

The Use of Locally-made Fish Rearing Cages in the Iraqi Marshes: A Case Study

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Abstract. Fish cages and enclosures are known to be one of the intensive fish rearing methods which utilize small water area and provide high fish production. They are recommended for areas of low productivity, limited water resources and risk of pollution such as the southern marshes of Iraq. The limited use of such technique has always been related to high cost of construction and maintenance. The need of this technology in the poor areas of the marshes led to the proposal of simple technological designs that use locally available materials and satisfy the critical criteria of fish rearing systems. Use of such system as a family fish farm would enable local inhabitants to increase fish production in their areas, increase family income and improve livelihood conditions through better socio-economic status. The proposal includes the following steps: 1. Test of local aquatic plants and tools which can serve as raw materials. 2. Applying the most suitable design in terms of cost, time, building flexibility and maintenance. 3. Contribution of local inhabitants in construction steps of the fish cages. 4. Site selection survey of the most suitable areas for implementation in terms of water depth, velocity, quality, productivity and availability of shelter and security. 5. Implementing the constructed fish cages in the selected areas under the supervision of the local inhabitants. 6. Training and capacity building of members of local inhabitants on operating and maintenance. 7. Introduction of a selected commercial fish species for rearing, using the available fish fingerlings from local fish hatcheries. 8. Applying the most effective feeding method and monitoring fish wellbeing. 9. Periodical recording of fish growth criteria such as instantaneous growth rate, feed conversion efficiency and survival. 10. Performing fish production analysis and economical values to local inhabitants.

Introduction

1. Cage Culture

Cage culture of fish is a method of raising fish in containers enclosed on all sides and bottom by materials that hold the fish inside while permitting water exchange and waste removal into the surrounding water. Cages are constructed in a variety of shapes using materials such as reed, bamboo or wooden slats and wire, nylon and other synthetic meshes. Support structures can hold cages on the water surface or suspended above the bottom of a body of water (3). It is an aquaculture production system where fish are held in floating net pens. Cages are widely used in commercial aquaculture overseas and individual cage units come in all shapes and sizes and can be tailored to suit individual farmer's needs. Cage units can be made from locally available construction materials such as PVC pipes, wood or/and steel. Cages can be used in both freshwater and marine environments.

2. Advantages

The advantages of cages compared with other culture systems, as pointed out by Chue (7) include:

1. Use existing water bodies and provides private ownership in public waters
2. Technical simplicity with which farms can be established or expanded
3. Lower capital and initial expenditure cost compared with land-based farms
4. Easier stock management and monitoring of fish health and growth.
5. Fish cages and enclosures are easy to build, require minimal maintenance
6. Offer protection from predators and competitor species of fishes
7. Provide controlled feeding.
8. Provide simplify harvesting of stock
9. Cages are a convenient approach to raising fish for personal consumption and for marketing
10. High yield of fish and good economic return.
11. A method to develop fish husbandry skills before considering more expensive production systems.

3. Cage Culture in Asian Countries

Cage farming in Asia is practiced in fresh, brackish and inshore coastal waters. It currently occurs in all freshwater habitats and is extremely diverse in nature, varying in cage design, intensity of practice, husbandry methods and the species farmed (10). In general, freshwater cage farming is practiced on a small scale, but in some instances clustering of cage operations can contribute a significant level of production (2). In 2004, FIMA (Aquaculture Management and Conservation Service) convened an expert workshop on cage culture in Africa. This activity was given a high priority considering the rapidly-growing interest in cage culture in the region.

The Philippine Bureau of Fish and Aquatic Resources (BFAR) INCA has access to the various technologies and experiences in developing and operating cage fish culture systems for various species of fish production. According to Pillai and Sollows (11), work carried out on the culture of fish in cages in Nepal, the introduction of the practice to private fishermen by the project and its technical and economic aspects are described in their report. With plastic circular or rectangular fish cage system, various high value fish can be produced intensively to standard marketable sizes. Depending on loading densities of fish fingerlings, production capacities of these fish cages can be up to 10 to 20 Metric tons of fish harvest every grow-out cycle of 4 months. There are times when existing

bodies of water do not lend themselves to open pond culture and cage culture may be the best alternative (<http://www.inca.com.ph>).

4. Cage Construction

Fish cages can be constructed from a variety of materials. Generally, the longer a material can last in contact with water, the more expensive it is to use. Some consideration should be given to the expected “life” of the fish cage. There are a few basic principles to consider when planning building a fish cage:

1. All materials used for the cage should be durable, nontoxic, and rustproof. Plastic netting is often used. Sunlight can also damage the plastic mesh, so leaving the cages in the water year-round may be better.
2. The netting material used for the body of the cage must allow maximum water circulation through the cage without permitting fish escapes. Mesh sizes less than 1/2 in. often clog with algae. Netting material of 1/2 in. and 3/4 in. mesh size are most commonly used.
3. Some type of flotation is needed to suspend the cage at the water’s surface — small inner tubes, plastic jugs, or pieces of styrofoam.
4. Sunlight stresses fish; therefore a lid should be included to block some of the light.

5. Types of Cages

Fish cages can be built in two forms depending on the depth of water:

- a) Floating (convenient for water bodies where depth of water is more than 5m).
- b) Fixed (convenient for water bodies where depth of water is less than 5m).

They can be built in different shapes such as the most convenient rectangular shape or the square and round (circular) shape.

These simple yet ingenious cages made of reed or bamboo and netting, enable poor people to breed fish, providing families with a protein-rich diet and a way to generate vital income. In contrast to natural fishing, where fishermen have to depend on chance, raising fish in cages enables a predictable and more assured source of income. Fish cage culture is one of the fastest growing business opportunities right now. Cage culture can be integrated into almost any standing water, provided that the water quality is suitable and there is adequate water depth beneath the cages to allow water movement. Adequate depth depends on the depth of the net and intensity of production. The depth should be sufficient to keep the nets clear of the sediment and allow water exchange beneath the net.

6. Cage Placement

One of the most important considerations affecting cage culture is the placement of the cage. Weather and shelter are important considerations in determining the suitability of a site for cage culture as they can impact on both the cage structure and enclosed fish. The cage units should be built to withstand prevailing wind and wave conditions at the selected site. Good water exchange is also important in cage culture to replenish oxygen and flush away wastes. Therefore, the fish cage should be placed in an area where there is at least $\frac{1}{2}$ m of water between the bottom of the cage and the lake bottom. The fish cage should also be placed where the water can move freely through and around the cage. Since wind action is the primary contributor to water movement, the cage should be placed in open water where the prevailing winds can create water movement. Water quality factors such as temperature, salinity, pH, suspended solids and the presence of algal blooms can potentially influence the growth and survival of your fish. In addition, sources of pollution and the tendency of the water body to stratify during the summer can also negatively impact on water quality. Disturbances near the cage, such as swimming, boating, and fishing activities are not desirable.

7. Stocking Densities

The minimum recommended stocking density for common carp is 80 fish/m³. A recommended maximum stock density for beginning farmers is the number of fish that will collectively weigh 150 kg/m³ when the fish reach a predetermined harvest size (17). The smallest recommended fingerling size for stocking is 15 g. A 15-g fish will be retained by a 13-mm bar mesh net. Larger fish can also be stocked into cages. Survival rates in well-placed and well-managed cages are typically 98 to 100 %. Unless greater mortality is expected, no adjustment is needed to calculate stocking density.

8. Fish Production

The weight of fish produced in cages depends on many factors including the fish species, stocking density, fish size at stocking, culture period, cage size, water quality, and feeds used. Reported yields can be misleading unless production details are provided (8). According to Pillai and Sollow (11), there is relatively less accumulation of metabolic wastes, and constant renewal of oxygenated water within the cage since there is constant circulation of water through the meshes of the cages. This enables higher stocking rates and consequently, higher production per unit volume than in ponds.

Fish Cages in the Southern Marshes: A Case Study

1. The Southern Marshes of Iraq

The marshes of Southern Iraq comprise a complex of inter-connected shallow freshwater water bodies which covers 20,000 km² of open water, and includes both

permanent and seasonal marshes. At the beginning of 2003 only seven percent of the original marshlands remained. Satellite photos indicate that by 2005 a percentage of 39% of the destroyed marshes had standing water (19). Field analysis concluded that water quantity and quality were sufficient to restore some area of the marshes (12). The values of the Marshes are numerous, including rich flora and fauna, livestock grazing fields, fish and other wildlife breeding places (9). They are important for economic, social and biodiversity values as appeared in number of studies (5).

The result of a recent survey carried out by FAO (15), pointed out that the economy of many people living in the region has been intimately involved with the marshes which provide important habitat for a wide range of fish species, many of which are of economic importance. Inhabitants of the marsh are currently suffering from several socio-economic problems. Traditional fishing and agricultural practices are not especially productive due to lack of scientific techniques, training and economic feasibility. In addition, dangerous fishing methods have been practiced in nearly all marshy areas such as the use of toxic pesticides and electric fishing.

The same FAO survey, which has been done on Al-Huweza Marsh (15), showed that the current fish stocks, fishing activities and production of fish in the marshes fell dramatically due to negative changes in the environmental conditions and drainage disaster. Fisheries development in the marshes may help the socio-economic status for people inhabiting the region, because fishing is their main tool to cover their living expenses. Accordingly, a development programme is needed to improve the living standards of such communities. Refolding of the marshes refreshes the hope of increasing fish production through restocking of fish fingerlings in extensive farms and rearing fish in intensive ponds or cages.

2. Fish Farming in the Marshes

Fish farming represents an additional activity which may increase fish production in the area along with fishing wild fish (4). Selected suitable farming practices might be suggested to help the people of the marshes economically and fighting unemployment. Most of these practices are easy to construct besides being very profitable. Aquaculture systems suitable for extensive and semi-intensive fish farming in the marsh were previously suggested by Salman (14,16). They include:

1. Ponds with transect dikes which can maintain adequate water supply for ponds with larger depth and improve water depth in shallow area, so that it can be used as fish ponds.
2. Ponds with peripheral dikes and ditches are suitable for extensive (large area & low coast) fish culture, by increasing water depth than the surrounding for growing field crops during dry season into an appropriate production cycle between fish and crops. water body. Ponds surrounded by peripheral dikes may also be used

3. Fish cum rice culture style of South East Asia, Production conditions are not encouraging to start such trials but it can be used when the rice cultivation in the marsh return back as it did in the past.

4. Fish cages and net enclosures which serve as intensive or semi-intensive rearing systems which can be practiced in the marshy area with low cost as a family owned farm. Locally-available fishing nets and reeds can be used to build such low cost enclosures which serve both nursing and growing purposes.

3. Marshes Inhabitants

Inhabitants of the southern marshes of Iraq are primarily depending on water for their livelihood. The main livelihood activity is fishing. Fish production has declined during recent years due to overfishing, shortage of water, draining and salination (18). Accordingly a dramatic decrease in the family income of marsh inhabitants was noted. This has been pointed out by many United Nations reports. The Suggested project aims at providing simple technology which enables those people to increase fish production on family or tribe scale. The project includes the use of locally available materials to build fish cage system for intensive rearing of commercially important fish species at selected suitable sites in the marshes. The system can be used as a small-scale family farm or expanded on large-scale to serve larger community.

4. Needs and Tasks

Proposing this study came for the following reasons:

1. Because of water shortage in Iraq and the need to use it for crop irrigation, it would be much better to use readily available natural marsh land for fish culturing activities.
2. The costs for culturing fish in cages and net enclosures are lower than that of earthen pond; moreover the net production in this system is better.
3. Decline of carrying capacity of Marshland for commercial fish species, so these kinds of projects will enhance the fishery resources.
4. The socio-economic status of people living in the Iraqi marshes, impose the urgent need for new technological development of fish production. This project can be considered as pilot project for local people habitat.

The study deals with the introduction of a new simple technology which can serve as basis for future improve of marsh inhabitant's livelihood. Among the four practices suggested by Salman (14), to promote fish farming in the marshes area the cages and net enclosures are selected for this project for the following reasons:

- 1- They can serve as a fish cultivation tools for a single family or small groups in the marshes community.
- 2- They use limited water resources.

- 3- The method needs little training on construction and management compared with other practices.
- 4- It can be established with limited financial support.
- 5- It can be operated using locally-available, low cost raw materials and cheap work power. .
- 6- Cages and net enclosures are considered as new fish farming technology in the southern marshes of Iraq.

5. Objectives

The overall objectives of aquaculture activity in the marshy area are:

1. Making use of neglected water bodies and turning them into profitable farming sites.
2. The use of locally-available raw materials to build a useful tool for fish farming.
3. Maintaining cheap food supply to the local people.
4. Improving the socio-economic status of people living in the marshes of Iraq.
5. Creating new employment and income opportunities.
6. Development of a new fish farming technology to the marshes area.
7. Encourage investment in fish cultivation in the marsh.

The key objectives are:

1. Design and construction of fish cages from locally available materials.
2. Testing and evaluation of the suitability of these models of cages.
3. Determining the economic feasibility of such method for the marshes habitats.
4. Testing the response of the local fish species for rearing in cages
5. Studying fish growth, feed conversion efficiency and production of cage culture
6. Training of local inhabitants to practice fish farming in cages
7. Evaluating the role of fish cage culture in increasing the income of local poor people in the marshes.

6. Expected Outcome

1. Obtaining new designs of cheap fish keeping cages manufactured from unconventional materials which are locally available.
2. Expanding new technology of fish culture in the marshes of Iraq for the first time.
3. Helping local poor people to increase their income, by using the naturally available resources.
4. Throughout such project training on cage fish culture would be conducted together with an expository tour for interested farmers.
5. If reed poles and nets which are locally available prove to be more economical tools to build fish cages, investment may be encouraged in this respect.

6. Local technicians could be mobilized to assist in the planning, implementation and monitoring of future projects.
7. Enhancement the fishery resources for local people.
8. Engagement of local people in the whole process of this activity.
9. The local people will get new experience of this technique.

7. Beneficiaries

The main beneficiaries of this project are the poor fishermen and farmers inhabiting the southern marshes of Iraq on family and community levels. Such project will introduce an additional and profitable source of income for them unlike before that they depend on farming only under unfavorable conditions. Producing fish in floating cages require a small fraction of the farmer-beneficiaries time. It is estimated that they only spent at most one hour a day to tend to the fish. The rest is devoted to their farm or other activities. The success of this project may attract private or governmental investment in the area. That will help in creating more employment opportunities for local people. The economic uses of the marsh resources by the farmers will help in sustainable development and environmental protection from water pollutants. The sustenance of the indigenous species thriving in the marshes is ensured since the community can produce their fish requirement instead of catching these species with pesticides and electric fishing (18).

8. Commercial Potential

The proposed fish cage system can well be produced on commercial purposes for future investment. Upon project success, relevant policies and support might be provided by the Municipal Governments towards the development of this industry and protection of the marshes habitats. The fish production industry can be a source of additional income not only to the farmers but also a source of revenue for the Municipal Government and investors.

Practical Steps of the Case Study

1. Site selection survey

Survey for the most suitable sites would be conducted in the marshes area to select sites that maintain the essential criteria. Those include water depth, shelter, weather, water exchange and circulation, water quality, pollution hazard and fishing activities. Besides these criteria, site selection survey would take the presence of poor communities in the selected area into consideration.

2. Preparation of raw materials

Materials used for cage construction should be inexpensive and readily available. They should be durable and strong, but lightweight and allow complete exchange of water

volume every 30 to 60 seconds by using a minimum of 13-mm square mesh size. The materials must allow free passage of fish wastes and be resistant to fouling but not stress or injure fish.

Raw materials for cage construction consist of main and auxiliary materials. The main materials are frame and plastic mesh. The auxiliary materials represent floats, anchors, feeding box, cage cover and walkway. Frame materials would be selected from local plant materials such as reed and wooden sticks. Fixing materials are mainly from plant origin. PVC pipes and joints may also be used to support the cage walls. The empty drums would be used as floats for the cages. The cages will be bound to a wooden platform or walkway floated by oil drums.

3. Cage and enclosures construction

The cages and net enclosures would be constructed according to the planned designs using locally available reed and wooden sticks of cheap price. PVC pipe may also be used when needed in the construction. Square and rectangular cages of selected sizes (2x2 and 2x3 m²) can be constructed from readily available reeds and nylon ropes. Inside the reed frame a well stitched inner nylon cloth of suitable mesh size and a closable lid is tied. Floats, anchors and walkways needed are to be fixed according to field trials.

4. Positioning of the cages and net enclosures

The cages and enclosures are planned to be positioned in relatively open areas with good water circulation, away from still or stagnant water where poor water quality may stress or kill fish. Water depth of 1.5 – 2.0 m is necessary to ensure that the cage bottom is at least 0.2 m (0.5 m preferred) above the bottom sediments. Net enclosures might be fixed in shallower area. With rows of cages spaced at least 1 m apart in easily accessible areas to facilitate routine maintenance and feeding.

5. Release and feeding of selected fish species.

Stocking densities is to be decided according to the cage sizes, aiming at harvesting 100 kg/m³. A planned density of 80 – 100 fish of 15-30 g weight would be cultivated for the monoculture. Balanced combination of stocking densities for the polyculture is under consideration. Balanced feeding ration would be formulated and prepared as pellets using local feeding staff. Cages shall be supplied with feeding trays for feeding the fish at certain feeding level (5-8 % of body weight).

6. Continuous monitoring of growth, feed conversion and health of fish

Samples of fish are taken at biweekly intervals to measure length and weight and therefore growth rates. Feed conversion efficiency is to be determined by calculating the amount of supplemented feed and increase in fish weight (1). During the cultivation period fish health monitoring would be conducted and any sign of parasites or disease infection would be diagnosed and isolated.

7. Monitoring of water quality criteria and other environmental parameters

Temperature, salinity, pH, dissolved oxygen, nutrient concentration and water productivity would be monitored biweekly to ensure suitable water quality.

8. Harvesting of fish at the end of the experimental period

Upon harvesting fish after the 9 months period, fish will be weighed to estimate the production levels for the benefit of the poor local people.

9. Conducting production analysis

Lists of fixed consumable expenditures along with profits of fish production would be analyzed to calculate economic feasibility.

10. Training of local people

Throughout all previous steps, training of local people should be carried out, to get them involved and have technical experience for future management of their own projects.

Pilot Experiment

1. Polyculture of Carp

Farming three fish species (Common, Silver and Grass carp) in mono- and poly-culture style is possible in the cages. Six different combinations are to be farmed in six cage and enclosure units. Replicates shall be considered for some treatments. Statistical analysis of data collected at certain time intervals would be performed using computerized statistical program (SPSS).

The seven experimental treatments are:

<u>Polyculture</u>	<u>Monoculture</u>
Common carp + Grass carp + Silver carp	Common carp
Common carp + Grass carp	Grass carp
Common carp + Silver carp	Silver carp
Grass carp + Silver carp	

2. Time Schedule

Task	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
Site selection												
Cage Construction												
Fish Farming												
Harvesting & Data Analysis												

Requirements

Consumable requirements for building a unit of seven cages are outlined below:

Description	Qty.	Unit
Construction materials for 7 cage		
Reeds and ropes	bulk	-
Plastic pipes	10	6 m length
Plastic connectors	50	6 inches
Iron pipes	20	6 m length
Cage nets	7	5 x 5 m
Anchors	7	
Buoys	14	
Sub total	7	
Small Fish (150-200 g)	3000	No.
Fish feed	3	Ton

There is a need to build a walkway or a service wooden platform if boats are not used for that purpose.

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استخدام الأقفاص المصنعة محليا لتربية الأسماك في أهوار العراق الجنوبية: دراسة حالة

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الخلاصة. تعتبر تربية الاسماك في أقفاص شبكية ومسجات إحدى طرق الاستزراع المكثف للأسماك التي تستخدم مساحة محدودة من المياه لجني محصول عالي من الأسماك. ويوصى بها خصوصا للمناطق التي تعاني من شحة المياه ومن أخطار التلوث كما هو الحال في أهوار العراق الجنوبية. إن الاستخدام المحدود لهذه التقنية يعود الى كلفتها العالية في الإنشاء والإدامة. ولكن الحاجة لتطبيق هذه التقنية في أهوار العراق الجنوبية قادت لاقتراح تصميم تقنية مبسطة لمنظومة أقفاص لتربية الأسماك معتمدة على ما يتوفر محليا من مواد الإنشاء وتلبي متطلبات أنظمة تربية الأسماك. 1. فحص المواد الخام المتمثلة بالنباتات المائية وبعض المواد والأدوات المتوفرة محليا لاختبار صلاحيتها لتصنيع الأقفاص والمسجات الشبكية. 2. استخدام التصميم الأمثل للأقفاص والمسجات بناءً على الكلفة والعمر ومرونة الإنشاء والصيانة. 3. إشراك السكان المحليين في مراحل الإنشاء المختلفة للأقفاص والمسجات. 4. القيام بمسح ميداني لاختيار المواقع المناسبة لتطبيق هذه التقنية من حيث عمق المياه وسرعة التيارات ونوعية المياه والإنتاجية الطبيعية وتوفر سبل الحماية الطبيعية والبشرية. 5. تدريب مجموعة من السكان المحليين على خطوات الإنشاء والتركيب والتشغيل والإدامة وزيادة قدراتهم لاستيعاب هذه التقنية الجديدة. 6. تركيب الأقفاص والمسجات التجريبية في المواقع المختارة بمشاركة وإشراف السكان المحليين المدربين. 7. استزراع بعض الأنواع التجارية من الأسماك التي تتوفر إصبعيتها من مفاص الأسماك المحلية. 8. اتباع الطريقة الأكثر فعالية في تغذية الأسماك باستخدام أنسب العلائق المصنعة المحلية وطرق تقديم الغذاء للحصول على أعلى إنتاج وأقل فقد ممكن ومتابعة معيشة الأسماك وحالتها الصحية. 9. مراقبة مؤشرات نمو الأسماك بشكل دوري على مدى فترة التربية وحساب معدل النمو النوعي وكفاءة التحويل الغذائي ونسب المعيشة. 10. إجراء تحليل لعوامل الإنتاج والمنفعة الاقتصادية المتحصلة لفائدة السكان المحليين.