8.5 Asian experience on farmer's innovation in freshwater fish seed production and nursing and the role of women

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Nandeesha, M.C. 2007. Asian experience on farmer's innovation in freshwater fish seed production and nursing and the role of women, pp. 581–602. In: M.G. Bondad-Reantaso (ed.). Assessment of freshwater fish seed resources for sustainable aquaculture. *FAO Fisheries Technical Paper.* No.501. Rome, FAO. 2007. 628p.

ABSTRACT

Innovations of farmers laid good foundation for aquaculture development in many Asian countries. In China and India where aquaculture has a long history and tradition, the role of farmers in innovating culture practices and seed production techniques are highly visible. The invention of hypophysation technique in the middle of the last century in both countries opened a new era for the expansion of aquaculture on a large scale by ensuring availability of quality seed.

By understanding the working principles of the Chinese hatchery system, many farmers have innovated smaller, cheaper and economically viable and environmentally friendly models of Chinese hatchery technologies. More recent innovations such as hapa nursing technology to produce big size seed or stunting fish seed in ponds to obtain bigger size and aged seed are additional examples to indicate how farmers continue innovations to improve economic viability of the system.

This paper presents information on different types of innovations by Asian farmers and the role of Asian women in the freshwater fish seed sector.

BACKGROUND

Farmers innovate as part of their quest to cope with necessities of life for survival as well as to improve their economy. Evolution of carp culture technology by farmers of West Bengal is an example of how farmers have been able to utilize their inventive potentials to evolve a technology that has stood the test of time for centuries. Traditional technology evolved by farmers gave a yield of 3-4 tonnes/ha and the scientific community attempted to enhance this yield to 10 tonnes, by incorporating additional species into the system. However, this technology evolved by the scientific community, without due consideration to economics and marketing has been completely changed by farmers to develop a new carp culture system with only 2-3 native species of carps that is now giving a yield of even up to 15 tonnes/ha/year (Veerina, Nandeesha and Gopal Rao, 1993; Nandeesha and Ramakrishna, 2005). This has stunned the scientific

community in India and has inspired farmers from all over the country to learn from these innovative farmers. While all the innovations of Andhra Pradesh farmers is not possible to be imitated in other parts of the country because of the social, economical, agro-climatic condition variation, farmers in others parts have continued adaptations to evolve systems that would suit their local conditions.

Farmers undertake innovations as a necessity driven by economy to earn the livelihood necessities. Hence, whatever knowledge farmers gain either from researchers or development agents are always tested and verified before integration into their farming operation. Even after integration, farmers continue innovation year after year in order to make sure that operation efficiency of the activity is improved and economic loss does not occur (Reij and Bayers, 2001). This basic principle adopted by farmers has sustained aquaculture activity in many parts of Asia .

This paper presents information on different types of innovations by Asian farmers as well as the role of Asian women in the freshwater fish seed sector.

INNOVATIONS IN SEED PRODUCTION

Although farmers were able to advance the technology for the Indian carp culture, they were dependent on the natural collection of seed from rivers for stocking purpose. As the practice involved not only the collection of desired species of fish but also several other undesired species, farmers of Bankura and Midnapur districts of West Bengal developed a method of fish breeding called the "bundh breeding" to overcome the problem. This technique involved artificial simulation of the natural breeding environment observed in rivers. The technique was successfully applied for breeding of all the Indian major carps as early as in 1882. These techniques of wet bundh and dry bundh breeding provided pure quality seed essential for carp culture; the technique is completely natural and did not involve any hormone treatment.. These techniques are well described by Jhingran (1990) and more recently by Mondal, Mukhopadhyay and Rath (2005). The technique, however, received less importance due to large-scale establishment of carp hatcheries in many parts of West Bengal and other parts of the country. As the quantity of seed obtained through such naturally-induced spawning is reported to be better than other hatchery produced seed, with the growing importance of organic farming, this technique is likely to regain its importance in fish seed production. It should be noted that farmers evolved also the technique for the hatching of eggs in specially prepared small mud ponds plastered with clay soil. This was later improved to evolve the 'hapa-based' hatching system.

Innovations in seed production in Bangladesh, Cambodia and India are described below.

Innovations in seed production and nursing in Bangladesh

Most hatcheries in the private sector of Bangladesh are built and operated using the glass jar hatching principle. Instead of allowing the fish to spawn naturally, farmers identify fish that have come to spawning condition by observing tail movement of fish kept in rectangular cement tanks, which although with shallow water, still provides clear visibility to observe fish movement. Fish exhibiting straight tail movement are considered not yet ready for stripping. However, fishes that show a bend in its tail are considered ready for spawning. Fish in such condition are selected, stripped and fertilized with milt and placed in jars for hatching. Cement jars help carry out hatching operation for small volume of eggs of different species simultaneously and can save water. In some difficult-to-breed fishes like catla, the Chinese hatchery system is used. Seed production is no longer considered as a major constraint in a number of hatcheries established in the country. The "hundi" method of seed transportation still remains as the popular method among farmers.

Common carp breeding by farmers. Small-scale farmers have been successful in producing seed of common carp in their ponds. Mature brood fish of male and female common carp are collected from ponds and are kept for breeding in hapa using water hyacinth as the adhesive agent. Eggs attached to water hyacinth are hatched in cement tanks or small ditches. The ditches are protected from predation by encircling them with plastic or net material. The larvae are fed with egg yolk, wheat flour, cooked rice, etc. until they reach fry stage. At this stage, fry are stocked in paddy fields for further culture. The widespread adoption of this common carp breeding technology by farmers has helped to increase seed availability. Common carp bred during winter season are nursed in paddy fields during the boro season. Those farmers with a facility to continue culture operation during the subsequent season continue to grow fry to market size.

Control of aquatic insects in nurseries. In carp nurseries, aquatic insects (e.g. *Notonecta*) are the major problems that damage the carp spawn. The ditches or paddy fields are heavily loaded with back swimmers. Though various chemical methods are available for the control of insects, farmers are unable to adopt the technologies either because of the cost factor or often such technologies do not resolve the problems. Aquatic insects depend on atmospheric oxygen through their tracheal tube. Preventing insects to come to the surface for drawing air is one of the mechanical ways for the control of insects. Farmers devised a trap box for controlling back-swimmers. The trap box covered with fine mesh net with a size of 10 x 10 ft showed that insects trapped in such a box would die within 30-40 min. The dead insects in turn became a source of good nutrition as they contain high amount of protein.

Gher innovation and nursing of prawn seed. Farmers in the southwestern part of Bangladesh have invented a new method of using rice fields for cultivating both prawns and fish. Farmers invented this method since rice cultivation in such low lying areas was not economically beneficial and was not providing adequate income to meet the family necessities. Hence, some farmers started experimentation of growing prawn in the *gher* which has an elevated embankment with the soil obtained from the trenches dug in the field. The trench covers an area of 30 to 40 percent and rest of the total area and the central portion is left for growing paddy. Stocking prawn seed obtained from the natural collection in the coastal area has not given good results due to poor survival. To overcome this problem, farmers invented a simple method of blocking a portion of the trench creating a pocket *gher* for nursing of prawn seed. After nursing the seed, bundhs are cut to allow larvae to escape into the *gher*. This simple method of improving the larval growth of prawn has resulted in enhancing survival of the prawn seed and increased profitability. Farmers have also evolved a number of artificial food combination for prawn larvae. Nearly 12 different types of feed-making machines have been designed indigenously by farmers and these equipment are widely used by the farming community. These feed makers range from a simple piston-based operation using hollow bamboo to a mechanical pellet making machine. Simple rice noodle-making machine used in houses is modified into fish pellet preparation equipment (Nandeesha, 2003).

Development of breeding technology for *Pangasius*. Farmers have successfully evolved breeding technology for *Pangasius hypophthalmus*. Seed production operation for this species is done efficiently using pituitary gland. The seed produced are nursed in specially prepared nursery ponds. With the present technology, farmers are able to get 30 to 40 percent survival from nursery operation. Successful breeding operation for this species has resulted in the inclusion of this fish into the prevailing culture systems of the country. Egg stickiness is removed successfully by washing with milk.

Acclimation of shrimp to fish water condition. The most successful attempt of farmers is seen in the acclimatization of tiger shrimp seed to freshwater condition and its successful culture under freshwater environment. Although there are controversies with regards to the culture of tiger shrimp in freshwater environment, this activity is likely to be further improved by farmers to make the operation environmental friendly. In Andhra Pradesh in India, several thousands of hectares of water bodies are successfully used for the cultivation of shrimp in the freshwater environment. A similar scenario is likely to occur in Bangladesh, particularly in coastal areas where there is opportunity to have minimal salinity essential to trigger survival and growth.

Innovations of farmers in Cambodia

Small-scale aquaculture is expanding gradually in Camboida to meet the growing need for fish. Seed availability has been one of the major constraints encountered throughout the country for the sustenance and expansion of the small-scale aquaculture activity. Establishment of the Chinese hatchery systems in the capital city Phnom Penh and in some provinces, helped to create large centrally-operated seed production facilities and stimulate aquaculture development. However, as the activity begun to gain acceptance with farmers, seed availability became a major issue. Hence, some of the progressive farmers were encouraged to undertake seed nursing operation in different areas and they were provided with the fry for nursing operation and further distribution to other farmers. With the experience and profitability gained from the nursing activity, some of these farmers initiated seed production of some of the easy-to-breed species like common carp, silver barb and tilapia. Innovations made by farmers in nursing and later in seed production activities have demonstrated the inventive potential of farmers (Nandeesha, 2002).

Breeding common carp. A farmer had developed cement water jars which are placed at an elevated height for water storage and to create gravity flow that will induce common carp to spawn. Bamboos are used as protective material; polythene sheets are laid to store water and for use as spawning place for fish. Recognizing the interest of this farmer, he was given small support to build a circular breeding pool. He was able to build such a simple facility and even provided PVC pipes to provide a sprinkler effect. This circular tank (3 m diameter and 1/3 m of height) served both as breeding and hatching chamber for common carp, silver barb and even silver carp. This facility served as an example to show other farmers how simple breeding facilities can be built on the farm. Many other farmers were inspired because of the simplicity of the structure and the potential profitability that could be obtained.

An officer of the Mennonite Central Committee (MCC) with an agriculture background came in contact with the Central Seed Production Centre which promoted the new concepts in pond design supported by the family food programme. With the successful effort made by the MCC to alter the design of the ponds to suit fish culture activity, large number of farmers initiated seed production. Hence the organization went one step further to help a farmer who had served as a local resource person to promote fish culture to initiate fish seed production. The farmer was able to build the smaller versions of the Chinese hatchery model and was able to produce seed of silver barb, silver carp, common carp using the revised technology. Tilapia seed production was undertaken using the pond breeding method. Another farmer, in area of PADEK project, built a small-scale hatchery using the principle of shallow water tube well pumps. Since the pump required a lot of energy to generate water, an overhead tank with cement rings was built which successfully generated water using a diesel pump. This farmer was highly successful in producing seed of various species including silver carp and supplied seed to other farmers for nursing activity. With further increase demand for seed, there are already other farmers who have established further

improved version of the hatchery, to exploit the market opportunity. The European Union (EU)-funded project in some of the provinces of Cambodia, promoted fish culture as an important activity. Some of the EU-sponsored trainees in centralized seed production facility have successfully improved hatchery technology suitable for the production of commonly cultivated fish species. Modification design of hatchery units established have been successfully used for the breeding of common carp, silver carp, silver barb, etc.

Bamboo-based Chinese hatchery and Chinese hatchery through earth excavation. The use of bamboo for the construction of breeding *cum* hatching pool is another successful innovation attempted by the farmer in the AIT-supported project area. A second interesting farmer innovation is the building of Chinese hatcheries through excavating earth and covering the excavated area with polyethythene sheet. The inner chamber was built by bamboo frame and was covered with net material. This farmer used his knowledge to preserve the prepared hormone solution by simply lowering the bottle filled with hormone to the bottom of the pond. All these farmer innovations have helped in providing the required seed. In addition to this, techniques have been adapted by farmers for production of tilapia seed and nursing of seed in ponds. Women are active participants in tilapia seed production and nursing of various species of carps.

Innovations in fish seed nursing operation. In nursing of fish, a number of innovative approaches have been successfully used by the farmers using locally available feed resources. Larvae stocked in the nursery pond are fed with local ingredients such as rice bran, soybean, dry fish that are mixed/cooked. For brood fish, various types of naturally available feed resources such as lemna, Azolla, termites are used. Household waste combined with rice wine waste are also commonly used as feed to pond-grown brood fish.

Innovations by Farmers of Andhra Pradesh, India

Pond construction. The area around Kolluru Lake in East Godavari District is known as the rice bowl of India producing good quality rice. The increasing cost of cultivation of paddy, coupled with recurrent floods and droughts have made the paddy cultivation uneconomical. In search of alternatives to paddy crop, agriculture farmers initiated carp culture activity by transforming paddy fields into fish ponds by employing the trench method of pond construction. In this method of pond construction, trenches around the paddy field are dug to a depth of 0.5 m with a breadth ranging from 5 to 20 m all around the paddy field. The soil excavated from the trench is used for the construction of bundh. Ponds varying in sizes from 0.5 ha to as big as 100 ha are built with the application of this simple technology which has reduced the cost of construction and provided the possibility of returning to agriculture activity in case fish culture proves to be uneconomical. Farmers achieved enormous success in the culture of Indian carps, particularly rohu, as the dominant species in the culture system. In the early stages, farmers were importing seed from West Bengal. Innovative farmers quickly adopted the Chinese hatchery technology for carp breeding which resulted not only to self-sufficiency in terms of seed requirement within the state, but enabled the state to become an important source of seed for other states.

Broodstock management. Unlike the belief promoted that the broodstock of fish need to be reared with special care to bring them to maturity, farmers in this state use the brood fish obtained from the normal culture operation since they believe that every organism will come to maturity in the life cycle when its basic necessities are met. Most farmers in Andhra Pradesh use stunted seed, aged 6-12 months, for culture. Such aged seed attain maturity during the second year of culture operation onwards. Fish

seed producers obtain broodstock required for the farm activity directly from farmers and save huge cost involved in broodstock rearing. This has helped farmers to select from large numbers of fish and this appeared, to a great degree, to have eliminated the problem of inbreeding observed in several other states with the limited number of brood fish maintained in the farm.

Breeding innovation. Farmers in Andhra Pradesh have modified the Chinese hatchery technology to some degree to suit their convenience. There is no separate breeding chamber. Most farmers use the hatching chamber itself for breeding fish and once the breeding is completed, eggs are collected and distributed to different incubation units for hatching purposes. This has reduced the cost of construction involved in building the breeding chamber (six to seven m in diameter) as well as the huge volume of water required for the operation of such large breeding chamber. This is expected to save at least 30 percent on the cost of construction of hatchery.

Identification of maturity status. Some experienced farmers have developed the "touch technology" method to ascertain the suitability of fish for breeding purposes; it involves touching the abdomen of the fish to indicate the condition of the breeder. Farmers use this technology when purchasing breeders from the growers. Since farmers breed several sets of fish daily, this touch technology has been very helpful in deciding the suitability of the breeder. Almost 100 percent of the fish selected by the use of this touch technology has given almost 100 percent breeding response.

Substitute to pituitary. As an alternative to the unstable supply of quality pituitary glands, farmers have searched various other drugs that are used in the field of human medicine. Although ovaprim, a compound manufactured using "Limpe" method with a sound scientific basis, farmers have been finding it difficult to use this drug due to its high cost. The technology used by farmers in southeast Asia of combining LHRH analogues with dopamine antagonist has been successfully employed by some enterprising farmers. It was learned that the cost of production is reduced by almost 40 percent, without any loss in breeding efficiency. Although the "Limpe" method used the sGNRH to have the best effect, carps farmers are happy with the results obtained with mammalian LHRH combined with Domperidone. This clearly indicates that laboratory results need to be verified under practical field conditions and the choice to choose the best should be left to farmers.

Innovations in nursing technology. The scientific community believed that small ponds of less than 500 m^2 are the best size for nursery management and medium-size ponds of less than one ha are good for growing market size fish. Farmers in Andhra Pradesh have found more than 500 m^2 ponds as good for nursery and for grow-out ponds. The larger the size of pond, the better is the growth of fish and as a result grow-out ponds are more than one ha. The nursery pond preparation technology has been developed by farmers to get the best economic returns. Lime application continues to be one of the key factors before the initiation of seed nursing and it is applied at the rate of 300-500 kg/ha. Cattle manure is applied in combination with ground cake, mixed using a ratio of 7:3 at a dose of 4 000 kg/ha. The manure cake is mixed with 300 kg of mono-super-phosphate and it is kept in wet condition on pond embankments. Two to three days prior to stocking, this composted manure is applied to the pond. This organic mixture combined with phosphorous is known to provide a rich plankton bloom for the stocked seed. Farmers remove fibrous materials from the manure by sieving and squeezing the entire fermented manure with a cloth. Spawn are stocked at 4 to 6 million/ha. The seed are fed daily with rice-bran and oil cake mixture using a ratio of 1:1. It is reported that farmers were able to get 40 to 50 percent survival by

using this technology. The nursing operation is continued for about one month and the nursed seed are sold to other farmers for stunting purpose.

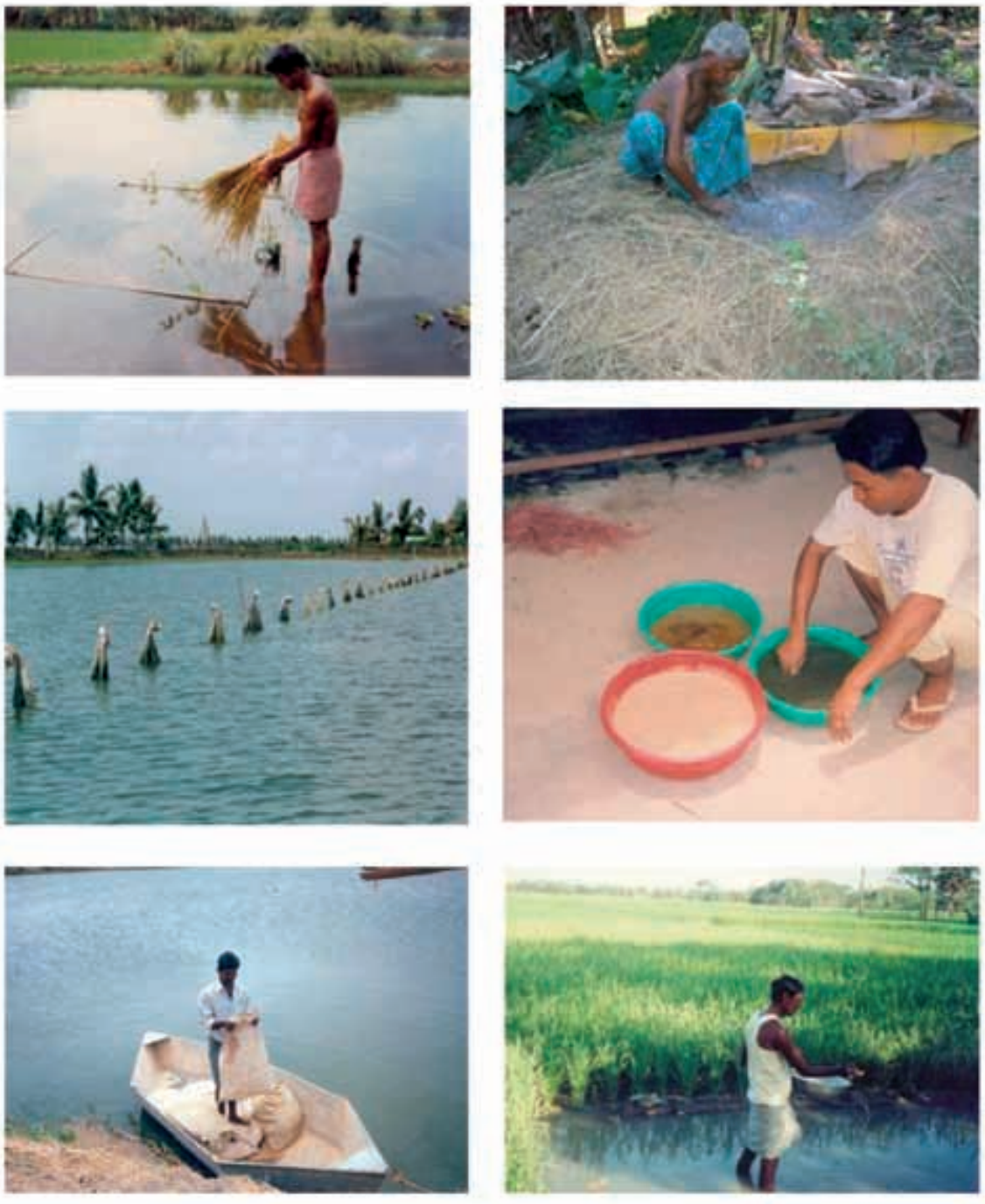
Innovation of stunted fish technology. Carps are known to grow rapidly during the second year of their age. Recognizing this basic growth pattern, farmers have developed a technology to supply stunted fish seed that are aged, but have not yet attained full growth potential. For purposes of stunting, farmers stock the seed at 25 000 to 100 000/ha and feed them with minimal amount of feed, i.e. good enough for their survival. The stocking density used is also based on the final growth desired for stocking in grow-out ponds. For example, at lower stocking density, fish would attain a weight of 100-150 g, but at higher stocking density, fish would reach about 25-50 g. In addition, ponds are fertilized to maintain the green water condition. Seed are stunted for a period ranging from 6 to 12 months. During this period of stunting, weak and unhealthy seed are also eliminated from the system. Healthy seed which survive the stunting process are used for culture purpose. Based on the intensity of stocking and level of feeding adopted, the weight of the fish attained would vary. Such stunted seed when stocked in the culture pond would compensate for the growth lost during the stunting period and attain a weight of one kg. Most importantly, the survival of such stunted fish is almost 100 percent, except for mortalities due to other environmental conditions. This technology of stunting fish seed developed by farmers is considered as one of the most important practical solutions found by farmers to address the problems related to fish growth and yield. As stated earlier, farmers are now able to obtain, most commonly an average yield of 8 tonnes/ha and some of the progressive farmers obtain a yield of more than 15 tonnes/ha/year.

Seed transportation. Farmers have begun to use large PVC containers of 2 000 to 3 000 l capacity for transportation of seed. Tanks placed on trucks are filled with water and the conditioned fish seed are stocked in the tank. These tanks are connected with oxygen supply from the cylinder placed on the truck. Using this method, farmers are able to transport the seed over long distances without any mortality problem.

Feeding methodology innovation. The size of ponds used by farmers is generally large in Andhra Pradesh. Because of this, the broadcast method of feeding resulted in huge wastage of feed and poor growth of fish. To overcome this problem, farmers have developed a simple and effective technique of feeding fish through "feed bags".Chemical fertilizer bags made of polyethylene with a capacity of 20-30 kg are commonly used for making feed bags. Small holes at the bottom of feed bags arranged in 2-3 rows are made. Feeding bags are filled with rice-bran and oil cake mixture and tied to bamboo poles and fixed in the ponds. Fish feed through the holes and the feed is generally exhausted in less than two hrs time after suspension. This simple, practical and economic method of feeding developed by farmers had helped in many ways. Firstly, the technique has reduced feed wastage drastically and almost all the feeds kept in the bag are consumed directly by fish. Secondly, feed bags are an excellent indicator to assess the health and growth of the fish. If the feeds provided in the bag is not exhausted within the given period of time, immediately farmers suspect for problems with health and/or water quality. Thirdly, for treating fish in such large culture ponds, the bag method of feeding has given a very effective pathway. Farmers use various drugs to feed fish through feed and for external treatment, containers filled with chemicals and having perforations are tied close to feed bags. Dissolutions of chemicals into the water provide an opportunity for treating fish infected with disease.

Growth promotion. Farmers in Andhra Pradesh incorporate salt along with feeds to improve the growth of fish. It is reported that incorporation of salt is done at levels

PLATE 8.5.1
Farmer innovations in Asian aquaculture



ranging from 0.5 to 2 percent along with the feed. This technology of using salt for growth promotion is widely known in many parts of Asia since salt is known to be an essential component for physiological activity. Research results carried out by the scientific community to ascertain the value of this practice of farmers has shown that it is possible to improve the growth of carps by incorporating the salt at 0.5 to 2 percent for different species (Gangadhara *et al.*, 2004).

Innovation of farmers in eastern India

Ash, as a substitute to lime. Lime is an essential requirement to promote the healthy growth of fish. However, lime is not easily accessible to all farmers. Due to the cost as

PLATE 8.5.2
Farmer innovations in Asian aquaculture

well as non-availability of lime in remote areas, farmers have begun to use ash produced from banana stem as a substitute to lime. Banana stem with an alkaline condition is known to improve water quality similar to lime. This practical technology has become helpful to farmers to solve the problem of lime availability in rural areas. In addition, ash produced in the family through burning of wood materials for cooking purpose is also used for aquaculture.

Removal of stickiness of eggs. The eggs of catfish are sticky in nature. Farmers have found solution to this problem by using milk to remove such stickiness. The eggs are thoroughly washed with milk and resulted to complete removal of egg stickiness.

Mixing of milk with water during transportation. When carp seed are carried in *hundi,* mortality is known to occur due to high temperature. Farmers have found a solution to this problem by using milk with water. It is believed that milk brings down the temperature and also provides nutrition to the fish during the course of transportation, besides preventing fish from the direct exposure to sunrays.

Hatching technology innovations. Farmers have not only used the technique of Chinese hatchery technology to improve seed production; they have also modified the glass jar technology for building large cement jars that help to hatch small amount of eggs. Cement jars constructed almost like glass jars are used for hatching eggs by ensuring adequate supply of water to keep the eggs under constant motion until hatching and post-hatching to keep the yolk-laden spawn under constant movement. This simple adoption of glass jar principles has helped the hatcheries to produce seed of different species simultaneously.

Innovation in broodstock management. Brood fish are fed with feeds containing additives like molasses and eggs known to improve the quality by providing some of the essential nutrients. In addition, farmers also balance the feed given to fish with such ingredients that will have good amount of protein and provide other essential nutrients.

Seed nursing. The spawn are stocked in nursery ponds prepared with the application of organic manures with oil cakes. Inorganic fertilizers are generally avoided. Seed stocked in such ponds and fed regularly with locally available feed ingredients like rice-bran and oil cake have a survival rate between 60 to 70 percent. These seed are sold to traders who transport them to distant places in *hundies*.

Stimulating and recognizing farmer innovations

There are many ways by which innovations of farmers or groups can be recognized. One of the best methods that have been found in Bangladesh is to provide a platform for farmers to share their observations with other farmers. Organization of farmer science congress at the district level wherein innovative farmers could share their innovation with other farmers and scientific community boosted their morale and built confidence. Many of the scientists from agricultural universities and development personnel from various organizations reacted negatively on organizing such farmer science congress. However, after witnessing the event and observing the enormous interest of farmers and the impact it created on the community, several such scientists endorsed that it is a worthy idea to promote such events on a regular basis. Unfortunately, such events are organized sporadically as part of projects and they are discontinued once the project phase is completed. It is necessary that national policies are developed to acknowledge, respect and recognize farmers' innovations equally like those for scientists. In Indonesia, such farmer events to discuss and debate on innovations are held regularly with the participation of the action research centers that are established in different parts of the country.

There are some good examples available from the agriculture sector like the integrated pest management (IPM) and the Honey Bee Network created to recognize farmer innovation. There are also special awards introduced in some countries including India where farmers are recognized for their innovation in farming activities. However, such programmes are not the regular part of the existing activities of many departments, since it is believed that farmers are takers of knowledge and not the creators of knowledge. If the change in perception is brought at various levels starting from policy formulators down to project implementors at the ground level, it is possible to begin recognizing farmers for their innovation. Such policy shifts would help farmers also to

be more responsible and scientific in their approach in carrying out farming activities. In India, in recognition of the successful fish breeding accomplishment made on the 10th of July 1957, this date has been declared as the "Fish Farmers Day" and it is celebrated throughout the country. On all these occasions, Fishing Chimes, a magazine dedicated for the development of fisheries in the country has instituted an award for innovative farmers. For the past three years, this award has been given to farmers who have made a difference not only to their lives but also to the lives of other farmers. Several fisheries institutions also celebrate the "Fish Farmers Day" and innovative farmers of the area are honored. However, the idea is yet to be integrated strongly into the system. More recently, the professional fisheries graduate forum of India has taken a lead to create interest among fisheries graduates by organizing essay competition on farmers' innovations. Such competition has evoked reasonably good response and has inspired some of students to carry out study in this emerging area. The organization has also initiated another national level competition to recognize farmer innovation by involving farmers, scientists, students, etc. It is hoped that in the coming days, this activity can become part of the major activity at the Asian level to stimulate similar interest in other countries. It is also interesting to note that organizations like FAO through IPM, World Bank through CGIAR system, and NACA have been promoting the need for documenting farmer innovations and also promote actively innovations by farmers. Such support by established institutions will have good impact and would result in a major gradual shift in the thinking process of research and developmental organizations in Asia. The Asian Fisheries Society which has been created largely as a forum for professional scientists to drive research in Asia has good opportunity to initiate programmes in the area of farmers innovations and help in making this new activity as a common agenda in its activities.

WOMEN IN SEED NURSING

Overall, the participation of women in aquaculture sector is limited globally. Women involvement in seed production is reported only from a few places, but their role in nursery rearing is more visible in many countries due to the common perception of women's maternal instinct. Described below are experiences of women involvement in the freshwater seed production sector in Bangladesh, Cambodia, China, Indonesia, India, Malaysia, Nepal, the Philippines, Sri Lanka, Thailand and Viet Nam.

Bangladesh. In Bangladesh, several NGOs are active in the area of aquaculture and fisheries. Some of the larger NGOs like CARE, PROSHIKHA, BRAC, CARITAS, etc. have initiated a number of women-centered aquaculture activities. Women have played an excellent role in influencing men to give up usage of pesticides and to undertake fish cultivation in rice fields. Farmers have developed a simple technique of placing water hyacinth roots attached with eggs in paddy fields and allow them to hatch and feed on food available in the system. This technique was found to be economically viable even with a survival rate of only 3-5 percent. In case of cage culture, women groups were more involved in nursing fish in cages using various types of waste materials. Women generally tend to place higher priority on family nutrition than selling all fish for cash. Women in Bangladesh actively participated in small-scale fisheries sector. About 30 percent of women in rural areas were engaged directly or indirectly in fisheries activities, while 10-12 percent women were employed in the aquaculture sector (Siason, 2001).

CARE had experienced that in training sessions, men dominate the discussion. Women's views or needs are often overlooked as the staff are also men. So it is important that extension workers design training and follow-up activities with careful consideration of both information needs of the women as well as learning styles. Women's lack of familiarity with formal learning environments and their lower

level of literacy can result to their particular learning needs and requirements being overlooked. Based on this experience the organization is tackling issues through a three-tiered approach by:

- having specific goals for the participation of women as stated in project's frameworks;
- using extension approaches and promoting interventions that will facilitate increased benefits to women in agriculture and aquaculture systems; and
- promoting staff development activities that result in a gender-sensitive organization.

In CARE projects, it has been observed that female groups are more difficult to form in conservative areas, though women want to work, in-laws and husbands do not always support the ideas of women. In such areas, raising community awareness and the provision of longer-term support to female groups helped in the active participation of women in aquaculture activities as the project progressed. It was found that movement of women was restricted to cage culture in the homestead territory or fish culture or seed nursing around homestead area. After the seed is produced and stocked in ponds or cages, women take an active role in nursing operation. The seed production of common carp is usually undertaken within the premises of the house and women were found to be more efficient than men in undertaking this activity. Most impressive progress in terms of common carp seed production and nursing was undertaken by women groups. Once the group formation has been completed and the healthy relationship were established within the group, women group take a pro-active role in disseminating knowledge and skills earned through various activities that included seed production, nursing, vegetable cultivation, etc.

It was also observed that after joining the learning session and utilizing their skill in aquaculture, women used most of their income from sale of fish seed or fish to meet the family needs particularly children. The activities helped them to develop confidence and have greater influence with regard to decision-making on children's education as they were able to contribute in cash towards school fees and other educational requirements. A large portion of the cultured fish often was used for family consumption. Women felt that having a rice-fish plot, cage or pond makes it easier to fulfill social obligations of entertaining guests in the family. Many women feel that their social status and status within their family changed dramatically by undertaking additional income generating activity like seed nursing (Debashish *et. al*., 1998)

In Bangladesh, there is a growing recognition of the capability and potentiality of women due to the efforts of a number of organizations. CARITAS has organized a total of 18 269 beneficiaries including 47 percent women. However, their role in seed production has not been identified clearly, though it was reported that women were involved in raising common carp seed in rice fields (Shelly and Costa, 2001). It was further reported by them that 43 percent of the total beneficiaries engaged in pond aquaculture in CARITAS were women and they did almost all the activities that were done by men like earth-cutting, pond preparation, feeding and fertilizing, accounts keeping, decision-making on marketing, etc. Involvement of women in aquaculture activity enhanced women status both in the family as well as in the society. The living standards have improved and the beneficiaries were able to send their children to schools as they were able to cover educational expenses of children. The women groups in particular, have demonstrated a strong bond and unity as well as commitment towards their quest for self-development through aquaculture.

Cambodia. Goddard *et al*. (1994) reported that Cambodian women had an active involvement in all aspects of integrated aquaculture. In an assessment of the farm activity, it was indicated that women contributed to 31 percent of total activity, whereas 55 percent of the work was carried out by men and 14 percent by children. Women were found to actively participate in feeding and marketing of fish.

A study conducted by Hatha, Narath and Gegory (1994) on the roles and the responsibilities of women and children in small-scale aquaculture, indicated that involvement of women increased with the fish production cycle. It was also reported that women-managed ponds yielded better result as compared to man-managed ponds.

Nandeesha (1994) reported the role of women in small-scale aquaculture in Cambodia. It was observed that a low level of production was obtained (20kg/100m^2/eight months) in ponds, where involvement of women was poor. Nearly 45 percent of families obtained high production of (20-40kg/100m^2/eight months) with the active involvement of women. Women are actively involved in nursing of *Pangasius* seed. This is a major activity that brings a lot of economic benefits.

Following the success of small-scale aquaculture, women are engaged actively in seed production of common carp, Nile tilapia and silver barb. Women are the most active participants in production and nursing. Much of the success in seed production through small-scale hatcheries was due to the active involvement of women. Some women have undertaken tilapia seed production by daily collection of seed using scoop net and nursing them in ponds and selling to other farmers (Nandeesha, 2004).

China. Rural aquaculture in China is reported to have been carried out by all members in the family. Kelkar (2001) reported that women are active particularly in seed production, seed collection, rearing and stocking. Song (1999) indicated that among the 7 878 workers employed in the seed propagation units, 26.8 percent were women. Zhonghua (2001) presented an interesting account of pond fish farming and gender roles in Yunnan Province of China. The women contribution to fish culture and the improvement in decision making power of women was observed with the introduction of fish culture. Although women had to do several hrs of work in terms of cutting grass, women considered fish culture as an activity that brings benefits to them. Also, how illiterate women learn all activities from their husbands who were able to attend the training is an interesting aspect. Certainly there are many more aspects of women involvement in aquaculture seed production and nursing activity that need to be yet documented. It is also reported that in Taiwan, Province of China, women are actively engaged in various aquaculture activities and there are also many innovations done by women. However, published information on such participation is not available.

India. Women are actively involved in subsistence aquaculture in India, taking care of fish after stocking. However, these women are not targeted for training and empowerment because of the lack of focus on women coupled with cultural and social constraints that prevent women participation in such activities. Women are active participants in fish seed collection from the riverine environment; this activity is no longer a major event since farmers are able to get seed from the hatchery production.

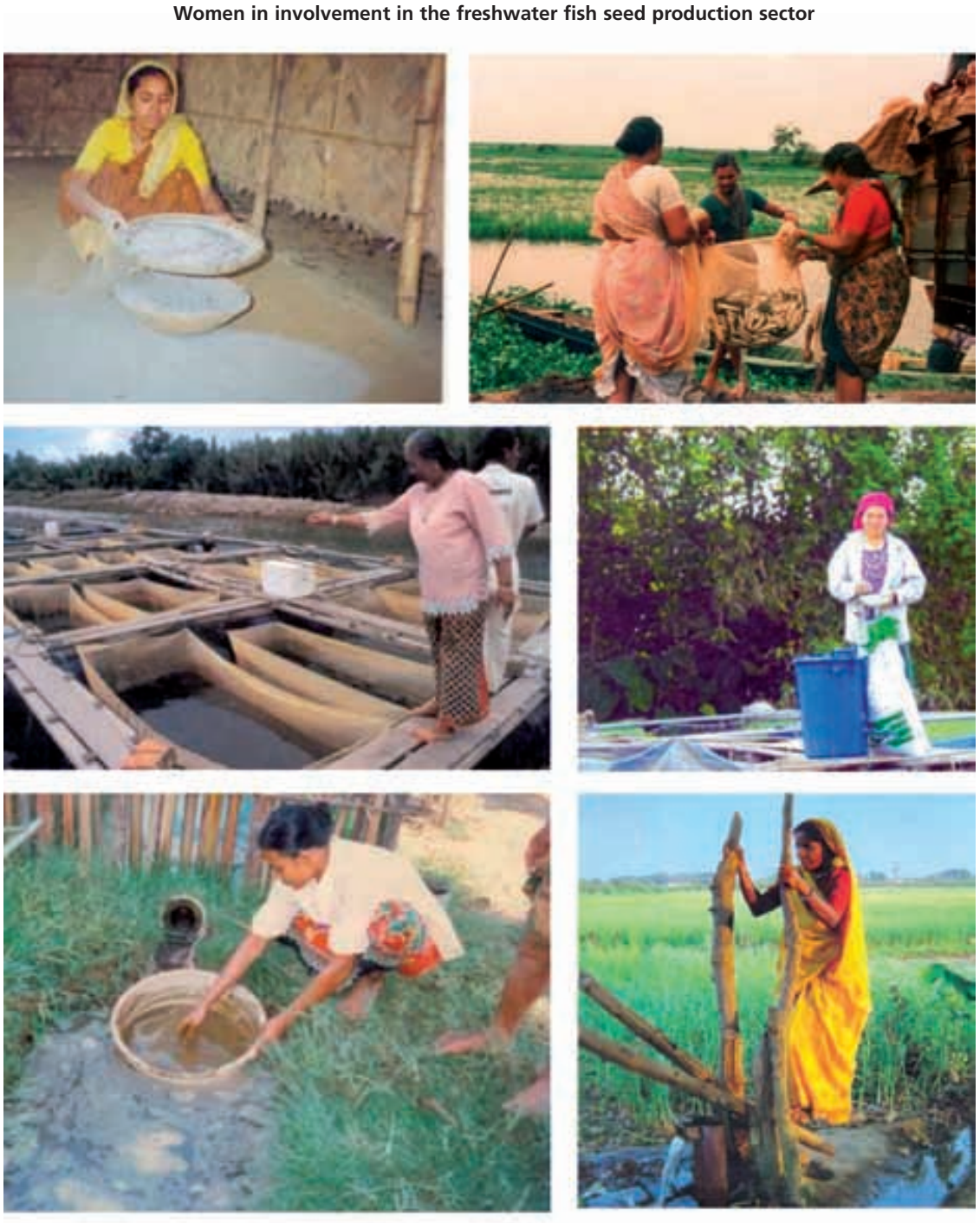
Jena *et al.* (1998) reported that small seasonal backyard kitchen ponds (0.05-0.2 ha) used for carp seed raised by tribal women in Orissa could enhance the economic status of women when managed properly. The result of such activity showed that survival of 45.5-55 percent for catla, 53 percent for mixed rearing of catla, rohu and mrigal were obtained. The project demonstrated the potential of fish seed nursing as an income generating activity for the women.

Ghosh, Mahapatra and Datta (2003) have presented an account of women involvement in the ornamental fish industry in West Bengal. Most of the ornamental fish farmers are based in and around Kolkata. Men are generally involved in seed production and marketing, while women and children carry out feeding, daily change of water, etc. Women are also involved in collection of different types of live feeds from sewage canal and other derelict water bodies for selling to farmers. This provides a good part-time job for extra income.

PLATE 8.5.3
Women involvement in the freshwater fish seed sector

The involvement of women in aquaculture is restricted to certain activities such as the collection of wild seed; men often consider aquaculture as an activity that could not be entrusted to women. In poor families, women were allowed to work in the field but such poor families do not own fish ponds. In the northeastern region of the country, women are actively involved in various field activities; in Manipur, women are engaged in fish seed nursing activity (Gurumayum, Aruna and Nandeesha, 2004). 'Self Help Group' (SHG) is one important social developments witnessed in India and it has been found to be a powerful tool to empower women by helping them to undertake agriculture practices including aquaculture using credit facilities. A number of women SHGs are engaged in aquaculture activity with seed nursing as an important component that is benefiting women (Ray and Pathak, 1998).

PLATE 8.5.4
Women in involvement in the freshwater fish seed production sector



Mohanty and Jena (1996) reported on women participation in Orissa, identified their constraints and presented a plan to overcome these constraints. They reported that a social dogma persisted among women as they thought fish seed production is highly complex and a fear of psychosis disabled them to participate in this activity.

Das (1997) identified that matrilineal society of kinship among the Khashi community in Meghalaya presents a different scenario of women in the society as compared to other parts of the country where patriarchal system is prevalent. Women in this community are actively engaged in a variety of activities. Women are involved in all aspects of livelihood activities; fish culture activity is initiated recently in Meghalya State.

Goswami and Ojha (1997) reported on the role of women in Assam in fisheries and a few cases of women involvement in seed rearing and nursery rearing of carps. Women in rural areas, lacking employment and with low literacy rate, have received funding assistance to undertake such income generation activity. It was also reported that small-sized ponds (100-1 000 m^2) were managed by women easily as they could fertilize them with cattle dung and feed fish with kitchen waste. Backyard ponds of 200 m^2 were suitable for women to undertake seed nursing during the short period of time. In Assam, women are allowed to weave gill nets, work in dry fish industry, make baskets used for fresh fish transportation, sell fish door to door. All such activities are done by women in the lower economic strata of the society to meet their livelihood necessities.

Radheshyam (1999) initiated a program of IVLP (Institute Village Link Programme) under CIFA (Central Institute of Freshwater Aquaculture). In this program, women were particularly targeted to undertake common carp breeding. Women in this village carried out the activity very efficiently by being involved in all stages of operation from collection of brood fish, breeder maintenance, egg hatching and seed nursing. Through this programme, women demonstrated that if a supportive environment is provided, seed production activity can be easily undertaken by women.

Indonesia. Indonesian women have higher participation in society because of low cultural and religious restrictions (Brugere, 2001). Indonesian aquaculture which is dominantly small-scale and household-operated (78 percent of household operated farms have less than 0.5 ha) (Purwanto, 1999) highlights the importance of the system. It is also reported that families derive the best economic benefits from aquaculture in this country, though gender-based information on such benefits are not available. Although women participation is high in aquaculture activity, whether the position of women in the family has improved or not because of this activity is not known. It is reported that women are the major participants of fish seed production, nursing and culture in Indonesia. The study carried out by Brugere (2001) had shown that women need training in entrepreneurship and it was recommended to create successful models of women running aquaculture enterprises.

Malaysia. Freshwater aquaculture is relatively a small size industry, contributing about 25 percent of the total national production. The system is dominated by the following species: tilapia, eel, Chinese and Indian carps, ornamentals, catfish and freshwater prawn; aquaculture of many of these species is carried out at an industrial or commercial scale. It was reported that women's participation in aquaculture activity is very limited due to complex cultural, social and traditional factors. However, women are involved in small-scale, family-based aquaculture activities. Although there are many challenges facing women's active involvement in aquaculture, Jahara (1998) reported that women can be encouraged to participate in small-scale aquaculture within their homestead and which can be easily integrated with other household activities, thus increasing their participation in aquaculture.

Within the Chinese community, women are seen to be involved in the ornamental fish industry and in the fish seed producer group. Detailed information on the extent of their involvement in the activity is not known. Engle (1987) has suggested that a specialized gender training to suit women's conditions and needs be undertaken.

Brugere (2001) reported that fattening of Javanese carp and tilapia in cages showed an indirect opportunity for women's participation. About 20 percent of women are wives of farmers with many cages. In Malaysia, women's control over budget and finances were very limited including their decision making powers; thus, women's roles are confined to traditional reproductive and productive role in the houses. Patriarchal societal structures of both Indonesia and Malaysia restricted women to involve in

aquaculture (Brugere, 2001). Development interventions should therefore focus on challenging the existing societal structures even as they try to empower women through participation in income generating activities.

Nepal. In Nepal, aquaculture in the plain region of the country is fast expanding with indigenous carps while in the colder regions apart from tolerant carps, coldwater species like mahseers are promoted. Focus on women in seed production and nursing is yet to be undertaken.

Philippines. Out of one million people working in the fishery industry, 26 percent are reported to be involved in aquaculture. The 1980 comprehensive census did not promote gender-disaggregate data of the 221 492 Filipinos employed in aquaculture (Yap, 1999). Government policies on aquaculture are gender-neutral and do not specifically address women's issues. Much of the women's work is officially unrecognized, unvalued, or underpaid. Women are heavily involved in fry collection, feed preparation, feeding of stocks and disposal of catch in communities which earn incomes from fish cages or fish pens. In Taal Lake, more women are involved in fish feeding than men. Extension work in aquaculture targets only men and a cultural perception that "aquaculture is a masculine job" exist in the community. Men have greater and easier access to credit and women are not assertive and confident enough to seek bank-managed credit. Women have less access to training. There are also some social factors that are responsible for less involvement of women in aquaculture. Shrimp or milkfish farms normally require living on site and this on farm activities makes it less attractive to women. The introduction of labour-saving technologies in farming has reduced the demand for women's labour. In rural areas, alcohol abuse by men and domestic violence are common. Religious concerns are also responsible for women's passive participation in aquaculture._Freshwater fish ponds and cages in larger inland water bodies are controlled by families and though many women are shown as owners, activities are still largely controlled by men and few families (Recide, 1999). Siason (2001) reported poor access to credit as one of the reasons for women not being able to derive benefits from aquaculture. Women's participation in income-generating activities and other development tasks are constrained by the multiple burdens of the reproductive role assigned to them. Unless provisions are made to lighten household responsibilities, such as equitable sharing of tasks with the spouse and children, or by providing community child care arrangements, sustained participation of women will not be realized.

Rabanal (1998) reviewed the 100-year history of the Philippine aquaculture and fisheries and indicated that men dominate both the public and private sectors. It is important to note that in families that earn income from cages/pens, women are heavily engaged in fry collection, feed preparation, feeding of stocks and disposal of catch. In rural areas, women are reported to be active in pond aquaculture operation, though quantified data is not available. Felsing and Baticados (2001) suggested that because of the social structure prevailing in the society, women's control over aquaculture production in the Philippines is unlikely to increase considerably in the near future.

Sri Lanka. In the ornamental fish industry, particularly involving freshwater fish species, women are reported to be actively involved in breeding and nursing activities. Income generated has helped in the improvement of women position within the family (S. Siriwardena, pers. comm.). Aquaculture is not yet a major activity, though some of the organizations have made efforts to promote this activity as a sustainable system.

Thailand. In Thailand, women are involved in various aquaculture activities, including purchase of fingerlings. Marketing is solely a women-dominated actively, while men are responsible for harvesting of fish. Feeding and maintenance of ponds are the

activities carried out with the participation of both men and women (Kelkar, 2001). In a study carried out by Suntonratana (2001), it was shown that women are important in the aquaculture sector of Thailand with many men migrating to city for better income, leaving behind women to take care of farm activities. According to the study, while trainers are not gender sensitive to take care of the women necessities, other information media like television, radio, newspapers, technical bulletin, etc. also do not provide benefits to women, either because of their busy schedule or because of the highly technical nature of the information provided. These issues need to be considered carefully when addressing gender issues. It was also shown that men have better access to training and credit because of the other family commitment of women. Like in other areas, women are active in caring the pond after stocking. The need for gender-sensitive policies and generation of gender-disaggregated data are essential in obtaining better information not only on participation, but other related issues such as reasons for participation or non-participation, development of women friendly technologies, long-term implication of the aquaculture policy on gender relations, etc. In another interesting study carried out on women's access to information on aquaculture technology in Thailand, it was shown that it is necessary to increase the interaction of women with others to enable them to have better access to information. However, mobility is another major factor that limits access to quality knowledge and information. Mobile phones appear to play an important role in information exchange in a country like Thailand wherein more than 77.1 percent of the respondents possessing mobile phones indicated the usage of mobile phones for aquaculture purposes. It was further observed that involvement of women in various activities declines as the activity becomes more technical. In hatchery operation, only 13.3 percent of the women respondents were found to make plans by themselves, while 70 percent of the activity was planned by men. Kusakabe (2001) has further shown that as intensification of the activity increased, women's role in aquaculture declined. This is an important issue to be considered to ensure exclusion of women with the anticipated intensification that is likely to occur to all species in various ways. Planners have to take note of this issue and the activities should be designed in such a manner that will meet the necessities of women so as not to exclude them as a result of the intensification process by addressing the issues of access to information as well as mobility.

Viet Nam. In Viet Nam, seed nursing is the activity wherein active involvement of women could be seen as women feel that it is a simple task that they can managed. Minh, Huong and Tuan (1997) reported that the large amount of the family income was earned by women by undertaking seed nursing activity. Women were involved in all activities that included pond preparation, buying fingerlings, feeding, managing fish health and marketing. As ponds are within the homestead area of the house, it has become an attractive income generating activity for women. Although seed nursing added additional work hrs to women, the income earned enabled them to feel that the work is worthwhile.

Voetan and Ottens (1997) presented an account of the gender roles in the VAC system of integrated farming including aquaculture. Though women are responsible for carrying most of the activities of aquaculture, men play the role in buying seed and stocking the pond since men are assumed to have better knowledge on seed quality. After stocking, it is the women who play the critical role in pond management. However, with the harvest of fish, it is the men who get the income from sale of fish to be utilized for various activities.

Increasing women participation in fish seed production and nursing

In ornamental fish seed production, women involvement is higher in many countries. It is believed that as the technique of production of most aquarium fish does not involve

hormone application, it appears to have become popular with women. While women are actively involved in common carp breeding and nursing, tilapia seed collection and nursing, whenever any hormonal injection treatment is involved, women appears to be excluded. Necessary training on induced spawning should be provided to women to encourage their participation in this activity.

In seed nursing, women are active participants in many parts of Asia though their visibility is not high. However, in view of their motherly nature, women are always considered as best suited for the job of nursing. It is the change in attitude that has to be brought to involve more women in seed production and nursing activities and enable them to derive the maximum economic benefits from the activity. Once the women are able to see the economic benefits of such activities, the sustainability for the programme will be high. All scientific conferences that have been held so far beginning with the first workshop on Women in Aquaculture in 1987 by FAO until the last Global Symposium on Gender in Fisheries in November 2004 have identified two prominent areas to enhance women participation in aquaculture. These are: (1) training by ensuring clearly defined target number and (2) provision of credit facility to enable women to initiate the activity.

Many scientific events held thus far have emphasized mainstreaming of gender and brought gender awareness. While this is a good start, much needs to be accomplished. Gender sensitization programme should be considered a priority as this will greatly help in gradually mainstreaming gender in various activities of the organization.

With regards to provision of credit, the success of self-help groups (SHG) in different parts of Asia had encouraged many Asian governments to initiate such activity with a focus on women. Since money is involved and some of the basic principles of SHG are sometimes compromised, there have been more failures than successes in government-operated programs. It is therefore necessary that early steps are taken to prevent the loss of opportunities on the enormous potential of this concept in transforming the lives of women.

CONCLUSIONS

The study demonstrates that farmers have been actively engaged in innovations in the field of aquaculture. In fact, farmers do not adopt any technology without innovations to best suit their farming conditions. This may be called as an adaptive research by farmers. There are also farmers who are willing to undertake risk to innovate using new ideas that have completely transformed the aquaculture scenario in many parts of the Asian region. The lessons learnt indicate the need for building a database on farmer innovation. Regional organizations like NACA should undertake such an activity and promote sharing of information through the magazine and via the internet. Reporting of farmer innovations may also be mandatory. In the Asian region, there is a need to recognize farmers' innovation and bring them as partners in policy formulation and identification of research strategies. In the area of human resource development, it is essential that training programs consider gender issues, identify the needs of women and encourage their participation in seed production activities. As a long-term strategy, women strength should be increased significantly in all countries by attracting more women to fisheries courses and making provisions for their employment in various organizations. South Asia needs special attention on this particular aspect. The fisheries curriculum has to be modified suitably to ensure that gender issues, farmer participatory research and other social issues are included in the graduate programme.

THE WAY FORWARD

As an immediate step, it would be worthwhile to stimulate more research into documenting farmer innovations in various countries. Such documentation of farmer innovation should become available to all to stimulate further research and development

in the discipline. Conscious efforts to train women in seed production and nursing and provision of required credit would bring major benefits to the sector.

ACKNOWLEGEMENTS

The author is grateful to all those who helped in gathering information required on innovations and women participation in fish seed activity from various Asian countries. In particular , the support received from Mr. Manidip Roy, Ms. Rupali Chakraborty and Ms. Ankana Dey in compiling this review is gratefully acknowledged. The permission granted by the University authorities to undertake this assignment and to participate in the workshop are also gratefully acknowledged. The support Dr Melba Reantaso from FAO enabled me to complete this report.

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