2. The second design consists of a foam-filled platform on which are mounted sections of piping suitably bracketed; again a radar reflector and light are attached. The anchoring method is the same.

Cost for the construction of one floating object would be approximately 1,100 US dollars. Maintenance, of course, would be a recurrent expenditure which could be met from a small levy on fishermen using the objects.

The National Marine Fisheries Service is fully convinced that a network of objects strategically placed will give the declining tuna fishery off Hawaii a much needed boost. Other Pacific islands must certainly follow suit and the aggregation systems may soon be an accepted feature of fisheries development in tropical seas.

Editors' note: Fisheries Newsletter No. 15, p. 14 contains the project summary of the Pacific Tuna Development Foundation study on aggregation of skipjack to floating objects.

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PAPUA NEW GUINEA'S SEPIK RIVER SALT FISH INDUSTRY*

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ABSTRACT

After the inadvertent introduction of tilapia, Sarotherodon mossambica, to the mighty Sepik River, it became evident that a tremendous amount of fish surplus to subsistence requirements there, but badly needed elsewhere in Papua New Guinea, was being produced. Subsequent investigation indicated that the fishery could only be exploited economically by means of "intermediate technology", and a small successful industry was set up. An Asian Development Bank loan has made it possible to begin the rapid expansion of this fishery, although the recent introduction of the aquatic fern Salvinia molesta may present serious problems.

The Sepik River may be classed among the great tropical rivers of the world such as the Amazon and Mekong. During floods it can discharge over 8,500 m^3/sec. For most of its 1,200 km course it flows from west to east, draining a flood plain of 500,000 ha which supports a population of 80,000 people. It enters the sea between the provincial capitals of Wewak and Madang (Figs. 1 & 2).

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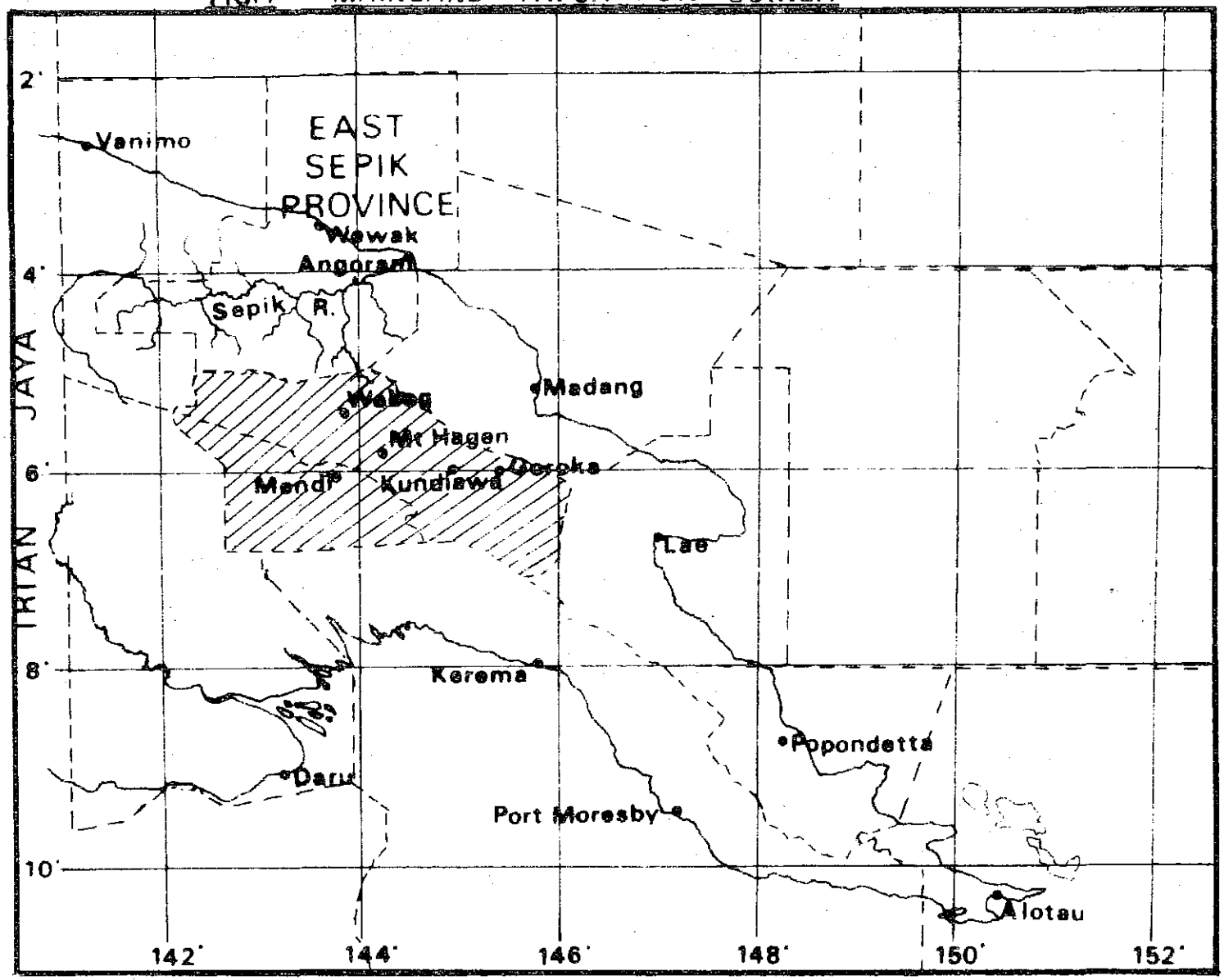
* This is the reprint of a paper presented to the IPFC 18th Session Symposium on Fish Utilization Technology and Marketing in the Indo-Pacific Region held in Manila, Philippines, 8-11 March 1978. The proceedings of the symposium are being printed by the Indo-Pacific Fishery Commission Secretariat, FAO Regional Office for Asia and the Far East, Bangkok 2, Thailand, with the kind assistance of the Philippine Bureau of Fisheries and Aquatic Resources.

FIG. 1 MAINLAND PAPUA NEW GUINEA



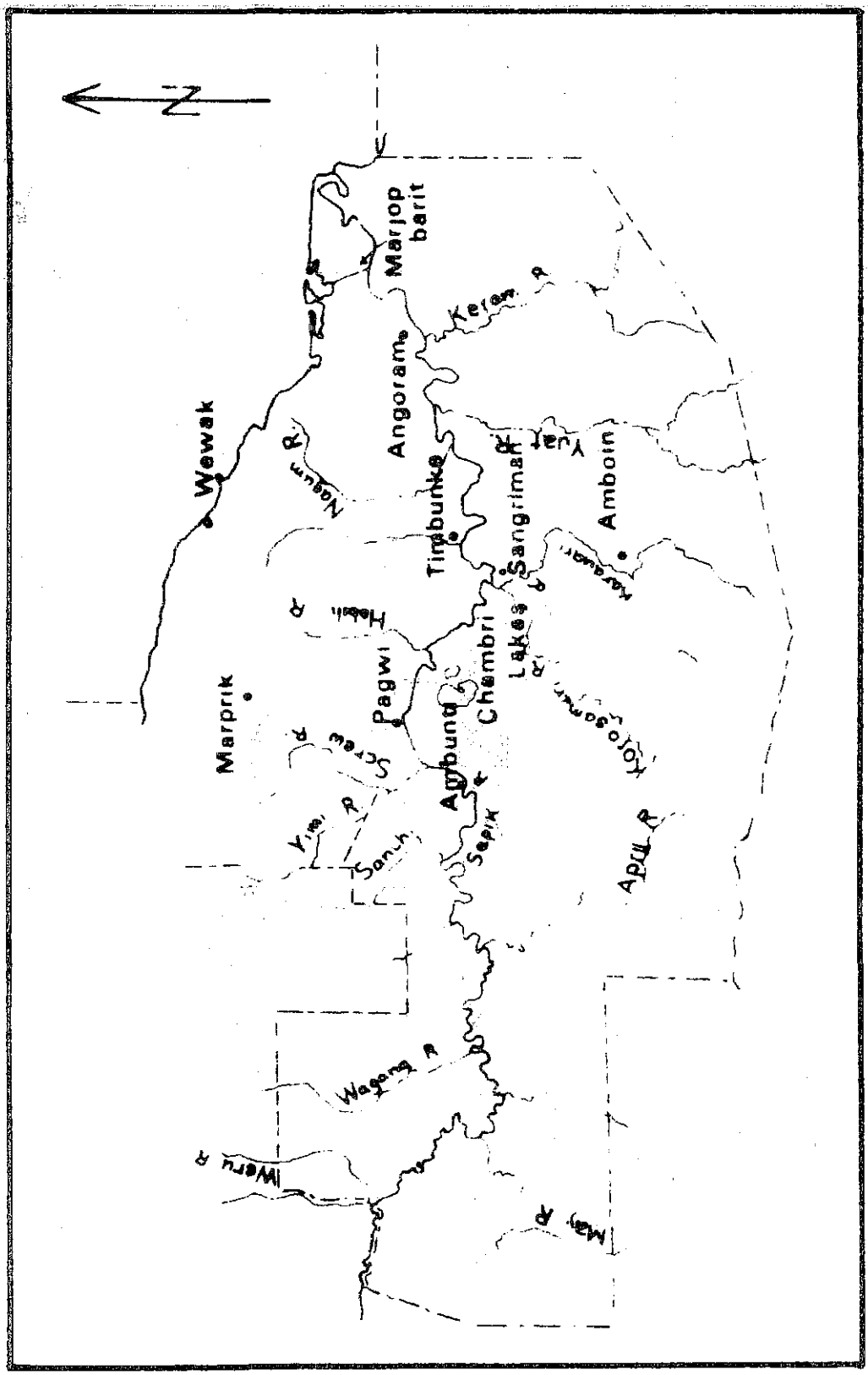


FIG.2 EAST SEPIK PROVINCE

Traditionally most of the day-to-day fishing on the Sepik is done by women with woven cane traps. There has always been a surplus fish catch on the river, traded as far into the interior as practicable. The people of the flood plain, themselves, derive an unusually high amount of their energy requirements from fish, the lack of arable land making carbohydrates relatively scarce (Korte, unpublished).

Nowadays many men own gill nets, the preferred size being 10.16 mm mesh by 50 meshes deep by 100 m. The mean annual daily catch (dusk to dawn set) of these nets would be approximately 40 kg, 28 kg of which would be tilapia, Sarotheradon mossambica, the type of fish used in the salt fish industry. The bulk of the remainder is forktailed catfish (Fam. Ariidae) plus approximately two per cent gudgeons (Fam. Eleotridae) (Glucksman, unpublished).

Estimates of the annual fish production of the Sepik flood plain are between 30,000 and 40,000 t/yr. Of this, approximately 8,000 t are consumed for subsistence. This leaves a considerable tonnage, over half of which is tilapia (Anon. 1976).

The potential for a Sepik tilapia fishery was first recognised in 1950, when a visiting fisheries specialist noted that fish production was below the potential indicated by primary production due to the paucity of native plankton-eating species (Schuster, 1951). However, the introduction of tilapia to the Sepik was unintentional, They were washed out of ponds at Maprik in 1959 and entered the Sepik via the Screw River. By 1966 they had reached their present distribution from the May River to the Marjop Barat. They were immediately adopted into the subsistence fishery and called "makau" in Melanesian Pidgin, the lingua franca along the river (West and Glucksman, 1976).

By 1970 reports of extensive fish (tilapia) kills, due to natural anoxia (Wirthrington, personal communication), at Chambri Lakes indicated that numbers were greatly in excess of subsistence requirements. Agricultural officers began to encourage the increased production of traditionally smoked (non-brined) fish. These fish were marketed as far away as Maprik and Wewak, despite their rather short shelf life.

The then member for the House of Assembly, Jim McKinnon, constructed a large smokehouse with brine tanks and a freezer at Angoram. He produced extremely palatable lightly-brined smoked tilapia, as well as frozen tilapia fillets for export to the Highlands and Inland Sepik areas, but his operation soon failed, because his centralised plant could not be supplied properly and the facilities for the distribution of frozen fish were inadequate.

The Sepik fishery, like other tropical riverine fisheries, has characteristics which make its development a very different matter from fisheries in more temperate climates. Topography, lack of motorised, refrigerated vessels and ambient temperature combine to make the servicing of any large centralised processing plant impossible. Social factors such as fishing rights strictly defined on a spatial basis and lack of incentive to enter a purely cash economy also conspire against centralised fish processing (Glucksman, in press).

If the processing is to be decentralised it most certainly cannot employ the conventional western methods of icing, canning or freezing since neither the energy, clean water, expertise, nor the capital to create them exist even in the administrative centres, much less in outlying areas of the Sepik province.

In 1972 the Department of Agriculture, Stock and Fisheries (now Department of Primary Industry) conducted an extensive investigation of the potential fishery,

which revealed the factors mentioned above. The search for alternative methods of development then began. After an examination of the development of other tropical riverine fisheries, it became evident that processing by some simple means of dehydration would be the most suitable method, and that a large part of it would have to be done either chemically (salting), physically (pressure), or with fuelled driers because of the high rainfall.

After considerable experimentation a process combining brine salting, pressure and sun drying was developed. It consisted of heading, scaling and splitting the fish down the back, leaving the belly flap intact. The body cavity was then scrubbed clean and the fish placed between layers of salt in the polyethylene drum. A plank and stone were placed on top of the fish to assist the salt's osmotic drawing of water with physical pressure and to keep the fish completely submerged in the brine which formed. After 48 hours of this treatment the fish "struck" (all flesh in equilibrium with a saturated salt solution). They were then sun-dried, but they could be returned to a saturated brine solution during bad weather and re-dried later. With this method individual fishermen could preserve their fish at the point of catch and transport them to a central market at their leisure.

In mid-1975 this method was introduced to a river village and by mid-1976, 25 villages were producing 6.5 t of salted tilapia per month, which represents a catch of about 20 t. These salted fish were then transported to packing centres at Angoram and Pagwi where the fishermen received Kina 0.40 per kg (US$1.00= Kina 0.80). The fish were then sealed in 10 kg plastic bags (with cooking instructions), four of which were sewn up in a hessian (copra) bag for shipment to the Highlands and other inland areas.

Initially, they received a good reception in most areas where people were properly instructed in their preparation (prior to this exercise salt fish was completely alien to inland diets). Soon, however several important drawbacks became evident:

1. The bones and spines of the split fish punctured the plastic bags during transit, allowing the entrance of humid air which shortened the shelf life considerably.
2. There is a very large market for deep fried fish in batter, which requires fillets.
3. Inland people were familiar only with the pre-cooked bones of tinned fish and the inedible bones of the split tilapia were a health hazard.

All these problems were solved at a stroke by processing fillets rather than split fish, in the manner described above. This method has the added advantages of reducing the time it takes for the fish to "strike"; being easier for the processor (scrubbing the body cavity of a split fish clean is a laborious process); providing a more attractive offal for pig and crocodile farm use; and removing the bones which served as reservoirs for oil which readily oxidised or became rancid.

At the collection centres the fisherman now receives Kina 0.50 per kg for the sun dried fillets which are then kiln dried for a uniform moisture content and packed in 250 g, 500 g, 1 kg and 5 kg polyethylene bags displaying the brand name, "SOLPIS", and cooking instructions. The bags are shipped in 10 kg cardboard boxes. Production of this product is presently 2.5 t/month representing a catch of 15 t.

In 1976 the Asian Development Bank investigated the feasibility of and finally granted a loan for the development of five integrated projects in the East Sepik Province. The "SOLPIS" project described above was one of them. The

fisheries sub-project share of the loan is Kina 770,000 to be spent over a 15-year period, after which it is hoped that enough capital will be amassed on the river to form a co-operative.

The fisheries sub-project will encompass the Sepik and its tributaries from Ambunti to Angoram. This production target is 500 t of "SOLPIS" per year (3,000 t catch by year five, 1983) There will be two main collection, extension and packaging centres at Pagwi and Angoram and six primary collection, extension and salt distribution points (see Fig. 3). A training centre will be constructed at Angoram where fishermen will be taught those skills necessary for protracted commercial fishing and where in-service courses will be held for personnel. A biological research centre will also be constructed at Angoram.

From the two main packaging centres the fish will be sold to large food wholesale/retail companies with outlets in the Highlands and inland Sepik areas. If target production is reached at the end of year five the retail value of the product, based on the present recommended retail price of Kina 1.40/kg, will be Kina 700,000; of this the primary producer will receive Kina 250,000. This "SOLPIS" will be equivalent in nutritional value to 1,500 t of imported tinned mackerel, which presently retails at more than Kina 1,000/t. The import and consumer savings which will actually occur in the future will almost certainly be far greater, as the production costs of "SOLPIS" will rise along normal inflationary lines while the price of tinned mackerel will be affected by political factors such as the 200-mile exclusive economic zones.

The fisheries sub-project will also entail credit and supply facilities. Such items as salting vessels, salt, and filleting knives will be distributed from extension centres. The main item for which long term credit will be extended is nets. Although the limitations of gill nets have been recognised, and considerable research has already been done on alternative gear, a floating set with the 10.16 mm mesh gill nets described above remains the best gear discovered to date.

Sometime between 1972 and the present the noxious water fern Salvinia molesta was introduced to the Sepik. As the weed reproduces almost exclusively vegetatively, it is usually considered to have been spread by hand over long distances for "ornamental" purposes and then by navigation and drift within a river system. Salvinia had reached epidemic proportions in some parts of the Sepik by December 1977, interfering with navigation and the setting of nets.

None of the chemical, physical, or biological controls employed with only marginal success elsewhere seem feasible for the Sepik, primarily because of topography. It is thought that the extreme fluctuations in water level in Salvinia's original South American habitat prevent it from causing too much damage there. Normally there are similar fluctuations in the Sepik, but in 1977, the first year Salvinia became detrimental, these fluctuations did not occur. It is hoped that when the Sepik returns to its normal high and low water regime the Salvinia population will fall below the point where it interferes with the fishery (Johnstone, unpublished). Meanwhile the search for methods of control applicable to the Sepik continues.

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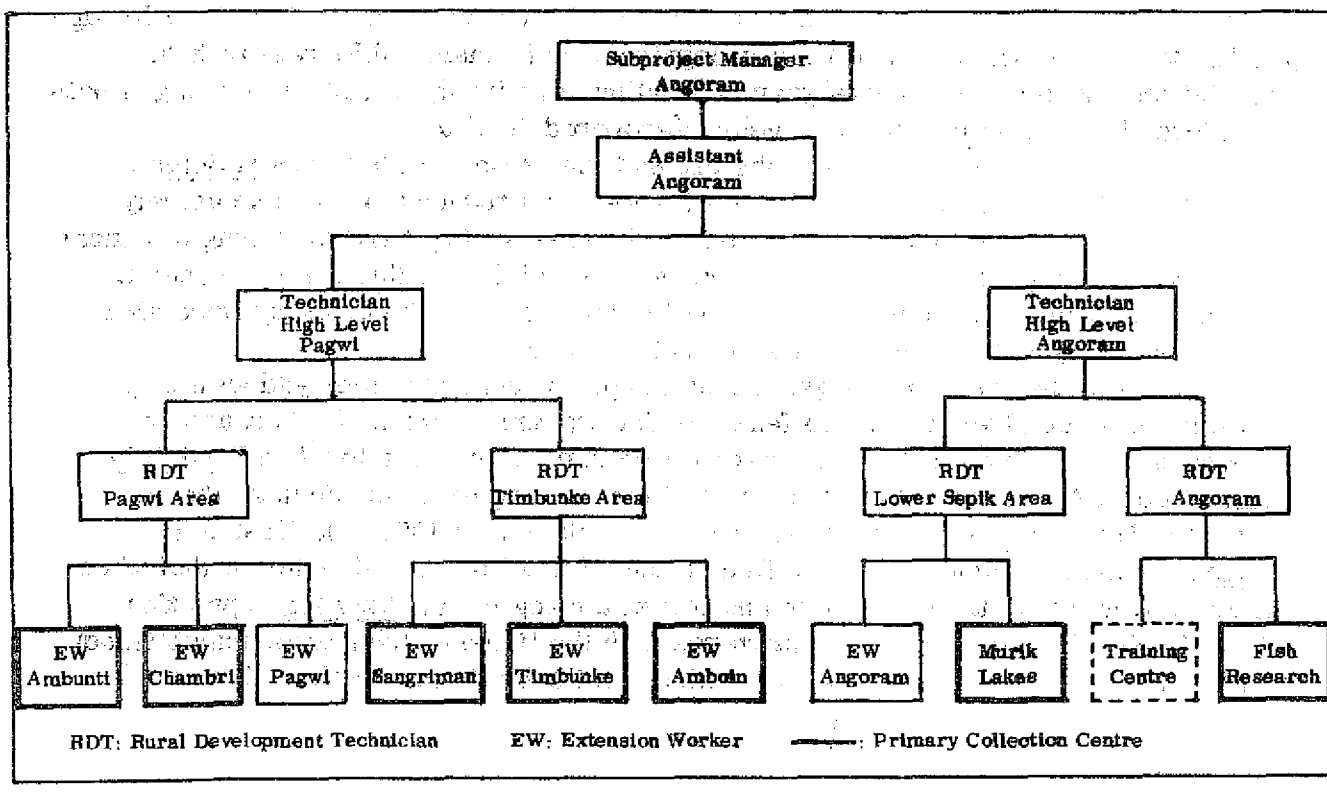

Fig. 3: Organization of Asian Development Bank fish production and processing sub-project, East Sepik Province.