

# Estimation of Surplus for the Different Research Problems Relating to Fisheries Sector by using Economic Surplus Model and Prioritizing the Problems

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## ABSTRACT

This paper dealt with different level of surplus in the research problems relating to fisheries sector, faced by different communities and other related persons who are involved and related to fisheries. In this paper research works are categorized in different steps. First of all the collection of different type of research problems with the help of scientific and other related community was performed. Second step involved estimation of economic surplus, consumer surplus and producer surplus with the help of different variables. Then we estimated surplus for different research problems in social welfare and prioritized all the research problems in descending order. Some of more important citations are bio-diversity conservation and quarantine measures shifted from serial number 13 to 44, impact of Farakka barrage on breeding and production of Hilsa and Mahasheer, shifted from serial number 29 to 3, impact of Tehari Dam on breeding and production of fish species shifted from serial number 30 to 10 is an equally important research problem that is a concern of environmental scientist all over the country. Similarly, the priority genetic engineering for the evolution of new fish species of economic and medical importance shifted from serial number 4 to 5, which indicates nominal change on priority list showing its high importance for research.

## Highlights

- ① A total of 63 research problems were collected from different institutes and other sources who were involved in fisheries.
- ② All the information relating to estimation of economic surplus were collected.
- ③ Estimation of economic surplus was done by using the economic surplus model.

**Keywords:** Surplus, Prioritizing, Elasticity, Adoption

Institutionalizing Fisheries Research Priority Setting, Monitoring, and Evaluation in the National Research System aims to promote resource allocation among alternative research problems in an efficient manner. The process of institutionalization should be objective and based on scientific principles. Enhancing production and productivity was the main challenge for the scientists in the early seventies. Research managers had a relatively simple task of allocation of resources for research.

The recent decade has added complexities, regional balance, sustainability, trade technology links, shift in demand (preference pattern), efficiency, equity, health, nutrition and energy, which are a few of the many new challenges confronting fisheries scientists today. With time, these complexities will grow further. On the other hand, availability of public funds for fisheries research is declining. Research managers are finding it difficult to address all the challenges and pursue all scientific options to tackle



them. These factors necessitate more analysis using decision rules along with technical information applying optimization techniques for the allocation of scarce resources on research disposal among alternative research possibilities. Research planning and prioritization has thus become a complex and specialized task. Institutionalization of this process is therefore much more challenging; prioritization is required at different levels. The Indian Council of Agricultural Research lays out broad institutive priorities taking into account the national needs and objectives. It also had to take a long-term view of natural resource conservation and sustainability issues. Such *ex-ante* judgments require analysis of expected costs and benefits. The subjective and institutive judgment, thus, are inadequate in context of the contemporary complexity. The formal analysis has to be built, and what is more important is to be institutionalized at all levels in the NARS.

The choice parameters for decision making are income, employment, productivity growth, efficiency, sustainability, ecology, biodiversity, trade and equity, which interact among themselves while deciding the research priorities. Institution and subjective judgment happens to fail in capturing these complexities. Research manager need more information and analysis in order to make decisions for priority setting and for the allocation of scarce resources. The current capacity at various levels is inadequate to address information and various need of systematic prioritization of work. Almost all constituents unit of NARS recognize the need for planning unit. Such exercises are usually driven by a supply side orientation emphasizing technical/scientific parameters. There is no analysis of socio-economic justification and impact (trade of) of the main determinants of a demand driven research agenda. The main objectives were undertaken as follows:

1. To characterize research problems in Fisheries
2. To estimate the economic surplus of the research problems.
3. To prioritize the research problems on economic surplus

## Review of literature

George W. Norton and Jeffery Alwang (1997) studied that economic surplus analysis is likely to

the basis for policy research evaluation. The key questions are how to deal with uncertainty and causality apportioning credit about turning the evaluation into a major research project. A Bayesian frame work is a useful way to conceptualize the value of policy research information and in some cases to measure that value through the application of Bay's formula combined with economic surplus analysis with a modified Bayesian approach in which prior or posterior probabilities are elicited on particular parameters and distribution is developed around the parameters. In any case, elicitation of probabilities from people involved in the policy decision will be needed. An econometric approach can be useful for evaluating benefits of social science research with economic agent such as producer and consumer who are the decision makers.

Christofer L. Delgado and Claude Courbois (1997) investigated that the consumption of fish and fisheries products are increasing rapidly with income. The 30 percent of world fish export to developed countries will be produced in developing countries in the future. Policy research in developing countries, therefore, needs to address the factors that influence the demand for fish and compacting products in both the developed and developing countries and these changing patterns are likely to influence relative fish prices and trade flow.

Vicent H. Smith and Philip G. Pardey (1997) studied about estimating the benefits of agricultural economics and other social science research which is a daunting and perhaps presumption task. The issue is that, agricultural economics and economics research institutions will surely be required to address with increasing rigor in future. Therefore, economist should take the question seriously and work on identifying and developing conceptual and empirical methodologies to address it.

B.C. Ray and K.K. Dutta (2000) identified the environmental and socio-economic constraints affecting crop yield. Different yield gap ends were analyzed based on the analysis and priority research are recommended. Rice wheat crop sequence has emerged in a big way in the state of Haryana during the last two decades. The area under rice and wheat in the state is 0.83 and 1.97 million hectare, respectively and as a system rice wheat covers more than 0.6 million hectare. Wheat rotation is concentrated in the belt known as Indo-



Gangetic plains. Rice wheat economy of this region is of great importance due to many reasons. Apart from its significant contribution towards national food security and farm employment, this system is crucial for farm export.

Reddy G.P., Sontakki B.S. *et al.* (2003) Studied the methodology for the prioritization of fisheries research in India. In this method, both the single criterion method and multiple criterion methods were used. In single criterion method, congruence and benefit-cost analysis were used and in multiple criterion method, scoring method, analytical hierarchy process and mathematical programming were used.

### Methodology

The methodology deals with the sampling plan, nature and method of data collection. For simplicity and convenience, this section was further divided into three parts:

1. Scientific survey
2. Producer survey
3. Consumer survey

**Scientific Survey:** For the scientific survey, Central Inland Fisheries Research Institute Regional station at Allahabad was purposely selected for the prioritization of fisheries research. In order to characterize the research problem with which inland fisheries it was confronting to, the scientific survey was conducted using a well design questionnaire containing the parameters of supply and demand for research. All the scientists, technical staff of the center and also the fisheries department of Allahabad University, officers of state department of fisheries Lucknow, extension officers, field officers of Fish Farmer Development Agency and other scientists holding research management positions including retired scientists of the regional station were intensively interviewed using a scientific questionnaire, which was designed for this purpose. Scientific survey questionnaire comprised of two parts (a) the information relating to personal details of the scientific community directly linked to scientific productivity, (b) the information relating to each research problem regarding parameters of demand for research and supply of research. The parameters of demand for research are reduction in per unit cost of production and rate of adoption.

For this study we have collected information from 80 scientific persons who are involved in fisheries.

**Producer Survey:** For the purpose of collecting information from producer or fisherman, we selected various landing points in Allahabad district located at river bank of Ganga, Yamuna and other related places, which were purposively selected. The main landing points were Daraganj, Jhushi, Salori, Rasulabad and Karolbag. A total of 100 producers were identified for the survey from these landing centers according to probability proportion to size of the population of respective landing centers. From these landing centers the information were collected from well design schedule develop for this purpose. The information on the type of family, social composition of fisherman and his family, occupational structure, social structure, fishing assets, information to fish catch, price of different fish in the market were collected. In order to establish fish catch relationship, the amount of fish catch per day of different fish species in rainy season, winter season and summer season were gathered. The information of supply for different fish species like quantity of fish supply to the market, price of fish in domestic and international market, price of substitute commodity, time devoted in fishing, different type of technology adopted for fish catch and parameters of ecology were collected from different points and from fishing community. The nature and adoption of different technologies of fish catch done with constraints were also collected. The fishing employment, problem faced by fisherman and important parameters effecting fish production in inland water viz construction of dam, sewage out fall, pollutants, siltation and water velocity were also noted.

**Consumer Survey:** A total of 100 consumer were identified for survey from different fish markets according to probability proportion to the size of sample population. The different fish markets were Daraganj, Teliarganj, Karolbag, Jushi, Salori and Katra. Mainly the consumer survey was conducted for estimation of demand function of fish. The total amount of fish consumed per day in Kg., price of different fish species, time of using (daily, weekly, monthly and other) and income of the consumer household were collected from the market. The price of substitute commodity as well as for different fish species, egg, mutton, chicken were also collected.



The economic surplus estimate return to investment by estimating the benefits from research problems in terms of changes in consumer and producer surplus that result from technological changes. The ex-ante analysis usually incorporate expert opinion to determine research impact, adoption rates and probability of research success and provide estimates of the economic efficiency and distributional implications of fisheries research resource allocation.

### Analytical Tools

The economic surplus model served the basis of computation of economic surplus for research priority setting. This model is also referred to as a literature on benefit cost analysis in which discounted benefit and discounted cost are computed for solving a research problem in consideration. The economic surplus is comprised of consumer surplus as well as producer surplus. The total economic surplus approach estimate returns to investment by estimating the benefit from research in terms of the change in consumer and producer surplus which results in technological changes. Ex ante analysis usually incorporates expert opinion to determine project research impacts. Adoption rates and probability of research success provide estimates of the economic efficiency and distributional implications of fishery research resource allocation. The formula for computation of economic surplus, consumer surplus and producer surplus is as follows:

$$T.S = P_0 Q_0 K a (1+0.5 nZ)$$

$$C.S. = P_0 Q_0 K a (1+0.5 nZ)$$

$$P.S = T.S. - C.S.$$

$$Z = \frac{Ke}{(e+n)}$$

T.S. = Total surplus

C.S = Consumer Surplus

P.S. = Producer Surplus

Po = Price of fish

Qo = Quantity of fish

e = Elasticity of supply

n = Elasticity of Demand

K = Reduction in per unit cost of production

a = Rate of adoption

The elasticity of supply and elasticity of demand were estimated for computation of economic surplus. The magnitude of supply shifter reduction per unit cost of production K and rate of adoption a in the formula are the average value computed based on scientific survey.

The research priority setting was carried out to sort out the research problems in descending order based on the absolute value of economic surplus of the research problem.

### RESULTS AND DISCUSSION

The exercise was made to prioritize the research problems solely on ground of the economics surplus values. Afterwards the economic surplus values were combined together with other factors like cost of production to set the priority in a broader perspective. Thorough brain storming discussion related to researchable problems were made with research scientists, technical officers, fishery extension officers, state department of fisheries, fisheries development agencies, fisheries development managers and NGOs working in the field. A list of 63 problems relating to productivity research, ecological research and policy research were assimilated and summarized in the table. The magnitude of economic surplus for individual problems was computed by using the formula motioned in analytical tools. The values of elasticity of demand and supply were estimated by using formula given in analytical tools. The values of rate of adoption and decline in per unit cost of production as generated through scientific survey was used for computing the total economic surplus. The values of total economic surplus, consumed surplus and producer surplus for each problems are given in the table. The average value of total economic surplus, consumer surplus and producer surplus were computed to be 4.19 E + 09, 60385008 and 4133301190, respectively. The total economic surplus was found to be ranging from minimum of 4224431 to maximum of 1.43 E + 10. Similarly the consumer surplus was found to be ranging from minimum 422 44 31 to maximum 1.85 E + 09, further the producer surplus was found to be at minimum of 1.4154 E + 10. These economic surpluses in further sections were used to prioritize setting the research problems in descending order of sequence. The other parameters considered for priority setting of

**Table 1:** Different research problems

Sl. No.	List of research problems
01	Bio-technological investigation on growth of important fish species in India.
02	Study of biochemical compound of medical importance in various fish species of India.
03	Investigation and dynamics of disease problems in fishes through gene mapping.
04	Genetic engineering for evolution of new fish species of economic and medical importance
05	Assessment of Environmental degradation on aquatic life of important River of India.
06	Assessment of Environmental degradation on aquatic life of important Jheel of India.
07	Assessment of Environmental degradation on aquatic life of important reservoir of India.
08	Assessment of Environmental degradation on aquatic life of important Lake of India.
09	Assessment of Environmental degradation on aquatic life of important canal in India.
10	Assessment of bio-diversity changes in different rivers of India.
11	Investigation of habitat degradation in relation to fishes ecology of different rivers of India.
12	To study the possibility of breeding culture of Tengra species.
13	Bio – diversity conservation and quarantines measures in Indian water ecosystem.
14	Legal issues related to quarantine measures for important foreign fish species migrating into India.
15	Possibilities of culture and breeding of Thai mangur through modification in its cannibalistic habit.
16	Impact of dam construction on rivers on ecology, water velocity (siltation) and breeding of fish species.
17	Development of management practices for Jheel and reservoirs
18	Effect of introduction of alternative fish development polices in India
19	Constraints analysis of extension programme for development of fishes in India.
20	Study of energy flow in various water ecosystem of India.
21	Investigation on priority setting for fishery research in India
22	Measuring scientific productivity in ICAR system and investigation on constraints and remedies.
23	Investigation on depletion of natural resources for inland fisheries and measurement of environmental efficiency.
24	Development of appropriate cropping strategies under water logging soils and around the canals of India
25	Possibilities of pen and cage culture of prawn and corps species in water ecosystem.
26	Documentation of Bio-diversity of fish species in India
27	Impact of pollution on nutrition value of fish species in relation to adverse impact on human health.
28	Investigation on environmental impact of biotic community in rivers and associated ecosystems.
29	Impact of Frakka barrage on breeding and production of <i>Hilsa</i> and <i>Mahasheer</i>
30	Impact of Tehari dam on breeding and production of fish species
31	Development of management strategies for different inland aquatic ecosystems.
32	Cause and cure of mass mortality of fish species of river Ganga during flood season.
33	Investigation on ecology and habitat for production of ornamental fisheries
34	Data base management in inland fisheries
35	Projection and forecasting of demand for supply of fisheries in India.
36	Investigation on causes and cure of diseases in aquatic ecosystem.
37	Development of technology for culture & breeding of wild species of natural resources namely sour and channa.
38	Investigation on degradation of Niche and its effects of production and productivity of riverine fisheries.
39	A study of somatic and genital development of Catala and Rahu in river ecosystem.
40	Investigation of production capacity of water ecosystem and constraints or factors responsible for production capacity in natural resource ecosystem.
41	A comparative analysis of productivity and production potential of different fish species in natural eco system and culture based system.
42	Conservation of endangered fish species.
43	Management and strategy for improvement productivity of reservoir and cage culture as an alternative.
44	Pen culture as a tool of enhancement of productivity of Bheel.



- 45 Biology of important fish species with special reference of habit and habitat in relation to dynamics of environmental changes in aquatic ecosystems.
- 46 To enhance fish from reservoir and lakes.
- 47 To develop methodology for conservation of threatened fisheries resources.
- 48 Methodology for diversification of fish culture (new species)
- 49 Method for eradication of exotic species from riverine system.
- 50 To develop methodology on rehabilitation for migratory fishes like *Hilsa*.
- 51 Eradication of aquatic weeds (eichornia) from lentic systems.
- 52 Environmental Impact Assessment of reservoir, canal and interlinking rivers.
- 53 Research related to engineering components of fish catch Viz., development of new types of net, *Happa*, mechanized crafts, gears and similar other type of innovations.
- 54 Detection of food borne pathogenic bacteria from fish and fishery products.
- 55 Development of kit for rapid detection of fish borne pathogens by molecular techniques.
- 56 Detection of marine tonics from fish and fishery product by rapid molecular method.
- 57 Detection of antibiotics in fish and fishery products by High Power Liquid Concentration.
- 58 Development of value added products through bio-technological intervention. For example crab sent in low value fish (selfish.)
- 59 Legal issues related to quarantine measures of important foreign fish species migrating into India
- 60 Impact of interlinking rivers in India and its impact of production of inland fisheries.
- 61 Impact of interlinking rivers in India on ecology and bio- diversity.
- 62 Investigation of the impact of interlinking rivers in India on soil health. (Soil flora, fauna and physico-chemical parameters of soil in relation to rise in ground water level).
- 63 Investigation on suitable ownership pattern and property right.

**Table 2:** Economic surplus of different research problems

Sl. No. of Research Problems	List of research problems	Total Surplus	Consumer Surplus	Producer Surplus
01	Bio-technological investigation on growth of important fish species in India.	3822641186	49203684	3773437502
02	Study of biochemical compound of medical importance in various fish species of India.	2719413792	28826273	2690587519
03	Investigation and dynamics of disease problems in fishes through gene mapping.	4368732784	49203684	4319529100
04	Genetic engineering for evolution of new fish species of economic and medical importance	10599192482	106111487	10493080995
05	Assessment of Environmental degradation (Industrial effluents) on aquatic life of important River of India.	4160053022	74965422	4085087600
06	Assessment of Environmental degradation (Industrial effluents) on aquatic life of important Jheel of India.	4710752214	106111487	4604640727
07	Assessment of Environmental degradation (Industrial effluents) on aquatic life of important reservoir of India.	2496031813	74965422	2421066391
08	Assessment of Environmental degradation (Industrial effluents) on aquatic life of important Lake of India.	3533064160	106111487	3426952673
09	Assessment of Environmental degradation (Industrial effluents) on aquatic life of important canal in India.	4992063626	74965422	4917098204
10	Assessment of bio-diversity changes in different rivers of India.	1638274794	49203684	1589071110
11	Investigation of habitat degradation in relation to fishes ecology of different rivers of India.	1599655172	28826273	1570828899
12	To study the possibility of breeding culture of Tengra species.	9421504428	106111487	9315392941



13	Bio – diversity conservation and quarantines measures in Indian water ecosystem.	1599655172	28826273	1570828899
14	Legal issues related to quarantine measures for important foreign fish species migrating into India.	375081883	4224431	370857452
15	Possibilities of culture and breeding of Thai mangur through modification in its cannibalistic habit.	7066128321	106111487	6960016834
16	Impact of dam construction on rivers on ecology, water velocity (siltation) and breeding of fish species.	2730457990	49203684	2681254306
17	Development of management practices for Jheel and reservoirs	3276549588	49203684	3227345904
18	Effect of introduction of alternative fish development polices in India	9421504428	106111487	9315392941
19	Constraints analysis of extension programme for development of fishes in India.	2239517241	28826273	2210690968
20	Study of energy flow in various water ecosystem of India.	458520337	20656690	437363647
21	Investigation on priority setting for fishery research in India	5888440267	106111487	5782328780
22	Measuring scientific productivity in ICAR system and investigation on constraints and remedies.	4368732784	49203684	4319529100
23	Investigation on depletion of natural resources for inland fisheries and measurement of environmental efficiency.	6240079533	74965422	6165114111
24	Development of appropriate cropping strategies under water logging soils and around the canals of India	9421504428	106111487	9315392941
25	Possibilities of pen and cage culture of prawn and corps species in water ecosystem.	959793103	28826273	930966830
26	Documentation of Bio-diversity of fish species in India	3822641186	49203684	3773437502
27	Impact of pollution on nutrition value of fish species in relation to adverse impact on human health.	1919586206	28826273	1890759933
28	Investigation on environmental impact of biotic community in rivers and associated ecosystems.	185474538	8355769	177118769
29	Impact of Frakka barrage on breeding and production of <i>Hilsa</i> and <i>Mahasheer</i>	11081867617	142641878	10939225739
30	Impact of Tehari dam on breeding and production of fish species	8924085262	123703642	8800381620
31	Development of management strategies for different inland aquatic ecosystems.	1279724137	28826273	1250897864
32	Cause and cure of mass mortality of fish species of river Ganga during flood season.	14248115508	142641878	14105473630
33	Investigation on ecology and habitat for production of ornamental fisheries	8243816375	106111487	8137704888
34	Data base management in inland fisheries	1063853777	38341938	1025511839
35	Projection and forecasting of demand for supply of fisheries in India.	1279724137	28826273	1250897864
36	Investigation on causes and cure of diseases in aquatic ecosystem.	921173481	13833189	907340292
37	Development of technology for culture & breeding of wild species of natural resources (River) namely sour and channa.	5824074230	74965422	5749108808
38	Investigation on degradation (damage) of Niche and its effects of production and productivity of riverine fisheries.	307057827	13833189	293224638
39	A study of somatic and genital development of <i>Catala</i> and <i>Rahu</i> in river ecosystem.	2496031813	74965422	2421066391



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40	Investigation of production capacity of water ecosystem and constraints or factors responsible for production capacity in natural resource ecosystem.	4992063626	74965422	4917098204
41	A comparative analysis of productivity and production potential of different fish species in natural eco system and culture based system.	1914936799	38341938	1876594861
42	Conservation of endangered fish species.	3003503789	49203684	2954300105
43	Management strategy for improvement productivity of reservoir and cage culture as an alternative.	917040674	20656690	896383984
44	Pen culture as a tool of enhancement of productivity of Bheel.	9421504428	106111487	9315392941
45	Biology of important fish species with special reference of habit and habitat in relation to dynamics of environmental changes in aquatic ecosystems.	93770470	4224431	89546039
46	To enhance fish from reservoir and lakes.	8243816375	106111487	8137704888
47	To develop methodology for conservation of threatened fisheries resources.	4992063626	74965422	4917098204
48	Methodology for diversification of fish culture (new species)	14338227959	184556596	14153671363
49	Method for eradication of exotic species from riverine system.	1375561012	20656690	1354904322
50	To develop methodology on rehabilitation for migratory fishes like Hilsa.	2766019821	38341938	2727677883
51	Eradication of aquatic weeds (eichornia) from lentic systems.	383822284	13833189	369989095
52	Environmental Impact Assessment of reservoir, canal and interlinking rivers.	4368732784	49203684	4319529100
53	Research related to engineering components of fish catch Viz., development of new types of net, Happa, mechanized crafts, gears and similar other type of innovations.	4992063626	74965422	4917098204
54	Detection of food borne pathogenic bacteria from fish and fishery products.	460586741	13833189	446753552
55	Development of kit for rapid detection of fish borne pathogens by molecular techniques.	6656084835	74965422	6581119413
56	Detection of marine toxins from fish and fishery product by rapid molecular method.	460586741	13833189	446753552
57	Detection of antibiotics in fish and fishery products by High Power Liquid Concentration.	3617102843	38341938	3578760905
58	Development of value added products through biotechnological intervention. For example crab sent in low value fish (selfish.)	11081867617	142641878	10939225739
59	Legal issues related to quarantine measures of important foreign fish species migrating into India	7066128321	106111487	6960016834
60	Impact of interlinking rivers in India and its impact of production of inland fisheries.	537351197	13833189	523518008
61	Impact of interlinking rivers in India on ecology and biodiversity.	1279724137	28826273	1250897864
62	Investigation of the impact of interlinking rivers in India on soil health. (Soil flora, fauna and physico - chemical parameters of soil in relation to rise in ground water level).	460586741	13833189	446753552
63	Investigation on suitable ownership pattern and property right.	1074702395	13833189	1060869206

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**Table 3:** List of prioritized research problems based on economic surplus generated by different research problems.

Sl. No.	Sl. No. of prioritized research problems	List of research problems	Total Surplus	Consumer Surplus	Producer Surplus
1	48	Methodology for diversification of fish culture (new species)	14338227959	184556596	14153671363
2	32	Cause and cure of mass mortality of fish species of river Ganga during flood season.	14248115508	142641878	14105473630
3	29	Impact of Frakka barrage on breeding and production of <i>Hilsa</i> and <i>Mahasheer</i>	11081867617	142641878	10939225739
4	58	Development of value added products through bio – technological intervention. For example crab sent in low value fish (selfish.)	11081867617	142641878	10939225739
5	4	Genetic engineering for evolution new fish species of economic and medical importance	10599192482	106111487	10493080995
6	12	To study the possibility of breeding culture of <i>Tengra</i> species.	9421504428	106111487	9315392941
7	18	Effect of introduction of alternative fishes development polices in India	9421504428	106111487	9315392941
8	24	Development of appropriate cropping strategies under water logging soils and around the canals of India	9421504428	106111487	9315392941
9	44	Pen culture as a tool of enhancement of productivity of Bheel.	9421504428	106111487	9315392941
10	30	Impact of Tehari dam on breeding and production of fish species	8924085262	123703642	8800381620
11	33	Investigation on ecology and habitat for production of ornamental fisheries	8243816375	106111487	8137704888
12	46	To enhance fish from reservoir and lakes.	8243816375	106111487	8137704888
13	15	Possibilities of culture and breeding of Thai mangur through modification in its cannibalistic habit	7066128321	106111487	6960016834
14	59	Legal issues related to quarantine measures of important foreign fish species migrating into India	7066128321	106111487	6960016834
15	55	Development of kit for rapid detection of fish borne pathogens by molecular techniques.	6656084835	74965422	6581119413
16	23	Investigation of depletion of natural resources for inland fisheries and measurement of environmental efficiency.	6240079533	74965422	6165114111
17	21	Investigation priority setting for fishing research in India	5888440267	106111487	5782328780
18	37	Development of technology for culture & breeding of wild species of natural resources (River) namely sour and channa.	5824074230	74965422	5749108808
19	9	Assessment of Environmental degradation (Industrial effluents) on aquatic life of important canal of India.	4992063626	74965422	4917098204
20	40	Investigation of production capacity of water ecosystem and constraints or factor responsible for production capacity in natural resource ecosystem.	4992063626	74965422	4917098204
21	47	To develop methodology for conservation of threatened fisheries resources.	4992063626	74965422	4917098204
22	53	Research related to engineering component of fish catch like development of new type of net, Happa, mechanized boat, gears and similar other type of mechanical innovations.	4992063626	74965422	4917098204



23	6	Assessment of Environmental degradation (Industrial effluents) on aquatic life of important Jheel of India.	4710752214	106111487	4604640727
24	3	Investigation and dynamics of disease problems in fishes through gene mapping.	4368732784	49203684	4319529100
25	22	Measuring scientific productivity in ICAR system and investigation of constraints remedies.	4368732784	49203684	4319529100
26	55	Environmental Impact Assessment of reservoir, canal and interlinking rivers.	4368732784	49203684	4319529100
27	5	Assessment of Environmental degradation (Industrial effluents) on aquatic life of important River of India.	4160053022	74965422	4085087600
28	1	Bio-technological investigation on growth in important fish species in India.	3822641186	49203684	3773437502
29	26	Documentation of Bio – diversity of fish species in India	3822641186	49203684	3773437502
30	57	Detection of antibiotics in fish and fishery product by HPLC.	3617102843	38341938	3578760905
31	8	Assessment of Environmental degradation (Industrial effluents) on aquatic life of important Lake of India.	3533064160	106111487	3426952673
32	17	Development of management practices for Jheel and reservoirs	3276549588	49203684	3227345904
33	42	Conservation of endangered fish species.	3003503789	49203684	2954300105
34	50	To develop methodology for rehabilitation migratory fishes like Hilsa.	2766019821	38341938	2727677883
35	16	Impact of dam construction on rivers on ecology, water velocity (siltation) and breeding of fish species.	2730457990	49203684	2681254306
36	02	Study of biochemical compound of medical importance in various fish species of India.	2719413792	28826273	2690587519
37	7	Assessment of Environmental degradation (Industrial effluents) on aquatic life of important reservoir of India.	2496031813	74965422	2421066391
38	39	A study of somatic and genital development of Catala and Rahu in river ecosystem.	2496031813	74965422	2421066391
39	19	Constraints analysis of extension programme for development of fishes in India.	2239517241	28826273	2210690968
40	27	Impact of pollution on nutrition value of fish species in relation to adverse impact on human health.	1919586206	28826273	1890759933
41	41	A comparative analysis of productivity and production potential of different fish species in natural system and culture based system.	1914936799	38341938	1876594861
42	10	Assessment of bio-diversity changes in different rivers of India.	1638274794	49203684	1589071110
43	11	Investigation of habitat degradation in relation to fishes ecology of different rivers of India.	1599655172	28826273	1570828899
44	13	Bio – diversity conservation and quarantines measures in Indian water ecosystem.	1599655172	28826273	1570828899
45	49	Method for eradication of exotic species form riverine system.	1375561012	20656690	1354904322
46	31	Development of management strategies for different inland aquatic ecosystems.	1279724137	28826273	1250897864
47	35	Projection and fore casting of demand for supply of fisheries in India.	1279724137	28826273	1250897864
48	61	Impact of interlining rivers in India on ecology and bio-diversity.	1279724137	28826273	1250897864
49	63	Investigation of suitable ownership pattern and property right.	1074702395	13833189	1060869206



50	34	Data base management in inland fishery	1063853777	38341938	1025511839
51	25	Possibilities of pen and cage culture of prawn and corps species in water ecosystem.	959793103	28826273	930966830
52	36	Investigation on causes and cure of disease against aquatic ecosystem.	921173481	13833189	907340292
53	43	Management strategy for improvement productivity of reservoir can cage culture as an alternative.	917040674	20656690	896383984
54	60	Impact of interlinking rivers in India and its impact of production of inland fisheries.	537351197	13833189	523518008
55	54	Detection of food borne pathogenic bacteria from fish and fishery products.	460586741	13833189	446753552
56	56	Detection of marine tonics form fish and fishery product by rapid molecular method.	460586741	13833189	446753552
57	62	Investigation of the impact of interlinking in India on soil health. (Soil flora, fauna and physico - chemical parameters of soil in relation to rise in ground water level).	460586741	13833189	446753552
58	20	Study of energy flow in various water ecosystem of India.	458520337	20656690	437363647
59	51	Eradication of aquatic weeds (eichornia) from lentic systems.	383822284	13833189	369989095
60	14	Legal issues related to quarantine measures of important foreign fish species migrating into India.	375081883	4224431	370857452
61	38	Investigation of degradation (damage) of Niche and its effects of production and productivity of riverine fisheries.	307057827	13833189	293224638
62	28	Investigation of environmental impact of biotic community in rivers and associated ecosystems.	185474538	8355769	177118769
63	45	Biology of important fish species with special reference of habit and habitat in relation to dynamics of environmental changes in aquatic ecosystems.	93770470	4224431	89546039

research problems were also combined to find the cumulative effect of different factors. The priority setting of research will provide useful information to understand the importance of different research problems relating to productivity, ecology and policy research. The priority setting of fisheries was carried out in two ways. The exercise made to priority setting of the research problems solely on ground of economic surplus values was combined together with other factors like cost of production to set the priority in a broader perspective. The priority setting in both ways are presented in the table. It can be observed from the table that the five research problems after priority setting are:

1. Methodology for diversification of fish culture. This problem was originally at the serial number 48, which is now occupying the first place.
2. Cause and cure of mass mortality of fish species of river Ganga during flood season.

This problem was originally at the serial number 32, but now it is appearing at 2. This issue is really important causing immediate concern of scientific community.

3. The problem number 29 is now placed at serial number 3. The problem is impact of Farrakhan barrage on breeding and production of Hilsa and Mahasheer. This is also to be taken up at priority basis.
4. Similarly, the problem at serial number 58 is now placed at priority list of 4. The problem is the Development of value added products through biotechnological intervention.
5. Surprisingly a problem at serial number 4 is now placed at priority list of 5. It is amply clear that the problem, because of being important could not be replaced at a lower scale. The problem is Genetic engineering for evolution new fish species of economic and medical importance.



Appraisal of five research problems based on priority list of lower scale are:

1. Problem at serial number 45, biology of important fish species with special reference of habit and habit in relation to dynamics of environmental changes in aquatic ecosystem, is now placed at serial number 63 because of their lower importance in social welfare.
2. The problem at serial number 28, investigation of environmental impact of biotic community in river and associated ecosystems, is placed on priority list 52.
3. Similarly, the problem at serial number 38, investigation of degradation (damage) of Niche and its effects of production and productivity of riverine fisheries is placed on priority list of 61.
4. The problem at serial number 14, legal issues related to quarantine measures of important foreign fish species migrating into India, is now placed that serial number 60, showing its lower importance given by scientific commodity.
5. The problem at serial number 51, eradication of aquatic weeds (eichornia) form lentic systems, is placed at serial number 59 because of its lower importance.

Some more important citations are bio-diversity conservation and quarantine measures (serial number 13), develop of cropping strategy appropriate for water logging soils, shifted from serial number 24 to 08, impact of Theatrical on breeding and production of fish species shifted form serial number 30 to 10 is an equally important research problem causing concern of environmental scientist all over the country. Similarly, the research problem possibilities of culture and breeding of thigh mangur through modification of cannibalistic habit remains unchanged on the priority list, showing its high importance for research.

## CONCLUSION

It can be concluded that first five research problems were shifted from serial number 48 to 1, 32 to 2, 29 to 3, 58 to 4 and 4 to 5, should be put under high priority list as it requires immediate solution. Appraisal of five research problems based on

priority list of lower scale are 45 to 63, 28 to 62 , 38 to 61, 14 to 60 and 51 to 59, which can be put under low priority list and may be postponed for future.

## Implication Including Recommendation

Priority setting of research will provide useful information to understand the importance of different research problems related to productivity, ecology and policy research. The research problem of high priority list requires immediate attention and those problems under the low priority list may be postponed for future.

## REFERENCES

- Daya Nath Jha, Praduman Kumar, Mrathyunjaya, Suresh Pal, Selvarajan, S. and Alka Singh 1995. Research priorities in India Agriculture. Policy paper (3). National Center for Agricultural economics and policy Research, May 1995.
- Franzel, S.H., R.E. Evenson, R. Herdt and M. Hossain, Jaenicke, and Janssen, W. 1996. Choosing the Right Trees: Setting Priorities for Multipurpose Tree Improvement, Research Report 8, ISNAR, The Hague.
- Joshi P.K. and Bantilan, M.C.S. 1997. Intitutionalisation of research prioritization monitoring and evaluation. Paper resented in the workshop on institutionalization or research prioritization monitoring and evaluation. Held on 21-23 July 1997. At NCAP New Delhi.
- Modayil Mohan Joseph 2003. Prioritization of research in marine fisheries. National Workshop under NA TP recognize by National Academy of Agricultural Research Management Rajendranagar, Hydereabad. Nov. 10-11,2003.
- Mc Calla, A.F. and Ryan, J.G. 1992. Setting Agricultural Research Priorities: Lessons from CGIAR Study. *American Journal of Agricultural Economics*, **74**(5): 1095-1100.
- Nagireddy M.V.S. 2003. Aquaculture in Andhra Predesh with respect to emerging crisis. National workshop under NA TP "Methodology for Prioritization of fisheries research in India." November 10-11, 2003.
- Norton, G.W. Pardey, P.G. and Alston L.M. 1992. Economic Issues in Agricultural Research Priority Setting. *American Journal of Agricultural Economics*, **74**(5): 1089-1094.
- Reddy, G.P. and Santakki, B.S. *et al.* 2003. Metholodology for prior it ization of fisheries research in India. National Workshop under NATP recognize by National Academy of Agricultural Research Management Rajendranagar, Hydereabad, Nov. 10-11, 2003.
- Shumway, C.R. 1973. Allocation of scarce resources to agricultural research: review of methodology, *American Journal of Agricultural Economics*, **55**(4): 547-58.
- Sompo Ceesay *et al.* 1989. Analysis of Agricultural Research Priorities in the Gambia. Paper prepared for the National Agricultural Research Board of the Gambia, March 1989.