

Small-scale aquaculture in rural development

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Contents

Rural definition & features of rural communities
Small-scale aquaculture
Vulnerability of small-scale farmers
Features of rural aquaculture
Models of small-scale aquaculture
Planning & promoting small-scale aquaculture
Subsidies and support
Conclusions

Rural definition

- **Population size and density:** Typically rural areas have small population size and low population density compared to urban areas
- In numbers: countries have its own definition
 - Rural community in Canada refers to a population of 1000 or fewer inhabitants. In the USA, a rural area comprises open country and settlements with fewer than 2500 residents. In India, a town with a maximum population of 15,000 is considered rural
 - In regard to population density/square kilometer, the rural area has been defined as 150 people in Canada, up to 385 in USA and up to 400 in India

Features of rural communities

Rural communities are characterized according to key categories:

- **Ties and relationship:** Strong interactions (help each other in distress and share the happiness). Emphasis on family blood lines, and kinship relationships
- **Source of income:** Traditional sources that are transmitted among generations (e.g. agriculture – fisheries). In India, a minimum of 75% of male working rural population are involved in agriculture activities
- **Employment:** limited work opportunities with lower wages
- **Rate of change:** usually slow because of lower level of education and modern technology

Rural population (% of total population) - Sub-Saharan Africa (2018) – Reference: World Bank Group

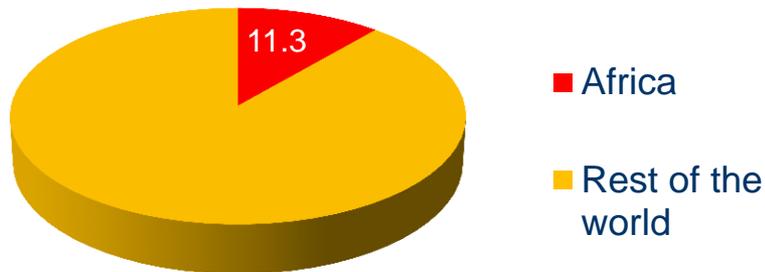
Country	%	Country	%	Country	%	Country	%
Angola	34	Cote d'Ivoire	49	Liberia	49	Senegal	53
Benin	53	Eq Guinea	28	Madagascar	63	Seychelles	43
Botswana	31	Eritrea	64	Malawi	83	Sierra Leone	58
Burkina Faso	71	Eswatini	76	Mali	58	Somalia	55
Burundi	87	Ethiopia	79	Mauritania	46	South Africa	34
Cabo Verde	34	Gabon	11	Mauritius	59	South Sudan	80
Cameroon	44	Gambia	39	Mozambique	64	Sudan	65
Central Africa	59	Ghana	44	Namibia	50	Tanzania	66
Chad	77	Guinea	64	Niger	84	Togo	58
Comoros	71	Guinea Bissau	57	Nigeria	50	Uganda	76
Congo Dem Rep	56	Kenya	73	Rwanda	83	Zambia	56
Congo	33	Lesotho	72	Sao Tome	27	Zimbabwe	68

Urbanization

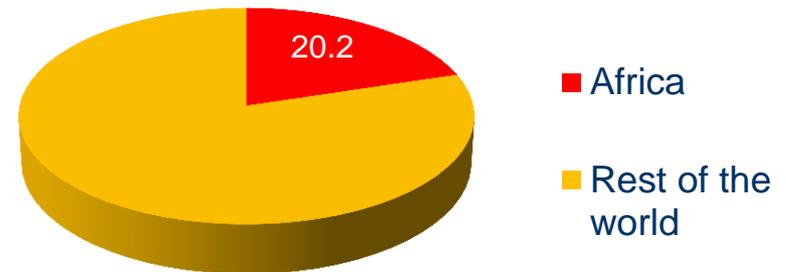
- Many rural residents –especially youth- travel and settle in the urban for various reasons including:
 - hope of changing ones economic circumstances through:
 - More work opportunities (Non-agricultural work, i.e. trade, commerce or provision of services)
 - Higher wages
 - Agricultural technology, industrial technology
 - Others
- Learning institutes, hospitals, and regional government, are usually located in urban areas

Urbanization in Africa

Urbanization % (2010)



Urbanization % (2050)



Global share of African urban residents is projected to grow from 11.3% in 2010 to 20.2% by 2050

Sub-Saharan Africa is regarded as the world's fastest urbanizing region

In 2016, about 40% of the region's total population resides in cities, compared to 31% in 2000

Small-scale aquaculture

- Globally, commercial aquaculture is the principal producing system (in tonnage). It is characterized by:
 - *Profit is the principle motive*
 - *Rely on urban markets or may operate through brokers or middlemen*
 - *Tend to be capital intensive*
 - *Relying on wage labor,*
 - *Mostly use external energy sources and mechanization*
- Often, social elements may be overlooked in commercial aquaculture (mal-nutrition, unemployment, migration, gender, etc.)
- Small-scale aquaculture can address the over-looked issues – More over, it can be of great benefit to rural families especially when commercial aquaculture does not exist
- Being small-scale, produced fish should be of comparable quality to commercial aquaculture.

Fish and livelihood



Credit: Patrick Appenteng (Ghana)

Mother deguts harvested fish from a fish farm in the Asuogyaman District of Ghana

Fish of good quality and affordable prices is always needed in rural areas where income is usually low and fish is at high demand

It is not necessarily that fish in this case is of premium size or neatly packed but should be of good quality

This little boy would be happier with a small fish than with a bigger piece of a larger fish

Features of rural communities (related to aquaculture)

- Low income people may not be able to afford cash expenses even in small amounts
- If the lack of cash is coupled with difficulties in accessing credits, it turns to a solid barrier to sustaining small aquaculture projects
- Sharing physical labor among farmers is a means to overcome a part of cash problem



Small-scale projects do often exist where roads are not suitable for heavy machinery or for transporting production inputs or fish produced



Credit of the above photo: Emmanuel Hahirwabasenga and Rwigiriza Augustin Kanimba (Rwanda)

Features of rural aquaculture (general)

Although the definitions of rural aquaculture operations vary, they have something in common:

- Utilizing small areas of land and/or volume of water
- Simple culture infrastructure - Not mechanized
- Rely primarily on on-farm inputs including organic fertilizers and possibly simple supplemental feeds
- Operated mostly by the household
- Generally requires minimum or no capital investment
- Family demand of fish is met before selling **extra fish**. If this is not the case, a social problem is there
- Ornamental fish projects are an example of cash crops of small-scale aquaculture



Family managed



Credit of above photo:
Kevin Fitzsimmons (USA)

Features of rural aquaculture - Labor involvement

- Small projects are constructed with more labor and less to no machinery
- Family may carry out most of farming practices
- Some family members (e.g. women) can work in family projects **but will not accept** to work for others
- Women's role can go beyond feed preparation or hapa making to pond management



in
Bangladesh



in Mozambique
in Malawi



Photos' Credit: Gabriel de Labra (Spain)

Small-scale aquaculture in development programs

- There are successful models of small-scale aquaculture (e.g. backyard hatchery for freshwater prawn in Thailand- during 1980s)



- Promoting family aquaculture is justifiable for incorporating fish as good source of animal protein in family meal
- Aquaculture has been incorporated in rural development programs either as a sole activity or in integration with other agricultural activities

Species criteria for small-scale aquaculture

- Farmers can deal with in ease
- Does not require neither exceptional skills or sophisticated husbandry arrangements
- For quick turn over, it is preferred to use fish species that have short generations
- Above all, the species should be widely accepted by target consumers



Credit: Eudes E. Sanchez (Colombia)



People like it



Species criteria – Preferably native species

Advantages

- Do not pose environmental threats to biodiversity, disease, etc.
- Known as a species and ways of preparation to local people
- Broodstock/fingerlings –when needed- can be obtained from natural waters
- **Theoretically**, its reproduction and husbandry is known at local level

Disadvantages

Often native species did not receive enough attention from NARS. This led to:

- Reproduction technology and seed production is often not well developed
- Not performing any genetic programs and so selected strains do not exist
- Absence of reliable data on its performance in aquaculture

NARS: National Agricultural Research System

Recommended fish species for the low-cost fish farming in rural aquaculture in Pakistan

Source: Introduction of low-cost fish-farming in rural areas of islamabad capital

Local/common name	Scientific name	Species selection considerations
Grass carp (introduced 1964)	<i>Ctenopharyngodon idella</i>	<ul style="list-style-type: none"> ■ Phytoplankton and zooplankton-feeding fish are more appropriate for the small-scale fish farming system ■ In such system, natural food could be produced easily at low cost ■ When integrated with agriculture crops and/or animal husbandry, there is an opportunity for safe recycling of farm by-products and/or manure in fish ponds providing nutritional base for fish production readily and economically
Silver carp (introduced 1964)	<i>Hypophthalmichthys molitrix</i>	
Thaila	<i>Catla catla</i> <i>Gibelion catla</i>	
Rohu	<i>Labeo rohita</i>	
Mori (Mirgal)	<i>Cirrhinus mrigala</i>	
Common carp (introduced 1964)	<i>Cyprinus carpio</i>	



The wrong choice: Golden Apple Snail

- Introduced with a welcoming campaign to feed poor rice farmers in Asia. (came from Argentina in 1980 to Taiwan then to Asian countries).
- Farmers (target beneficiaries) did not like it: **Top-bottom planning**
- Began to infest rice fields and prey on little rice plants (7-15 days old) causing significant losses

Golden apple snail (GAS) in rice paddies (a useful case study)

- Has invested about 800,000 ha of rice in the Philippines in 1995
- In Vietnam, GAS invested about 110,000 ha of rice paddies in 1997. In some parts of “Thua Thein Hue” province, rice farmers had to reseed rice several times
- In China, a monetary bonus is given against handled GAS to be burned

A bigger campaign to get rid of it

Vulnerability of small-scale farmers

Small holders in rural areas are often vulnerable in many aspects:

- Limited access to natural resources and often **lose competition**
- Limited capacity to cope with **crisis situations and risks**
- Prime motives include risk avoidance and household food security
- Limited ability to meet specific requirements for technology adoption – probably due to low literacy levels
- **Hesitant to try** but may apply what was found successful in their neighborhood
- Limited access to aid programs which could have been **designed for them** (e.g. credit)

Challenges facing small-scale aquaculture in East Africa

(Source: Wageningen University & Research)

Shortage of good quality and affordable fish feed

- Good quality feed is expensive because it's often imported from overseas.
- Farmers often lack the capital to buy commercial feed
- To keep production costs low, fish farmers prefer to buy cheaper, low-quality feed, or they produce their own feed
- The price of raw materials used in farm feeds can be seasonally high with significant fluctuation
- The lack of proper knowledge among farmers on the right feed formulation leads to doubtful quality of feed produced

Challenges facing small-scale aquaculture in East Africa

(Source: Wageningen University & Research)

Inadequate knowledge and lack of technical skill among small-scale farmers

- A lack of knowledge among small-scale fish farmers and access to the right technologies is another important issue
- In many places within this region aquaculture has existed no more than a few decades, so there aren't generations of experience to draw on
- Support from government extension workers is also limited because they don't have enough resources for the vast areas that they are trying to serve

Challenges facing small-scale aquaculture in East Africa

(Source: Arie Pieter van Duijn et al.)

Case study: Uganda

- Poor cooperation: Most farmers are not well-organized; they sell low volumes with weak bargaining capacity
- Because farmers are not organized enough, they are not able to buy bulk inputs with lower prices
- Some farmers complain that middlemen have too much power and take high percentage of the profits.
- Lack of capital: Farmers or family do not sufficient capital while at the same time they cannot get a commercial loan
- Under-capacity of extension services: Due to large travel distances, extension workers cannot reach target farmers while farmers have difficulty to visit extension workers

Poaching

- Although it is a sad incidence, it happens
- Incidences increase as fish ponds or cages are far from farmers' households
- Security arrangements may be needed (e.g. clustering operations, anti-theft or planting sticks)
- Guarding arrangements among producers is found effective



Guarding and
anti-theft
arrangements



Credit of above photos:
Kevin Fitzsimmons (USA)

Constraints and problems faced by small-scale aquaculture enterprises in west Nigeria (40 interviews)

Problem	%	Problem	%
Shortage of fry/fingerlings	95	Lack of capital/credit	85
High mortality of stocked fish	100	Lack of good water for fish farming	45
High price of feeds	100	Marketing problems	50
Unavailability of adequate funds	80	Lack of extension agents	75
Lack of skilled workers	85		

Reference: Yemi Akegbejo-Samsons and Deji Adeoye. Measuring profitability in small scale aquaculture enterprises in south west Nigeria

Barriers to adoption of improved farming practices or technologies in Cambodia (n = 228)

Barrier	%	Barrier	%
Access to sufficient supply of water	54.8	Selling price of fish in markets	46.5
Price of fish feed	39.0	Farming operation is too small	25.9
Quality of fingerlings	24.1	Quality of fish feed	21.9
Access to credit	21.5	Access to fish markets	19.3
Access to fingerlings	17.1	Insufficient knowledge	15.8
Price of fingerlings	14.0	Insufficient education or skills	12.7
Lack of secure land tenure	10.1	Access to fish feed	05.7
Fish farming is not profitable	05.3	Lack of labor and time	01.8

Reasons for discontinuing the practice of small-scale aquaculture in Cambodia (n = 112)

Barrier	%	Barrier	%
Access to sufficient supply of water	56.3	Price of fish feed	49.1
Selling price of fish in markets	45.5	Fish farming is not profitable	40.2
Quality of fingerlings	26.8	Access to credit	26.8
Access to fingerlings	24.1	Lack of labor and time	24.1
Access to markets	23.2	Farming operation is too small	23.2
Price of fingerlings	20.5	Quality of fish feed	19.6
Insufficient knowledge	15.2	Access to fish feed	15.2
Lack of secure land tenure	13.4	Lack of education or skills	12.5

Out of 436 operations, 112 had already discontinued the practice of small-scale aquaculture at the time of the household survey.

Models of small-scale aquaculture

- Rice – fish culture
- Manure systems (ducks – chicken - rabbits)
- Cages

Rice-fish culture (features)

- Not a new practice to most rice farmers
- Low-risk technology
- Minimum skill will be sufficient
- Very low investment required if any (ditch & screen)
- Minimum conflicts with other farm activities – if any

Credit: Deepak
Bhusal (Nepal)



As rice is the main crop, fish has to cope with rice requirements & practices and **never vice versa**

In case of short growing rice:

stock fish at larger size or

stock fast growing fish

stock fish which could be consumed at smaller size

Rice - fish aquaculture - Benefits

- About 5-15% increases of rice production
- Fish can control algae and soft plants and their seeds and hence reduce the need for algaecides
- Control mosquito larvae and snails
- Consume rice insects (e.g. brown plant hopper)
- Higher net revenue due to the saving on fertilizers and pesticides
- Harvested fish -when **consumed**- supports the nutrition of families (even seasonal)
- If produced fish is beyond the immediate consumption, drying and/or smoking can prolong the utilization period

Fish species in rice fields – Based on their:

(food habits – acceptance for consumption – adaptability to the system)



Rice-fish culture in Madagascar



Photo credit: BE Jean Jacques (Madagascar)

The integration between rice and fish is an old practice in Madagascar that goes back to around 1900.

The practice began with several fish species which are namely common carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), and black diamond cichlid (*Paratilapia pollen*).

Recently, tilapia is being integrated in the system.

The adaptability of fish species to the rice system as well as the **demand on these fish** has been the main criteria in selecting these species.

The involvement of private sector has been found essential in regard to overcoming the system obstacles such as the limitation of fish fry.

There are about a million hectares of rice fields in Madagascar.

Rice – fish culture (challenges and considerations)

Challenges	Considerations
Harmonizing fish growth (production) with the calendar of the short season of rice strains	Proper choice of fish & size upon stocking Consider feeding Could target fingerlings rather than table fish
Shallowness of water and fluctuation of temperature & dissolved oxygen	Construction of refugee ditch Proper selection of tolerant fish (e.g. air breathers, tilapia)
Possible applications with chemicals or pesticides	Rice varieties resistant to insects and disease Partly drain the field to guide fish to the ditch Change water after 3-4 days
Risk of grazing on rice seedlings or seeds	Safe size of chosen species after rice is well established

Fish-duck farming

Historic background

Has expanded rapidly in Central Europe after World War II to offset the shortage in animal protein

Afterwards, the practice has expanded to Asia and beyond

Suits rural development where ducks are traditionally consumed

With the exception of France, most consumed ducks occur in Asia

Ducks are left on water surface for most of the day and sheltered during night

Applications

Stocking density of ducks could be:
Low: in **Germany**, 300 ducks/ha led to 100 kg/ha of common carp

High: in **Hong Kong**, ducks are stocked at 2500-3500/ha to yield 5 to 6 t/ha of meat and 2750-5640 kg/ha of fish

What is the leading crop?

30 ducks are
Required to fertilize
1000-m² pond
14-m² duck shelter



Fish-duck farming

Benefits

- Fertilize water (non-labor manuring machines)
- Suppress the undesirable aquatic vegetation
- Water aeration through swimming (biological aerators)
- Pond water provides about 25% of duck's diet (plants, insects, aquatic larvae, and earthworms)
- Loosen pond bottom and release soil nutrients (phosphorous)

Challenges

- Compatibility between warm-blooded birds and cold-blooded fish
- Cannot be justified where ducks are not traditionally eaten
- Ducklings are nursed and grown somewhere until they can swim



Fish-duck/fish gees farming in Africa

Applications

- The growth cycle of ducks is about 2 months; about 120 to 150 ducks can be raised on a 100-m² pond in a year
- Above mentioned ducks produce 4 to 6 tons of manure during the year
- Ratio (fish : duck): For 200 grown fish, about 20-30 ducks are required in 200-m² pond
- In case of geese, 10 to 20 birds are ideal for the same number of fish and size of the pond

Fish-duck in Tanzania



Fish-chicken farming (Not water birds)

- Chicken when raised in a shelter (~0.5m above water level):
 - Maximize the use of space
 - Saves manuring labor OR
- Adjacent to the ponds; poultry excreta are recycled and used to fertilize fish ponds
- Could be either for broilers or for laying hens
- With few exceptions, the ratio between numbers of birds required for given aquaculture operations is based on personal experience



Credit: Emmanuel Godfrey
and Mashaka (Tanzania)



Fish-chicken farming

Considerations

- One-day chicks are nursed for at least 14 days before being sheltered in this



Photo credit: Innocent Zambou (Cameroon)

- Each broiler requires 1.5 ft² floor area; each layer requires 3 ft²
- Enough cross ventilation should be maintained
- Floors should have 1 cm gap, to allow excreta to fall into the pond, but not to trap the chicken's feet.



Photo credit: Alain Murekambanze (Burundi)

Challenges

- If water turns deep green due to plankton blooms, dissolved oxygen may drop to lethal levels
- If this happens, plastic sheets are placed below the chicken shelter to prevent chicken excreta from reaching water
- Fish feeding may be suspended for enough time
- Pond water is refreshed with freshwater whenever possible
- Unless chicken treatment or vaccination is carried out in isolated facilities, there will be a chance for contaminating pond water with residues of drugs and chemicals that ultimately reach the fish

Fish-chicken farming – Case study (Tanzania)

Description

- This farm is located at Tarime District in Mara Region, where temperature ranges from 20-25 C
- This practice has been benefited from a national study carried out in the district
- The implementation of this project adopted a participatory approach with contributions from fishery agency, research institutes and farmers
- The chicken huts are placed on the top of pond water where tilapia has been stocked. The chicken huts –in regard to laying hens- are furnished with wooden egg laying boxes (30 cm × 30 cm × 30 cm)
- Chicken feed is made of locally available ingredients mixed on the farm
- No supplemental feed is provided to fish throughout the culture period as the poultry droppings and spilled feed from poultry provided feed for the fish either directly or through enhancing water productivity

Comments



Photo credit: Lucka Paschal and Erick Kiiza
Tanzania)

Notes: Issues considered

- ❖ Benefitting from previous studies
- ❖ Climatic conditions have been considered (for fish/birds)
- ❖ Participatory approach has been adopted
- ❖ Manageable approach rather than highest productions was found appropriate (e.g. feeding)

Rabbit-fish farming

- Field observations in Rwanda showed that 10 rabbits are sufficient to provide enough organic fertilization to 1-acre fish pond
- The only source of fish nutrition in this system could be the natural food which is stimulated and maintained by the organic fertilization (rabbit excreta)
- Although rabbits are not traditionally eaten in many countries, there are significant national efforts to promote the consumption of rabbit meat
- Rabbit meat is low in fat, low in cholesterol and rich in proteins (Rwanda)



Rabbits with mix-sex Nile tilapia in Rwanda

Rabbit-fish farming - applications

The advantages of the rabbit in this integrated system:

- Rabbit-fish system has promising applications in world rural development programs especially where rabbits are consumed
- Rabbits have short generation, high productivity, fast growth rate, and low production costs
- Being herbivores, rabbits can be fed on variety of farm byproducts. Forage, cassava, and sweet potato vines are examples
- Job creation especially after some training

Highest rabbit meat consumption occurs in the Mediterranean countries whereas Italy has the world lead in rabbit consumption (about 6 kg/capita/year)

Although there is no religious taboos against eating rabbit meat, in some cultures, rabbits are looked at as cute and fuzzy animals causing many people hate to eat rabbits



Photos credit: Fidele Kampayana & Emmanuel Hahirwabasenga and Rwigiriza Augustin Kanimba (Rwanda)

Cage aquaculture

Benefits

- Ideal for landless people who get an access to water resources
- Could be used to produce table fish or fingerlings
- Investment cost is usually lower than land-based infrastructures
- Women can have an active role especially in feed preparation
- Ease of handling and harvesting

Challenges

- Compatibility with environmental standards
- Vulnerability to poaching if not properly secured



Marketing of extra fish (1)

- Small-scale aquaculture may go beyond household consumption
- A part of produced fish can be sold to offset other household expenses
- Often marketed fish is in small quantities
- Produced fish are often sold within the community or through middlemen
- If sold through middlemen, farmers are often over-exploited and get the least benefit from their production



Photo credit: David Sykora
(Paraguay)



Photo credit: Evelyn Ame
(Philippines)

Marketing of extra fish (2)

- Expected to be at affordable prices
- If difficulties in fish marketing is detected, a community fish market would help
- Consumers trust such truly non-iced fresh fish (they may witness the harvest)
- Witnessing the harvest provides an opportunity to small producers to sell their product without additional marketing expenses
- Direct marketing eliminates the traditional layers in marketing



Credit: Herman Hennig
(Argentina)



Credit: Domwa Mathieu
(Cameroon)

Planning & promoting small-scale aquaculture projects

Promoting small-scale aquaculture in Africa (rationality)

Per-capita (kg/year) fish consumption in Africa 2016 (Source - FAO Year Book)

World average	19.7 kg		
Africa average	9.9 kg		
< 5 kg	Algeria, Botswana, Burundi, Djibouti, Eritrea, Eswatini, Ethiopia, Guinea Bissau, Kenya, Lesotho, Niger, Reunion, Somalia, South Sudan, Sudan, Zimbabwe		
5 – 10 kg	Burkina Faso, Central Africa, Chad, Congo Dem., Guinea, Liberia, Madagascar, Malawi, Mali, Mauritania, Nigeria, Rwanda, South Africa, Tanzania		
>10 – 15 kg	Cabo Verde, Comoros, Mozambique, Namibia, Togo, Tunisia, Uganda, Zambia		
>15 – 20 kg	Angola, Cote d'Ivoire, Eq Guinea, Libya, Senegal		
> 20 – 25 kg	Benin, Cameroon, Egypt, Mauritius, Morocco		
> 25 kg	Congo, Gabon, Gambia, Ghana, Sao Tome, Seychelles, Sierra Leone		

Promoting small-scale aquaculture

Ensuring initial success

- Choose the most appropriate technology
- Select target beneficiaries based on transparent criteria
- Choose the right species of fish
- Consider all production-related issues from farming until marketing
- Ensure that activities meet existing regulations (e.g. environment, food safety)
- Develop a special credit line for the project
- Plan for project sustainability (afterwards)

These projects should not be subject to trials & errors

The use of quality fingerlings is of high priority to ensure that small-scale fish farmers are starting off their production cycles with the best quality stock

Promoting small-scale aquaculture (planning approaches)

Top-bottom approach

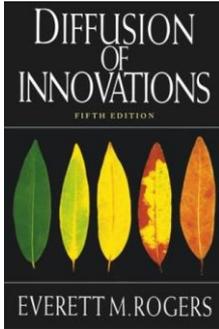
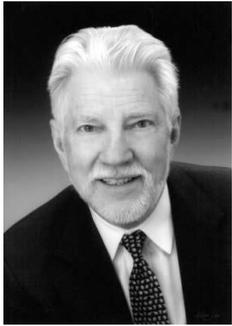
- Planning is done by the central government "which knows better than beneficiaries" - theoretically
- This approach lacks the two-way information flow whereas only one side generates the information

GAS is an example

Participatory approach

- Done via a participation of farmers, researchers and extension agents – all are winners
- Farmers adopt the outcomes of their own programs
- Extension agents act as catalysts and stimulate group efforts

The recent shift is towards greater farmer participation



Adoption curve and potential beneficiaries

Everett Rogers
1931-2004



Source: Everett Rogers, *Diffusion of Innovations*, 5th ed.

Adoption groups and potential beneficiaries

<p>Innovators:</p>	<p>Experienced, wealthier, brave & creative Fond of developing and trying new ideas Capable to take risk and can absorb some financial loss If they fail, they quickly move forward to next innovation Play a critical role in the early phase of the diffusion process. They pull the change from conventional methods which they normally do not appreciate.</p>
<p>Early adopters</p>	<p>Often educated with Sufficient financial resources Interested in trying new ideas proven successful somewhere. Socially respected and opinion leaders Their adoption to a given innovation eliminates most of the uncertainties Reliable sources for quality information. Ideal partners in field trials</p>
<p>Early majority</p>	<p>Rationalist, thoughtful and careful Accept changes especially those tried by trusted sources such as early adopters Prefer simple ideas and hate complexity Avoid taking risks and prefer ideas of rapid payback periods</p>
<p>Late majority</p>	<p>Last portion to adopt an idea Conservatives – skeptic – less resources Use new ideas after seeing that most of people use it Usually older, less educated and less wealthy Their opinions are often shaky and could be changed by discouraging rumors and other opinions They like to be absolutely sure then all of the uncertainties are removed before adopting a new idea.</p>
<p>Laggards</p>	<p>Laggards: Traditional people who resist the change Comfortable with traditional practices Suspicious, extremely cautious about new ideas which are felt risky Like to be 100% sure that a new idea will not fail If they finally adopt an innovation, it may already have been outdated They may never adopt Often older, with limited resources Take very long time before making their minds</p>

Planning and threat assessment (case studies)

Fish cages in Kaptai Lake (Bangladesh)

Project: Promotion of fish cage farming of carps at Kaptai Lake

Disaster: cyclones damaged fish cages, surviving cages experienced poor fish growth, and operators did not repair or replace damaged cages

Careful planning should include risk assessment

The analysis of stakeholders' willingness and capacity to face such risks will be also needed

Fish cages in Kenya

Cage culture project "BOMOSA" conducted trials on cage culture in small water bodies in Lake Victoria Basin (Nile tilapia and Victoria tilapia)

The trial at Dunga beach was aborted as a result of destruction of the cages by water hyacinth (*Eichhornia crassipes*) while the trial at Obenge was abandoned after the cages were destroyed from low quality netting and rocky substratum

Source: Asian Development Bank, 2004, Special evaluation study on small-scale freshwater rural aquaculture development for poverty reduction.

Simplicity concept and sustainability

- By definition; small-scale projects are simple
- However, project objectives should be met
- Factors determine the level of simplicity include: target production, adoption level of the farmer, climatic conditions, ...etc.
- For example, if open system for fish reproduction would achieve the target production, it will be wise to start with
- Insisting on the use of poor quality farm inputs may lead to **unsustainable** projects
- Simplicity concept is still based on scientific information and established technologies
- Remember, simplicity does not apply to the planning



Natural spawning of tilapia
(Madagascar)



2 million tilapia fry
(Egypt)

Simplifying advanced technology (Example: Aquaponics)



In Kenya

A simple version of hi-technology operations

It is easy to operate, inexpensive, and could be optimum for people with limited economic resources



In Colombia



Credit: Edwin Gómez Ramírez
(Colombia)

Criteria and definitions: (family or small-scale aquaculture) – (Philippines)

Fish hatchery

- Production is less than 30,000 fingerlings/month
- Surface area is less than 1000 m²
- No ability to nursing fry
- Incomplete security regarding the area under utilization (via lease, partnerships and others)
- Vulnerable to the risk of flood/ or draught

Meeting three of the above means, the hatchery is a small one

Criteria and definitions: (family or small-scale aquaculture) – (Philippines)

Pond/ pen/cage farms

- **Size**
 - **Earthen farm:** size of each pond is less than 1000 m² in less than 1-ha farm
 - **Pens:** less than 1000 m²
 - **Cages:** less than 200 m²
- Financial resources are not sufficient. And no access to formal credit
- Quantity sold in cash does not exceed 30% of produced fish
- Utilization instability (lease/utilization) of land lack stability
- Water resources are either insufficient or seasonal

Meeting three of the above, the project is a small one

Criteria of small-scale fish pond (Malawi)

- Earth pond: between 100 – 500 m²
- Fed with crop byproducts such as maize and rice bran
- Farmers who have access to livestock manure are encouraged to use them as pond fertilizer
- Using monoculture of tilapias (*Oreochromis shiranus*, and *Tilapia rendalli*) or in polyculture with catfish, *Clarias gariepinus*
- Farmers are encouraged to integrated fish pond with crops grown near the pond dikes. Pond water is used to irrigate the crops, and add usable waste crop materials to the ponds as fish feed or used as compost manure
- Production is both for home consumption as well for sale



Chimatiro, S.K. 1998. Aquaculture production and food safety hazards in sub-Saharan Africa: with special reference to Malawi

Criteria of small-scale aquaculture – Sub-Saharan Africa

- Rely primarily on on-farm inputs including organic fertilizers and simple supplemental feeds
- Operated mostly by the household
- Integrated -to varying degrees- with other agricultural enterprises
- Prime motives include risk avoidance, diversification as well as household food security
- Generally requires minimum or no capital investment
- Not mechanized

Criteria and definitions: (family or small-scale aquaculture) – (Indonesia)

Farms with less than 1000 m² (pond culture)

Less than 30 unit (cage culture)

Less than 2 unit (floating net) **and**

Less than 2 ha (rice field)

Criteria and definitions: (family or small-scale aquaculture) – (Chile)

Micro-entrepreneurs

Hold less than 10 ha in concessions

Use less than five workers **and**

Operate with low levels of investment and technology

Criteria and definitions: (family or small-scale aquaculture) – (Rwanda)

A field surveys in Rwanda, indicated that fish farming provides cash to the family and supplements the diet of the Rwandan farmer.

Harvested food-sized fish:

- 61% were sold

- 31% were consumed by producers

- 8% were given away

Notes on criteria

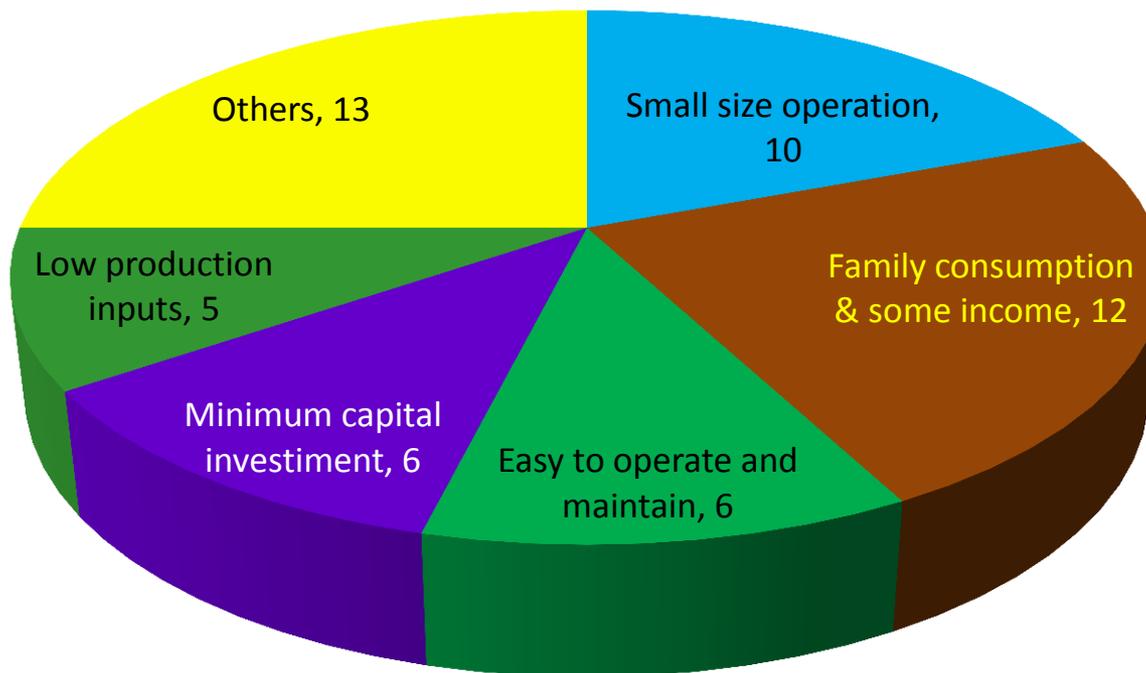
The criteria for small-scale beneficiaries which are considered in a country may not have the same weight or seen irrelevant in another country (e.g. flood, draught, etc.)

This requires site/country-specific criteria

Criteria of small-scale aquaculture

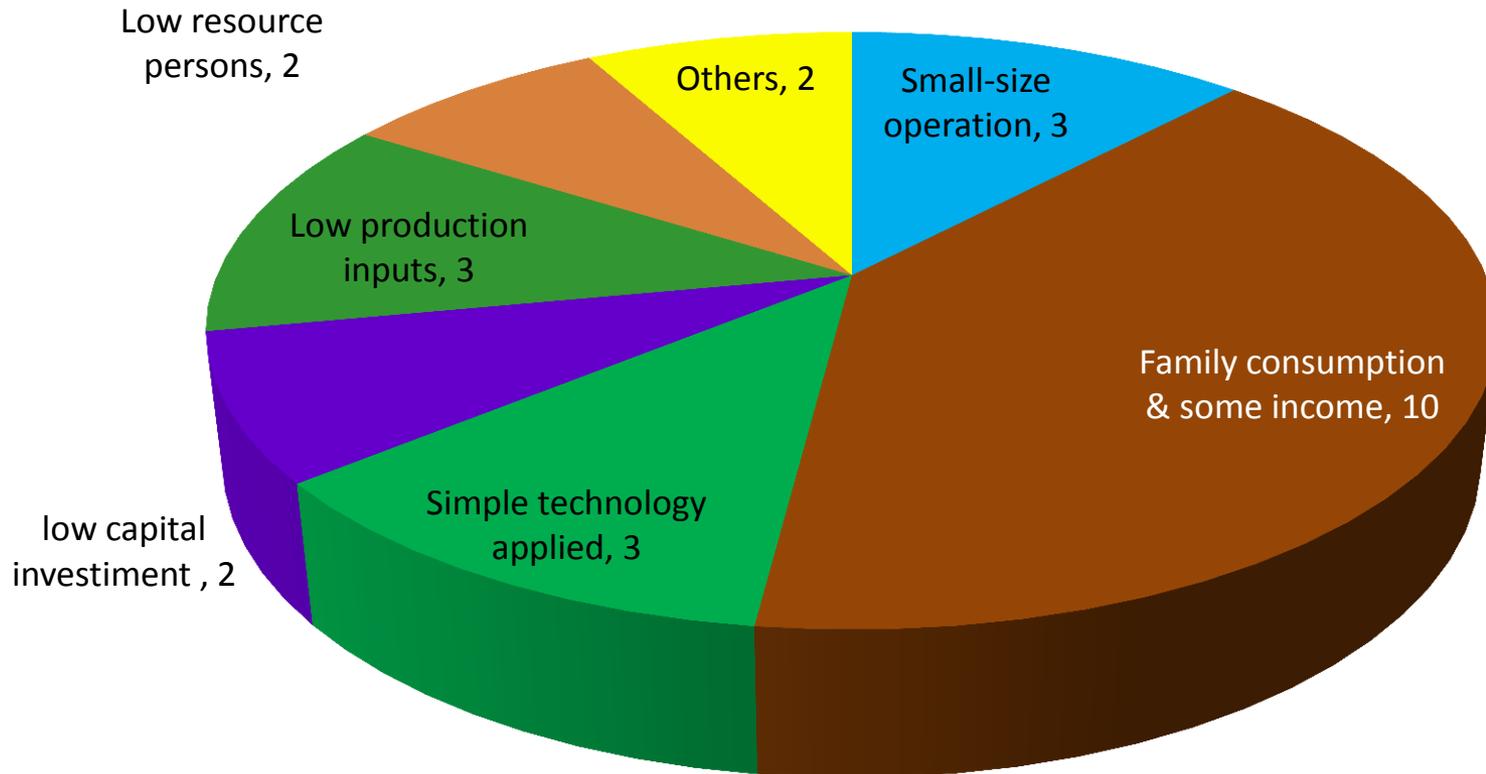
(Based on inputs provided by 15 specialists from 9 African countries)

Category



Criteria of small-scale aquaculture

(Based on inputs provided by 14 specialists from 12 African countries)



Setting success indicators and identify requirements

Setting success indicators

- The sustainability of the projects beyond the end of the development programs is the most important indicator
- More reproductions of original projects
- Incidences of reaching beyond small-scale criteria (upgrading)

Identify requirements

- Small-scale beneficiaries do not have access to consultancy services (they may run simple assessment)
- Extension service is essential and should receive adequate support (budget, staff training)

Careful planning & securing project requirements eliminate unpleasant outcomes

Extension service and small-scale projects

General

Extension agents (trainers) should be well-trained themselves

Chosen trainers should have the ability to communicate with beneficiaries

Trainers should admit **not knowing** sometimes instead of giving wrong advices

If trainers lose farmer's trust there might not be another chance

Challenges

Farmers do not trust agents with poor advice

Extension agents get readily discouraged if they are not accepted

Lead farmers with special training could be selected to transfer farming technology to fellow farmers (e.g. Bangladesh, China, Congo and Liberia)

Cultural issues should be identified and respected

Photo credit: Manuel Cano
(Guatemala)



Photo credit: Kanwal Odhejo
(Pakistan)



Feed and small-scale aquaculture

Types of fish feed

Ranges from natural food (high in protein), to:

- Supplemental feed (low cost & high in energy), to:
- Specialized feed if technically and economically justified

Cost of feed will remain an important issue to consider in promoting rural aquaculture



Feed and small-scale aquaculture

- Some of farm byproducts could be used while others **should not** be used
- Most farmed fish have difficulty in digesting plant materials
- Compost and/or silage improve the quality and digestibility of plant materials
- The use of external feed should be an option when economically feasible
- Some of usable farm byproducts have found to be useful in small-scale projects (e.g. yam/sweet potato leaves – duckweed - cassava)



e.g. Water hyacinth is not nutritionally balanced. The plant may be good for other usages but **NOT** as feed.



Cassava

Some of usable farm byproducts in small-scale aquaculture

Yam/sweet potato leaves

- Around 95% of the world's yams are grown in West Africa; Nigeria produces about 70% of world's yam
- China produces about 80% of world production of sweet potato. In Africa, Uganda is the largest sweet potato producer
- Nutritional merit of yam and/or sweet potato leaves recommended its use in animal feeding. Yam leaves are rich in vitamins A and C as well as riboflavin, fiber and iron
- Sweet potato leaves contain about 27% protein on dry matter basis; also rich in minerals and vitamins.
- A significant proportion of fish farmers in Uganda use the leaves of yam and/or sweet potato as a supplementary fish feed.



Photo credit: Saverino Nuwasiima



A tank for duckweed production could be recommended to feed fish

Photo credit: Louis Landesman

Fish seed and small-scale aquaculture

- Good quality fry = good harvest
- Reducing the production cost through giving-up the high quality fry should not be an option.
- Fry costs are usually marginal when compared to other production inputs



Small-scale aquaculture can use the best quality seed available

Credit and small-scale aquaculture

- To financial institutes, aquaculture is regarded as a relatively unknown business and hence is considered a risky activity
- Most small-scale fish farmers do not have the collateral as required by the commercial banks. some of which are very difficult or **unrealistic** (e.g. salary depositing; money against money)
- Rural communities are not generally familiar with banking systems and often they do not enjoy credit history
- Some producers do not prefer bank credits as well as interests for personal beliefs

Note: Supporting small-scale projects should be always the responsibility of governments and cannot be left to commercial banks

Credit accessibility (target and actual beneficiaries)

- Bank requirements are frequently not in favor of the landless, small-scale farmers and short lease cases
- Instead of banks, farmers may rely on informal credit from other sources, including suppliers' credit.
- **Supplier's credit** made fish farmers to accept a modest quality fish feed. Interestingly, Farmers are often aware about that

Credit for small-scale projects (Egypt)

- A credit line has launched in mid 1990s to provide soft loans to agricultural sectors including aquaculture
- Small/medium projects have been the immediate target to such credit line
- Credit officers in collaborating banks were not familiar with aquaculture activities
- Commercial companies in other sectors were well-prepared for the credit line
- Target groups were not comfortable with banking system; also lack collaterals and no credit history
- A single day workshop was effective for introducing aquaculture to the bankers



Educating bankers



Size of the small-scale aquaculture projects in governmental & aid programs

Increasing the number of beneficiaries could be done for political reasons. Although this may look a noble intention, it could threaten the sustainability of small-scale projects



Beneficiaries may lose interest in case of under-sized projects



Social studies are necessary for these small projects
Often, beneficiary are not aware or cannot afford feasibility studies

It is more valuable to have fewer but successful projects than more of abandoned ones

Small-scale aquaculture & family livelihood

Cages in Mymensingh River in Bangladesh



Aims to provide a protein rich food for families and to generate some income

Photo credit: Abu Sayed Talukder & Zahangir Alam (Bangladesh)

Small fish ponds in Thailand



The production goes first to family consumption while exceeded quantities –if occurred- could be exchanged with neighbors or sold

Photo credit: Worawut Koedprang (Thailand)

Small earthen ponds in Malawi



The outputs form an important part of household livelihoods

Photo credit: Gaves Mulaleya (Malawi)

Small-scale aquaculture & production inputs

Integration with large animals in Rwanda



Ponds are owned by cooperative farmers in Nyagasambu site. The number of animals is sufficient to produce enough manure as required by the fish farm

Photo credit: Emmanuel Hahirwabasenga and Rwigiriza Augustin Kanimba (Rwanda)

Cages in Mymensingh River in Bangladesh



Fresh natural foods (e.g. duckweed, snails), household vegetable wastes, low cost feeds (e.g. rice bran and oilcake). In some cases, commercial feed could supplement the traditional feed

Photo credit: Abu Sayed Talukder & Zahangir Alam (Bangladesh)

A program for small fish holders in Narino, Colombia



Fish feeds primarily on azolla while banana, yucca, bore are alternatives food sources

Photo credit: Andres Delgado (Colombia)

Subsidies and support – Case studies

Malawi

Fingerling Debt Program:

- Farmers are supplied with free seed for their start-up crop from the Domasi Experimental Fish Farm (DEFF)
- In return they incur the obligation to provide free seed to another farmer when he begins operations

Kenya

- In the earlier years of introduced credit scheme, cash was given for securing production inputs
- Significant loans were not repaid
- A new credit scheme focuses now on in kind credit; no cash is given. Instead loans are used to buy fingerlings from the fry production centers and feeds and so on

Subsidies – Free/subsidized production inputs

- Governments –while promoting small-scale aquaculture- may feel responsible for providing some production inputs for limited resource producers
- Subsidized inputs could be “all”: (e.g. Rwanda, Thailand and Colombia) **OR** could be “only seed”: (e.g. Cameroon, Zimbabwe, and Guatemala)
- Free seed are determined by the official authority such as Asian sea bass in Thailand, common carp in Sri Lanka & Egypt and tilapia in Mexico
- In India, Indian carp seed has been distributed at 50% of its cost
- Why fish seed?
- Fingerling production may be out of the ability of target beneficiaries or may represent a substantial cost especially for subsistence farmers
- Providing fish seed would eliminate doubts related to seed quality in regard to project performance



Photo credit: Marx Garcia (Philippines)



Photo credit: Andres Delgado (Colombia)

Specific subsidies (Case studies)

China

- The government does not subsidize farm inputs except in very few cases
- The government offers a 200 yuan/mu subsidy to encourage shrimp farmers (1 yuan=0.16 US\$; 1 mu=666 m²)
- Fish farmers obtain credit through the Agriculture Bank of China (ABC) and Agriculture Credit Cooperation (ACC)
- Credit policy targeted to support national agriculture development strategy and has been used to support specific crop production. (Economic tool)

Panama

- Cost sharing approach has been adopted - a part of the cost should be tolerated by beneficiaries
- Success is measured by farmers' acceptance to provide their share of the cost (not necessarily equal shares)
- Ministry of Agricultural generally provides bulldozers for earthmoving
- Project participants provide labor, housing, and food for the bulldozer operators, diesel fuel for the bulldozer, and all other materials needed to construct the ponds

Free supply of production inputs

Negative opinions

- According to FAO study, the number of free fingerlings delivered was frequently **lower than reported numbers**
- Dependence of producers on free supply of seed has been reported to be a major cause of the failure of aquaculture projects
- Free seed from governmental hatcheries may hinder the development of private seed industry especially for the provided species
- Unfortunately, it seemed easier for the extension agent to supply free seed rather than train farmers to produce their seeds
- The transfer of seed production technology should be attempted before the free supply of seed whenever applicable (Panama)

- Real farm economics may be difficult to assess in the light of subsidies
- Beneficiaries will get used to it. Efforts will be spent for its continuation rather than trying to produce their own seeds
- If a government terminates or suspends the free gifts for whatever reason
- Farmers feel that, if they wait long enough, the government will resume the subsidy
- If the termination of subsidies continues, the sustainability of projects could be threaten
- Farmers who are not getting such incentives may develop jealousy feelings
- Could lead to unnecessary **corruption**

Cost sharing example (Pakistan)

Source: Introduction of low-cost fish-farming in rural areas of Islamabad capital territory

Contributor	Doing - providing
Farmer	Pond construction – manure - labor
Government	<ul style="list-style-type: none">▪ Assigning a qualified engineer to design and estimate the construction costs▪ Recommending a loan program to the Agriculture Development Bank▪ Supervising the pond construction▪ Providing 5–8 cm fingerlings free-of-charge of various cultivable fish▪ Conducting checks on growth as a follow-up to monitor the activity▪ Continue to train the farmer at site
FAO	<ul style="list-style-type: none">▪ A Consultant to:<ul style="list-style-type: none">➤ assist the national authority and staff in selecting the sites➤ orient the farmers in carrying out the activity➤ orient the extension personnel in carrying out the follow-up program▪ Equipment: the field equipment will assist the extension service to carry out the follow-up program

Technical support – Capacity building

- Training is important for project success
- Courses should be carried out in educational centers; **only** parts of the courses could be done in the field
- Selected group of beneficiaries should receive training to acquire basic aquaculture skills
- The training program needs to cover handling of different fish species, stocking of fish in a culture units, feeding, preliminary water quality management, harvesting, and marketing.
- The training targets to prepare the target farmers to operate and manage their projects



A farmer to farmers training
Photo credit: Marcel
Adavelo (Madagascar)

Role of associations, cooperatives & other umbrellas

Case study in Kerala India: A model of homestead ornamental fish farms that are run by rural unemployed people in their homes

Farms are linked to satellite farms that provide fish seedlings as well as the infrastructures

The production from the homestead farms will be taken by the satellite farms

This activity comes under the umbrella of a Kerala government initiative; Kerala Aqua ventures International Limited (Kavil)

The initiative targets to produce and export ornamental fish of particular species to meet the growing demands

Small producers should get fair returns for their efforts

Associations and cooperatives could endorse small-scale producers when buying production inputs

Cooperatives could act on behalf of small producers who lack collaterals for accessing credits



Photo credit: G. Venkata Raju (India)



External - funded priorities (national & international perspectives)

Advantages

External funds intend to bring international experiences into national programs

National systems are responsible to highlight the country needs

Working on and resolving areas of conflicts –if occur- was successful in most cases (but not all)

It turns sad when national systems modify priorities or insert some parts in order to fit the donor interests

Concerns

External fund is not always a blessing especially in work atmosphere

When the external fund ends, it becomes difficult to operate and maintain facility that begins to deteriorate

National extension priorities that are often placed on food security and quality of life may not agree with the interest of international donors

Small-scale aquaculture and human health

Small-scale projects and human health (Sub-Saharan Africa)

Millions of people rural areas such as in the sub-Saharan African region are undernourished through deficiencies in essential vitamins and minerals, especially vitamin A, iron and zinc.

These deficiencies are especially important at key stages of human life, namely pregnancy, breastfeeding and childhood, and can have severe and irreversible impacts for health and physical and mental development.

Fish can contribute to reducing micronutrient deficiencies in the human body and reducing the health burden of malnutrition and physical and mental underdevelopment.

Some fish species, in particular the small fish that are important in the diets especially of young children, infants and pregnant and lactating mothers.

Small-scale projects and human health

There is a long historical record of nutritional merit and safe use of spirulina

Spirulina is rich in beta-carotene and hence can overcome eye problems caused by Vitamin A deficiency.

Very digestible and has very high 65% protein, B-vitamin complex, iron and trace minerals

Has a substantial GLA, an essential fatty acid that helps regulate the hormone system.

Spirulina culture in Burkina Faso

Some of small-scale spirulina operations of 8-m² pools have been built at some hospitals.

The product received the approval of Ministry of Health in 2005.

A spirulina provides the portion that goes rehabilitation and health centers is subsidized and sold at loss

Spirulina culture in Farende village (Togo)

Dried paste of spirulina was distributed at the health clinic whereas undernourished children took it as a daily supplement.

One 100m² pond could supplement the diet of 100 children a day.

It has been claimed that undernourished children when taking a tablespoon a day mixed with water brought great results.

Small-scale projects and human health

Culture of “Mola” in rice fields (Bangladesh)

Mola (*Amblypharyngodon mola*) is a small indigenous fish that do exist in household ponds and natural waters in Bangladesh.

In addition to the animal protein content, mola is rich in vitamin A (20 times higher than commonly cultured fish species). Mola is also rich in calcium, iron, zinc, and phosphorus.

Including mola as part of the diet can help those suffering from malnutrition and micronutrient deficiencies, especially pregnant and lactating women and children younger than 2 years of age.

Human nutritionists claimed that “mola” can play a major role in lowering the incidence of child blindness, night blindness and infant mortality in Bangladesh



Photos' credit: World Fish Center



Small-scale projects and human health

Culture of “Mola” in rice fields (Bangladesh)

Production features of “mola”:

- Feeds on natural food organisms stimulated by fertilization
- Spawns naturally two to three times a year (no need for sophisticated hatchery facilities)
- When cooked as a whole and processed into a paste, and mixed with rice and vegetables, turns to a child-friendly one-pot meal (*khichuri*) which is high in micronutrients .

Notice that focus has been placed on health benefits rather than biomass produced or monetary revenue



Photos' credit: World Fish Center



Conclusion (1)

Integrating aquaculture in rural development programs through family farms could generate significant social benefits when carried out properly

Simplicity concept of small-scale projects means simple operations **but never simple planning**

Improper or easy planning was behind the failure and the non adoption of these projects as been hoped

Earlier studies have indicated that small-scale farmers can potentially benefit from the advances of research. GIFT tilapia performed well enough when disseminated

Conclusion (2)

Although the social dimension in rural aquaculture is of top importance, the economics of these projects determines its sustainability

Social nature of these projects should not come into conflict with environmentally practices or quality standards

Total and unlimited dependence on external assistance threatens the sustainability of these projects

It should be remembered that subsidies and support should be of temporarily nature

Although rural aquaculture, implies simple practices and modest outcomes, there should be some room for development even if beneficiaries move out of this category