tidwell et al. 1992). This fasting was also recommended to reduce the stress on the fish during harvesting and transport. Exchanging the water in ponds 24–72 hours prior to harvesting was also suggested to improve the flavor of the flesh for consumers and could be applied if farmers could afford additional water-pumping costs.


Photo Credit: Sylyvann Borei/WorldFish

A woman feeds her catfish in Stung Treng, Cambodia.

CONCLUSIONS

Farmers' lack of basic knowledge regarding aquaculture and pond management contributed to lower-than-expected results from the WISH pond project. Farmers need more practice to become familiar with the requirements for fish feeding, feed handling and water management to ensure the end product (fish market size, overall fish biomass at harvest and vegetable production) becomes profitable. Fish feed costs constituted a minimum of 50% of total fish production costs in WISH ponds; it is therefore imperative to ensure minimal waste of the formulated feed. The use of floating pellets was advantageous, as it allowed farmers to monitor the amount of feed consumed by fish. However, the pellets were often provided during disease outbreaks or when other stress factors were affecting fish. In addition, pellets frequently remained on the surface of the water long after meal provision, leading to significant waste and ultimately increasing production costs. Fish observation was therefore encouraged as part of the culture requirements to facilitate decisions regarding amounts of feed used and assessment of fish welfare.

Nevertheless, when the profit from fish consumed by the most successful households was included in the total profit, a result of 33.5% of farmers with benefits was achieved suggesting that the income potential could significantly improve if the farmers followed appropriate WISH management practices.

Due to declines in wild fish stocks, aquaculture will need to contribute to domestic fish supplies. Equitable access to inexpensive low-risk aquaculture technologies and markets has potential to contribute to poverty alleviation in developing countries such as Cambodia (van Brakel and Ross 2011). Njagi et al. (2013) investigated factors affecting the profitability of fish farming in Tigania East District in Kenya and found a strong association between training of fish farmers and aquaculture growth, indicating that more elaborate training programs on pond management and aquaculture technology should be developed to enhance potential benefits. Moreover, the Kenyan study found that farmers who were frequently visited by extension service providers were more aware of fish pond management techniques, which improved their farming returns.

WISH farmers were provided with additional support and training, during which information regarding fish farming and vegetable gardening was delivered using simple approaches (visuals, pictures, schemes, practical exercises, etc.). This was particularly important since not all farmers understood the overall benefit of WISH ponds. Farmers were encouraged to construct and/or expand their gardens and use water from the pond for maintenance. In addition, farmers were trained on how the pond water, which is rich in nutrients, could be utilized by plants in the garden to minimize overall waste (e.g. overfeeding) and to enhance production of the WISH cycle. Farmers were encouraged to keep records and calculate feeding rates. Moreover, the most successful farmers were encouraged to provide support and advice to other farmers, particularly through the village enterprise networks, for a better transfer of knowledge.

Fish farming is a process that can become ineffective due to poor extension services, marketing problems, influence of cultural backgrounds and/or poor pond management practices. The WISH pond project is an opportunity for many households in rural Cambodia to expand their farming understanding and expertise, which could eventually lead to well-established and profitable enterprises. Therefore, to evaluate the benefits of the project, additional cycles need to be completed by farmers. The initial two cycles should be considered time for farmers to learn and gain farming and gardening confidence. Additional cycles should be assessed in order to produce more data for accurate insight into the project's potential and to allow precise estimation of WISH system production gains and losses.

An important outcome of the WISH pond project was improved gender balance, which potentially contributes to increases in household income and family nutrition. Women's involvement in developing aquaculture provides them with an opportunity to contribute to the household income, which they tend to spend on family needs, such as food and education. It is well known that the role of women in aquaculture has not been fully recognized, although they have been involved in small-scale aquaculture in various stages of operation: fertilization, stocking and harvesting, fish feeding, pond management, and marketing. Participation of women in the WISH pond project should be further encouraged. According to Shirajee et al. (2010), a positive relationship exists between training received by women and increased farming performance. This suggests that WISH ponds can have a greater impact in the future if certain aspects, such as appropriate training and involvement of women, could be improved along the way.

The Aquaculture Development Plan of Cambodia (2000–2020), produced by the National Fishery Administration, aims to expand aquaculture production to at least 300,000 metric tons of fish per annum by 2020 to maintain the annual per capita consumption level of 30 kg (Joffre et al. 2010). To meet this demand, a significant increase in total aquaculture production is needed. This will require different implementation strategies across the sector to target both small- and large-scale aquaculture development (Johnstone et al. 2012).

Aquaculture, however, can be a challenging activity. Lack of access to external support, including private sector and/or extension services and knowledge sharing and cooperation within the community; high initial costs; lack of technical knowledge; and poor market access were identified as constraints to sufficient aquaculture development (Joffre and de Silva 2015). The WISH system is adjacent to the house, eliminating the need for mobility for women who may normally be restricted to the house. This placement serves as an opportunity that can contribute to the economy and nutrition, particularly in villages that currently depend profoundly on a declining fishery during the dry season. If farmers are able to obtain sufficient water for their ponds (following one of the WISH principles of sufficient access to water supplies), the increasing market price of fish later in the dry season will provide a significantly increased return for WISH pond fish. The WISH system should be further evaluated, possibly through a scale-out involving more households in other target areas. A focus on improved technical and business management practices, nutrition, and empowerment of women will allow it to serve as an example of a well-established enterprise that can contribute to further expansion of the aquaculture industry in northeast Cambodia.


Photo Credit: Michal Wojno/WorldFish

WISH ponds connected with a vegetable garden.

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Contact Details:
WorldFish, PO Box 500 GPO,
10670 Penang, MALAYSIA
www.worldfishcenter.org

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