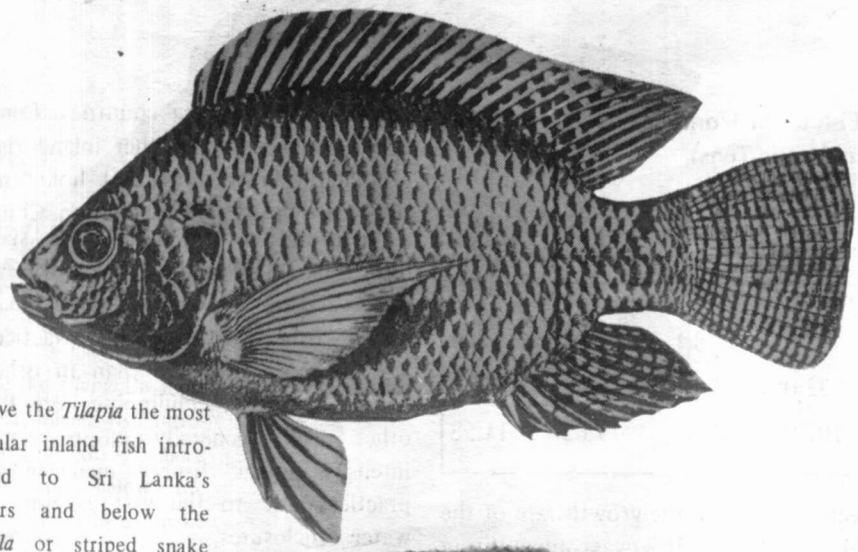

Above the *Tilapia* the most popular inland fish introduced to Sri Lanka's waters and below the *Loolla* or striped snake head the popular indigeneous fish.

INLAND FISHERIES

The earliest ancestors of man who lived in the pre-historic era, consumed fish hunted from their environment; which was a habit of all carnivores at the time. Fishing is therefore one of man's oldest activities; when in earliest times in all parts of the world he fished, just as he hunted, to obtain food. Evidence of man pitting his wits against fish and animals is found in many pre-historic artistic expressions of ancient civilizations. These ancient practices are seen in primitive cultures or among the less modernised societies even today, with slight modifications in forms of preperation for consumption. Despite the modern advances in fishing technology, food science, cooking methods and eating habits, by and large modern man, like his ancestors, still hunts fish wildly in his environment, rather than domestically rearing or culturing the fish he requires.

However, in certain parts of the world people obtain their edible fish from the ocean, while in other areas it is obtained from inland water bodies. Proportionately the latter is much less, with the world's total inland fish landings being only 11.6 percent of all fish produced in 1983, according to the FAO. Furthermore, among these inalnd fish were two types of landings identified by their manner of operations, namely capture and culture fishery.

Capture fishery depends largely on natural environmental conditions which influence the growth of fish resources in the water mass and also the technology applied to trap them. But hunting of fish in the natural environment has not been able to produce sufficient to meet rising demand. With a steady increase in production of capture fisheries there have been fears that traditional fishing grounds were being over fished. In certain areas, with the use of modern technology, it was found that the hunting rate was faster than the natural growth rate of fish resources. An alternative was seen in culture fishery; but it is very rare and difficult to apply fish culture methods in the open seas or over massive extents of water. Also the fish from capture fishery has not met needs of all consumers and in some areas people realised that edible fish should be domesticated just as other animals and plants were also "cultured" or domesticated for food purposes. It is in this context that people started rearing of fish in water enclosures or in inland waters and brought to light the significance of inland fisheries. The possibilities of this type of fishery supplying future demand in the world for fish, with fast developing culture methods, has now been realised.

International Perspective

From early times people have been aware of the importance of inland water fishing as a source of food; but the existing evidence of culture fisheries is far less than that of capture fisheries. Some of the Asian countries have a long history of fish culture, although practices with regard to naturally bred stocks of fingerlings and artifical spawning techniques were developed only in the mid 20th century, which also helped greatly to accelerate the development of acquaculture.

FAO records reveal that inland fisheries contributed an estimated 11.58 per cent of the total fish landings of the world in 1983; this was a slight improvement in production over 1977 when 10.44 per cent of the world's total fish caught in that year were from Inland Fisheries (See Table 1). However FAO has predicted that total inland fish production will be about 50 million tons by the year 2000. When the contribution of inland fish production is compared to total fish landings in the Asian Region it is observed that there has been an increase from 13.9 per cent in 1977 to 16.5 per cent in 1983; which shows a greater rate of involvement in inalnd fishery development in this region. During the same period Sri Lanka has shown a better performance than the overall development in Asia where the proportion of inland fishery went up from 9.4 per cent in 1977 to 15.4 per cent in 1983. It should be noted that Asia contributed 58.73 per cent of the world's aquacultural production in 1977 and this increased to 64.87 per cent in 1983. Data obtained in 1977 and 1983 from FAO sources

Table: 1 **Contribution of Inland Fish to the World's Total Fish Catches (Mn Metric Tons)**

Year	1977	1978	1979	1980	1981	1982	1983
Inland	7.7	7.1	7.3	7.6	8.1	8.4	8.9
Total	68.2	70.2	71.0	72.0	74.8	76.5	76.5
%	10.44	10.10	10.22	10.59	10.89	11.02	11.58

highlights the Asian continent's growth performance of 37.37 per cent over this period; while world-wide fish catches in inland waters for the period 1977–1983 had increased 24.36 per cent, as seen in Table 2.

This growth rate is more than two-fold of the production growth of the previous seven year period. The growth rate of inland fish production during the period was the highest rate of growth recorded for any period. However, the lowest growth rates were seen in USSR and Oceania. The African continent has also shown a decline in inland fish production during the period 1977–83.

Comparing these figures with the growth rate of the marine fisheries sector (12.09%), the growth rate of the inland sector (24.36%) was comparatively high. Also, the growth rate of marine fisheries in the Asian region for this period, was lower than the growth rate of inland fisheries. This rapid growth of inland fisheries brought Asia into the leading position as a producer of inalnd fisheries.

At present Asia produced more than 5.8 million tons of inland fish and 92 per cent of this quantity was from ten major producer countries. Ranking the major inland fish producers in the Asian continent it is observed that China, India, Bangladesh, Philippines, Indonesia, Japan, Vietnam, Thailand, Burma and South Korea were respectively in the first ten positions at the end of 1983. Also the first three have been recognised as the world's biggest inland fish producing countries. Compared to these, the other inland fish producer countries do not hold any significant position in production. China alone produced 32 per cent of Asia's total inland fish landings, according to FAO statistics. Generally, in Japan inland fishery management practices are far more intensive than in other Asian countries. Philippines on the other hand generally adopts semi-intensive inland fishery management practices due to the vast extents of water enclosures and fish resources naturally available, although its areas under intensive aquaculture have increased the rate of growth of this industry. Though these countries produced large stocks of inland fish, their growth performance in production for the period 1977–1983 has been overtaken by developing countries like Malaysia and Sri Lanka, whose performance was 489.9 per cent and 160.9 per cent respectively. Malaysia, especially, has boosted its inland fish landings by increasing the area under inland fishery, although the growth rate, in productivity per unit declined at the rate of 7.3 per cent per year. In contrast, in Sri Lanka both the expansion of the area under inland fishery as well as increased productivity per unit area were the causes for higher growth. But inland fishery activities in these countries are still in their infancy and production also does not meet national requirements. According to the FAO/UNDP only 10 per cent of the total aquacultural resources have been exploited so far in the South East Asian region and the potential of fishery (inland) has not been exploited sufficiently.

The South Asian countries particularly have great potential and extensive inland fishery operations are possible in the man-made lakes or in reservoirs. For instance, Sri Lanka, Bangladesh and India have approximately 300,000; 600,000; and 1,000,000 hectares of inalnd water masses, respectively, and these are now being used for multiple purposes such as irrigation, domestic water supply, animal husbandry and fishing.

Table: 2 **World Total Fish Catches in Inland Waters (Mn Metric tons)**

Year / Region	1977	1978	1979	1980	1981	1982	1983	Growth for the period
Africa	1.5	1.4	1.4	1.4	1.4	1.4	1.4	– 4.14%
America North	0.1	0.1	0.1	0.1	0.2	0.2	0.2	+29.95%
America South	0.2	0.3	0.2	0.3	0.3	0.3	0.3	+27.02%
Asia	4.2	4.2	4.3	4.7	5.1	5.3	5.7	+37.37%
Europe	0.3	0.3	0.3	0.4	0.4	0.4	0.4	+33.25%
USSR	0.8	0.7	0.8	0.7	0.8	0.8	0.8	+ 3.09%
Total	7.1	7.1	7.3	7.6	8.1	8.4	8.9	24.36%

Source: *F.A.O*

INLAND FISHERIES IN SRI LANKA

Though Sri Lanka is an Island and fishing has always been favourable in maritime conditions more and more limitations have emerged on catches in this sector in recent decades. Firstly, is the limited potential of fish resources in the seas around Sri Lanka, together with increasing conservation problems. There are also problems such as heavy capital requirements and high technology required for exploiting deep sea fishing potential. These limitations are expected to intensify in the future and it is therefore time to look seriously at an alternative. This situation has helped somewhat to shift the focus towards inland fisheries, as a means of meeting part of the food and nutrition requirements of the country. The result has been that over the past 9 years the share of sea fish in total fish production of the country has been on the decline, as seen in Table 3 below.

While prospects of major increases in marine fish production appear to be uncertain, the potential in Sri Lanka's Inland Waters is now getting clearer. The inland waters scattered over the island (see map) cover an extent of around 800,000 acres, including brakish water lagoons at Full Supply Level (FSL), and have an estimated fish production of 60,000 to 70,000 tons per annum. This capacity could be further increased with the expansion of existing water bodies and more technical inputs and intensive farming being introduced into this sector of fisheries. Furthrmore, from the pilot projects carried out by various agencies (both local and foreign) the cost of developing inland fisheries has been found to be comparatively lower than marine fisheries, while the benefits could be high and more widened, and due to their smallness such projects are easier to administer. In the present situation of ethnic tensions and unsettled state of marine fishing in the productive waters of the North and East it has also become necessary to consider how fisherfolk whose normal activities are disrupted could be gainfully occupied. The extent of this disruption is apparent in overall figures of marine fish production which in 1984 were found to be 25 percent lower than in 1983.

Also, the supply of sea fish from the coastal regions to the interior areas is controlled by a well organised chain of middlemen. This factor adds further to overheads in the price of fish for consumers in areas away from the landing centres. Also, increasing costs were pushing prices of seafish beyond the means of many. Particularly in areas away from the coasts, the rising fuel cost and preservation and distribution problems were taking prices well beyond the reach of the poorer households.

The large number of inland water bodies could therefore help to reduce the constraints of centralisation of the fishing industry in the coastal belt, by reducing the overhead costs incurred in transport and handling. It would not only help in decentralising the fisheries sector but also help in accelerating its development. Such a development could also help to increase economic levels and nutritional standards of the rural population, especially in those areas where there are water bodies and no proper supply of fresh fish at a reasonable price. This position has been established in many research studies carried out in the Dry Zone areas.

Many surveys carried out in the South and East Asian countries have revealed that, depending on the location, fisheries and allied activities may be the main supplementary source of income for the rural poor. Inland fisheries therefore is most suitable as a subsidiary income raising activity. It is usually a subsidiary source of income for many who are landless and who work as part time agriculture labourers; and so too with brackish water and estuarine fisheries in shallow waters, lagoons and coves.

The attempt to popularise aquaculture activities among the people in Sri Lanka, where a large extent of inland water bodies are available, therefore holds promise of becoming a viable alternative to the capture fishery which now takes place on a large scale. With the depletion of fish resources from natural sources and the rising problem of unemployment and low income from small scale marine fisheries, the capabilities and high potential of aquaculture in providing better nutrition, higher incomes through additional employment, as well as better utilization of marginal lands such as coral pits, clay pits, gem pits and mangrove swamps

Table: 3

Contribution of sea fish to the country's total production (Tons)

	1977	1978	1979	1980	1981	1982	1983	1984*
Total fish production	136581	154121	165723	184722	205408	210100	217418	167750
Sea fish production	123718	137647	148573	164775	176398	176700	181918	135750
Percentage contributed	90.6	89.3	89.7	89.2	85.9	84.1	83.6	80.9

* Provisional

needs to be closely considered.

Further, the preliminary analysis of supply and demand for fishery products has shown that inland fishery is an effective means of filling the gaps in current and future supplies of many of the favoured aquafoods.

Unfortunately, inland fishery in Sri Lanka has suffered from inadequate recognition and support for a considerably long period, and it is only in recent decades that Governments have begun to devote greater attention to this means of fish production, mainly due to the factors discussed above. Many other Asian countries had realised this situation much earlier and are now practicing more intensive methods in aquaculture and are supplying a large part of their rural fish requirements through domestic production. Records show that the total quantity of production and consumption of inland fish increased very slowly and gradually from the mid 20th century and then over the last decade a rapid growth of the industry has been recorded. This expansion of inland fisheries in Asia has also revealed limitations in the policy of attempting to further invest in and develop marine fisheries. In contrast to the increasing costs and diminishing resources in existing marine fisheries, the inland fisheries need only a few technical and financial inputs, where small peasants could also attend to fish farming on their small agricultural holdings. Particularly, in the Third World countries where financial and technical capabilities do not seem to be adequate for expansion of their own deep sea and off-shore fishery projects, more attention has been paid to inland fishery in last three decades.

HISTORICAL RELATIONS

The habit of eating fish caught in inland waters has been in existence in Sri Lanka from pre-historic times. These early generations consumed fish as part of their food, either with or without a knowledge of its value as a source of protein. In the pre-historic era the geographical conditions of the country were favourable for fish habitats and gave early settlers an opportunity for fishing in inland waters. Fossils of fishes and fish hooks have been identified to as far back as 6000 B.C. by P. E. P. Deraniyagala. Such evidence has been found in Rawana Ella Rock Caves, Bellan Bandi Pellassa, Bata Domba Lena and other parellel pre-historic sites in Sri Lanka.

Large numbers of archaeological observations made on the locations and fossil findings of the pre-historic and ancient civilization provide evidence on the basic facts of a hydraulic society, most of which was connected to inland water bodies, which was in turn very closely connected to their ways and means of living. Before turning to the sea for their basic requirements, they were engaged in inland waters such as rivers, lakes, lagoons, etc., for their fish. Further historical evidence is found in Sri Lanka of inland fishing in the ancient period. A good example is the Perimiyankulam (Brahmin) inscription of the 2nd century B.C. which gives an idea of the utilization of the "share of fish caught" in the irrigation canals of the tanks of Polanakaraka. Also, reference to the "fish share" and the laws pertaining to the ownership of fishes in the canals and tanks were given in the Samanthapasadika and Papannasudani. According to the Mahawansa fish was always considered a luxury. Samanthapasadika says that some people who wanted to consume fish, catch fishes carefully from common or public waters, bring them into homested ponds, bred and fed them until they killed them for meals each day. It may be observed that there was an aquacultural practice that took place in this particular period and it was not prohibited or restricted by religion or legislation. It is evident that in ancient times the inland water bodies supplied most of the requirements of fish in the interior regions of the island.

In the medieval era of Sri Lanka inland fish was very popular and in certain areas it was an essential part of the meal, according to available historical sources. The Medirigiriya Pillar inscription of the 10th century gives evidence about the relaxation of rules granted to the Buddhist monks to eat fish. In the 13th century the loola, hunga, pethiya, theliya, anda (EEL) and Kudamessa were popular among the fish species consumed. Also, Robert Knox in 17th century recorded in his sketches the status of inland fishing in the country.

There is no doubt therefore, about inland fishing, both capture and culture, as well as the consumption of inland fishes without much religious, cultural or public taboos in Sri Lanka from the very inception of written history and of inland capture fishery even prior to this.

EATING HABITS AND CONSUMPTION PATTERN

People have continuously adjusted their eating habits according to the environment they live in. Food items found in close proximity became more popular, common and staple in their daily meals. Likewise, the fish they found from the surrounding environment became popular in their meals. Therefore, the coastal people preferred to have sea fish, while those people living in the central part of the country; distant from the sea, obviously preferred to have their fish from inland waters. In recent centuries, sea fishery became more popular due to various factors. Apart from the growing population in certain coastal centres, there was the additional social and economic identity people attached to fish which kept consumers of inland fish in a lower social category. This attitude resulted in people living in the

interior localities denying themselves of inland fish. A factor behind this attitude was that people were made to feel that those who consumed sea fish were the more wealthy people. Because of its higher price, caused by the cost of production and costly supply channel,an expensive food item such as sea fish were not affordable to the poor people.

Furthermore, those employees who migrated from coastal regions to the interior always wished to show their taste as practiced in coastal homes and they too blindly followed this prejudice against inland fish. However, the poorer village people who did not have the means of finding cheap animal protein regularly consumed inland fish. It was these factors that led to the majority of middle income people turning more to sea fish, mainly for the social status attached to its consumption rather than any particular nutritional or economic benefits. Hence, the higher and middle income earners living in interior areas were reluctant to consume inland fish even at times of short supply of sea fish, because of the social prestige attached to the latter; while the indigenous species whose growth rate is limited by themselves (carnivores) were popular as food among the hinterland people. Unfortunately, the new exotic species have not been able to enjoy the same popularity due to factors such as the people's food habits and taste etc. The necessity to introduce new cooking methods and tastes, which could be useful in popularising more and more exotic inland fish varieties in the rural areas was observed in an earlier issue of the Economic Review (Economic Review Feb/March 1983). Although inland fish was available more freely and cheaply at the doorstep, there was less of a preference of people for inland fish in the early decades of the introduction of exotic inland fish varieties. Two apparent problems regarding inland fisheries have been its taste and the way these fish are reared for consumption. Its popularity was also less than that of sea fish and therefore it was difficult to obtain a good competitive market price for the product. This led to lower incomes for inland fish producers which in turn resulted both in lowering the enthusiasm of the people involved in inland fishing and in slow progress of the industry as well. To overcome this situation the Government has spent a considerable amount over the last decade on subsidies and incentives (see table for recent data). One such step is the introduction of new cooking recipies which has helped to cultivate a taste and popularise the newly introduced fish. This effort has also helped to obtain good results in popularising and marketing of inland fishing in the face of existing social barriers.

A breakthrough has been recorded in recent years in the popularity and marketability of exotic fish varieties in the country, despite the traditional prejudices both cultural and religious, and in cooking methods. This has been achieved through improved but simple and low cost technology, organising of cookery demonstrations and the introduction of processed or semi-processed fish preparations. Rasa Malu Pethi, Fish Fingers, Fish Sausages, Fish Fillets, etc. were introduced to the more popular urban markets. In this context, it should be noted that an introduction of exotic inland fishes into the menus of tourist hotels, restaurants, and in higher social circles could effectively change the habits and consumption patterns of the people at large with a hope of economic returns to the inland producers; a step that has been taken recently with the demonstration programmes organised by the Ministry of Fisheries and NARA in different local communities.

In picking on these specific urban targets, however, there is one aspect of the overall objective in popularising inland fisheries that has been neglected and that is the poor rural people for whom this valuable protein is meant may ultimately not have the benefit of it.

Successive Governments after Independence have tried to increase the animal protein intake through better supply of fish to the local market through a number of fisheries development projects intended to increase the local production, and during shortages in local production by imports. It should also be noted that in the efforts made towards supplying more fish, the existing inland fisheries development strategy, which was conceived in the 1950's has had a very significant impact on the total fish landings since 1980 (Table). This programme resulted in an extraordinary change in inland fisheries, specially in the Dry Zone areas, and brought additional resources and wealth to the inland water bodies. Also, field surveys carried out in 1982 and 1983 the People's Bank Research Department studies on the Economic Impact of Seasonal Tank Fishing on Peasants in the Dry Zone,

Table: 4

Subsidies granted for Development of Inland Capture Fisheries

Year	1981	1982	1983	1984	1985 Upto June
No. of Fishing Units issued	370	901	669	1881	274
Value of the Subsidy granted (Rs. mn.)	.64	1.3	3.6	1.9	1.6

Source: *Ministry of Fisheries.*

have revealed that the per capita fish consumption levels of the peasants covered in these studies was 7.2 lbs. higher than the national level in 1983; that is 40.47 lbs. This is clear evidence of the progress in the programme of inland fisheries, particularly with the exotic varieties in the Dry Zone areas where there have been acute problems of malnutrition and overty in past decades.

Economic Impact of Seasonal Tank Fish Farming on Peasants in the Dry Zone – Tunkama

In the Dry Zone of Sri Lanka, which covers approximately 16 percent of the country's population, the peasant community is characterised by serious problems of poverty and malnutrition. This includes 70,000 families who depend for their main source of livelihood on paddy cultivation under the minor irrigated works and/or village/seasonal tanks in the dry zone. The lack of economic activities, except farming crops, and poor levels of income have been identified as the main reasons for the acute problems of poverty and malnutrition, in most studies carried out in these areas.

In this context it is of interest

POTENTIAL ROLE OF INLAND FISHERIES IN BIOLOGICAL CONTROL OF MALARIA

A. M. Jayasekera
Director of Inland Fisheries
Development Division
Ministry of Fisheries

Malaria is considered a major public health problem in the tropical countries affecting about 250 million people annually. Controllong of this disease involved interruption of the life cycle of the mosquito by controlling the bactor using chemicals and biological methods and controlling the parasite in man by chemotherapy. However, due to the gradual development of resistance of the vector as well as the parasite towards various drugs there has resulted a resurgence of this disease.

It is therefore, environmentally compatible to use biological methods for controlling mosquitoes. Although this method is of comparatively remoter origin it is now recognized as a potential tool for check of insect population without having any harmful effects on the human system. Culture of larvivorous fish, control of aquatic weeds and inland fisheries development in water bodies could have a considerable impact in controlling this disease.

Shallow derelict ponds, mining pools, clay pits, gem pits, swamps, marshes, village tanks and in fact, all inland water bodies provide abodes and shelter to mosquitoes, snails and a host of micro and macro-biota which are the vectors of parasites of diseases such as malaria, schistosomiasis and filaria. Inland fisheries development in the water bodies will improve the environment thus leaving less of a chance for the growth of mosquito larvae. Raising of larvivorous fish species and stocking them in various water bodies could play an effective role in control of malaria.

The main characteristics of larvivorous fish suitable for malaria control have been identified as:

- Small, so that it can move about in shallow waters;
- Hardy and flourish in both deep and shallow waters;
- Able to stand transport and handling;
- Difficult to catch and able to escape its natural enemies;
- Absolutely worthless and insignificant as food;
- A top-feeder and carnivorous in its diet; (Covell, 1927)

There are a number of exotic and indigenous species of fish which at one stage or other feed on mosquito larvae. Most of the cultured fish are also larvivorous in their young stages. Invariably these species when cultured in water bodies contribute to control of malaria.

Three introduced species *Carassius auratus, Lebistes* spp. and Gambusia affinis feed on mosquito larvae. Among the indigenous species which feed on mosquito larvae are *Notopterus Oxygaster, C. laubuca, Rasbora, Danio, Puntius, Wallago, Aplocheilus, Oryzia, Channa, Etroplus, Anabas, Mugil, Ambassis* and *Therapon.*

Hora and Mukerji (1953) have classified the larvicidal fish according to their mosquitocial activity.

- Typical surface feeders *(Aplocheilus, Gambusia,*) which are the most suitable mosquito fish;
- Those which are surface feeders but are less efficient owing to mode of life. *Oryzias, Lebistes spp;*
- Sub-surface feeders: *Amblypharyngodon, Danio, Rasbora* which are larvicidal to a considerable extent;
- Column feeders: *Puntius, Anabas, Therapon jabua, which* feed on mosquito larvae when a chance permits;
- Large size food fishes such Labeo, *Catla, Mugil, etc.* whose fry are helpful in the reduction of larvae;
- Predatory food fishes, *Wallago, Channa, Notopterus, Mystus,* where fry may swallow larvae but both young and adults are vey destructive to other fishes including larvicidal fish.

The exotic *Gambusia affinis* and *Lebistes reticulatus* (Family Peocilidae) and indigenous forms *Aplocheilus, Oryzias* (Family Cyprinodontidae) constitute the most important and useful forms (Jingharan, 1974)

Fish culture in various water bodies in Sri Lanka will assist in the elimination of mosquito larvae and making their breeding habitats unsuitable for their growth.

to assess the impact of the Ministry of Fisheries pilot project for fish farming in the Dry Zone seasonal tanks started in 1979 at Tunkama in the Ratnapura District and falling within the Dry Zone. The present situation is that seasonal tank fish farming has spread widely in the dry zone, with success being recorded in technical terms.

Since a fair amount and extent of water bodies are seasonal tanks, the results of the economic output of the fish farming on peasants may be useful to study in these areas.

The question needs to be asked whether the growth and expansion of inland fisheries in the seasonal tanks have an economic impact on the peasants of the neighbouring area. Indeed, the answer is in the affirmative. If it were negative, it is very unlikely that the industry here would have grown and that the people would show much enthusiasm for this activity. The inland fishery programme in the seasonal tanks has now successfully passed its sixth consecutive year. In 1986, this exercise was being practised in about 200 seasonal tanks, and it is planned to expand the programme to cover 7000 acres, under the seasonal tank fish cultivation programme for the year 1986/87 with a further anticipated production of 2100 tons of fish.

The Ministry of Fisheries started a seasonal tank fish farming project in October 1979 at Tunkama, where agriculture was the sole source of income. As it was a project new to the peasants the Ministry had to encourage the people to participate and this the Ministry did by getting involved and demonstrating the benefits of the project from the start. At the end of nine months they harvested 17,293 pounds of better grown fish and through this experience the programme has been expanded to about 200 seasonal tanks at present with the particpation of villagers in fferent areas in the dry zone.

The economic impact of the seasonal tank fish farming can be broadly divided in two:

a) Direct impact and

b) Indirect impact.

Direct Impact

Prior to the fish farming programme tank water was utilized only for irrigation, cattle feeding and domestic uses although there were ample possibilities of cultivating fish. However, after the seasonal tank fish farming project started these tanks have become a multiple source of income for the village economy. In a field survey we found that tank fishing generated additional or sometimes part-time employment and supplemen-

Introduction of larvicidal fish which are hardy and tolerant to a wide range of environmental conditions should be undertaken on a large scale. Selection of species play an important role in effective biological control of mosquitoes.

Training and education programmes for the extension workers are considered an essential step in the successful implementation of malaria control programmes.

Coordinated efforts of anti-malaria campaign extension workers, fishery extension workers, village level organisations and rural and urban communities can be considered essential for the successful implementation of malaria control programmes through such biological methods.

AREAS OF OPERATION OF INLAND FISHERIES STATIONS/CENTRES

Name of Inland Fisheries Station/Centre	Districts Covered
1. Udawalawe FWFS (New)	Moneragala
2. Udawalawe FWFS (Old)	Ratnapura
3. Inginiyagala FWFS	Amparai,Batticaloa
4. Panapitiya FWFS	Kalutara
5. Mankulam IFEC	Jaffna,Kilinochci, Mullaitivu,Vavuniya,Mannar
6. Galle IFEC	Galle, Matara
7. Muruthawela FWFS	Hambantota
8. Nuwara Eliya FWFS	Nuwara Eliya
9. Ginigathhena FWFS	Kandy, Kegalle
10. Polonnaruwa FWFS	Polonnaruwa,Trincomalee
11. Rambodagalla FWFS	Kurunegala
12. Dambulla Oya FWFS	Matale
13. Padaviya FWFS	Anuradhapura
14. Anuradhapura IFEC	Anuradhapura
15. Pitipana BWFS	Gampaha,Colombo
16. Pambala BWFS	Puttalam
17. Beragala FWFS	Badulla

FWFS - Fresh water fish breeding and experiment station
BWFS - Brackish water fish breeding and experiment station
IFEC - Inland fisheries experiment centre

tary income for the villagers through different means. (See Table 5).

It was found that the average household income (Rs. 7,906/-- was slightly higher than the general household income of the dry zone peasants under similar situations. If the fishing incomes were deducted, it would then be almost the same as the other dry zone peasant household income. It appears that the supplementary income at Tunkamagoda was a result of the seasonal tank fish farming. Agricultural incomes dominate; being as high as 73.37% in their gross incomes, while the share of fishing income was only 9.63%. However, the dependency of these farmers solely on agriculture has been reduced to some extent. (Table 6).

Fisher families received 22% of their total income from fishing activities. Therefore, it is very clear, that the fisher families are less dependent on agriculture-based incomes while the income situation of non-fisher families was entirely different. Further, the time at which farmers received fishing incomes was very significant particularly in an agriculture dominated economy, where incomes are seasonal. Fishing incomes could be obtained in the dry spell and generally come before the crop harvest when peasants are compelled to borrow from various sources. Therefore, the additional income of Rs. 2,200/- and Rs. 845/- per fisher member came in good stead in 1981 and 1982 respectively, and minimised borrowings of these farmers from external sources. Although, agriculture was the main source of income, fish farming may be considered the highest secondary source of income being within the range of 40 percent of total income.

Table: 5

Income and Source of Income

House Hold	Agri-culture	Agricultural Labour	Animal husbandry	Fishing	Others	Total
1	4,000	–	–	1,522	–	5,522
2	5,000	–	3,000	1,522	–	9,522
3	7,000	–	–	1,522	–	8,522
4	4,500	1,500	–	1,522	–	7,522
5	2,500	–	–	1,522	–	7,022
6	3,500	2,000	1,750	–	–	7,250
7	–	4,000	–	–	–	4,000
8	1,000	4,000	–	–	–	5,000
9	6,000	4,000	1,500	–	–	11,500
10	9,000	4,000	1,500	–	7,200	16,200
Total	42,500	15,500	6,250	7,610	7,200	79,060
%	53.76	19.61	7.90	9.63	9.10	100

Note: *1. Income received from the fishing activities is divided equally among members of the household. This is according to the accounts in books.*

2. Other income was taken to a nearest round figure, according to the interviewers.

Seasonal tank fish farming also provided farmers with cheap fresh fish during harvesting time. Moreover, inland fish prices were lower than those of sea fish by nearly 66 percent. This helped consumers of inland fish to reduce their costs of their food to a certain level, specially in the fish harvesting season. This situation indicates that between the two labour intensive peak seasons of agriculture, peasants could utilise their time to develop fishing activities, which may be expanded according to the increasing number of seasonal tank projects.

Indirect Impact

The lower prices of inalnd fish helped many people to consume more such fish in their meals, and also to increase per capita fish consumption levels which could have resulted in improving nutritional standards. The fish consumption level in Tunkamagoda (40.46 lbs) was slightly above the national level which was 33.2 lbs. A high level of protein intake through fish could lead to an improved nutritional status of the people; which may in the long term reduce expenditure on health and medical care.

Table: 6

Income share by various sources in fisher families and non-fisher families

	Agricul-ture	Agricul-tural Labour	Animal husbandry	Fishing	Others	Total
Fish Families*	65.51	4.27	8.54	21.68	–	100
Non-fisher Families	44.38	31.85	7.39	–	16.38	100
Average	53.76	19.61	7.90	9.63	9.10	100

** Fisher families refer to those peasant families who have taken to fish farming as a supplementary source of income. Non-fisher families are the peasant families who yet continue to engage only in farming of agricultural crops.*

Apart from seasonal tank fish farming, several Pen Culture projects have been introduced in 1983 on an experimental basis.

Some recent developments and critiques of inland fishery

Although inland fishery has been in existence in Sri Lanka for a considerable period, this form of fishery has not been highly productive and commercialized. Efforts were made during 1949 - 50 to maximise the use of irrigation tanks with a view to increasing food fish production by introducing some exotic hybrid fish varieties. There were no indigenous fish species of rapid growth and prolification and of commercial significance available and this led to the introduction of exotic varieties to Sri Lankan waters. Since 1950, therefore, Sri Lanka entered a new era of inland fishery mainly with the introduction of exotic hybrid varieties in the inland water bodies and with the expansion of infrastructure facilities. Until the introduction of Tilapia Mosambica, whose growth was established in tanks and reservoirs, the productivity of edible fresh water fish was very low in the inland waters, while the people practised traditional methods of fishing. But with the introduction of these hybrid varieties of fishes the unoccupied nitches of the hydro ecological system of the dry zone tanks were rapidly populated with fish and a phenomenal success was recorded as early as 1979 with 17,150 tons of inland fish being landed. By 1983 this figure was doubled with even greater success being achieved. (See Table 7).

There has been a clear increase in production over this 25 year period, which may be a reflection of the fact that exotic fishes were gradually better established in the tanks and reservoirs, due to the comparatively recent tank ecosystem and the enviornmental conditions here. In the very first years where the rapid distribution of Tilapia were carried out, every dry zone tank is reported to have gained considerably. But distribution studies on the inland fishes of Sri Lanka have shown that the Tilapia did not thrive in undisturbed streams. (Senanayake 1980 a.) According to Ministry of Fisheries sources the Parakrama Samudra recorded an average of 2.7 tons of fish per year prior to the introduction of Tilapia. Following the introduction of this new species, average catches were boosted to 500 tons per year in 1966 and presently to an annual average of 900 tons. Also it has been observed from data obtained on capture fishery that Tilapia generally comprises over 70% of the fish in the perenial tanks of the dry zone.

The heavily increasing number of fishes within these tanks has resulted in a stunting in size of the Tilapia, with competition getting more intense in their food habitat.

Several other fish culture methods have been adopted in Sri Lanka's inland waters over the last decade, but these are still being tried out on an experimental basis and have not yet been introduced to the public. (See Box). Fish culture is comparatively new to Sri Lanka, unlike countries like Philippines, Indonesia, China and Japan which have developed intensive fish culture prectices and where progress of this type of fishery has made a significant contribution to their protein requirements. There are other countries too where experiments are in progress. For instance, in Kuwait a successful research programme was carried out in 1982 where an acclimatized Tilapia fish was cultivated in saline ponds and this programme has made an impact on the country's fisheries. Freshness was the prime factor in the success of this home grown fish in Kuwait, and at present there is a growing demand for this fish in the Kuwait market.

Introduction of new fauna to the hydro ecosystem should carefully be observed especially according to their habitat; because it could result either for the good or bad of the entire tank ecosystem. Sometimes the negative impact on the existing indigenous fauna and flora by exotic strangers is possible.

Seasonal village tanks in the dry zone have also performed well in increasing their production figures annually, with the introduction of new fish culture methods as well as new fish species such as Catla Mirigal, Carp and Rohu. These new introductions took place from the late 1970's and these exotic fishes were able to occupy the empty nitches of the food chain and ecosystems in the seasonal tanks of the dry zone. Introduction of hybrid varieties whose food habits are different from other fishes gave a thick density to the fish population in the tanks which also resulted in better annual harvests. The benefits of this exercise has also been reflected in the economy of the people living in these particular areas.

Table: 7

Production of Inland Fish (Tons)									
Year	1960	1970	1974	1978	1980	1981	1982	1983	1984
	3350	8147	7539	13097	19947	29124	32798	35500	30097

Source: *Ministry of Fisheries.*

In Sri Lanka, pond fish farming was introduced in the late 1970's and various incentives were offered by the Government to promote this form of fishing. The Government offered a subsidy of 50 per cent for the construction of a pond, and also made available fingerlings, technical advice and follow up services. Considering, however, the increasing trend in subsidies (see Table) given to pond fish farmers, and the area under pond fish units, actual fish production does not appear to be commensurate with the expansion of infrastructural facilities.

There were 121 pond fish farming units which had been paid subsidies amounting to Rs. 242,168/- while the area covered by those ponds was 140 acres in 1981. By 1984 the increase, in terms of the cash subsidy had gone up to a sum of Rs. 4.9 million, with ponds covering approximately 1500 acres in extent. The subsidies granted in the first six months of 1985 increased further to Rs. 5.1 million, covering an extent of 1,525 acres of ponds. The total production

of fish from these pond fish units have not yet made a substantial contribution to the national fish harvest. The number of pond fishery units operating in the island at present cannot be regarded as a significant phenomenon. On the other hand, in countries like China and India where there has been a long tradition of pond fish culture, existing practices are being replaced by advanced fish farming methods, also providing more profitable harvests through intensive poly culture. In Sri Lanka according to the information gathered from the field farming in nearly 80 per cent of the fish ponds were economically not feasible, and most of the people who obtained the subsidy were not maintaining a fish pond at present. Though the money was spent, many ponds were not operated as fish production units mainly due to practical difficulties such as:

(a) Inadequate skils in the field of operation;

(b) Inadequate services rendered for a proper maintenance of ponds regularly and;

(c) Drawbacks in terms of economics, etc.

In promoting pond fish farming, instead of traditional fishing gear and methods used in inland fishery, recent governments have introduced some new and technically better fishing gear and methods. At the beginning these were introduced in the perenial tanks which were heavily populated by Tilapia. The issue of nylon nets and fibre glass reinforced plastics (FRP) canoes, under a government subsidy scheme were the first measures in the effort to increase capture fishery production.

As a further incentive, with a view to promoting more inland fishing units and increasing fish production in tanks, a government subsidy scheme was introduced in 1980, which granted 35% of the total cost of the craft and gear. These measures, however, have not had a considerable impact in terms of fish production in the perenial tanks. This subsidy was therefore increased to 90 per cent of the 1981 subsidy scheme, and is presently in operation under this subsidy scheme 4090 inland fishing units had received assistance up to June 1985.

This upward revision of the subsidy has resulted in an increase in fish production over the past few years. This increase both in the quantum of subsidy and the number of fishing units, gave rise to a 45 percent increase in country's inland fish production in 1981 compared with that of 1980. This increasing trend continued up to 1984 with the catch reaching 35,500 tons in 1984. (See Table, on production of Inland Fish).

Table: 8

Pond Fish Farms and Subsidies provided

Year	1981	1982	1983	1984	1985 Upto June.
Number of persons paid subsidy	121	460		2142	209
Amount paid as subsidy (Rs. M.)	.24	1.13	3.4	4.9	.51
Total extent (Acres)	140.15	99.25	472	1500	1525

Source: *Ministry of Fisheries.*

The rate of physical adoption, proliferation and establishment of inland fisheries in Sri Lanka is evident from the production figures in recent years. But the general enthusiasm among the population for this new industry has not developed according to expectations and in proportion to the increases in the fish population and production levels. This is mainly due to the culture, religion and food habits of the people living in the areas where inland fisheries are located. People in these areas have shown a preference for sea fish and the strange taste of inland fish was not liked by these people. Although there is a difference in taste, it was proved a few years back that inland fish can be palatable with certain recepies. But the acceptance by the people of strange fish species with their meals has made very slow progress.

This weak response of people for strange varieties of fish directly affects demand and results in low prices and discourages the development of inland fishing as an economic activity among the people. Thus, to maintain the inland fish production even at existing levels a subsidy is an essential input. The most effective solution to the problem of lack of popularity of inland fish would be the use of a crash propaganda programme to introduce ways of cooking inland fish in a palatable and attractive form and also showing that it is affordable by most people. At present in certain areas inland fish are very popular particularly among those people who have devised their own methods of cooking.

On the other hand, with the increased Tilapia population in the tanks many people in the dry zone tried to operate fishing units, but controls were imposed by the Ministry of Fisheries due to the following reasons which are still in force.

1. Over fishing could cause the depletion of fish resources.

Table: 9

Subsidies and crafts issued for Inland Fisheries (issued till 1985 June)

Year	1980	1981	1982	1983	1984	1985
No. of Crafts issued	7	197	1871	2077		
Subsidies paid (Rs. mn.)	0.004	6.918	14.789	21.711		

Source: *Ministry of Fisheries*

2. Income per fishing unit could be reduced with the increase in the numbers of operational units.

3. Rising competition in fishing may be harmful, as a result of fishing methods, like dynamiting, trawling etc., and

4. Excess fishing could destroy the entire structural and environmental set up of the inland fishery.

Therefore the Ministry of Fisheries has encouraged a gradual development of inland fisheries. However it has to be remembered that the original objectives of the inland fishery was to provide more cheap fish (protein) to the rural poor, rather than feed the coastal and urban areas. Contrary to this policy the factory at Minneriya (which is not functioning at present) was purchasing reservior fish species, mostly Tilapia from the surrounding areas at very low prices and selling the fish fillett they produced in urban areas at a considerably higher price. This process almost amounts to the purchase of the cheap protein meant for the rural poor being used by the better off urban people. Tilapiya has been purchased at around Rs. 5/- from the rural inland fishermen and sold to urban areas at Rs. 7/50 per 250gm. of fish fillett.

It is therefore necessary that the Ministry of Fisheries has control over this sector of fisheries till necessary fish culture methods and consumption patterns are established among the rural people.

However, during the last few years, a few positive attempts to popularise exotic inland fishes in the country, have resulted in a considerable impact on inland fish prices. In the year 1978 one kilogramme of Tilapia was priced at Rs. 4/- to 5/-. Due to these low fish prices people produced dried fish to obtain better market prices in the off season, but now in the same dry zone areas the price is over Rs. 10/- or even more and it is not easy to obtain dried fish produced from tank fishes due to better prices for the fresh fish. Urban markets have been invaded by Tilapia to a certain extent in recent years with prices ranging at Rs. 10/- to Rs. 15/- per 500 grams. Most of these new trends and popularisation strategies followed the establishment of the Inland Fisheries Division in the Ministry of Fisheries.

Another important result was that this sector has been granted high priority in the 1977–83 Master Plan in view of its vast resource potential. It was planned to produce 50,000 tons of inland fish by 1983, though it was not possible to achieve this target due to infrastructural shortfalls and other socio-economic constraints. Before the formulation of the Master Plan the capital investment allotted to the development of inland fisheries was considerably low; amounting to only 10 per cent of the total investment of the fisheries sector. It has been observed that even this financial investment for the development of the sector had not been utilised totally in 1984, mainly due to the institutional red tape. Public sector investment in this sector is given in the Table below:

Furthermore, necessary infrastructure facilities have also been set up gradually, to an extent that can assist the development of this sector. The experience of the Asian countries such as Japan, Korea, China, Philippines and Indonesia have been the driving force behind this development.

During the last three decades a series of research and experimental projects have been conducted by local and foreign scientists on various aspects of the conditions and resources available and general prospects of inland fishery in Sri Lanka. These experiments and research have shown that conditions were favourable and the prospects promising for inland fishery in Sri Lanka. It was therefore decided to provide more infrastructural facilities for the development of Inland Fishery, which included assistance in both cash and kind, through foreign and local aid channels. The assistance was utilised to set up fish breading and research centres to improve the technical standards and commercial know-how, and to promote fish farming activities in rural areas. This has resulted in the

Table: 10

Public Sector Investment in Inland Fisheries

Year	1972	1974	1976	1978	1980	1982	1984	1986
Amt. Rs. Mn.	.13	.82	5.49	3.82	6.86	29.90	15.9	
			-	2.00*	6.8*	16.0*	44.5*	103.5*

*Projected.

Source: *Ministry of Fisheries.*

establishment of inland fish breeding, stocking and distribution centres and making available more acquaculturists and inland fishery instructors in the rural areas.

Two more centres (one at Pimburaththawa and another at Kalawewa) have been proposed for fresh water fish breeding and extension services and these are expected to help to promote inland fishery in the Mahaweli Waters and among the settlers.

But though the necessary infrastructure is being built up for the development of inland fishery, it is important to consider the cultural and religious background of the people which can have a considerable impact on this programme. These factors, have not however, been an obstacle to the programme, probably due to the necessity of the people. But in order to attain a level of self sufficiency in fish consumption it would be ncesssary to adopt advanced fish culture methods at home level fish farms or ponds.

Resources Available

It has been realised that in the overall development programme Inland Fisheries can play a significant role. A look at the resources that can be harnessed in achieving this objective supports this view. A wide range of water bodies suitable for the development of Inland Fisheries are available here. They may be subdivided as follows:

A. Fresh water bodies
- (a) Major irrigation reservoirs
- (b) Medium scale irrigation reservoirs
- (c) Small scale irrigation reservoirs
- (d) Flood lakes and villus
- (e) Rivers and streams

B. Brackish water bodies
- (a) Lagoons and estuaries
- (b) Mangrove swamps and coves

C. Others
- (a) Clay pits
- (b) Coral pits etc.

Most of these are man made morphologies and are more concentrated in the Dry Zone of Sri Lanka (Map 1). Some are seasonal and large in numbers, but occupying small extents in the total. The larger extent is occupied by the water bodies retaining water throughout the year, although they are few in number. Flood lakes, villus, rivers, clay and coral pits and mangrove swamps have not been intensively utilised yet for inland fishery.

At present capture fishery is taking place everywhere in the country's inland fishery providing more than 90 percent of the total inland fish produced. Compared to the fresh water fishery, however, the economically more promising areas are in brackish waters, since they are extensive, fertile and the varieties of fishes found in them offer higher economic value in the market as well.

Furthermore, about 12,000 abandoned irrigation works could be taken into consideration as potential resources if they were restored. Although the extents are vast and scattered all over the country their conditions of efficiency differ in terms of physical features, fertility, as well as economic feasibility. Among the main limiting factors that have appeared in the development of inland fisheries are the following:

(a) Seasonal variations in water retention due to drought or heavy rainfall conditions,

(b) Change of fertility rates due to the activities in the catchment area; it being either a jungle area, agricultural area or barren land.

(c) Chemical composition of water which reacts on fauna and flora, such as salinity, alkalinity, etc.

(d) Socio-economic conditions of the surrounding area. Demand and people's perceptions also affect their enthusiasm and the development of inland fishery.

Research carried out by the Ministry of Fisheries and other agencies have shown that under these conditions it has been possible to produce nearly 50,000 tons of inland fish per year, utilizing the technical inputs being offered at present. But with an increase and introduction of new and advanced fish farming techniques, now being made available, fish production could be further increased. This could be done either through the introduction of new bybrid varities or new culture methods, and the expansion of water bodies for inland fish.

Considering the drought as a

Table: 11

Extent of Inland Water Bodies at (FSL)

Type of Reservoirs	No.	Extent (Acres)
Major irrigation reservoirs	73	175,000
Medium scale irrigation reservoirs	160	42,000
Small scale irrigation reservoirs	16,468	97,000
Flood lakes and villus	–	10,000
Hill Country Reservoirs	–	20,000
Mahaweli Reservoirs	–	60,000
Brackish water bodies	–	300,000
Others	–	–
Total (Approximately)		704,000

limiting factor for inland fishery, the adverse effects could be avoided by the introduction of short term, fast growing varities such as Chinese carp. At present, they are being used in seasonal tanks, mainly to provide a seasonal harvest but have proved their economic feasibility as a species for a short duration harvest. The introduction of Mirigal, Rohu and catla fishes also have proved that seasonal tank fish farming has been successful in the Dry Zone. Therefore, seasonal rains or droughts were not necessarily a barrier which cannot be avoided. It has been proved that this can be overcome either with the proper selection of fish species and or through suitable culture methods.

Likewise, the chemical composition and other natural conditions of the water bodies could also be tolerated with the selection of suitable fish and culture methods. For instance, Tilapia was the ideal species for the dry zone tanks and found is a suitable ecological nitch by responding well to this habitat. The surveys conducted on hydro ecological conditions have therefore provided very important findings for inland fishery development.

Socio-economic conditions of neighbouring areas are also very important in determining peoples participation in inland fishery as an economic activity. If in these areas people have no real interest in inland fishery, this activity will not thrive and propagating it will be difficult. On the other hand the response of the people in dry zone towards inland fisheries, over the last three decades, particularly as an alternative and or supplementary economic activity, has resulted in the rapid expansion of this fisheries sector.

There are also some idigenous fish varieties available for fish farming, which may be considered a useful resource. At present, there are a number of indegenous brackish water fish varieties that have been adopted to the new culture methods. For instance, milk fish and several varieties of shrimps. Also, in fresh water tanks there are some indegenous species whose adoptation to the new fish culture methods is being tried out. With the drop in fish output from the coastal waters of the North and East inland fisheries production reached nearly 20 percent of total production recorded in 1985, which means that this sector has come a long way from the 5 to 10 percent of total fish output in the 1970s. The programme for production and stocking of fish fingerlings, implementation of subsidy schemes for construction of ponds and issue of non-mechanized craft being carried out through the Inland Fisheries Division of the Ministry of Fisheries needs to be kept under constant review. The harvest of 16,000 metric tons in 1979 had doubled by last year and the target for 1986 is a tripling over the 1979 harvest. The experience over the last decade has proved that herbivores such as Tilapia, and some other species, are well suited to the warm water bodies of Sri Lanka and can be cheaply produced, and that growing and marketing is within the reach of the low income people in rural villages. Initial experiements in both cage culture and pen culture in inland waters have been partially successful and there are indications that these intensive breeding and harvesting techniques could catch on. The demand for more fish continues to grow; while fishermen and farmers are showing a greater interest in supplying it. It is only a well planned and sustained extension effort that can help to channel these forces of demand and supply into a highly successful inland fisheries programme.

MAP I INLAND WATER BODIES OF SRI LANKA

The above map indicates both the areas of operation of inland fisheries stations and centres and the concentration and deployment of extension services.

A large scale development of the fresh water fisheries sector could also raise many problems. For instance, the adverse environmental effects particularly on existing water bodies, indigenous fish species and other fauna and flora. A further problem that could reach unmanageable proportions is that of an equitable sharing of resources such as the fish and waters of public reservoirs and ponds. Another problem area is the commercialisation of the inland fish industry, especially at the expense of the rural fish farmer for whom the nutritional value of this programme means much. It is issues such as these that would need to be given constant attention of the authorities concerned.