Role of Extension in Mariculture Development

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Extension is a term which is open to a wide variety of interpretations. Each extension agent probably has his own understanding of what extension is. This understanding will be based on past experience and the particular type of extension service in which the agent is working.

The term extension may be examined by looking at a number of statements that have been written about it. Extension is an informal educational process directed toward the rural population. This process offers advice and information to help them solve their problems. Extension also aims to increase the efficiency of the family farm, increase production and generally increase the standard of living of the fishermen farm family.

The objective of extension is to change farmers' outlook toward their difficulties. Extension is concerned not just with physical and economic achievements but also with the development of the rural people themselves. Extension agents, therefore, discuss matters with the rural people/fishermen community, help them to gain a clearer insight into their problems and also to decide how to overcome these problems.

Extension links farmers with research

When recommendations are tested in the field, a new farm/aquaculture practice might produce good results at a research station but not do so well on a farmer's field or site. Trials on farmers' fields are an opportunity to test research recommendations and provide feedback for research staff. Sometimes farmers discover problems with a recommendation which the research station failed to note. With the feedback the recommendations can be adjusted accordingly. The two-way link between research, extension and the farmer is fundamental to sound extension practice and should be the basic principle of any extension activity.

Role of Extension in Mariculture

Large-scale mariculture is relatively new in much of the world. It requires shifts in livelihood strategies, expertise, infrastructure and governance. We can assess its adoption and development through the lens of diffusion of innovation theory (Morril,1968). Specifically, we can view mariculture as a system innovation, whereby new technology along with new social and institutional frameworks transform the seafood sector (Jofre *et al*, 2017). It has been argued that this type of system innovation, as opposed to incremental change, will be necessary to achieve ecological and social sustainability in aquaculture. Theoretically, the number of adopters of a new innovation follows an S-curve where adoption starts out among few due to hesitancy of individual actors to accept new practices, perceived risk and the time it takes for information to spread between potential adopters. As positive experiences, expertise and information spread, the innovation is taken up by many more adopters. Eventually, the innovation reaches its maximum saturation, there are limited opportunities for further uptake and adoption levels plateau. This pattern of slow initial rates of adoption, followed by faster rates of uptake and then a return to slower rates of adoption forms the typical S-curve (Morril, 1968). This pattern of innovation diffusion has been observed across sectors and innovation types. Furthermore, diffusion of innovation theory suggests that a variety of factors can affect the likelihood that a new innovation will be adopted and the rate at which it spreads. These include characteristics of the innovation itself, such as its complexity, demand for the innovation or its product and cost-efficiency, along with social factors, including an individual's or society's proclivity to innovate, the availability of information, training opportunities and the visibility of the new practice. Additionally, enabling policies that diminish regulatory burden, supportive governance, favourable economic conditions, and conduits for scientific collaboration and information dissemination are key factors in successful innovation spread.

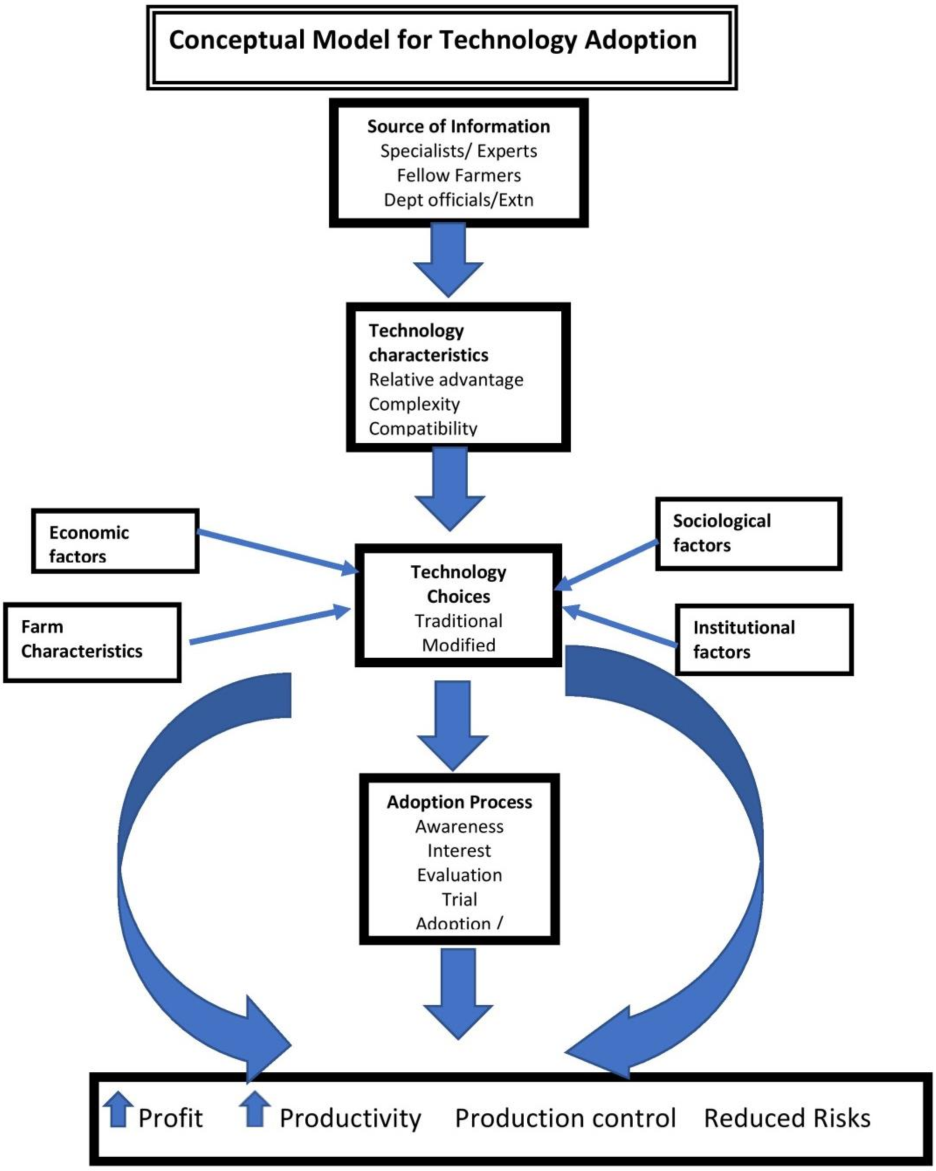
Marine cage culture is a new entrant in Indian Mariculture sector. The cage culture technology focuses on conversion of open sea into a controlled production system. This involves a number of socio-political issues apart from the technological ones. Prominent among them is the production enhancement of desirable fish species in bulk. India's recent entry into sea cage culture marks a significant milestone in the mariculture pursuits of the country. With the capture fisheries production levelling off in the recent years, the potential for sea culture is huge (Syda Rao *et al.*, 2013).

Factors affecting adoption of aquaculture technologies

Adoption of new technologies developed through research and development has played a key role in the evolution of agriculture and of aquaculture. However, farmers do not adopt technologies just because they exist and are available. It can be frustrating to aquaculture researchers when farmers do not adopt technologies that they have developed. The decision to adopt a new technology is complex, and the farmer must consider a wide variety of factors to determine if it is in the best interest of the farm to do so at any given point in time.

Adoption of technologies by farmers, is influenced by a variety of micro- and macro-economic factors. Most of the agricultural technology adoption literature highlights a few key factors that influence decisions on farms such as perceptions of the new technologies, resource utilization efficiency of technologies, economic and social policies, and infrastructural and institutional resources. These factors are not discrete or exclusive and have meager boundaries, which often overlap and have a cumulative effect on adoption decisions due to their co-dependency.

Although not exhaustive, from an aquaculture perspective, have grouped these factors into five broad categories in no particular rank order: (1) source of information, (2) characteristics of the technology, (3) economic factors, (4) farm characteristics, and (5) sociodemographic and institutional factors.



Extension Approach

Contact with extension personnel is a very important positive determinant of technology adoption as it counterbalances the negative effects arising from technology complexities, thus promoting ToT. The traditional agricultural extension follows a linear approach wherein research results are extended to farms, leading to adoption and increased productivity. However, this ToT approach is often met with failures due to the (1) inability in transforming research outputs into developmental impacts, (2) failure to tackle complexities associated with new technology, (3) failure to appreciate local and indigenous knowledge, and (4) lack of continuous learning about technology, environment, and the society . The Farming system research approach contextualized participatory research and moved away from a one-directional teaching to a feedback-based approach, thus facilitating continual technology adoption at the farm level.

Some of the more successful extension technology transfer efforts are those which include producers in the program planning, development, implementation, and evaluation phases. Such participatory approaches have greater likelihood of success as local priorities are also incorporated during the development of programs.

Participatory approaches through programs, such as Fish Farmer Field Schools (FFS), were instrumental in the improvement of aquaculture practices in several developing countries. Such aquaculture extension efforts promoted were designed at grassroot levels with better understanding of local community needs and provisions for continual support for learning.

Media and Training

Information reduces the uncertainties associated with technology performance and demystifies its complexities. Information is acquired through informal sources such as the newspaper, television, radio, scientific literature, site visits, meetings, and farmer organizations and through formal education. Exposure to information about a profitable technology induces its adoption (Rogers 1995). Although print scientific/extension literature remains an important information portal, the advent of internet and social media has made farming information ubiquitous. Chilean aquaculture producers who had greater access to internet had greater participation in organization and were willing to undertake more innovations on farms. The study by Salazar *et al*. (2018) also found that internet access promotes the extent and intensity of adoption of innovation on farms. However, the ubiquitous nature of information about technology on the Internet and social media makes it all the more important that farmers receive the right mix of reliable, consistent, and accurate information about a particular technology in its proper format, time, and quantity (Joffre *et al.* 2017).

Training is a key variable affecting the choices of carp-farming practices in several Asian countries. Lack of technical knowledge was identified as a significant deterrent to adoption of aquaculture technologies in Bangladesh (Pemsl *et al.* 2006), and the USA (Kumar 2015), as well as disadoption of aquaculture technologies (Dey *et al*. 2006). As in the green revolution, training methods such as the FFS were instrumental in aquaculture for propagating yield-improving technologies (Brown and Ratna 2013). Propagation of ornamental fish farming in rural areas of India was significantly improved through hands-on-training programs organized by extension activities of several central and state agencies (Silas *et al.* 2011). Effective national and regional-level training of coastal Indian farmers was instrumental in the improvement of aquaculture practices such as pearl oyster farming, mud crab, and green mussel farming (Subramnannian, 2013).

Characteristics of the Technology

The characteristics of the technology itself clearly play an important role in a farmer's decision to adopt a new technology. However, that decision is more complex than it might appear on the surface. For example, a number of studies have indicated that the individual's decision to adopt new technology is mainly based on personal perceptions (Rogers 1962) that may differ from what is reported in research findings, promotional materials, and/or real costs (Brickell 1976). Rogers and Shoemaker (1971) identified five distinct attributes (relative advantage, compatibility, complexity, trialability, and observability) that accounted for 49–87% of the variance in decisions by farmers to adopt new technologies (Rogers 1995; Ghadim *et al.* 2005).

Relative Advantage

Relative advantage (Rogers 1995) is the degree to which a technology is perceived as being superior to the one it supersedes. This characteristic of a new technology will influence its adoption, particularly if it is perceived to have more utility in terms of productivity, cost effectiveness, or riskiness. Improvements in productivity have been a key driver in the adoption of new technologies. Productivity changes the farm's production function through either increased output from a given level of input usage or from the reduced use of inputs for the same level of output.

Compatibility

Compatibility refers to the degree to which a technology is perceived to meet needs of potential adopters (Rogers 1995). Sophisticated farm vehicles and equipment were found to be more compatible with younger groups of adopters rather than older groups of adopters . In general, an idea that is more compatible would align more closely to a potential adopter in terms of value, past experience, and innovation need. New aquaculture technologies must be compatible with the local, ecological, and social conditions into which it is being adopted.

Complexity

Complexity of innovation, or the relative degree to which an innovation is perceived as difficult to understand and use, has a negative relationship to its adoption (Rogers 1995). Technologies are adopted more quickly if they are easy to understand and use; consequently, farmers typically prefer to adopt less-complex innovations over more-complex ones. In aquaculture, integrated aquaculture and polyculture practices were adopted in Panama and Malawi due to their relatively lower degree of complexity (Pullin 1993). Complexities arise depending on the degree and extent of change required from the traditional technology or management. These can be (1) incremental changes to existing technologies, (2) modular changes to management process without change in the technology designs/components, (3) design changes that require change in management, and (4) radical innovation where the technology and management are profoundly different.

Trialability and Observability

Trialability is the ability of users to experiment with an innovation. It helps early adopters to answer doubts about how an innovation might work under their farming conditions. Technologies that can be tried on an installment basis in limited space and time will be adopted more often and more quickly than less-trialable innovations (Rogers and Shoemaker 1971). An innovation that is more visible will stimulate communication among farmers and often lead to greater adoption (Vanclay 1992). For example, Abara and Singh (1993) suggested that small-scale rice farmers adopted new varieties only after observing significant yield improvements. Trialability and observability are directly related to the rate of adoption and are important factors influencing adoption decisions of early adopters (Rogers 1995). In aquaculture, technologies, such as new strains or hybrids of fish, that can be experimented with relatively easily in just a small area of the farm tended to be adopted more widely (Dey *et al*. 2010).

Divisibility

Divisibility of an innovation refers to whether a new technology can be used on a limited basis and if a specific subcomponent of an innovation package can be implemented for small-scale trialing and partial adoption. Farmers can adopt those parts of an innovation that they like or that are consistent with other farming objectives. Technologies that require high initial capital investment and that result in high fixed costs tend to be much less divisible.

Divisible technologies (such as hybrid catfish or GIFT tilapia) entail mostly variable costs, while an indivisible (lumpy) technology (such as a RAS) has an initial investment cost and a greater annual fixed cost that must be covered. Even when an innovation package is promoted to farmers as a tightly bundled package, farmers have a strong propensity to pull it apart and either adopt only some of its components or modify selected components. Adoption of several designs of water circulators in catfish split-pond system is an example in which farmers modified the water circulators in the original research design with less-expensive paddlewheels or with different types of water pumps to suit their farming and cost objectives.

Complementarity

Innovations are often perceived as tightly interrelated bundles of existing, modified, or new ideas. Hence, adoption of new technologies may be enhanced by the presence and availability of complementary technologies. Complementarity ascends when one technology aids the adoption of another (technology complementarity) or when one input aids the adoption of another input or technology (input complementarity). Early adoption of hybrid and selected crop strains were directly influenced by the existence of complementary mechanical infrastructures, such as tractors, precision levelling, and irrigation systems, and by the use of complementary inputs such as inorganic fertilizers. Improved feeds and fingerlings, availability of skilled labor, and transportation are critical complementary inputs that have influenced technology adoption decisions in aquaculture. Input complementarity between use of higher quality diets on farms with better infrastructure (i.e., electricity, generators, aerators) were observed in shrimp and milkfish farming (Chiang *et al*. 2004).

Economic Factors

Economic factors such as the expected profits, input and output prices, availability of investment and operating capital, and labor availability influence the adoption of new technologies. Producers who expect to obtain greater profits from the new technology are likelier to adopt it (Stoneman 1991).

Profitability

The rate and extent of adoption is directly related to the profitability associated with technologies. In aquaculture, expectation of greater profits from integrating aquaculture with agriculture was an important reason for adoption in Malawi (Dey *et al*. 2010). Strong commercial intent and expectations of greater profits were important determinants of the adoption of shrimp farming in India (Katiha *et al.* 2005).

Availability of Capital

Farms without adequate investment or operating capital will not be able to adopt new technologies Aquaculture is often capital intensive, and few farms have the capability to provide all the capital required for investing in new technologies.

Labor Availability

Adoption decisions are often dictated by availability of labor. Dynamics and seasonality of labor availability often dictates the extent of adoption of specialty crops that have narrow harvesting windows or that require high labor.

Perception of stakeholders

The perception of the stakeholder constituency and to reflect on the challenges and prospects of open sea mariculture is important. Since cage culture is a new technology it could either be adopted or rejected by the stakeholders. Innovation diffusion studies have recognised that adoption/non-adoption of a practice newly introduced technology is influenced by whether it matches with the adopters needs, situation, and perceptions of the innovation (Rogers,2003). The perception of the people on the probability of its adoption is mainly determined by innovation characteristics (Rogers, 2003). A notable feature of the innovation transfer model being attempted across the cage culture sites in India is the way in which various agencies and institutions are integrated. The dominant mode is that of Public Private Partnership.

The stakeholder of cage culture at different locations in the country in general had shown enthusiasm towards the technology as long as complete backing (financial as well as technological) was provided. The major constraint is the full adoption with ones own funds. High initial cost is one of the limiting factors in adoption of this technology. Many financial institutions are still reluctant to fund such projects as there is lack of many enabling legislations from the Government. Lack of self confidence in pursuing cage culture all by themselves even with financial backing was noticed.

Prospects and Challenges

The adoption and diffusion of the technology among entrepreneurs depends on 3 factors viz. i) technological ii) socio-economical iii) Governance issues.

Sociological factors

The fisher folk are in anxiety about the future sustainability of capture fishery due to increasing competition and thereby reducing the catch every year. The farmers are looking for alternative sources of livelihoods. In such a context , cage culture has convinced at least a few of them in different parts of the country as shown their involvement and enthusiasm. The emergence of a culture mindset is of utmost importance because fishermen are still believed to be in the hunter- gather mindset. If the financial backing is continued through government schemes, to the participating groups, it is more likely to be adopted at the earliest.

If proper supply demand situation is worked out and based on that community permits are issued then glut in the market can be avoided. Infrastructure and crop insurance and batch culture system can provide continuous financial benefit to the stakeholders. Though threats like poaching or vandalism are real, they can be remedied if the community is vested with the ownership of cages.

Political/ governance factors

Cage culture being a point of departure against the conventional sense of marine tenure it poses many challenges in this regard. For established ocean users cage culture is a new system of property that regulates access and usage of marine resources. Until recently the ocean was considered to be the last of the commons, where ownership is based on the labour that fishermen invested in the act of catching them. The marine fishing policy in the country, grant rights to fishing territories, they do not guarantee that fish would not migrate out of the these territories. Till a fish is caught it is owned by all. The concept of cage culture thus marks a significant departure from this notion. So, the need of the hour is to chalk out a suitable strategy for mariculture by giving due weightage to the rights of the community but not preventing socially committed groups from entering the scenario on a public private partnership mode.

The Indian coastal villages were always unaware of the R&D activities of institutes like CMFRI. There always has been an intangible barrier between the fishermen and the kind of scientific knowledge that has been generated by the researchers. Being relevant only at a wider policy level, there is no wonder that, this knowledge could hardly capture the imagination of the fisher folk.

Constraints

It is important to bear in mind the various constraints that may impede further development of marine fishing in India. Although growing fish in floating cages may be, under some conditions, less costly than on land, the marine fish farming industry has been focussing on raising species, which when supplied from capture fisheries, fetch relatively higher prices. While indeed may serve as a mass protein provider, its product is intended only for those who can afford the price. Some of the burning issues which cage culture farmers face are availability of credit and insurance support. These need to be addressed on a priority basis for the technology to move at a faster pace. The leasing policy needs to be evolved by each state. Goa is the only state which has notified a leasing policy for mariculture activities.

Demand for fish feed: The enormous demand for artificial fish feed especially for high value carnivorous species like cobia and seabass, that may arise in future may be difficult to tackle.

The cage aquaculture technology in India has many challenges as well as opportunities in store for the future. To tackle the challenges a great deal of discussion, planning and coordination is required to create dynamic networks on a value chain basis. However its fate lies in the collective will, social capital and institutional capacity of a number of agencies and institutions involved.

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