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Research Paper

The Role of Gender in the Development and Adoption of Small-Scale Aquaculture: Case Study from Northeast Cambodia

CHEA SEILA[1*], KWASEK, K.[2], TSATSAROS, J.[1] and JOHNSTONE M. G[3]

[1]WorldFish, # 35, Street 71 (Corner of Mao Tse Tong Blvd.), Sangkat Boeung Keng Kang 1, Khan Chamkar Morn, Phnom Penh, Cambodia
[2]WorldFish, Jalan Batu Maung, Batu Maung, 11960 Bayan Lepas, Penang, Malaysia
[3]WorldFish, Department of Fisheries, West Gyogone, Bayint Naung Road, Insein Township, Yangon 11181, Myanmar

Abstract

In Stung Treng Province north-east Cambodia, WorldFish in partnership with the Fisheries Administration (FiA) and the non-government organisation, Culture and Environment Preservation Association (CEPA), used community science to improve the uptake of small-scale aquaculture (SSA) by communities with limited space and experience of fish culture. The project was funded by the Wetlands Alliance Program and the SSA system, called "WISH-Ponds" that combines the words "Water and Fish" to reflect the integration of water and fish cultivation with water for storage and vegetable growing. WISH used participatory action research to establish a system of transformative learning in peri-urban households in northeast Cambodia, to assess and evaluate the costs and benefits of establishing SSA in the community. The WISH-Pond system has also been designed to promote the role of gender within the process of SSA development. This paper describes the WISH-Pond system and how research has been used by the community to test and develop aquaculture ponds that meet the needs of households, women in particular. This paper explores the role of gender in community science and in the development and adoption of SSA systems as an alternative livelihoods and contributions to improving management of wetland resources.

* Corresponding author. Email address: seilacsloct@gmail.com

Introduction

In Cambodia, aquaculture is one of the fastest growing food production sectors and contributes one sixth of the country's total fish production of 745,065 tonnes (FAO 2015). The Aquaculture Development Plan of Cambodia (2000-2020), produced by the National Fishery Administration (FiA), aims to expand aquaculture production to at least 300,000 tonnes of fish per annum by 2020 to maintain an annual per capita consumption level of 30 kg (Joffre et al. 2010). However, to meet this demand, a significant increase in total aquaculture production is needed. Ultimately, this will require different implementation strategies across the sector that target both small and large-scale aquaculture developments.

The aquaculture sector is often considered a male domain due to the intensity of the system and the way it depends on the adoption of new technology and techniques. However, rural women's involvements in aquaculture activities are important for several reasons including improving family nutrition and household income. In the floodplain of the Tonle Sap system, women's participation in fisheries ranges from approximately 50% in fish culture activities and 85% in marketing (ADB 2007).

Extensive homestead pond culture is the most common aquaculture system, promoted primarily for improving food security of rural poor households as they require limited resources such as land, labor and inputs. The promotion of aquaculture as a development strategy for women has been partially based on the perception that it could be an extension of women's domestic tasks, integrating with other housework such as childcare, home gardening and household chores (Brugere et al. 2001). The WISH-Pond system aims to empower women as a critical element to promote food security and income generation in peri-urban households through the adoption of new technologies and techniques. The empowerment perspective focus on gender relations reported by Economic and Social Commission for Asia and the Pacific (Brugere et al. 2001) focuses on changing the balance of power in households. Hence, the challenge for women's empowerment comes not so much from reversing existing power hierarchies in a society but rather empowering women to make their own choices, to increase their own sense of self-reliance and to identify with their own inner creativity and set of values. The goal of the

empowerment perspective is therefore to challenge and change existing gender relations. An important step in this process is to better understand respective gender roles in the households. The WISH-Pond project has been piloted in northeast Cambodia and implemented by a mix of different approaches including field visits by technical experts, group meetings with farmers, village training sessions, field monitoring and coaching of farmers to explore progress, challenges and solutions in testing the WISH technology and making sure both men and women farmers have equal opportunity to access the knowledge and information of small scale aquaculture.

This paper describes a process by which community science was used to help peri-urban households to test WISH-Ponds as a potential new SSA technology. It also provides a gender assessment of the different roles and tasks of men and women in households to test small scale catfish culture production: pond preparation, pond management techniques, supplementary feeding, best management practices, harvesting and marketing of fish products. This paper tries to answer the main research question: how does the WISH technology benefit men and women, and how does this technology empower women in promoting food security and income generation in their households.

Gender and the WISH-Pond system

Gender is socially defined as the relationship between men and women, not related to biological characteristics. Gender refers to socially-determined ideas, practices and attributes of men and women, including female and male roles. Gender relationships and patterns show differences in division of labour, access and control over the production of resources compared to accruing benefits as well as decision-making on developmental matters and skills, particularly in science and technology (Kingiri 2010).

ESCAP 2014 recognised that women continue to take primary responsibility for unpaid work, particularly domestic and caregiving work, and comprise the majority of temporary, low-paid and low-skilled jobs. In promoting women's economic empowerment, agencies need to strengthen efforts to achieve equal employment opportunities, to support women entrepreneurs, to support work-life balance and to address restrictive gender stereotypes, and strengthen efforts to achieve equal employment opportunities

that enable women to realise their full potential and to achieve their career and family aspirations. In advancing gender equality and women's empowerment, improving women and girls' participation in education as well as formal and informal trainings is associated with their economic empowerment, food security and poverty reduction. Therefore, to design and implement the WISH-Pond project, cultural norms and gender issues in the target community have been explored and investigated.

In the past, traditional and cultural norms of rural communities in Cambodia have constrained villagers, especially women, from adopting new technologies. In this paper, WISH technology is defined as practices or techniques, know-how and skills that are used to enhance productivity and save or reduce inputs costs such as labour or energy. Before 2010, villagers in Stung Treng, northeast Cambodia, were not interested in growing fish in their backyards. Villagers thought that fish lived in rivers and many fish were abundant, so why would they want to raise fish? Growing fish on land sites (plastic, cement tanks or earth ponds), might face a curse from god, like thunder, to the pond or to humans, according to Mrs. Song Chandai, a farmer in Kamphon Village. In the past, villagers kept young girls working at home. They did not want girls to go on to higher education. Therefore, for several reasons, a majority of girls in the communities dropped out after finishing primary school. Girls had to look after young sisters or brothers while their parents were busy with their livelihoods. When the girls grew up, they were married and took care of husbands, children and household chores. This leads to passive female participation and a lack of empowerment in a number of jobs.

Community science and the WISH-Pond system

Two models of research can be applied to generate knowledge and data to better understand the contribution of SSA to communities in Cambodia. The first is empirically-based research carried out by researchers who identify a problem and develop questions and methods to generate data independent of those who are being studied (German and Stroud 2006). The aim of this research is to make conclusive statements about a problem or issues of interest. The target audience of research under this model is the managed primary decision maker outside of the physical area of study. The research results are used to guide decisions in applying policy or an intervention. By contrast, the

second research model actively seeks to engage people who are being researched in the research process itself by working with them to identify research questions, design studies, collect and analyse data and apply results. In this paper, the term community science is used to describe this second process.

While empirical research is typically non-participatory, community science engages people in the research process. In the context of development and changes that occur within communities, the notion of community science can be conceived as research in development (R in D). This is research and research methods that function as learning processes that link and operationalise research for development (German and Stroud 2006). In practice this research represents a series of participatory methods and techniques that bridge the gap between research and development and engages people to learn about their environment and the changes that occur in its development (Ibid).

Similar to empirical research, community science identifies problems and employs various participatory methodologies to generate knowledge and learning. The knowledge obtained in this process is not used to prove or falsify hypotheses but rather to help construct a better understanding of reality, to reduce risks about the subject of enquiry and to predict with more certainty future outcomes.

The participatory research approaches and methods used in community science are part of a spectrum of science emanating from empirical research, through action research (AR) and moving towards participatory action-learning (PAL) (Table 1). The WISH Pond research is at the end of the research process where research is carried out by the community for the community applying PAL approaches. These approaches adopted for the introduction of the WISH Pond aimed to build research capacity and confidence within the community to design questions, indicators and key learning from adopted WISH technology (Johnstone et al. 2012). Throughout, the project team wears a gender lens to investigate gender relationships and roles in implementing the WISH-Pond technology.

Table 1. Typology of community science methodologies (adapted from German & Stroud, 2006)

Method	Who defines research / data characteristics	Research outputs
Participatory Action Learning	• Community involved in defining research • Lessons integrated in change process (transformative learning) • Data capture informal	• Approaches that 'work' relative to development goals / change process defined by beneficiaries • Applied to guide a change process
Action Research	• Research defined by community and off-site result users • Data capture relatively fixed but able to interpret emergent realities	• Generates general principles about development / change process • To help guide the development / change process
Traditional Empirical Research	• Research defined by decision makers, development agencies, resource users, policy makers • Data capture systematic	• Conclusive statements about subject of enquiry • Applied to guide decision-making

Main Objectives

The objectives of this paper were: (1) to explain a process of how to engage farmers (men and women) in designing and developing the WISH-Pond project and how the WISH technology benefits community households, women in particular and (2) Better understand the roles of male and female farmers and the distribution of benefits in households that participate in the WISH-Pond system.

Materials and Methods

Development of the WISH-Ponds

Initially, fifteen households from one village, Kamphon, in Stung Treng Province were engaged in this 2011 study and partnership with the government of Cambodia' Stung Treng Fisheries Administration Cantonment (FiAC) and NGO Culture and Environment Preservation Association (CEPA). Both these partners have been supporting SSA in Stung Treng Province in north eastern Cambodia since 2009 and have been funded as part of the Wetlands Alliance Program (WAP). The WISH-Ponds are much smaller than the extensive fish ponds

normally supported by development projects with pond size varying between 8 and 20 m².

The WISH-Ponds have been targeted at rural and peri-urban households that do not have access to or ownership of large areas of land but want to increase their water storage capacity and produce fish for household consumption and sale. The ponds can support a more intensive production system and are stocked using African catfish *Clarias gariepinus* (Burchell, 1822) (600 per pond), because this species can live in poor quality water conditions and fingerlings are available from local hatcheries (Kwasek et al. 2015).

The village of Kamphon was used for this case study; it is located on the Sesan River. The village has 494 households and a population of 1,702 people (Commune Data Base 2010). The livelihood of the community is dependent mainly upon agriculture, animal raising, construction work, petty business and fishing. However, since the construction of the Yali Dam in Vietnam in 1993, livelihoods have been impacted through changes in water levels that have caused losses in habitat to the flooded forest and deep-pools. This has reduced wild-fish catches and consequently the availability of fish protein that constitutes up to 85% of the total protein intake of Cambodians (IFReDI 2012).

Results

WISH-Pond farmers were selected through discussion and negotiation with the Kamphon Village Community Savings Groups (KCSG).The KCSG was established in 2009 and had 27 members.

Historically, women farmers usually had limited access to extension services for development projects as men were often the people called in for training and meetings on new technology or management practices. There was also a perception that if extension services were given to a member of the family, the knowledge will pass on to other household members, including female members. However, men do not transfer extension knowledge to them. To benefit all family members, particularly women and children, the WISH project was designed to supply equitable and inclusive women's access to new technology and training through different scales of transfer of knowledge at village level and household level. Through field monitoring and coaching,

project staff went to farmers' doors to check on daily records. To better understand the costs and benefits of the WISH-Pond, target farmers were asked to complete a daily data record. Since many can't read and write, they used a picture-based monitoring sheet. The data included financial costs, time spent on different tasks and gender roles to assess the division of labour between men and women in different activities.

Fig.1. The different WISH-Pond designs and systems in Stung Treng Province, NE Cambodia (left to right): concrete tank, plastic pond, plastic pond in timber frame.

A total of 10 households, including seven female farmer-headed-households, agreed to take loans through the KCSG. These were selected using criteria developed by the saving group, which included families dependent on fishing for home fish consumption and for sales, and female headed households with children. Out of these households, four constructed cement ponds and six plastic lined ponds. A further five households that had existing plastic ponds also agreed to participate in the research monitoring system.

After selection, all farmers went through a number of capacity building sessions including basic small scale aquaculture and best management practices, and how to complete daily records. FiAC and CEPA worked together and engaged in the research process by providing technical support and assessing the quality of data collected by fish producers. By involving the community and local partners in research within the study, the aim was to provide a more

sustainable basis for the adoption of SSA. The responsibilities for the construction of the ponds were designated in each household and the data fields for monitoring identified and agreed during discussions and training with the KCSG (Table 2).

Gender assessment of households involved in WISH-Ponds

The WISH-Pond system aims to empower women as this is a critical element in the promotion of food security and income generation in a household. Following the introduction of WISH-Ponds by each household a gender assessment was carried out to assess the division of labour and other benefits between men and women at the household level.

Table 2. Data fields collected during the production cycle

Data fields		Details
Construction	• Labour • Materials	• Time (hours) multiplied by average labour cost (USD) • Cost of cement, wood, plastic lining (USD)
Feeds	• Pellets	• Quantity of pellets purchased and used (USD kg^{-1})
	• Natural feeds *(termites, red ants, snail, frogs, worm)*	• Time (hours) spent collecting termites multiplied by average labour cost (USD) • Number of kg (cups) of termites used per day
	• Agriculture feeds *(rice, rice bran)*	• Cost of product (USD) multiplied by cooking time costs
Fish health	• Deaths	• Number of fish deaths per cycle
	• Water change	• Time, quantity and cost of water changes
Harvesting	• Feed conversion ratio	• Kg of feed that produces one kg of fish • Kg of fish produced in total
	• Consumption	• Kg consumed by household
	• Selling	• Kg sold • Market value (USD) of fish sold

Due to gender norms and levels of education, most technologies or a technology that became commercially profitable were taken up by male members of the household, thus restricting women's activities. But the WISH-Pond technology was introduced through consultation with target farmers on how pond design and technology could be easily taken up by both men and women and could benefit all. For example, as both male and female farmers found difficulty calculating feed ratios, they agreed on a type of basic measure,

such as a used condensed milk can, to measure feed for feeding their fish (Kwasek et al. 2015).

Women and men farmers undertook different activities during the development and adoption of WISH-Ponds. Data on gender and activities indicate that men were mainly involved in construction, changing water and pumping of water for harvest, otherwise the majority of WISH-Pond activities were carried out by women including making supplementary feed, feeding, harvesting and marketing.

Decision making in households was mainly done by men because they were household heads and the main providers of incomes, women-headed households being the exception. For SSA pond adoption was presented as a joint decision between men and women. Most women and/or children attended the WISH-Pond training and also were members of the savings group that decided when to take more credit and repay loans.

Table 3. Role of men and women in the development and adoption of WISH-Ponds

Activities	Men	Women
Decision making	- Most male headed households have control over decision making in the family and on adopting SSA	- Most of the women do not make decisions alone for developing and adopting SSA and need to discuss this with their husbands
Capacity building	- Men do not participate in capacity building and spend time on other activities or wage labour away from village	- Women participate in technical training and share results or challenges among the team
Pond construction	- Main physical activity carried out by the man; involves digging ponds; - Cement pond is normally prepared through hired labour	- Supporting men by piling up dirt, preparing plastic
Access to credit	- Participation of men in savings group is limited	- Women participate in savings group, and access credit for buying new plastic, new fingerlings or feed
Making Fertilizer	- Men not engaged in this activity	- Women and children responsible for collecting cow dung and herbs to make fertilizer at the start of raising fish.
Access to feed	- Men spend between 1 to 4 hours looking for natural feeds such as termites one or two times per week. - Men drive motorbikes or travel with a neighbour's truck to the	- Women spend up to 2 hours every day looking for natural feed around home or in rice fields. - If money is available they buy pellets for fish but the market is about 15 km from the village and

	forest and come back with a few bags of termite.	transport is expensive
Feeding fish	- Men make lights to attract insects at night for fish. - Sometimes men spend time feeding fish while women are busy	- If pond is nearby home, women will manage and feed fish. - Sometimes their children or old people help while they are in the rice field.
Maintenances / changing water	- Most men are responsible for draining and changing water by a pump machine	- Women collect water from ponds every day and for watering home gardens
Fish disease	- Some male farmers are late to report to their group or experts on abnormalities in their fish, such as fingerlings gasping at the surface of the pond. After some fish die, they call for help.	- When fish get diseased, women try to look for help from their group and sometimes from experts. They try to test different ways of tackling the disease
Harvesting fish	- Men pump water and help their wives transport fish for sale - Sometimes men collect a small amount of fish to eat with their friends during leisure - Men help wives and children in draining water and sometimes catch fish with cast nets	- Daily harvesting - women decide to harvest and also collect a few fish each day for cooking or processing
Marketing fish	- Men not involved in marketing or selling of fish	- Women collect fish to sell to their neighbours and relatives - Women look for a fair price for selling fish and some act as middle (wo)men to transport fish products to consumers - Money from selling fish is managed by wives to spend on daily food, buying new fingerlings or paying back credit loan
Record daily data	- Men do not note down data every day	- Most women are illiterate and have problems reading and writing - To complete the forms, they ask their children or husbands to record the daily data - Women spend their free time discussing results with their team when recording data

Only 13 households (eleven female farmers) provided daily data over the 3-month period (90 day growth cycle, Table 4).

Each pond used the same number of fingerlings (600 fingerlings). Households used three kinds of feed that included: fish-feed pellets, natural

feeds such as insects, termites, worms, snails, frogs and red ants that were collected everyday by women farmers nearby their houses and from the rice fields and river bank, while men sometimes went to the forest for hunting and logging and gathering termites. Lastly, agriculture products of rice-feed prepared for pigs were mixed together with rice barn or broken rice. The cost of the feeds was estimated at USD 40 per cycle, mainly derived from the cost of pellets with half the feed coming from natural feeds. From the gender data it appears that collecting and preparing feed is primarily a women's activity as they forage for natural feeds every day whilst men spend only one or two days per week looking for feed.

Table4. Summary of the data presented as an average per household for the 90-day production cycle

Data fields	**Average per household (n= 13)**		**Results**
Construction	• Labour	• Cost of an SSA pond (3x4m)	USD 158
	• Material cost	• Cost of cement pond	USD 295 (n=4)
		• Cost of plastic above ground pond	USD 89 (n=3)
		• Cost of a plastic below ground pond	USD 57 (n=3)
Feeds	• Pellets	• Percentage of pellet feeds used per cycle	40% (29 kg)
		• Total cost of pellet feed per production cycle	USD 32.68
	• Natural feeds	• Percentage of natural feeds used per cycle	49% (35 kg)
		• Total cost of natural feed per production cycle	USD 5.70
	• Agriculture feeds	• Percentage of agricultural feeds used per cycle	11% (7 kg)
		• Total cost of agricultural feed per production cycle	USD 1.68
	• All feeds	• Total cost of all feed types per production cycle	USD 39.02
		• Cost of all feed types per day	USD 0.43
Fish health	• Deaths	• Number of fish deaths per cycle	37/ 600
		• Percentage of deaths per pond	6%
Harvesting	• Feed ratio	• Feed conversion ratio	1.68
	• Consumption	• Quantity of fish produced per cycle	42.38 kg
		• Quantity consumed by household	17.69 kg
	• Selling	• Quantity sold	20.23 kg
		• Value of fish sold	USD 38.94

Women have been well-known in improving families' food security and nutritional outcomes (Kawarazuka and Bene 2010). The WISH Pond also proposed to improve food security and income generation from selling surplus fishes. Women appear to have control over the harvesting and marketing of fish. They earned income from fish sold of approximately USD 39 per cycle and consumed fish valued at USD 33. They used the money they made from selling the fish to purchase food and household items. It is clear also that women make the decisions with regards to feeding the family, and both men and women report that they use the pond to take fish to feed friends and family on a regular basis.

Significantly, although women found it difficult to record data about the pond, they would ask their children to complete the forms. Mrs. Vann Dymom said:

> *My children helped me to record the information on fish raising every day. And all family's members helped me to feed fish and change water and harvest fish for consumption and for sale.*

Women do use the results for discussion with other farmers and project staff. In addition, most farmers, women in particular, favoured the building of cement ponds. Not only were they easier to manage but they also provided a useful water store for vegetable gardening, which tends to be women's responsibility in Cambodia. This is an important aspect in better understanding the role gender can play in community science and contributing to decision-making about the adoption of SSA by the household.

Discussion

Results show that households have used WISH-Ponds to produce additional household income and also to support food security with half of the product used for consumption and the rest sold for income. Most households reported using the pond like a "refrigerator" instead of fishing in the river they now had fish at home. Discussions with the farmers' group about data and ways of improving the efficiency and benefits from SSA have resulted in a series of recommendations on loan repayments with most concluding that the ponds had reduced their reliance on catching fish from the river and allowed more time to

invest in other livelihood opportunities. This included growing vegetables or raising animals around the home and also highlighted the importance for women who could spend more time taking care of children and undertaking pond management activities rather than spending time away from home looking for casual labour opportunities or working in the rice fields. The study indicates how costs can be reduced by introducing a modality that allows households to develop their own pond construction methods. This has meant that costs and techniques vary between households and result in some people borrowing more whilst others less. The approach creates a platform for innovation that enables households to explore different techniques to improve the WISH-Pond product. This was particularly relevant to cement ponds perceived to be the most desirable as it provides easy to manage ponds particularly for women and also provided a useful water storage facility for watering the garden. The gender analysis generates more detailed data about how an SSA invention affects both women and men in households.

Applying a community science approach has improved the knowledge and skills of women and enabled them to participate more effectively in aquaculture activities. This is illustrated by the daily recording of activities by men, women and children. Engaging households in the recording of data also provides equity of knowledge between women and men in SSA development, and a better understanding of the costs, benefits, and opportunities between genders. Both sexes are encouraged to do research through the identification of research questions, designing studies, collecting and analysing data and applying the results.

Conclusions

WISH-Ponds provide a potentially more sustainable method for introducing aquaculture to households and especially for women who have limited experience in growing fish. The approach involves households in research and in generating data and this provides reliable data and a better understanding of how SSA can be developed and adopted as a new livelihood activity. However SSA is most likely to be sustained in households where there are multiple livelihoods.

The development of WISH-Ponds through the saving group has been successful and has also allowed members and particularly women to access credit to improve or expand their ponds. This has had a positive influence on self-reliance and sharing roles with husbands and children in developing and adopting SSA. Promoting SSA is a challenging task. Long term commitment support in terms of financial, technical and marketing are a must when SSA expands to many villages in this province or competes with imported fish from neighboring countries.

Although the study presented only a limited sample of households, it did provide powerful evidence that women can play an important role in aquaculture activities, and therefore designing SSA systems so they meet the needs of women is fundamental. Involving women in SSA provides a mechanism to build self-confidence through a better awareness of the gender divisions of labour, and it provides access to knowledge as well as networks for mutual help and support between producers.

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