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**Embargoed for: 4 p.m. EDT (21:00 GMT), Sunday, May 14, 1995**

*Ismail Serageldin, Chairman of the Consultative Group on International Agricultural Research (CGIAR), will be available for interviews on Thursday and Friday, May 11 and 12 by calling 703-820-2244.*

## **From 'Hunting' to Farming Fish Rapid Production Increases Are Possible**

Within 15 years, fish farming and sea ranching could provide nearly 40 percent of all fish for the human diet and more than half of the value of the global fish catch, says a new report by the Consultative Group on International Agricultural Research (CGIAR).

"The next great leap in producing food will come from 'domesticated' and genetically improved varieties of fish and other seafood," says Ismail Serageldin, the World Bank Vice President for Environmentally Sustainable Development, who is also chairman of CGIAR.

A new wave of fish farmers is already raising the "aquatic chicken," the tilapia fish that is native to Africa but is now being farmed in more than 85 countries in Asia, Latin America, Africa and even in the U.S. (Sometimes by young former urban professionals making their first tries at farming of any kind, or by Asia rice farmers trying fish farming for the first time). In large quantities, carp, giant clams, salmon, trout, catfish and scallops are increasingly produced and genetically improved on aquatic farms, just as cattle, sheep and chicken have been on land.

Fish is the fifth most important agricultural commodity and accounts for 7.5 percent of total world food production. More than 1 billion people in developing countries depend upon fish as the primary source of animal protein. Fish provides 28 percent of total animal protein in Asia; 21 percent in Africa; 8 percent in Latin America; 7 percent in North America; and 10 percent in Western Europe.

Global fish catches have increased five-fold between 1950 and 1989 to some 100 million tons, but overall production has stagnated since then as fishers have exhausted new sources of supply. The United Nations estimates that an additional 16 million tons would be needed annually to maintain consumption at current levels in the year 2010, assuming present population growth.

"The only way to meet increasing demand is to boost output by raising fish just as farmers produce livestock, poultry and plants, in addition to better managing existing wild fish resources," says Mr. Serageldin. "On the land we have learned to produce food by cultivation. But in the sea we still act as hunters and gatherers. We still catch fish like we used to hunt down buffaloes on the Great Plains of the United States, with similar results."

Rising global demand for fish, combined with declining stocks, has caused dozens of international incidents over fishing rights in recent years. Countries that have been involved in these disputes include Canada, Spain, Brazil, France, Japan, Iceland, Portugal, the United States, Russia, Norway, Taiwan, the United Kingdom, Indonesia, Australia and the Philippines.

"Under increasing scarcity, we expect more disputes and possible violence in the coming years as fishers compete for depleted fish stocks and as more areas are degraded by pollution and habitat destruction," says Meryl Williams, Director General of the International Center for Living Aquatic Resources Management (ICLARM), based in Manila, Philippines. "Everyone is seeking a better, more sustainable way to manage fisheries resources."

The present record of fisheries management around the world is not good. Of the 200 main marine fisheries stocks worldwide, almost two thirds are overexploited, depleted or recovering; and only about a third are under-used or moderately used.

A recent ICLARM study showed that in some coastal and nearshore marine systems, more than one third of the entire primary production of the seas was needed to sustain the current fishing levels. This is much higher than previous estimates and shows the heavy impact of fishing on the whole marine environment.

Nine of the world's 17 major fishing areas are in serious decline, with four depleted commercially -- the Gulf of Thailand, the seas in south-east Asia, the southern part of the North Sea and the northern Mediterranean.

The main reason: too much fishing, according to ICLARM. Between 1970 and 1990, the world fishing fleet doubled from 585,000 to 1.2 million boats. Today, some 3.5 million recorded fishing vessels are on the world's waterways; there are also millions of small unrecorded fishing craft. More than half the world's population live within 35 miles (60 kilometres) of the sea, and this share could rise to three quarters of humanity by 2020.

"Even in the most optimistic case, all we can hope for is to maintain current production from wild stocks," says Dr. Williams. "This is still a vital part of the production side of the world food equation. Slippage here will place impossible demands on aquaculture targets."

ICLARM is one of the specialized centers in the CGIAR system, which performs research to promote sustainable agriculture and food security in developing countries. The CGIAR is cosponsored by the World Bank, the United Nations Development Programme (UNDP), the Food and Agriculture Organization (FAO) and the United Nations Environment Programme (UNEP).

The steps that ICLARM believes should be taken to maintain the take from traditional ocean fishing grounds include allowing depleted or collapsed stocks to rebuild themselves through a sharp reduction of fishing effort, which could be achieved by eliminating direct and indirect subsidies to overcapitalized fishing fleets and enforcing legislation designed for conserving exploited fish populations. Some fisheries should be left entirely to small-scale fishermen, who should also be offered new alternative livelihoods to improve their standard of living.

ICLARM also says that fishery resources must be protected from open and free access by some form of property rights, held either by individuals or communities, and the owners must be involved and responsible for husbanding their resources. More extensive marine and freshwater areas must be put under various forms of protection to allow recovery of aquatic life and to act as sources of stock replenishment.

Globally, more than one quarter of all fish caught commercially, or 27 million tons, is discarded. These discarded fish were caught unintentionally along with commercially viable fish. ICLARM also says that all fish catches could benefit from better handling to overcome problems of spoilage that cause millions of tons of losses each year.

With wild stocks at their limits and aquaculture still developing, two important fish production trends are emerging:

- The sea is producing a lower proportion of overall fish catch. In 1993, world marine production (including aquaculture) was 84 million tons. Catches have remained below the maximum of 86 million tons since 1989.
- Production of aquaculture is steadily increasing and totaled an estimated 16 million tons in 1993, up from 11 million tons in 1988. Aquaculture produced 22 percent of food fish in 1993, versus 12 percent in 1984.

Humans use a wide array of aquatic creatures - more than 5,000 different species of fish and many hundreds of crustaceans, mollusks (clams, snails or squids) and echinoderms (such as sea urchins and sea cucumbers) directly as food, and many more species contribute indirectly through food and habitat support. The great majority of species, however, are taken only in small quantities.

In 1991, more than 40 percent of the global production was made of up of 24 species, each having catches of half a million tons or more. Almost all species, including the 24 major ones, are caught in association with other non-target species. In 1993, the most important sea fish were:

Anchovies - 8.3 million metric tons (Mt)  
Alaska pollack - 4.6 million Mt  
Chilean jack mackerel - 3.4 million Mt  
Japanese pilchard - 2.3 million Mt  
Capelin - 1.7 million Mt

Total aquatic production from the developing world began to exceed that of the developed world in the late 1980s. About 70 percent of the global catch is eaten directly, up to half of which is still produced by small-scale fisheries. Some 30 percent of production is used as feed, chiefly in aquaculture and to fatten livestock.

**Aquaculture** -- The farming of fish, shellfish and seaweeds grew rapidly from 1984 to 1992, with average rates of increase of 9 percent per year by volume and 14 percent per year by value.

The leading aquaculture producers in 1992 were: China, 8.6 million Mt; India, 1.4 million Mt; Japan, 0.8 million Mt; Indonesia, 0.6 million Mt; and the United States, 0.4 million Mt.

Apart from the few Asian countries that produce over 80 percent of the world's farmed aquatic products and some significant operations in other countries such as Norway, most countries have few aquatic farms. Aquaculture remains a new frontier, particularly in the tropics where fish grow fastest.

The solution is to develop, through research, aquaculture systems that will not damage the environment or lead to social problems and that will be compatible, or better still integrated, with other enterprises that depend upon natural resources: e.g., agriculture, fisheries, forestry, and water management for power generation, domestic supply, waste treatment, etc. New knowledge and skills are needed to accomplish this.

"This means substantially more investment in research is needed," says Dr. Williams. "Researchers, often in partnership with the farmers and others they seek to help, will hold the keys to the innovations and solutions that are needed."

The CGIAR is well-placed to help with such broad intersectoral research, across the different ecosystems of coastal zones, river catchments and uplands, all of which have profound influences on each other.

Between aquaculture and captive fisheries, a great range of technologies lie whose possibilities have barely been imagined.

**Sea Ranching** -- This provides one of the best possibilities for greatly increasing some fish and shellfish production, according to ICLARM scientists. In the process, artificially reared marine species known as fingerlings are released directly to the open sea and later recaptured after growing to market size.

The system may require modifications of the physical environment, such as the construction of artificial reefs, or protection from and enhancement of nursery and grow-out areas to improve the survival rate of released fingerlings and common property management in capture fisheries at the time of recapture. Sea ranching can also increase coastal productivity in an ecosystem faced with decline of fish catch as a result of overfishing and destruction of fishing grounds.

Sea ranching has evolved most rapidly in Japan, partly as a result of the adoption of the 200-mile exclusive economic zone (EEZ) regulation among coastal nations, thus limiting the fishing areas available to Japanese fishermen. The oil crisis in the 1970s also discouraged fishing in the high seas. These changes made the Japanese maximize the use of their coastal waters.

**Fish larvae** -- Another technology could involve the capture and resettlement of some of the vast millions of fish larvae that are annually swept away from productive reefs and lost forever in the open ocean.

**Marine feedlotting** -- In this system, high value fish such as tuna are captured when still young, and fattened in sea cages for a few months to get them to premium market condition.

### **Success Stories**

ICLARM researchers point to a number of examples that demonstrate the opportunities possible in cultured fish.

**Tilapia:** ICLARM has been working with national institutions and farmers in a number of countries to improve tilapia fish and ways to grow it. The Nile Tilapia, a freshwater fish from Africa, is very productive and thrives on agricultural wastes, making it inexpensive to grow. It has been dubbed "the aquatic chicken", because it can be grown in a variety of situations from backyards to intensive "battery" farms. It has been introduced widely to Latin America and Asia.

Its short generation interval, from four to six months in a breeding program, makes tilapia an excellent model for applied genetic improvement methods for fish. The best way of doing this in tropical fish is by selective breeding, breeding from the "best" individuals, a process that in one form or another has accounted for most of the improvements made in domesticated plants and animals in the past.

Presently farmed breeds of Nile tilapia reach a harvest size of 800 grams (1.75 lb.) after a growth period of five to six months, permitting about two harvests per year. In on-farm trials, a new strain developed by ICLARM and partners grew on the average 60 percent faster than present farm breeds, and their survival rate was almost 50 percent better. With this growth rate, three crops per year are possible.

"The tilapia has been one of the first successful examples of selective breeding of tropical food fish," says Dr. Williams. "Even so, we are just at the beginning. Fish breeding is 50 years behind livestock and 100

years behind plant breeding, but it shows the same great potential." Tilapia is also finding more and more of a market acceptance in the developed world, where it is starting to replace fish such as cod because of collapsed wild stocks.

**Giant Clams:** Research has demonstrated that giant clams can be cultivated. The meat from giant clams brings a high price, especially for sashimi (a traditional Japanese dish centered on raw fish) and in its dried form. Giant clams are also valuable for aquarium markets and for their shells, which have many uses.

The largest species, *Tridacna gigas*, was deemed most suitable for farming near coastal villages. ICLARM scientists conducted trials by distributing batches of giant clams to 40 villages in the Solomon Islands to identify cultivation systems and habitats that demonstrated promising rates of growth and survival. Experiments are in progress to further reduce the cost of juvenile clams, increase growth and survival at village sites and to find better ways to transport giant clams alive to distant markets. Similar experiments on five other species of giant clam are now in progress.

**Scallops:** In Japan, New Zealand and France, sea scallops spat (baby scallops) have been successfully seeded into the natural environment or onto trays, producing much greater harvests than had previously been possible from natural production.

### **Integrated Agriculture**

Most arable land and most freshwater on our planet are needed for agriculture. ICLARM scientists believe that one of the best ways to expand aquaculture in the developing world is to integrate fish farms with land-based agriculture, improving both in a process called Integrated Resource Management, or IRM. IRM brings farmers and scientists together to transform existing small-scale farms into integrated agriculture-aquaculture systems.

ICLARM is working on pilot projects in the Philippines, Bangladesh, Malawi and Ghana to show that even a small pond can add tremendous benefits and be ecologically safe. The program demonstrates that farmers can produce fish and use the water to produce vegetables and other crops.

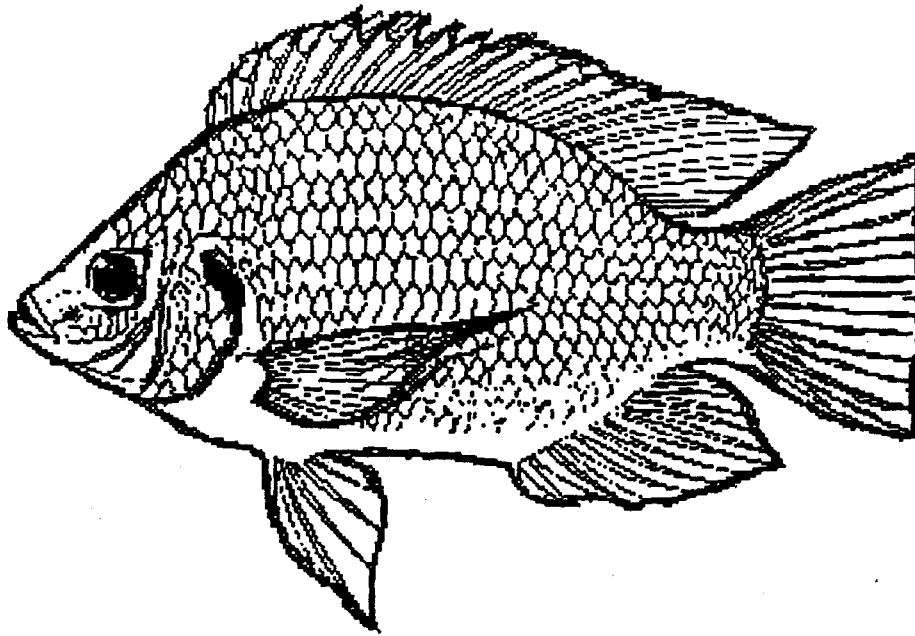
"Successive drought years in Malawi showed that farmers with ponds were able to produce crops around the ponds while 'traditional' farmers had no harvest," said Dr. Williams.

Net farm income in these pilot programs rose 50 percent in the Philippines, Bangladesh and Ghana, and a still impressive 15 percent in Malawi.

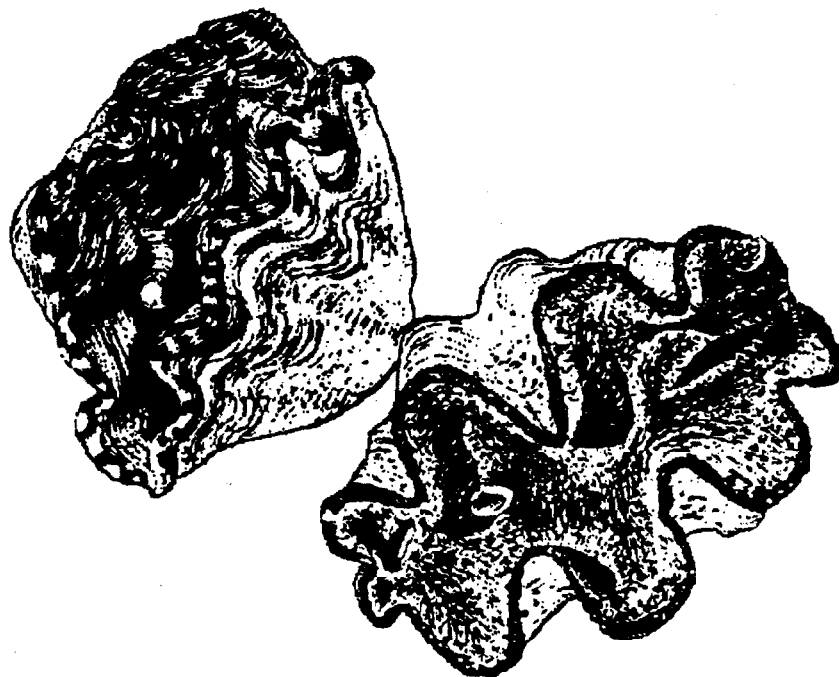
IRM seeks to develop systems for "new entrants" into aquaculture among the poorer groups of farmers in less favorable environments. IRM seeks to rehabilitate water sources and to increase incomes and food security of the small farmer.

"Despite the current enthusiasm for aquaculture, great care must be taken that low income people do not end up as losers, as has occurred sometimes in the past when new technology was hastily introduced," says Dr. Williams. "The limits of the environment must not be overstepped, and non-native species should not be introduced into water bodies where they can wreak environmental havoc. Diseases and pests will also follow many new aquaculture developments."

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Tilapia



Giant Clam