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PERCEIVED EFFECTIVENESS OF INDIGENOUS TECHNICAL KNOWLEDGE ON FISH PRODUCTION PRACTICES IN ASSAM

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A total of 23 indigenous technical knowledge (ITK) on fish production practices in Nagaon district of Central Assam were documented. Pond preparation and renovation (22.22%), water quality management of fish pond (27.78%), stocking managment (16.67%), fish feeding management (33.33%) and disease and pest control constituted the major categories of indigenous technical knowledges. Scientific rationality, awareness and adoption among farmers regarding these ITKs were analysed and 17 rationale practices as perceived by the experts were studied further to examine their perceived effectiveness. The scientific rationale/operational principles behind 17 rational ITKs were also elucidated in this study. Farmers' knowledge on a majority of selected ITK was good with more than 50% of the sampled farmers (51.25 to 84.50% per practice) were having awareness on 12 practices. Four practices were adopted by more than 50 % of the farmers. Of the 17 ITKs studied for effectiveness, 7 were perceived as highly effective by the farmers as well as experts from the particular location, implying that many indigenous practices were both rational as well as effective. This calls for more scientific intervention to validate the indigenous knowledge.

Key words: Adoption, indigenous practices, perceived effectiveness, rationality, traditional knowledge

Introduction

Assam is one of the richest States in the country in terms of water resources with about 3.91 lakh hectare area in the form of rivers, *beel*, derelict water bodies and ponds and tanks. Considering the fact that Assam get a lot of rainfall and that fish is an integral part of the diet of the people of Assam, the State produces about 5.7% of the total freshwater fish production in India. Although the scope for utilization of the potential water spread area for profitablen economic activity in terms of fish farming/fishing is high, yet at present scientific fish farming/fishing is carried out in only 5 per cent (3.91 lakh hectare) of the total water resource area (NEDFi, 2012). Therefore, traditional fish farming has been widely practiced in the fisheries sector in the state. Several experiments by the farmers, on trial and error basis have been taking place in the field of fisheries over thousands of years. They made a wise use of available natural resources and devised many technologies to increase the quality and quantity of the output of various enterprises, they had undertaken. The knowledge thus generated over the years is time tested and has the attribute of eco-friendliness. Such knowledge is called the 'indigenous technical knowledge (ITK)' or 'local knowledge' or 'traditional knowledge'. This knowledge is based on experience, often tested over centuries of use, adapted to local culture and environment and is dynamic and changing.

At present some ITK is lost naturally as practices get modified or are left unused for long time periods, the current rate of loss can be attributed to modernization and cultural homogenization, the current educational systems that believe macro-level problems can only be addressed through the global knowledge pool, and the slow growth of institution supporting grassroots innovations. A lot of traditional knowledge is also being lost because of the communication gap, since neither children nor adults spend much time in their communities. Because ITK is generally transmitted orally, it is susceptible to change, particularly when people move to new regions, or when people's lifestyles tend to change from that of their ancestors.

A number of ITK on Indian marine fisheries in context of fish catching and management of marine fisheries have been reported (Ray Choudhuri, 1980; Nirmale, 2004). ITK related to inland fisheries mainly on fish harvesting were documented by some researchers (Yadava and Chowdhury, 1986; Bhagabati and Kalita, 1987; De and Saha, 2001; Saha and Nath, 2013). Very few systematic works has been done in recent times in bringing the indigenous knowledge on important aspect of fisheries such as pond maintenance, fish health management and fish seed preparation to light (Kalita *et al.,* 2004). Furthermore, none of these studies have attempted to characterise the scientific rationale, adoption, awareness and perceived effectiveness of the traditional practices. In fact, no attempts were made to document ITK on aquaculture practices in Nagaon district, Assam. The district stood high in fish production with maximum fisheries resources among the entire district in Assam. The indigenous knowledge accumulated through experience of the farmers in these areas have never been documented systematically, hence these are not easily accessible to fishery researchers, extension workers and development practitioners. There fore, the present study is an attempt to document, explore the logics, extent of adoption and perceived effectiveness of prevalent traditional practices among fish farmers of Nagaon district with respect to aquaculture practices.

Materials and methods

The study was conducted in the Nagoan district of Assam in the year 2012-2013. Out of 18 blocks in the district of Assam, four blocks were selected with the help of purposive sampling method based on traditional fish farmers' populations. The selected blocks were Batadrawa, Kaliabar, Rupahi and Binakanti. Further, two villages from each block were selected purposively based on the population of traditional fish farmers. From each village, 10 fish farmers who have experience of at least 10 years were selected through Snow ball sampling technique. Thus, a total of 80 fish farmers were selected for the study. The ITKs were documented through interaction, observation and focus group discussion with farmers through semi structure interview schedule. Rationality scale (Hiranand, 1979) was used to judge the rationality of the indigenous practices. Rationality refers to the degree to which ITK can be explained or supported with scientific explanations, or have been established based on long term experiences (Husain and Sundarami, 2011). After collecting the indigenous practices from the farmers, the practices were listed and send to a panel of thirty judges *i.e;* fishery scientists of Raha Fishery College, AAU, Assam and College of Fisheries, CAU, Lembucherra, Tripura with 4-8 years experience in fishery science for judging the rationality of the documented ITKs and their response were rated on 5 point score. The weighted mean scores of individual practices were then calculated. The practices and beliefs, which were assigned a weighted mean score above 3.5 considered to be rational. Perceived effectiveness of the ITK, *i.e.,* the degree of relative usefulness of the ITK as perceived by the farmers in resolving the problems in fisheries activities, was measured using the Perceived Effectiveness Index (PEI) methodology (Sundaramari, 2001). The expert's opinion was also considered along with the perception of the farmers/ fishers adopted the ITKs to measure the MPEI. In this study, adoption was also operationalized as whether an individual respondent had ever practiced the selected ITK. For this, the suite of selected ITK was systematically explained to the respondents, enquiring whether they had adopted the ITK in their aquaculture practices. If the answer was "Yes", a score of one was assigned and if the answer was "No", zero was given. The scores awarded by all respondents for a particular ITK were summed up and an adoption index worked out to identify the level of adoption.

$$\text{Adoption index of ITK} = \frac{\text{Number of farmers adopted}}{\text{Number of farmers having applicability}} \times 100$$

Result and discussion

A suite of 23 items of ITK were documented as part of this study and a category-wise summary of the same is presented in Table 1. The technological dimension in which the ITK abounds highlights the fish capture and harvesting category including gear and trap (43.33%); this was followed by post harvesting operation (13.11%), feeding management (9.84%).

Table 1. Classification of the documented indigenous technical knowledge (ITK) on fish production practices in Nagaon district, Assam

ITK category	Practices under each category	Percentage (%)
Pond preparation & renovation	4	17.39
Water quality management	5	21.74
Stocking management	3	13.04
Fish feeding management	6	26.09
Disease and pest control	5	21.74
Total	23	100

Rationality analysis revealed that out of the 23 practices evaluated, 17 were rational and the remaining 6 irrational as per the perception of the experts. The underlying scientific rationale of the rational practices is presented in Table 2. As can be seen from the data presented, most of the ITK have sound scientific bases as perceived by the experts.

Rationality, knowledge and adoption

Overall, the knowledge level of farmers on fisheries based ITK was quite high. For instance, of the 23 ITKs, 12 (52.17%) were known to more than 50% of the respondent farmers. In particular, ITK 3, 4, 9, and 14 were known to almost 75% of the respondents.

Regarding adoption, the results show that 4 ITKs (ITK 9, 14, 20, 22) were adopted by majority of the farmers (more than 50%). Among this ITK 9, 20 and 22 were perceived as highly effective by practicing farmers and experts. There were fifteen ITK (1, 2, 6, 7, 8, 10, 11, 12, 13, 15, 17, 18, 19, 21 and 23) adopted by less than 25 per cent of the farmers. ITK-11 *i.e.,* Rice cum fish culture by introducing common carp was the age old method practiced by two farmers as against twenty five farmers had the applicability. The rationality of releasing common carp in paddy cum fish culture is that it tries to dig out and eat the insects available in the mud and hence helps in releasing nutrients from the soil besides reducing the insects in paddy. Reportedly, farmers release fry or advanced fry in paddy cum fish culture and after four months (as four months is necessary to complete one paddy cycle) it attains a size of nearly

Table 2. Scientific rationale of the indigenous technical knowledge (ITK) on fish production practices in Nagaon district, Assam

ITK code	ITK statement	Scientific rationale (as perceived by experts)
Pond preparation & renovation		
ITK-1	Squeeze method for soil testing (Fig. 1)	This method is useful to identify the presence of clay particle in the soil as well as selection of suitable site for pond construction.
ITK-2	Hole method of testing the water holding capacity of soil: Around 2 meter hole is dug and filled it with water and cover it with banana leaves.The next day water level is examined. (Fig.2)	This method may be useful to test the level of ground water as well as the water permeability of the soil. If the hole is filled with ground water in the very next day it may indicates high ground water level and need for bet ter drainage. In general, the water level will be lower in the very next day as the dykes of the whole probably becomes saturated with water and in the next day (after filling the water again in the hole) is the water level is still high, the soil is impermeable enough and is suitable for pond construction. If water disappears again the site may not be suitable for pond construction unless the bottom is first cover with heavy clays or plastic sheet.
ITK-3	Use of bamboo fencing for retention of pond dyke (Fig.3)	Since the district experience heavy rainfall and flood, the bamboo fencing is useful to protect the pond dyke from erosion.
ITK-4	Traditional Spillway using bamboo pipe (Fig.4)	The technology is simple and cost effective to drain out extra unwanted water from the pond.
Water quality management		
ITK-5	Use of banana stem to correct water quality (Fig. 5)	When farmers use banana stem in the pond, it moves up and down in the surface of the water by the wind's action and hence the oxygen in pond water may be in creased.
ITK-6	Use of Banana ash (Kalakhar) for reducing turbidity of water (Fig. 6)	This ash is usually alkaline in nature and for which it is applied in the water to increase the pH. Banana ash has the binding capacity with dissolve & suspended particles in the water column and thus clears water by coagulating the particles. Thus, effectively correct the pH of the water body to make the water suitable for higher phytoplankton growth, which in turn supports the fish growth.
ITK-9	Beating the water surface of the pond with bamboo for 15-30 minutes to increase the oxygen level.	While beating the pond surface, it disturbs the water surface and hence it can absorb more oxygen from the atmosphere.
Stocking management		
ITK-10	Use of javaputi (*Puntius sarana*) to control aquatic vegetation	*Puntius sarana* feeds heavily on *Lemna* and *Hydrilla* species. In this way the species can be grown with less capital investment.

Continued

ITK code	ITK statement	Scientific rationale (as perceived by experts)
ITK-11	Rice cum fish culture with common carp (Fig. 7)	The advantage of releasing common carp is that it tries to dig out and eat the insects available in the mud and hence helps in releasing nutrients from the soil besides reducing the insects in paddy. The system of raising fish in rice fields probably started in the Northeast with the beginning of rice cultivation itself 12.
Fish feeding management		
ITK-14	Substrate such as bamboo, wood, stem and branches of plants are put in the pond bottom (Fig. 9)	Planktons, insects *etc.* may come in contact with Bamboo and release their eggs and young ones. Fish take these as their feed and hence it may helps in growth of the fish. Moreover, it provides shelter to the fish and prevent poaching of fish
ITK-15	After complete harvesting of previous batch of fish, farmers sow the seeds of dhanusha in the pond bottom. (Fig. 10)	If one grows dhanusha/ dhaincha (*Sesbania aculeatabefore*) in very low water level in the pond before stocking say up to 55 to 60 days (but make sure that dhanusha/ dhaincha plants are at least 1 meter high) about 25 t biomass (fresh weight) per hectare may be produced. Incorporation of 25 t fresh biomass ensures supply of at least 125 kg N/ha and this is enough for increasing nitrogen level in the soil as well as improves physiological and biological health of the soil.
ITK-16	Use of banana and bamboo leaves as feed of grass carp (*Ctenopharyngodon idella*)	Grass carp (*Ctenopharyngodon idella*) is a herbivorous fish. By using this locally available feed, farmers can increase their production in less cost.
ITK-17	Use raft to control aquatic weeds and apply feeds (Fig. 11)	Due to the light weight of bamboo plant the raft floats in water and hence can be used effectively for applying feed.
ITK-18	Control the spreading of weeds in pond surface by using bamboo	Complete removal of weeds from ponds is not possible and hence the remaining weeds are settled to one corner by using bamboo as barrier.
Disease and pest control		
ITK-20	Application of turmeric with lime at 3:7 ratio to control the EUS.	Turmeric have some anti microbial property where as lime is responsible for maintaining the pH. The combination of both can be effective against EUS.
ITK-21	Old gunny bags were submerged in pond water and removed them periodically to dry and kill eggs of *Argulus* deposited over them.	Since the eggs of *Argulus* is sticky and adhesive in nature, they will deposite the eggs on gunny bags which can be lifted out later on to disrupt the life cycle of *Argulus*.
ITK-22	Application of Salt and Neem plant to control of Epizootic Ulcerative Syndrome (EUS)	Both salt or neem have anti microbial affect and hence can be effective against EUS.

15-20 cm, which is suitable for supplying to hotes and restaurants.

It is pertinent to note that ITK 9 were adopted by >85% of the respondents. During winter season, the dissolved oxygen level in the fish pond decreases due to lower water level. In order to ensure proper dissolution of atmospheric oxygen into the pond water, a traditional knowledge, based on agitation of the pond water with bamboo for 15-30 minutes or putting pieces of banana stems into the pond surface is very popular. When farmers use banana stem in the pond, it moves up and down in the surface of the water by the wind's action and hence the oxygen in pond water may be increased. ITk-3 and ITK-4 were practiced by more than 30 per cent of the respondents and are found highly effective as perceived by the experts. Since the district experience heavy rainfall and flood the bamboo fencing is useful to protect the pond dyke from erosion. The traditional spillway is simple and cost effective to drain out extra unwanted water from the pond (Kalita *et al.,* 2004). He documented the use of spillway and plantation of coconut and betel nut on the dykes to prevent the dykes from erosion in hilly region of Assam.

Of these, ITK 14 was considered by the farmers as a good technique to reduce termite damage and to stimulate rooting, without additional labour, and was consistent with the high rationality score (3.15). Likewise, ITK 21 is an age-old practice, which is consistent with the present spacing recommendation for coconut. Applying salt to coconut palms (ITK27) is also a traditional practice, now being recommended by experts. ITK 25 which deals with basin preparation for coconut is also a time-tested practice for collecting, preserving, and utilizing water efficiently, and also for the effective utilization of plant nutrients.

ITK-13 (Dimaru (*Ficus*) fruit as fish feed) was adopted by 6.25 per cent of the respondents and reportedly, fish mainly IMCs take the fruit of this plant as their feed. They normally prefer to take ripe fruit, which is red in colour. But the ITK found to be in rational due to lack of proper experimentation on nutritional composition of the fruit. This provides an excellence scope of proper validation of the ITK in laboratory.

The ITK-7 and ITK -8 was found to be not so rationale by the experts. But these were the age old practice by around 5-6 per cent of the farmers in the study area. In connection with application of straw for controlling clay turbidity some experts had the opinion that the clay particles may come in contact with these straws and get attached with it. Finally when it is settled at the pond bottom the water may become clear. But deposition and decomposition of straws in the pond bottom may produce toxicant gas which may create more hazards. Regarding application of cow urine no scientific rationality is reported but the farmers reported that with this traditional technique the algae can be controlled convincingly within one to two weeks. Therefore, more future research on this area is required. Das *et al.,* (2013) in their study in Tripura also documented the application of cattle urine to control the problem of algal bloom formation in pond water.

Effectiveness of ITK on fish production

Out of the 17 ITK selected for assessing the perceived effectiveness, seven ITK *i.e.,* 41.18 per cent (ITK 3, 4, 9, 15, 16, 20, 22) were found to be highly effective as perceived by the practicing farmers and experts. ITK 1 was rational and less effective, while the rest 9 practices (52.94%) were rational and effective (Table 3). Of these, high mean PEI values were obtained by ITK 22 and 20 (MPEI is 2.78 and 2.75 respectively) and these

Table 3. Rationality score, knowledge level, adoption, and perceived effectiveness of indigenous technical knowledge (ITK) on fish production practices in Nagaon district, Assam

ITK	Rationality score (n=30)	Farmers with knowledge on ITK (n=80)	Number of farmers adopted (n=80)	MPEI n=30 experts+ (Adopted farmers)	Remarks
Pond preparation & renovation					
ITK-1	R (3.54)	35 (43.75)	08 (10.00)	1.90	R+LE
ITK-2	R (3.60)	30 (37.5)	10(12.50)	2.35	R+E
ITK-3	R (4.06)	70 (87.5)	29(36.25)	2.56	R+HE
ITK-4	R (3.60)	60 (75.00)	24(30.00)	2.6	R+HE
Water quality management					
ITK-5	R (3.60)	41 (51.25)	25 (31.25)	2.10	R+E
ITK-6	R (3.72)	35 (43.75)	12(15.00)	2.06	R+E
ITK-7	IR (2.18)	21 (26.25)	06(5.00)	-	-
ITK-8	IR (2.45)	12 (15.00)	08(6.25)	-	-
ITK-9	R (4.20)	70 (87.50)	70 (87.50)	2.57	R+HE
Stocking management					
ITK-10	R (3.90)	15 (18.75)	04 (5.00)	2.40	R+E
ITK-11*	R (4.37)	56 (70.00)	02 (8.00)*	2.50	R+E
ITK-12	IR (3.10)	22 (27.50)	03 (3.75)	-	-
Fish feeding management					
ITK-13	IR (3.00)	46 (57.50)	05 (06.25)	-	-
ITK-14	R (4.18)	60 (75.00)	52(65.00)	2.10	R+E
ITK-15	R (4.23)	25 (31.25)	08(10.00)	2.64	R+HE
ITK-16	R (4.09)	62 (77.50)	24(30.00)	2.60	R+HE
ITK-17	R (3.57)	22 (27.50)	08 (10.00)	2.07	R+E
ITK-18	R (3.60)	30 (37.50)	08 (10.00)	2.10	R+E
Disease and pest control					
ITK-19	IR (3.09)	25 (31.25)	06 (7.50)	-	-
ITK-20	R (3.81)	55 (68.75)	41(51.25)	2.75	R+HE
ITK-21	R (3.72)	51(63.75)	15(18.75)	2.45	R+E
ITK-22	R (3.83)	62 (77.50)	47 (58.75)	2.78	R+HE
ITK-23	IR (2.54)	42(52.50)	04 (5.00)	-	-

R = Rational; IR= Irrational; Figures in parenthesis in column 3 and 4 denote percentage values; RE = Rational and effective; RLE = Rational but less effective; - indicates ITK not evaluated; Rationality score: <3.5= irrational, >3.5= rational; MPEI= mean perceived effectiveness index: 3 = most effective, 1 = ineffective, <2.0= less effective, >2.0= effective,> 2.5 = highly effective.

N=25 Number of farmers having applicability (as Twenty five (25) number of farmers were having rice field)

were also very popular practice among the respondents (adoption was more than 50%). ITK 22 that recommends application of Salt and Neem plant to control of Epizootic Ulcerative Syndrome (EUS) disease is also a traditional practice, now being recommended by experts. ITK 20, which suggests application of turmeric with lime to reduce EUS. One of the effective scientific methods of controlling EUS is to make the water alkaline. Turmeric have some anti microbial property where as lime is responsible for maintaining the pH. The combination of both can be effective against EUS. The cause of the spread of EUS involves the role of infection agents in association with water quality parameters. Hence the application of turmeric, neem, salt which have anti microbial property was reported to be effective against EUS. Farmers used ash of hay or bamboo plants to control EUS in hill zone of Assam (Kalita *et al.,* 2004).

ITK-1 & ITK-2 were used by 10 per cent and 12.50 per cent of the respondents for selection of the suitable site for pond construction. ITK-2 are perceived more effective (MPEI-2.35) than ITK-2 (MPEI-1.90). However, both the ITKs have rationality and scientific base. ITk-1 can be used to get first hand idea about the presence of clay particle in the soil. ITK-2 can be used to test the level of ground water as well as the water permeability of the soil. ITk-3 and ITK-4 were practiced by more than 30 per cent of the respondents and are found highly effective as perceived by the experts. Since the district experience heavy rainfall and flood the bamboo fencing is useful to protect the pond dyke from erosion. The traditional spillway is simple and cost effective to drain out extra unwanted water from the pond. In the hill zone of Assam farmers planted of coconut and betelnut on the dykes to prevent the dykes from erosion (Kalita *et al.,* 2004).

Out of the three ITks are documented on stocking management in aquaculture, two are found rationale and effective as perceived by the experts (MPEI are 2.40 and 2.50 respectively). ITK-10 may be effective as *Puntius sarana* feeds heavily on lemna and hydrilla species. Therefore, the species can be grown with less capital investment in the ponds infested with aquatic weeds such as *Lemna, Hydrilla, Azolla etc.*

Farmers in the study area found to practice six ITKs on feeding management in fish pond. Apart from ITK-13 all the five ITKs documented are perceived as rationale. ITK-15 and ITK-16 are found to be highly effective (MPEI- 2.64 and 2.60 respectively). Besides supplying nitrogen, dhanusha/ dhaincha green manure improves physiological and biological health of the soil. As a result, farmer can expect more produce in the next season. Banana and bamboo leaves are also found very effective feed of grass carp.

Six ITKs (26.08%) were perceived as not rational by the experts due to lack of efficacy or scientific experimentation and validation. However, The ITKs with lower rationality scores should not be neglected as these were age old practices and also possessed certain advantages.

ITK-7 Application of straw/husk (Kher pelai) in pond water for reducing clay turbidity

Farmers believe that the clay particles may come in contact with these straws and get attached with it. Finally it is settled at the pond bottom and water will become clear. However, But deposition and decomposition of straws in the pond bottom may produce toxicant gas which may create more hazards.

ITK-8 Application of cow urine in the pond surface to control algae

Farmers reported that with this traditional technique the algae can be controlled convincingly within one to two weeks. Therefore, demands future in depth study. Das, *et al.,* (2013) in their study in Tripura also documented the application of cattle urine to control the problem of algal bloom formation in pond water.

Supplementation of cattle urine with bicarbonate supported the growth of the algae up to a level of 3 per cent urine, beyond which the urine per se seemed to inhibit algal growth even with addition of bicarbonate (Venkataraman, 1979).

Fig. 1. Squeeze method for soil testing

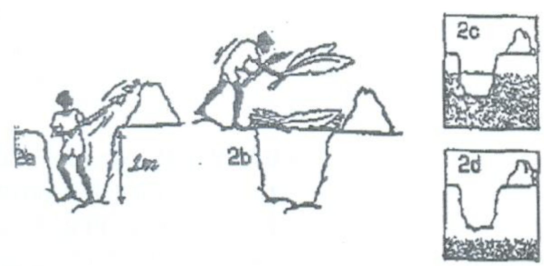

Fig. 2. Hole method of testing the water holding capacity of soil

Fig. 3. Use of bamboo fencing for retention of pond dyke

Fig. 4. Traditional Spillway using bamboo pipe

Fig. 5. Banana stem to correct water pH

Fig. 6. Banana ash (Kalakhar) for reducing turbidity of water

Fig. 7. Rice cum fish culture

Fig. 8. Dimaru (*Ficus*) fruit as fish feed

Fig. 9 Use substrate in pond bottom

Fig. 10. Use of dhanusha as green manure

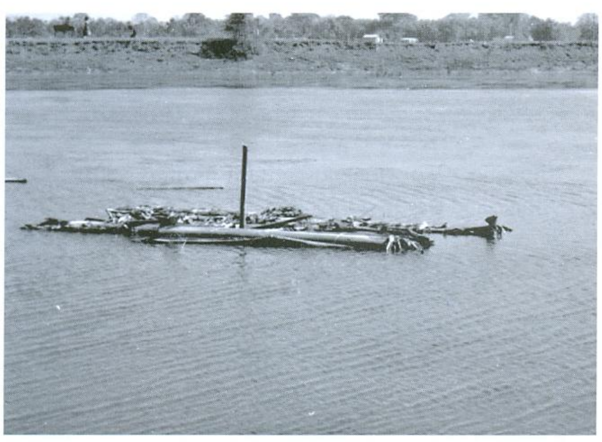

Fig 11. Use raft to control aquatic weeds and apply feeds

ITK-12 Stocking the *Labeo gonius* and *Labeo calbasu* instead of common carp to protect the dyke from erosion

The ITK may be important in the particular location when the farmers are accepting this as age old practice and getting good returns but comparative study is required to come in exact conclusion. Stocking of Calbasu (*Labeo calbasu*), a candidate species of fresh water aquaculture in the pond @ 205 nos./ kani (0.16 ha) were found to be effective by the farmers to avoid the problems of wild cat attack because stocking of this species in the pond provides a characteristics of odd smell to keep wild cat away from the pond (Das *et al.,* 2013).

ITK-13 Dimaru (*Ficus carica*) fruit as fish feed (Fig. 8)

ITK 13 was found to be in rationale due to lack of proper experimentation on nutritional composition of the fruit. But this is an age old practice. The protein, carbohydrate and fat contents of the ficus fruit need to be evaluated for further conclusion. This provides an excellence scope of proper validation of the ITK in laboratory.

ITK-19 Use of Pachatiya plant to reduce Argulus (Fig. 12)

Perceived as not rationale by the experts as there is no validation that how the application of Pachatiya plant is effective against *Argulus*. However, this ITK was found as an age old practice of 7.50 per cent of the respondents and the plant may contain some anti parasitic agent as active ingredient, therefore, it demands further study in this area.

ITK-23 Preventing snake by growing turmeric plant on pond dyke

As information perceived from the fish farmers of Nagaon it was found that snake does not like the smell of turmeric plant. However, the scientific validation is required for further conclusion.

Conclusion

Rational and effective ITKs may directly recommended by the extension system for diffusion among the farmers having more or less similar type of agro ecological system. Some of them are not tested scientifically thus provide the scope for further research. Hence, the effective indigenous practices suited to the local situations and local culture may either be suggested for adoption or may be recommended to the scientists for further examination or blended with modern fish production technologies, which in turn would promote sustainable fish production.

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