Weed based aquaculture system

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Concept: The weed based system refers to the use of some inputs from plant sources, eg., weeds or grasses or leaves or macrophytes like duckweeds, Azolla etc. as supplemental feed in fish production. These inputs are consumed first as feed by herbivorous fish and subsequently a part of the semi digested faecal matter of the macrophytes feeding fishes are consumed by the other fishes and the remaining part will be recycled in food chain as nutrients for primary production, thus they have potentiality to increase the total fish production of aquaculture system. Weed based system may be a good option as a low cost, environment friendly sustainable aquaculture technique in Bangladesh (Grover *et al*., 2000).

Importance of weed based system as low cost aquaculture technique: Nutrient rich feed (specially higher protein content in diet) is one of the important factors to intensify the fish production. Fish feed generally constitutes 60–70% of the operational cost in intensive and semi-intensive aquaculture system. The fish feed used in aquaculture is quite expensive, irregular and short in supply in many third world countries. These feeds are sometimes adulterated, contaminated with pathogen as well as containing harmful chemicals for human health. Naturally there is a need for the development of healthy, hygienic fish feed which influences the production as well as determines the quality of cultured fish. Aquatic weeds are highly nutritious with protein content of 20-30%, when cultivated in nutrient rich waters. Importantly, they are preferred food of a wide range of herbivorous fish such as grass carp (*Ctenopharyngodon idella*), silver barb (*Barbonymus gonionotus*), tilapias (*Oreochromis niloticus*, *Tilapia rendalli*, *Tilapia zillii*) and rohu (*Labeo rohita*). Aquatic weed can be collected or produced at little cost. And thus weed based system is considered as low cost environment friendly technology.

Potentials, history and development: Aquatic plants have been utilized as food components and thus have played an important role in culture of herbivorous fish since 4000 years ago in Egypt and 2500 years ago in the Orient, including Indian subcontinent. Duckweeds might be having as much potential as fish foods that could be utilized in preparation of suitable fish feed essential in expansion of low-cost aquaculture system in the tropics. Since long *Azolla pinnata*

utilized as biofertilizer in agriculture has been popular among farmers. Nowadays, its utility in pisciculture has come to limelight and has been proven worthy of note because of its two unique activities: capable of nitrogen fixation from atmosphere that enhances nitrogen in semi-intensive pisciculture systems and used as direct food by some macrophagous fish. Fresh duckweed (and also the dried meal) is suited to intensive production of herbivorous fish and duckweed is converted efficiently to live weight gain by carp and tilapia. IIRR-ICLARM (1992) reported some farmers' proven weed based integration to aquaculture farming in different countries like China, Malaysia, Vietnam, Philippines and India. In 1989 the NGO, PRISM- Bangladesh set up an impressive programme to develop and disseminate duck weed aquaculture in Bangladesh. Comprehensive weed based research was initiated by ICLARM (WorldFish Centre) in 1999 in Bangladesh.

Table 1: Aquatic macrophytes used as fish feed in weed based aquaculture

Sl. No.	Scientific name	Local name	Characteristics
1	*Azolla pinnata*	Azolla	The species is typically triangular measuring about 1.5 to 3.0 cm in length, 1 to 2 cm in breadth. Newly form leaves are green but aged leaves are brown in color. With roots.
2	*Spirodela polyrriza*	Sonapana	Leaves are flat or oval, 6-10.5 mm in length, 5-10 mm wide and 0.6-1.5 mm thick. Deep green above but with deep brown/reddish ventral. It contains 10-15 roots which are 10-40 mm long.
3	*Lemna minor*	Khudipana	Leaves are flat and elongated, like tamarind tree leaves, 3-4.5 mm in length, 2-2 mm wide and 0.2-0.3 mm thick. Deep green or green in color. It contains single root which is 10-15 mm long.
4	*Wolffia arrhiza*	Sujipana, Dimpana	Leaves are minute and rounded, 0.6-1.2 mm in length and 0.5-1 mm wide. Deep green in color and without roots.

Azolla based fish farming in pond

About Azolla: It is a fern type smaller floating plant used as feed by the herbivore fishes. It is available almost all the geographic locations of the country. Since Azolla is rich in nitrogen content, the cost of chemical fertilizer can be reduced by azolla application to a greater extent in pond. Soil fertility can also be increased through it's use as organic fertilizer. One hectare land fully covered with azolla produces 10-15 tons of raw organic fertilizer and 20-25 kg of nitrogen (equivalent to 45-55 kg of urea fertilizer). Azolla can be supplied to the fishes through collection from nature. It can also be produced in ponds/ditches/canals/rice fields easily through preparing the Azolla bank.

Pond selection: Important considerations are: round the year water availability of the pond; good water holding capacity of the pond soil; pond surface well exposed to sunlight (sunlight penetration for 8-10 hours); mud layer of the pond bottom not exceeding six inches; good facility

Pre-stocking pond management: emphasis should be given on pond remodeling (in terms of inlet and outlet facilities and repair of the embankments) to protect from flood water entrance or to drain the excess water (in case of emergency); staffing with grass on the embankment so as to protect soil erosion (specially in red soil area); deweeding; and removal of predatory and unwanted fishes/animals.

After 3 days of predatory fish removal, liming should be done to remove clay turbidity and to disinfect the pond water (CaO@1 kg/decimal) for normal soil. Ash treatment (ash @15-30 kg/decimal) including liming (CaO@ 2-3 kg/decimal) is required for red soil. After seven days of liming, fertilization (organic fertilizer/compost @10kg/decimal, urea @ 250g/decimal and TSP @ 250g/decimal) should be done to produce plankton in pond water; after five days of fertilization azolla bank should be developed to supply sufficient azolla in the pond.

Development of azolla bank: Around 10% of fish free water area of the pond is separated by bamboo fencing to keep the compost for maintaining azolla layer round the year. Fresh Azolla seeds are inoculated @ 100-200g/m^2 or 4-8 kg/decimal (considering both for pond area and

compost area) over the compost area. The favourable temperature for the growth/reproduction of Azolla is between 25-30^{o}C.

Fish stocking: After 10-20 days, stocking (Fish size between 3 and 5 inches) should be done subjected to the sufficient production of azolla.

Fish species	**Stocking density (Number/decimal)**	
	Model-1	**Model-2**
Catla *(Catla catla)*	06	08
Silver carp *(Hypophthalmichthys molitrix)*	08	06
Rui *(Labeo rohita)*	04	04
Grass carp *(Ctenopharyngodon idella)*	03	03
Raj punti/Sarpunti *(Barbodes gonionotus)*	10	10
Kalibaus *(Labeo calbasu)*	-	06
Mrigel *(Cirrhinus mrigala)*	06	-
Carpio *(Cyprinuscarpio var. communis)*	03	03
Total	40	40

Post stocking pond management: Liming can be done periodically (CaO@100-250g/decimal/fortnight for normal soil). In addition to lime application, ash treatment (ash@5-10 kg/decimal/fortnight) is required for red soil. Application of organic fertilizer (Cowdung/compost @200g/decimal/day) and inorganic fertilizer (TSP@10g/decimal/day) are required for smooth supply of azolla round he year. Usually there is no necessity of supplementary feed application during availability of sufficient amount of azolla in the pond. During unavailability of azolla, supplementary feed (rice bran-50% and mustard oil cake-50%) can be given @3-5% of fish body weight.

Fish harvesting: The SIS fishes can be harvested after 3-4 months of stocking, on the other hand, larger size carps can partially be harvested and replaced by stocking.

Precaution: Increase in temperature is harmful for azolla, therefore, there should be provision of shading over the azolla bank for it’s smooth production.

Duck weed based fish farming in pond

About duck weed: It is a smaller floating plant used as nutrient rich feed by the animals and herbivore fishes. The soil, water and climate favors well for the growth and production of duck weed and it is available almost all the geographic locations of the country. Naturally it grows ponds, ditches, canals etc. There are six species of duck weeds in our country and among them, three species namely *Spirodela polyrriza* (Sonapana), *Lemna minor* (Khudipana) and *Wolffia arrhiza* (Sujipana) are culturable. Duck weed based fish farming has gained popularity due to increase in fish production through low cost protein rich feed application.

Pond selection: Any type of water body can be used for duck weed production towards commercial fish production. However, unutilized or less utilized or unproductive waterbodies (derelict ponds/ditches/road side canals etc.) can be selected for duck weed based fish farming. ponds or canals having with high level of organic matter content are more suitable for the production of duck weed. Some other important considerations are: round the year water availability of the pond; good water holding capacity of the pond soil; pond having partial or maximum shading facilities; good facility for water drainage; and easy availability of the aquaculture inputs closer to the pond.

Pre-stocking pond management: emphasis should be given on pond remodeling (in terms of inlet and outlet facilities and repair of the embankments) to protect from flood water entrance or to drain the excess water (in case of emergency); staffing with grass on the embankment so as to protect soil erosion (specially in red soil area); deweeding; and removal of predatory and unwanted fishes/animals.

After 3 days of predatory fish removal, liming should be done to remove clay turbidity and to disinfect the pond water (CaO@1 kg/decimal) for normal soil. Ash treatment (ash @15-30 kg/decimal) including liming (CaO@ 2-3 kg/decimal) is required for red soil. After seven days of liming, fertilization (organic fertilizer/compost @10kg/decimal, urea @ 200g/decimal, TSP @ 200g/decimal and MP@ 200g/decimal) should be done to produce plankton in pond water; after five days of fertilization, a separate production unit should be developed to supply sufficient amount of duck weed in the pond.

Development of duck weed production unit: Around 75% of the pond is separated by bamboo fencing to produce the duck weed. Duck weed seeds are inoculated (sonapana @ 25 kg/decimal, sujipana @25 kg/decimal and khudipana @ 16-17 kg/decimal over the production unit. According to research report, per decimal 2.5-3.0 kg of khudipana, 4.5-5.5 kg of sonapana and 5.0-5.5 kg of sujipana can be harvested through regular fertilization. On an average, per decimal 3.0 kg of duck weed can be harvested per day through regular fertilization.

Fish stocking: After 5-7 days, stocking (Fish size between 3 and 5 inches) should be done subjected to the sufficient production of duck weed.

Fish species	**Stocking density (Number/decimal)**	
	Model-1	**Model-2**
Catla *(Catla catla)*	06	08
Silver carp *(Hypophthalmichthys molitrix)*	08	06
Rui *(Labeo rohita)*	04	04
Grass carp *(Ctenopharyngodon idella)*	03	03
Raj punti/Sarpunti *(Barbodes gonionotus)*	10	10
Kalibaus *(Labeo calbasu)*	-	06
Mrigel *(Cirrhinus mrigala)*	06	-
Carpio *(Cyprinuscarpio var. communis)*	03	03
Total	40	40

Post stocking pond management: Liming can be done periodically (CaO@100-250g/fortnight decimal for normal soil). In addition to lime application, ash treatment (ash@5-10 kg/decimal/fortnight) is required for red soil. Application of organic fertilizer (cowdung/compost @800-1000g/decimal/day) and inorganic fertilizers (urea @25-35 g/decimal/day, TSP@8-10g/decimal/day and MP@)6-8g/decimal/day) are required for smooth supply of duck weed round the year. The mixture of fertilizers with water (fertilizer: water @ 1: 7) should be kept for 24 hours mixture solution should be spread over the duck weed free water area of the pond. The amount of duck weed produced per day in the pond should be maintained similar amount of the stocked seeds. Duck weed as feed should be supplied @ 100% of fish body weight. After

consumption by the fishes, surplus amount of duck weed can be harvested for supply to another pond. Change (increase or decrease) in the number of stocked fishes can be done for proper utilization of the duck weed produced in the pond. Usually there is no necessity of supplementary feed application during availability of sufficient amount of duck weed in the pond. During unavailability of duck weed, supplementary feed (rice bran-50% and mustard oil cake-50%) can be given @3-5% of fish body weight. Other weeds like azolla, banana leaf, vegetables and soft grasses can also be supplied as fish feed instead of duck weeds. Improved yield can be achieved if both weeds (30-50% of fish body weight) and supplementary feeds (2-3% of fish body weight) are provided with the fishes. However, it is better to reduce the use of supplementary feed and to increase the efforts for duck weed production and consumption for the fishes.

Fish harvesting: The SIS fishes can be harvested after 3-4 months of stocking, on the other hand, larger size carps (500 g and above) can partially be harvested and replaced by restocking.

Precaution: Clear water (i.e. water having no nutrients through fertilization) can affect the duck weed production.