

Shri J.M. Sen Gupta* and Shri Paul Jacob* : *Fishery statistics of India with special reference to estimation of Inland fish catch*

Introduction. India has vast resources of marine and Inland fishery employing a large number of people in exploitation of fish as their main occupation. As a matter of fact, fish in its various forms constitute a very important item of our national diet. But it is well known that there is no reliable statistics available at present specially in respect of Inland fisheries. In recent years, estimates of exploited marine fish are obtained on the basis of sample surveys by the Central Marine Fisheries Research Station, Mandapam. As regards the Inland fisheries, there has been no objective methods adopted so far to obtain relevant statistics. The total marketable surplus of fresh water fish was estimated as 41.3 lakhs of maunds in the year 1948 (Report on the marketing of fish in the Indian Union). This estimate was based on information supplied by local officers, the trades and municipalities. Some ad hoc estimates of Inland fish production are being furnished at present by the States (Report on the pilot survey of Inland Fisheries, Orissa 1962-63). According to the 1948 estimates marketable surplus in W. Bengal was of the order of 12 lakhs of maunds with 10 lakhs in Bihar, 7 lakhs in Assam and 4 lakhs in Orissa respectively.

The inadequacy of fishery statistics was realised as early as 1943 and was pointed out many times since then. This was considered in some detail by the all India Fishery Conference held in 1948. A sub-committee appointed by the conference, submitted a programme of work which the conference recommended as follows :

"It should be given effect to by stages because of the practical difficulties involved and that an expert committee should be appointed at technical level to work out the detailed proposals."

In pursuance of the recommendation of the conference a technical committee was constituted by the Government of India in the Ministry of Agriculture. This committee in its report in 1950 recommended the following integrated plan for the collection of fisheries statistics.*

A. Data to be obtained by a complete (or partial) enumeration :

(i) Once in five years :

- (a) water resources—nature, number, area, and exploitation,

* 8 & 9. Indian Statistical Institute, Calcutta.

* Source : Coordination of Fisheries Statistics (Ministry of Food & Agriculture—March 1950).

- (b) families and population engaged wholly and partly in any branch of fish industry.
 - (c) fishing craft and tackle, and fish transport vessels,
 - (d) number of curing yards, fish farms, ware-houses, ice plants, refrigeration and transport equipment, and
 - (e) sources of supply of spawn, fry, fingerlings.
- (ii) *At shorter intervals :*
- (a) arrivals at selected markets (daily),
 - (b) internal trade,
 - (c) processed fish and fish products, such as fish liver oil, fish oil, fish meal and fish manure. (annual),
 - (d) data on spawn, fry, fingerling and fish collected, reared and disposed of inland fish farms under Government or quasi-Government management and large commercial farms (annual), and
 - (e) landing, wholesale and retail prices. of fish at selected centres of production and consumption, (weekly).

B. Data to be obtained through periodical sample surveys :

- (i) *Once in 5 or 10 years, conducted on an intensive basis :*
- (a) extent of exploitation of different classes of fisheries,
 - (b) sources of supply of gear, yarn, nets, and crafts, and other materials required for fishing,
 - (c) efficiency of different fishing practices,
 - (d) efficiency of different types of craft and gear,
 - (e) marketing, storage, transport and refrigeration,
 - (f) the economics of fish industries, manufactured fish products and by-products,
 - (g) sources of supply of finance and volume of indebtedness of fishermen,
 - (h) consumption of fish by fishermen and confishermen, and
 - (i) economic and sociological conditions of population engaged in fishing and related industries.

(ii) *Continuous sample surveys :*

- (a) catches of inland and marine fish.

C. Data requiring controlled experiments and observation over a long period of time :

- (i) Data on biological factors.

It is obvious that no statistics is being collected as per above scheme except some regarding items in A(ii), B(ii), and (C). As regards B(ii) the Committee pointed out :

"The difficulties in the collection of primary statistics of landings are well-known. A complete enumeration of all the daily catches of an individual fisherman is obviously impossible but even the application of the sampling method is beset with difficulties because of the various types and practices of fishing and the uneven and scattered nature of the distribution of the industry."

It has already been mentioned that a pilot survey with the object of estimating marine fish catches, is being undertaken on the Malabar Coast under the auspices of the I.C.A.R. The technique of sampling adopted for this survey, with the boat as the sampling unit, may not be suitable for inland fisheries. It is necessary to evolve special sampling techniques for the estimation of catches of inland fisheries and pilot scheme with this object should be organized immediately. Such a pilot survey may be carried out in the State of West Bengal in view of its prominent position in the inland fisheries of India. This survey may be carried out through an organization which has previous experience in handling problems of a similar nature and has sufficient acquaintance with the local conditions, such as the Indian Statistical Institute at Calcutta.

As soon as the appropriate techniques are developed the surveys should be extended to other States and statistics of production should be obtained for the country as a whole with convenient break-ups at regional levels."

The I.C.A.R. was already carrying out pilot surveys with the object of estimating marine fish catches and since then developed necessary sampling techniques. Regular sample surveys are now being carried out in the coastal belt of villages to estimate the marine fish production. But no such schemes regarding Inland fisheries have been undertaken excepting some isolated attempts for evolving suitable sampling techniques by the Indian Statistical Institute (I.S.I.) in West Bengal during 1960-1961 and the Agricultural Statistics Division of the Directorate of National Sample Survey (N.S.S.) in Orissa during 1962-63.

This paper briefly discusses the broad results obtained from the above studies carried out by I.S.I. and N.S.S. It also suggests certain lines of approach based on experiences already obtained and on a-priori grounds, for obtaining statistics on Inland fish production.

Pilot studies on fish catch in Inland waters : As already referred, only two pilot studies are known to have so far been carried out for the estimation of fish catch in inland waters, namely, (i) the try out

experiments of West Bengal in 1960-61 and (ii) the pilot studies of Orissa in 1962-63. A brief account of the special features of these studies along with some broad results have been furnished in the Appendices A/1 and A/2. We shall here discuss the merits of these investigations and draw the lessons they have to offer.

The West Bengal studies have given us some acquaintance with the field problems. The sample was seriously disturbed and no estimation has been attempted on it. The results obtained are merely some broad indications of the variability of the character under study in different stages of sampling. The Orissa surveys were on the other hand successfully carried out and have thrown up some estimates however tentative, and on the whole give a better perspective on the total problem. Our observations will therefore dwell mainly on the Orissa experiments.

Physical limitations to an investigation of fish catch on the spot.

In the Orissa Scheme, an individual investigator must have found his work difficult to manage, especially in view of the extensive area that he was expected to cover. Attending the bulk catches on a scheduled date would have been physically impossible, if several of them took place simultaneously (not unusual at the proper season). It is true that the average number of water-units worked out to be only six per village in Orissa, the same for West Bengal being much higher. Thus, even if the scheme has been feasible in Orissa, it can hardly be adopted for some of the States like, West Bengal, Kerala etc.

As a matter of fact, a lot of catches must have been missed altogether, as is evident from an abrupt lowering (of the order of 50%) in the estimates of 1962-63 against that of 1961-62, the latter being based on interviews. In fact, doubt has been expressed about the completeness of catch data for 1962-63 in the report itself. It has also been suspected that owners/operators might have postponed their catches in order to evade the investigation. On the other hand, they might as well have taken a catch without the knowledge of the investigator. The personal presence of the investigator on the spot thus ensures at best an accuracy in those units as were successfully attended, while whole units may have been missed altogether, leaving us wiser in the matter of pennies alone. Quality of data collected through an interview method may not thus be necessarily worse than a so-called objective spot enumeration, not fully under one's control. On the other hand, if we presume that owners would have a tendency to suppress rather than exaggerate the quantity of catches and

consider that there would be some lapses in recall, the 1961-62 figure itself is likely to have been an underestimate, in which case the fall in 1962-63 compared to 1961-62, would be much more than 50%.

It is here emphasised, that errors of ascertainment at the unit level is a greater danger than the incidence of large sampling errors, the latter being amenable to control by a proper designing of the survey. All these point out to the need of making the investigators' total coverage relatively small, so that he is in a position to revisit each village at reasonably short intervals. An unreasonable load may tend to make the investigator desperate and casual in his work, passing on data collected through personal enquiries as one based on actual observation on the spot.

The Orissa enquiry was confined to ponds, tanks and swamps only, while rivers and streams forming estuaries have been left out as relatively un-important. So far as West Bengal is concerned, rivers, beels and large tracts flooded by rivers in spate during the monsoon months, are known to have considerable contribution towards total catch. Any survey in West Bengal would have to cover these sources as well, which will bring up a lot of difficult problems.

The Concept of Area Under Water. The concept of effective water surface as the unit of reference adopted in the Orissa studies, seems to be completely un-realistic, in as much as :-

- (i) its determination must be highly subjective and grossly inaccurate
- (ii) it introduces an additional and large element of error in the estimation of water area and hence in the estimated output.

It may be presumed that the investigator on reaching the selected tank, takes a measure of the water surface as he finds on that day, enquires about the maximum and minimum levels that the water reaches and then makes an approximate guess of the surface area that would be assumed at each stage (unless he happens to be present at one of them). Mean of the maximum and minimum which was accepted as the average measure of water area is, however, likely to be overestimated, as the high level is usually maintained for only a short spell and quickly falls at first, slowing down gradually.

For purposes of estimation, it should be enough and certainly more practical to go by the firmer concept of gross geographical area bounded by raised banks where they exist or by the periphery of the catchment area, as can be fairly recognised and thus amenable to

verification by another observer. Most of the tanks are cadastral survey plots identifiable and shown on the maps. It does not matter if catch-yield is made to refer to a gross area, all of which may not be under water at the time or at any time, and no attempt is made to ascertain the yield-rate per unit of net water area. A firmer basis of reference will more than offset the doubtful prospects of reducing variability, which an effective unit of area as the basis of reference may apparently offer.

Errors of Estimation. Total catch in Orissa was estimated by a double sampling procedure, in which the independent character, namely the area under water was estimated by a stratified two stage sampling. A smaller sub-sample was employed for the estimation of catch yield per unit/per acre. The computation of sampling errors would necessarily be subject to a number of theoretical assumptions, a good many of which may or may not have been satisfied. The safest and best procedure would be to split up the total sample into several subsamples of independent first stage units. Error of the estimate could then be worked out from these sub-sample estimates, and thus independent of these initial assumptions.

Stages of Sampling. In the Orissa sample, contribution (towards variance) of villages in the second stage was found to be more important than that from "Panchayats" which were selected in the first stage possibly on grounds of operational facilities. An unistage sample with villages completely enumerated as in Orissa or by selecting tanks in the second stage when work load per village must be kept small, as was done in West Bengal, seems to be more justified.

Cost of Operations. It appears that the money cost of field operations for estimating total catch for the three districts taken as a whole with a standard error of 10% would be rather high. This does not take into consideration the question of non-sampling errors or ascertainment bias, which would not be controlled by increasing the sample size.

Alternative Approaches to the Problem of Estimating Inland Fish Catch

Spectral features of inland fishing. The technique for estimating the exploitation of marine fish through organised marketing centres or by a sampling of fishing boats or fishing enterprises cannot be adopted for inland fishing, for obvious reasons. In marine fishing, the coverage is confined to a limited belt along the coastal lines. For

inland waters, fishing is done not merely on boats but by fishermen working singly or in teams, using other equipments and devices as well. For rivers and estuaries, the fishing practice would more or less be in the same lines as in the case of marine exploitation. The coverage in such cases will be extensive, merging with areas covered by inland fishing in tanks and ponds. Deep inland, beyond marine fishing and even river-fishing zones, fishing enterprises are less organised, the operation being often an amphibian one, *i.e.*, on boats or on foot. For this region, a registration of boats and building up of a sampling frame does not seem to be feasible.

It may be noted here that unlike crop-yield estimates where the object is to measure the total produce standing on the field, fish catch is a measure of what the owner of a tank cares to exploit (and not its total produce), which depends on his personal reasons and other extraneous circumstances. For instance, catch may be very high in draught years when the ponds dry up and less in other or as and when the prices go up. Apart from the uncertainties in ascertainment, exploitations are therefore subject to large variations in time and current market fluctuations. A number of alternative approaches for the sampling of inland fish catch employing different sampling frames are however being discussed below, bringing out the advantages and disadvantages in each.

Sampling by units of exploited area. The pilot studies of West Bengal in 1960-61 and of Orissa in 1962-63 have both tried out sampling by units of water-area. The area/number of the inland water-units was to be estimated by a larger sample and the rate of exploited yield per unit of water-area was to be based on a sample of smaller size by interviews or by an 'on the spot' observation. Sampling by area units obviously is not applicable in case of marine catches or for that matter for rivers and estuaries. In fact rivers, estuaries and large water-surfaces like 'Beels' etc., similar to marine waters should perhaps be treated as a separate stratum altogether and sampled differently from tanks and ponds. It seems that the Estuarine waters should either be merged with Rivers or with Marine. In fact, many of the species of fish are common to rivers and estuaries on the one hand and between estuaries and seas on the other.

The determination of the number of and area under tanks and ponds, classified by their catchment sizes, seasonal depths and existing conditions, is by itself (apart from exploitations), an important job, as this furnishes the basic material for any developmental plan,

on which the type and quantum of aid needed for the promotion of fish culture would depend. For this purpose, "gross" area "engaged" by ponds and tanks rather than the effective water surface would be more relevant.

In the year 1944-45, a plot-wise complete enumeration of undivided Bengal was carried out (Ishaque's Report—Agricultural Statistics by Plot to Plot Enumeration in Bengal 1944-45), from which the area occupied by tanks, ponds, canals, beels and cadastral surveyed rivers at the Union level are available. The areas under such water units were also being systematically estimated by the Indian Statistical Institute as a bi-product of its seasonal land-utilisation surveys. While in the years prior to 1951 standard sized grids of a square shape were demarcated on the village maps and represented the ultimate sampling units, in latter years, clusters of a specified number of cadastral plots were adopted as the sampling units for estimating the percentage of area under different utilisations, water-areas of different kinds being one of them. The sample size was considerable and consistent results have been obtained from year to year which compares well with the complete enumeration figures of 1944-45, as will be seen below :—

Estimated acreage under tanks and ponds, canals, beels etc. for different years.

Survey	Year	Acreage (in 000) acres		
		autumn	winter	average
(1)	(2)	(3)	(4)	(5)
Ishaque's C.E.,	1944-45	—	—	1276
Bengal crop survey	1947-48	1030	1105	1068
	1948-49	888	1060	964
	1949-50	1157	1169	1163
NSS-Special	1961-62	1217	1528	1372
	1962-63	1396	1576	1486
	1963-64	1528	1353	1440

So far as the estimation of water-area classified under specified categories is concerned, such independent large scale surveys can furnish this important data, merely as a bi-product at very little or no additional cost. This would give an objective estimate of the water areas of different categories. For some of the characters linked up with the owner/operator, a sub-sample of units may be chosen and the data collected by an 'on the spot' observation or by a personal interview of the respective owners/operators of the water-units. The latter was in fact given a trial in the West Bengal Studies of 1960-61 and apart from small casualties was found to be feasible in practice. Thus the area estimation may be based on an objective method while the operational particulars including exploitations may be obtained through interviews.

Sampling by units of exploitation agencies

(a) *Fishermen units.* Sampling through individual fishermen which was considered by the technical committee as one of the likely approaches, but discarded as un-practicable was however tried out by the Indian Statistical Institute in 1962-63 for first hand experiences. The enumeration of a sample of specified fisherman-days, by accompanying him personally in his daily activity presented insurmountable difficulties. The scheme was eventually abandoned on receiving disconcerting reports from a number of reliable investigators. The task of contacting and fixing up an appointment with a fisherman who would engage in fishing on a particular day is tremendously difficult, and seemed to be beyond the scope of an outside investigator, specially a mobile one, as is employed in the Institute's usual surveys.

(b) *Operating household units.* On the other hand, the data may also be collected through a sample of households owning or operating tanks. An 'on the spot' observation of all catches in all tanks possessed by them appears to be equally difficult.

A fully objective investigation by witnessing the catch with one's own eyes did not seem to be practicable and it was felt that personal interview of the fisherman or of the possessing household shortly after the incident, would be the next best source of information. In fact, in enquiries, where a large number of investigators are engaged, the decision should be taken not on the basis of what an exceptionally diligent and conscientious worker might do, but what an average but trained one is capable of doing. Interviewing a sample of individual 'fisherman'-units or of 'operating-household' units, would thus be

a near-objective and practical course. It may be noted here that in listing of fishermen defined *not* by their caste, but by their actual activities, a complete enumeration of all households in the village would have to be undertaken.

Sampling through selling units. Exploitation data may also be collected through fish stalls or vendors retailing fish. At this source, there may be an opportunity to classify the commodity into marine, river-estuarine or catches from tanks and ponds with some degree of reliance. It is however pretty difficult to ensure that any list of selling units constituting the sampling frame would be really complete, especially in view of the un-licensed vendors and petty hawkers.

Sampling through consuming units. A household to household interview for data relating to fish consumption using a short reference period and a very recent one, is perhaps the most exhaustive accounting of fish exploitation, excluding consumptions in the non-household sector. The question of carryover from year to year and net imports will have of course to be kept in mind. The much debated question of biased reporting on food items generally, will of course be there. But a series of estimates would in any case bring out the year to year trends. Besides, a parallel survey for exploitation through household interviews should check up against non-marine, non-riverine supply of fish, *i.e.*, exploitation from tanks and ponds. If the consumption is recorded separately for each species, some sort of apportioning the total among these different sources may perhaps be attempted. Since the households will not generally have the necessary knowledge for indentifying the sources of supply, and again as some of the species are both riverine as well as marine or from tanks and ponds, such a classification is not expected to go very far. One has to go to the very sources of supply, immediate or higher up for necessary information.

A Two-fold programme for the estimation of water-area and quantities of fish exploited from different sources :

For an on-the-spot investigation of catch in tanks and ponds, the investigator has to remain stationed within a small coverage, for vigilance and maintaining an un-broken contact. This means employment of a large staff for whom there is not enough work for the year round. Such a scheme will therefore be too costly, unless it is integrated into a multipurpose scheme along with other enquiries. Taking

all these into consideration, a two-fold programme in the following lines may be suggested :-

Scheme (I) (a) Detailed particulars relating to the classification of water areas according to their size, depth and general conditions may be collected through a plot to plot enumeration in conjunction with seasonal land utilisation surveys (with due provision for urban areas).

(b) For a sub-sample of plot-clusters, the respective owners/operators of all tanks/ponds in them, may be contacted and particulars relating to various operational measures and exploitation made during the season may be collected by interview method.

Scheme (II) (a) A fish consumption survey may be carried out by household interviews integrated with a current consumption survey during each season for the estimation of fish consumption, and a list of fish stalls or sources from which the fish was purchased may be collected for each household. In addition to weekly, monthly or whatever reference period is adopted for consumption data, actual procurements made on the day of visit itself may perhaps be collected on the spot for a sub-sample of households.

(b) A few fish stalls selected from those reported by the consuming households in the village (or block) may be interviewed for estimating the proportion of supply commanded by the different sources, marine, riverine etc. In some cases, it may be necessary to follow up to higher stage in the hierarchy of distribution in order to trace the real source of supply.

Estimates of water-area based on 1 (a) would be objective, while 1 (b) would give the yield of catch per unit of area exploited from tanks and ponds alone, based on interviews, *i.e.*, subjective. Schemes 2 (a) and 2 (b) jointly should give dimensional estimates of the supply from different sources, which is more than what we can hope for, under the present circumstances. Thus the two Schemes together will furnish not only the abstract aggregates for policy decisions and planning, a complete pattern of fish exploitation and its consumption by the different strata of our people will also come out. Any such scheme should, of course, be designed in independent interpenetrating net-work of sub-samples (Mahalanobis) for exercising control over the field work and estimating sampling errors.