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Traditional knowledge of the fishermen community of Indian Sundarbans: An assessment of rationality and effectiveness

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ABSTRACT

The present paper describes various Indigenous Technical Knowledge (ITK) of the fishermen community of Indian Sundarbans in West Bengal documented during the period from 2013 to 2015. A total of eleven ITKs were documented including therapeutic value of fish with special reference to small indigenous fishes (SIF) and were categorised based on their uses. Effectiveness and rationality were assessed based on the view of the experts as well as that of fishers. The study indicated that seven ITKs documented were rational and effective. Those valid ITKs include four types of unique fishing methods; fish as special energy booster; methods to support natural fish breeding and fish marketing. Remaining four ITKs, like use of fishes to address unique human health issues, method to reduce mortality during prawn seed transport and behaviour of fish for forecasting extreme climatic events, although appeared as irrational and less effective as per the view of experts, fishers are practicing them and hence demand special attention for proper validation, improvement and popularisation in the context of changing regional resource structure and stakeholders' needs.

Keywords**:** Effectiveness, Indigenous Technical Knowledge (ITK), Rationality, Small Indigenous Fishes, Sundarban

Introduction

Indigenous Technical Knowledge (ITKs) can be defined as expertise, skills, practices, ideas, experiences and information gained over a long period of time, sustained and passed on from generation to generation orally within a community in a particular geographic area, often forming part of its culture. It also includes the knowledge, know-how, experiences and practices developed, used and preserved by people having close interaction with their natural environment. An ITK is socially desirable, economically affordable, sustainable, involve minimum risk and focus on efficient utilisation of eco-friendly resources (Ponnusamy *et al.*, 2009; Shenoy, 2009). Indigenous knowledge may be local or generated elsewhere (Van Der Bleik and Van Veldhuisen, 1993), developed and transformed by informal research of a community of a particular area and incorporated in their way of life. Various research studies have shown that use of traditional knowledge by farmers are more in complex, diverse and risk prone areas. Fishers of Indian Sundarbans in West Bengal have also developed indigenous knowledge system over the years to cope up with the diverse and risk prone saline coastal mangrove ecosystem.

Sundarbans is the largest halophytic formation situated in the estuary created by the combined flow of river Ganga and Brahmaputra (Muhibbullah *et al.*, 2007). The mangrove swamps of Sundarbans are the breeding ground of various finfish and shellfish species. Indian Sundarbans consists of 106 deltaic islands with a network of innumerable rivers, rivulets, creeks, water channels and canals characterised by variety of fishing and aquaculture activities, such as coastal capture fisheries, brackishwater aquaculture and several freshwater aquaculture variants (Muhibbullah *et al.*, 2005). More than 5.2 million people live in Indian Sundarbans and most of them are primarily marginal farmers and fishermen (GoI, 2011). Capturing small fishes, prawns and crabs from local water bodies have always been the livelihood base for the traditional fishermen community of the Sundarbans (Datta *et al*., 2011; Sen and Pattanaik, 2017). Fishers of Sundarbans use their time-tested knowledge for catching as well as for storing fin/shellfishes from different water bodies. These fishermen possess rich traditional knowledge about fisheries and skills in fishing activities which they gathered from their experiences and transferred from generation to generation. Traditional knowledge for therapeutic use of fishes is also common in Sundarbans. A participatory study in Sundarban areas showed that farmers/fishers preferred to culture *Ompok pabda, Heteropneustes fossilis, Amblypharyngodon mola* and other Small Indigenous Fishes (SIF) over major carp

species for good taste, improved family nutrition, better marketability, good price and ease of culture (Saha, 2003). Das *et al*. (2003) have documented a total of 1998 ITKs practiced by the Indian farmers in the areas of agriculture and allied sectors like veterinary and animal sciences, pest and disease management in crops, grain/ seed storage, horticultural crops and cropping systems as well as fisheries. A number of ITKs were documented from geographically disadvantaged areas like North-east India and Bangladesh regarding fishing gear, crafts as well as use of fish as therapeutics (Bhattacharya *et al*., 2004; Dutta and Bhattacharya, 2008; Dutta and Bhattacharya, 2009; Pravin *et al*., 2011). Various researchers have documented ITKs related to inland fisheries mainly on fishing devices (Swathi Lekshmi, 2018; Sandhya *et al*., 2019), fishing crafts (Swathi Lekshmi *et al*., 2013), fish harvesting and fishing methods (De and Saha, 2001; Saha and Nath, 2013). Some researchers have documented the indigenous proverbs (Swathi Lekhmi and Dineshbabu, 2009) and culture and fishing practices of primitive community (Roy *et al*., 2018). However, documentation of ITKs related to fisheries particularly of SIFs in Sundarban area has not so far been attempted systematically. Keeping this in view, a study was conducted in Indian Sundarbans with the objective of documenting the ITKs related to fish and fisheries with special reference to SIFs and testing the rationality and effectiveness of the documented ITKs.

Methodology

Study site and data collection

Indian Sundarbans comprises of six blocks of North 24 Parganas and thirteen blocks of South 24 Parganas districts of West Bengal. The present study was conducted in Minakhan block of North 24 Parganas (N) and Kakdwip, Frezarganj, Sagar and Gosaba blocks of South 24 Parganas (S) during 2013-15 selecting two fishing villages from each block (total 10 villages). Information on various aspects of ITKs including traps and other fishing gears were collected from 150 fishers involved in various fishing activities in Sundarbans through personal interview (Fig. 1). Traditional knowledge associated information was collected from the elder generation with Prior Informed Consent (PIC) applying participatory tools such as focus group discussion, semi-structured interview method, observation and key informants' interviews. All the fishing gears were photographed and their modes of operation were also documented.

Assessment of rationality and effectiveness of ITKs

Rationality refers to the degree to which ITKs can be explained or supported with scientific explanations, or established based on long term experiences (Husain and Sundaramari, 2011; Ponnusamy *et al*., 2017). Rationality scale (Hiranand, 1979) with some modification was used to judge the rationality of the ITK. After collecting the information on the indigenous knowledge/practices from the fishers, a list of the ITKs documented was sent in the form of a statement to a panel of thirty judges. The experts having a minimum of 5 years research experience in fishery science particularly in Sundarban region (out of which 50% having research experience on working with ITKs) were drawn from ICAR-Central Inland Fisheries Research Institute (ICAR-CIFRI), Barrackpore; Uttarbanga Krishi Viswavidyalaya, Cooch Behar; ICAR-Central Institute of Fisheries Education (ICAR-CIFE), Mumbai; College of Fisheries, West Bengal; College of Fisheries, Tripura and ICAR-Central Institute of Freshwater Aquaculture (ICAR-CIFA), Bhubaneswar. They were asked to expound the rationality of the given statements, using a four point continuum, with a score of 4, 3, 2 and 1 respectively (Somasundaram, 1995). Based on calculated rate of judges' response, the weighted mean scores of individual ITK was calculated. Mean scores were calculated for each ITK and those having a mean score of 2.5 and above were identified as rational and those below 2.5 were considered as irrational. The ITK assigned with a weighted mean score of above 3.5 was considered highly rational. Perception of the judges and relevant literature were also referred to find out the appropriate scientific explanations of the ITKs identified through field survey, wherever possible.

Effectiveness or efficiency can be defined by the degree of relative usefulness of the ITK as perceived by the fisher in resolving the problems in fisheries activities and measured by using the Perceived Effectiveness Index (PEI) methodology (Sundaramari, 2001). Expert opinion was also taken for judging the effectiveness of the documented ITKs and the responses were rated based on five attributes (Table 1) on five-point scale for relevancy weight. The perception of the farmers who adopted the ITKs was expressed as mean perceived effectiveness index (MPEI). The farmers were asked to rate each identified ITK based on these five traits on three-point scale (Agreed-3, Undecided-2, Disagreed-1). The Perceived Effectiveness Index (PEI) score of a particular ITK practice was calculated using the formula:

$$\text{PEI Score} = \frac{[W1R1+W2R2\ldots\ldots.WnRn]}{[R1+R2\ldots\ldots Rn]}$$

where, R1, R2, R3.....R5 were relevancy weights of the five traits and W1, W2, W3.....W5 were scores obtained for the traits of the ITK from a respondent.

$$\text{MPEI Score} = \frac{\text{PEI score of individual farmer for each ITK}}{\text{Total sample size}}$$

Table 1. Weightage scores of various parameters of ITK practices

Traits of ITKs	Relevancy weights
Effectiveness	0.86
Ease to prepare/administer	0.78
Cost effectiveness	0.79
Availability	0.85
Relative advantage	0.68

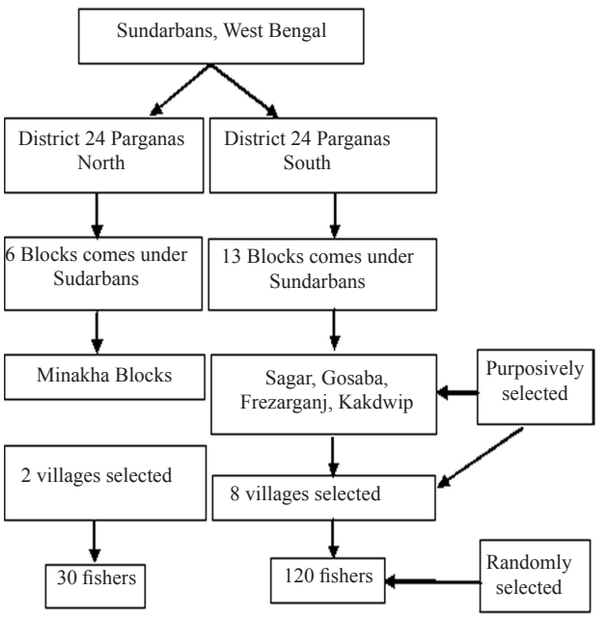


Fig. 1. Sampling design used in the study

MPEI of 3 was regarded as the most effective while MPEI of 1 was regarded as the most ineffective. ITK with MPEI greater than 2.0 were considered as effective. ITK with MPEI of 2.5 and above were regarded as highly effective (Table 3). Highly effective ITKs are scientifically valid, strongly adopted and practiced and hence can be propagated without any doubt.

Results and discussion

Description of the documented ITKs

Traps and barriers for catching fish

Ghuni, *Chero/Kero*, *Chokhia* and *Atal* (Fig. 2a, b, c, d) are rectangular shaped box trap made by bamboo splits, broom sticks, nets and coconut leaf tied by coir rope. These traps are used to catch fishes from slow flowing water channels. *Banki/mugri* (Fig. 2e), a triangular shaped trap is also used to harvest fish from marshy land, water channels and canals. In monsoon seasons, the barriers made of bamboo splits/nylon nets are set in the water channels with a small fish pass where these fishing traps are kept for catching fish.

Aran bata/Aran pata is a barrier system (Fig. 2f) used in Sundarban area to restrict movement of fishes from one water body to another or to drive fishes in a particular direction. The screen is made of bamboo strips and an opening is sometimes kept between two *Aran pata* to direct fishes to enter a trap already kept there. The lower side of the screen is made pointed so that it can be easily inserted into the soft mud at the bottom.

Catching air breathing/ Small Indigenous fishes (SIF)

It is very common practice for the people of Sundarban area to place pots like '*hundi*' in shallow waters with leftover food for some time to catch SIF particularly air breathing fishes. After sometime, they cover the mouth of the spherical pot with a piece of cloth and take it out from water to harvest the fish that entered the pot for hiding.

Catfish breeding

Catfishes are reported to have a habit of laying eggs in pits. To mimic their natural breeding habitat, earthen pots or circular shaped earthen rings are used to induce breeding of catfishes in paddy fields/water logged areas in Sundarbans. Fishers have a belief that this practice will help in breeding and could lead to increased availability of catfishes.

Channa gachua as energy booster

Chang machh (*Channa gachua*), a snakehead murrel, is an air-breathing freshwater fish and inhabits all types of water bodies from small ditches to rice fields in Sundarbans. The people of Sundarbans believe that consumption of *C. gachua* curry helps to fight anemia and boost energy of patients during convalescent period. The possible explanation may be the higher level of protein content (21.41±0.42%) and easy digestibility of the protein (Chakraborty *et al*., 2015). Therapeutic use of *C. gachua* is also reported from Majuli island of Assam to treat asthma and body pain (Saikia and Ahmed, 2012).

Mystus vittatus to heal burn injury

Oil extracted from *Mystus vittatus* by a very unique process, is used to heal burn injury. To extract oil, the fish is dried under the sun and then boiled with a small quantity of water till the water gets dried and the oil is retained in the pot. Physico-chemical and microbiological investigation of the lipid from *M. vittatus* showed antimicrobial activity against *Staphylococcus aureus* and *Shigella dysenteriae* (Molla *et al.,* 2007). But, nowadays practice of using *M. vittatus* oil to heal burn injury is not in vogue presently as people of Sundarbans prefer healing ointments available in the market. The wound

healing may also be due to the presence of specific amino acids like glycine and fatty acids such as arachidonic acid (Jais, 1994).

Chela (Salmophasia bacaila) to increase lactation

Lactating mothers are prescribed by the older women to consume *Chela* fish (*Salmophasia bacaila)* for better lactation. *S. bacaila* is rich in calcium and generally, SIFs consumed as whole which may explain more availability of calcium leading to improved lactation.

Transportation and preservation of small air breathing fishes

Marketing of live *Anabas* spp. (*koi*) is a profitable venture due to preference by the consumers and better market price. Transportation and storage of live fish is a serious issue as faced by both producers and sellers. The fishers and vendors generally add small quantity of lemon juice to the water where *koi* fishes are kept for enhancing longevity. Lemon juice is supposed to work as preservative, prevent infection, act as source of vitamin C and antioxidant when used in low dose (http://www.aquaticcommunity.com/aquariumforum/archive/index.php/t-92014.html).

Bay leaves reduce fish mortality

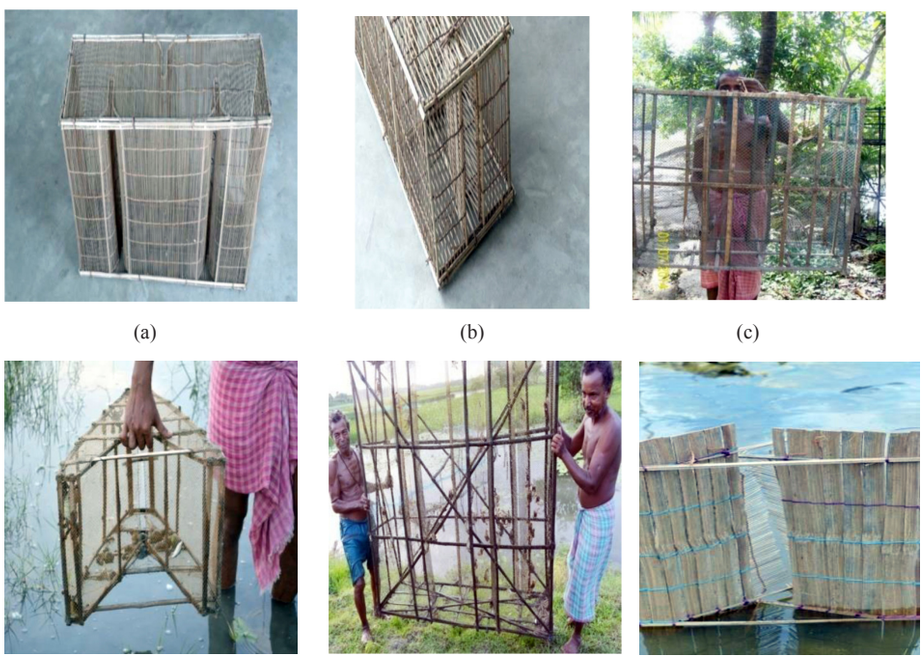
Use of bay leaves/*Tej pata* (*Cinnamomum tamala)* for reducing mortality of prawn seed is practiced in Sundarbans. After collection of prawn seeds from rivers and estuaries, bay leaves are crushed and added to the water in the container. Bay leaves have anti-microbial properties along with higher vitamin C and A content and also reported to have hypoglycemic action (http://www.nutrition-and-you.com/bay-leaf.html) and may help in reducing mortality in prawn seeds.

Indication of cyclone

Whistling sound of *Lepturacanthus savala* (ribbon fish) indicates/forecasts cyclone as claimed by traditional fishers of Sundarbans. Likewise, traditional marine fishermen of Maharashtra claim small black heron flying above sea surface as an indication of arrival of cyclone 15 days later. They even claim that appearance of black worms on sea surface or appearance of sea snake rolling itself in the waters is an indication of an impending cyclone within a few days (Swathi Lekshmi *et al.,* 2013). Such types of information are also available from other parts of the world. Oarfish (*Regalecus glesne*) is considered as messenger from the sea sending signals to beaches to predict earthquakes. But, no systematic study has been conducted so far in this regard (www. deepseanews.com/.../oarfish-can-supposedly-predict-earthquakes-apparently-they-).

Ankar/Anksi

Thin iron rods having curved ends, popularly called as *Ankar/Anksi* (Fig. 3) are used by tribal community to catch mud crabs (*Scylla serrata*) from mangrove



(a) (b) (c)

(d) (e) (f)

Fig. 2. Traditional traps and barriers used for catching fish. (a) *Ghuni,* (b) *Chero,* (c) *Chokhia,* (d) *Atal,* (e) *Banki/Mugri* and (f) *Aran pata*

swamps in Sundarbans. When the rods are placed into the burrow, the crab grips the rod with the claws and then fishers slowly take out the rods and collect crabs. Catching *S. serrata* by similar hooked-stick was earlier reported from Sundarbans (Hora, 1935).

Strengthening fishing net

Unripe gaab (*Diospyros embrypteris*) fruit extract is used for strengthening fishing nets in Sundarban area. It is also practiced by the fishermen community in other regions of West Bengal. The unripe fruit (Fig. 4) is rich in tannins and used for curing nets and leather. Miyamoto and Shariff (1958) reported that *panichikka* (fruit of *D. embryopteris*) helps to make the nets hard and rigid.

Rationality and effectiveness of the documented ITKs.

Based on the documented ITKs, a list of eleven ITK statements were prepared as given in Table 2. The list was sent to 30 experts for examination of the scientific rationale and effectiveness of the ITKs. Based on the perception of the respondents, seven practices were found to be rational while four practices were somewhat irrational (Table 1). Relative usefulness of the ITKs in terms of perceived effectiveness (Devi *et al*., 2014) as expressed by the experts and the fishers is given in Table 3. ITK-1 and ITK-11 were found to be most effective by the experts as well as fishers. On the other hand, ITK-2, ITK-3 and ITK-10 were perceived as effective by the experts as well as by the fishers. The ITK-6 and ITK-8 were found as irrational by the experts but were perceived as effective by the fishers. ITK-5, ITK-7 and ITK-9 were perceived as less effective by both the fishers and experts. Although, ITK-5 was professed as less effective and irrational by the experts, about 67.5% fishers adopted the practice. Most frequently practiced ITKs by the fishers were ITKs 4 (77.5%) and 11 (77.5%) followed by ITKs 1 (67.5%) and 5 (67.5%).

Fig. 3. *Akar/Anksi* used for catching mud crab

Fig. 4. *Gaab* fruit used for strengthening fishing nets

As observed with ITK-1, the fishermen community of Sundarbans uses their indigenous knowledge to harvest fishes using traps made of easily available material. But nowadays, the bamboo sticks are costly and durability is also less as reported by 74% of the fishers. So, modification of the traps, like using nylon nets instead of bamboo splits to make the trap and also the use of plastic containers instead of other storing devices has been observed in Sundarban areas as modified by the fishers according to their need and economic viability. Though net lined traps are gaining popularity in Sundarbans due to cost effectiveness, replacement of split bamboo strips with fine mosquito nets will certainly result in loss of icthyofaunal diversity in the long run as opined by Manna and Bhattacharya (2009).

ITKs 5, 6 and 7 involve use of fishes by the fisher folk as remedy for certain health issues. These were being practiced in Sundarbans for years as health facility was not always available near doorsteps in those days. However, nowadays, improvement in accessibility to health facilities and markets led people to be more dependent on modern medicine (Ravikumar *et al.*, 2017) as healing using fish based ITKs is time consuming.

This study was conducted in one of the very unique biospheres of the world where natives struggle each day for their survival. Sundarban area is also under developed and hence people of this area depend largely on natural resources for their livelihoods. People use traditional methods and traditional knowledge for their endurance. Due to limited access to the main land, these people adapt themselves with the nature with this traditional knowledge. The ITKs used in fishing are generally made of locally available material and the expertise is also available within their community. Similarly, use of certain

Table 2. Rationality, effectiveness and adoption of documented ITKs in Indian Sundarbans

ITK code	ITK statement	Rationality score (n=30)	MPEI (n=30)	Remarks	No. of farmers practising ITK (n=40)	Scientific rationale of ITK
ITK-1	In monsoon seasons, barriers made of bamboo splits are set in water channels with a small fish pass. Fishing traps are kept in the fish pass for catching fish	4.2	3.28	Highly rational and most effective	27 (67.5%)	Barrier directs fishes to migrate towards the trap inlet and enter inside the trap
ITK-2	Earthen pots or circular earthen rings are used to encourage breeding of catfishes in the paddy fields/water logged areas	3	2	Rational and effective	30 (75%)	Rationality based on the breeding behaviour of catfishes
ITK-3	Use of pots in shallow water area for catching SIFs particularly air breathing fishes	3.8	2.8	Highly rational and effective	23 (57.5%)	Based on their hiding behaviour
ITK-4	Consumption of *Channa gachua* curry helps to boost energy of patients during convalescence period.	2.6	2.4	Rational and effective	31 (77.5%)	Higher level of protein content and easy digestibility
ITK-5	Lactating mothers are prescribed to consume *Chela* fish (*Salmophasia bacaila*)	1.8	1.85	Irrational and less effective	27 (67.5%)	More availability of calcium reported
ITK-6	Oil extracted from *Mystus vittatus* helps to heal burn injury	1.57	2.57	Irrational but effective	9 (30%)	Lipids from *M. vittatus* reported to have antimicrobial characteristics
ITK-7	For better longevity (during marketing and transportation) of *Anabas testudineus* fishers add lemon juice in the container water	2.5	2	Rational and less effective	21 (52.5%)	Function as preservative and prevent infection as reported
ITK-8	Use of bay leaves/*tejpata* (*Cinnamomum tamala*) for reducing mortality rate of prawn seed during transportation	2	2.07	Irrational and effective	9 (30%)	Hypoglycemic action reported
ITK-9	Whistling sound of *Lepturacanthus savala* indicates/ forecasts cyclone as claimed by traditional fishers of Sundarbans	1.14	1.14	Irrational and less effective	11 (27.5%)	No report available
ITK-10	Thin iron rods with curved ends are used by tribal community in Sundarbans to catch mud crabs from mangrove swamps	4.14	3	Highly rational and effective	8 (20%)	Based on behaviour of mud crabs
ITK-11	Unripe *gaab* (*Diospyros embrypteris*) fruit extract is used for strengthening fishing nets	4.3	3.8	Highly rational and most effective	31 (77.5%)	Rich in tannins and used for curing nets as reported

Rationality Score <2.5: Irrational; 2.5-3.4: Rational; >3.5: Highly rational;
MPEI: Mean Perceived Effectiveness Index
MPEI <1: Ineffective; 1.0-2.0: Less effective; 2.0-3.0: Effective; >3.0: Most effective

species of fishes for therapeutic purposes by the fisher community of Sundarbans is mostly due to the easy availability of those fishes which can benefit them. Low income, limited access, illiteracy, limited health facility, less extension contacts force fisherfolk to use their indigenous knowledge. These methods and knowledge need to be conserved as they are unique, effective and adopted. If these ITKs are not documented and assessed in terms of effectiveness as well as adoption, it may lead to extinction of these knowledge. Documentation of the existing valid ITKs with fishers' perception and adoption as well as scientific rationale will help in more popularisation, adoption and further improvement to fulfill present need of the people. On the other hand, some ITKs prevalent in the area, as found in the present study, though reported to be effective for fisheries as well as for

Table 3. MPEI score of different categories of ITK practices

Category	MPEI score
Less effective	Less than 2
Moderately effective	2 to 2.5
Highly effective	More than 2.5

human health, are found somewhat irrational and hence ITKs prevalent in the area, as found in the present study, though reported to be effective for fisheries as well as for human health, are found somewhat irrational and hence demands special attention from the scientists as well as extension personnel, for proper validation, refinement and improvement.

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