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Research Article

Use of information and communication technologies (ICTs) in improving livelihood of marine fisher-folks in India: evidence from Reliance Foundation development intervention

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ABSTRACT

The article presents evidence of a development intervention that used Information and Communication Technologies (ICTs) and improved livelihood of marine fishermen in India. The intervention empowered fishermen by providing information on weather forecast and fish shoal that respectively supported them in taking decisions to venture into sea and getting additional fish catch thereby improving their livelihood. It used various ICTs, both conventional and digital, to reach out to fishermen in a format that is comfortable and provides equitable access to those with different educational levels. An evaluation conducted to measure outcomes of the program used experimental research design that included fishermen who are subject to ICT intervention and fishermen who are not part of any intervention but access information from open sources. Adoption rate of critical advisories such as early warning and potential fishing zone was high among its receivers. Analysis found that the fishermen in the intervention group are four-times more likely to have used potential fishing zones, and thus were able to get additional fish catch by 26 percentage points with the support from ICT intervention. The use of ICTs for social development has its relative importance, as the engagement could be seamless despite any crisis as experienced currently.

INTRODUCTION

The changing demographic composition of the globe has stressed the need for Information and Communication Technologies (ICTs) in overall development while the emphasis has been on the growing demand for food production to meet the population growth. Thus, the penetration of technology in rural areas in general, agriculture and allied sectors in particular, is gaining attention. The Human Development Report of 2015 highlighted the role of digital technologies in reshaping the link between work and human development, and stressed upon the need for government policies to foster positive outcomes of technology for people (UNDP, 2015). Global declarations for development and adaptation including Sendai Framework and the Paris Agreement underlined the need to build resilience and have underscored the role of ICTs in that respect. Understanding the importance and need, India in 2015, launched "Digital India" program to transform into a digitally empowered society and knowledge economy. This initiative has helped in transforming the approach towards improving livelihood, particularly the rural livelihood such as agriculture and allied sectors. Studies have documented the need and role of ICTs in improving rural livelihood. A study on agricultural extension pointed out the role of simple ICT intervention such as possession of telephone could significantly enhance the ability of poor rural families to continue and perhaps enhance their contribution to the greater society (Richardson, 2005). Atiqur *et al.* (2013) found that factors like social security, rural economy, health care facilities, women empowerment, disaster and emergency response etc. are very much reshaped and influenced by ICTs in Bangladesh.

In rural areas, demand for information is limited to certain livelihood such as farming and fishing where timely information is pivotal for decision making and sustaining livelihood. In particular, the marine fishermen need reliable and timely information to decide their voyage and make necessary arrangements in case of trips that are of multiple days.

A significant proportion of fishing society, particularly the small fishermen, are at higher risk because of unreliable information and uncertain climatic conditions. Meaningful two-way digital connectivity between the actors responsible for providing data and information, and fishermen who are at the receiver's end remains a big challenge. There have been few pieces of research in India like the one conducted in Maharashtra that evaluate the use, access and preferences of the communication recipients for fishermen like that of mobile phones. Another study in India underscored fishermen's need for information on navigation and sea safety measures, potential fishing zones (PFZ), the daily report on the weather condition of the sea, and responsible fishing among other things (Guguloth *et al*, 2017). While there are multiple ICT platforms, the most preferred platform makes the users access the information to the fullest benefit. Studies conducted in Malaysia dwelled upon most preferred ICT among fishermen along with its benefits as well as barriers. It assessed the range of benefits ICTs have to offer including increasing knowledge and skills, increasing socio-economic level, enhance sea safety of fishermen and market access (Siti, *et al*, 2011; Siti and Abdul, 2012).

Overview of the fisheries sector in India

Fishing is the second-largest source of livelihood in the primary sector after agriculture. It provides employment to millions of people and contributes to food security. Fisheries and aquaculture contribute 1.2% to the national Gross Value Added (GVA), and 7.3% to agriculture and allied GVA (MoSPI-GOI, 2020). India has a coastline of 8,118 km and millions of fishermen eke out a living by venturing into the sea for fishing in the country made and engine boats. With 2.02 million square km of Exclusive Economic Zone, the marine fish production in the country was 3.58mt during 2015-16 as against its potential of 4.41mt. The Marine Fisheries Census of 2010 shows there were 194,490 crafts in the marine fisheries sector of which 167,957 are fully owned by fishermen. Among the crafts, 53% were non-motorized, 24% were motorized and 23% were mechanized (ICAR, 2010). This indicates that most of the fishermen are marginal as they use low-end boats and even traditional ones.

Reliance Foundation intervention with fishermen in India

Reliance Foundation (RF) is a non-profit company that has been implementing social development initiatives under the Corporate Social Responsibility ambit of Reliance Industries. Through its information services program, RF is aiming to enhance the lives and livelihood of people dependent on agriculture and allied sectors including the marine sector. The program has reached out to more than 2.7 lakh fishermen across all nine coastal states of India. RF provides information services to fishermen on two major advisories namely early warning and PFZ.

1. Early warning advisories are meant to alert fishermen on forecasts related to sea weather, and prevent fishermen from the risks associated with bad weather while reducing an unsuccessful fishing trip that has a bearing on input cost and carbon footprint.
2. PFZ advisory provides fish shoal information. Using this, a fisherman would navigate to a particular location guided by latitude and longitude, and get better fish catch thereby improving their livelihood and optimize time spent on fishing. This also indirectly has bearing on reducing carbon footprint on fishing and conserving marine resources.

RF sources information from nodal government organizations including INCOIS (Indian National Centre for Ocean Information Services), CMFRI (Central Marine Fisheries Research Institute), CIFT (Central Institute of Fisheries Technology), SIFT (State Institute of Fisheries Technology) and State Fisheries Departments. Further, the information obtained in an unprocessed format is processed and disseminated to fishermen as information advisories. The advisories in the form of voice/text messages to mobile phones and its applications such as WhatsApp and Jio Chat. Besides, knowledge improvement activities are organized such as audio-video conferences, field interactive programmes, newspaper and as television scroll. RF has a toll free helpline number that is shared with its beneficiaries who want to seek further clarifications on the information received by them through any of the ICTs.

Need for the research and objectives

The interventions with marine fishermen are aimed at improving their livelihood and thereby bettering their lives. The use of ICT and digital technology is aimed at providing timely information and maximizing the reach to the needy. Furthermore, the interventions also contribute to the effort taken up by the Government of India towards conserving marine resources. RF carried out an evaluation to understand the outcomes and impact of the information services program in improving the lives and livelihood of fishermen. The findings presented in this study are an extract from the evaluation that focused on the following objectives.

- To understand the role of ICTs in improving access to information for marine fishermen; and
- To study the outcomes of the information services program in improving livelihood in the form of increased fish catch.

MATERIALS AND METHODS

Study Design

The evaluation used an experimental design that included Intervention and Control Group. As part of the intervention group, the fishermen who are receivers of advisories from RF were interviewed. The control group included fishermen who are not beneficiaries of RF but might or might not be receiving information from open sources. The program required measurement of key indicators to document the success and hence Quantitative Research Technique was used to collect data aided by a structured questionnaire.

Approach to sampling

The evaluation used proportionate random sampling. The study targeted to bring out estimates for each state and accordingly the sample size was calculated. The relative precision of population proportion method was used to estimate the sample size, wherein the adequate sample size is worked out to 383 fishermen. Further, a 5% contingency sample was targeted to overcome the shortfall due to incomplete interviews. Thus, the final intervention group sample size for each state was around 400 fishermen. In case of the control group, at least 50% of the required sample size was targeted. After estimating sample size, the required numbers of respondents were proportionately distributed among the districts that are administrative divisions within a state, to ensure the representation of the fishermen population present across each operational district. Together, 3,027 beneficiary fishermen enrolled with RF and 1,095 non-beneficiary fishermen were interviewed.

Data collection and analysis

Survey was initiated during November 2019. Data collection was done by the students of the state level educational institutions. Interviews were done telephonically and responses were entered using an online tool called "JotForm". The JotForm questionnaire worked both online and offline mode, and was accessed using laptop and mobile phones.

Table 1: Profile of fishermen interviewed (in %)

	Intervention fishermen	**Control fishermen**
Age		
18-30 years	9.7	10.0
31-40 years	29.7	30.5
41-50 years	38.8	40.9
50 years and above	21.7	18.5
Average age	*43.6*	*42.9*
Educational status		
Illiterate	12.0	6.6
Below primary	9.8	5.0
Primary	28.8	30.3
Middle	16.8	23.6
Secondary	19.2	19.4
Higher secondary	10.1	10.0
Diploma, college & above	3.2	5.2
Family size		
Below 5 member	65.9	71.2
6 to 10 member	29.9	25.4
11 member and above	4.1	3.4
Occupation		
Fishing only	90.5	96.9
Fishing and other	9.5	3.1
Owner / labourer		
Boat owner	60.7	71.4
Labourer / driver	39.3	28.6
Type of boat used		
Mechanised	31.7	36.7
Motorised	58.7	56.6
Non-motorised	9.6	6.7
Base: All fishermen	**3,027**	**1,095**

Students of participating institutions were trained on the questionnaire and its web-based version, survey processes, do's and don'ts of data collection, etc. They were also provided detailed information on the programme's interventions and its operations. Data analysis was done using statistical analysis software called STATA version 15. The article included univariate and bivariate analysis, binary logistic regression and propensity score matching to present the results.

RESULTS AND DISCUSSION

Profile of the surveyed fishermen

Table 1 presents a profile of the surveyed fishermen referred in terms of age, education, family size, occupation, ownership of boat and type of vessel used for fishing. Average age of the fishermen is around 43 years while the distribution by age group remains almost the same across both the groups. Relatively larger number of fishermen in the intervention group (12%) as compared to the control group (7%) are illiterate with no formal education. The fishermen who have a higher secondary and above level of education are 13% in the intervention group and 15% in the control group. Most of the fishermen in both intervention and control groups have small family size with five members or below.

Around 10% of the fishermen in the intervention group are engaged in any additional livelihood other than fishing while this is 3% in case of control group. Around 61% of the fishermen in the intervention group and 71% in the control group own boats. The remaining fishermen were either laborers or drivers. Almost 32% of the surveyed fishermen in the intervention group use mechanized boats while 37% in the control group use the same. Close to 60% of fishermen use motorized boats while non-motorized boat use was less than 10% among fishermen in both intervention and control groups.

Role of ICTs in improving access to information

Experience shared by researchers in India indicated that the choice of channels of disseminating information is almost always defined by prescriptive decisions of experts, which is top-down in approach and non-inclusive. This is alluded to have been the reason why at-risk people are reported to be unresponsive to early warnings and PFZ which addresses their livelihood concerns (Ali and Sushil, 2011; Jayita, *et al*, 2017; Kimbahune, *et al*, 2013). RF disseminates information to fishermen through multiple ICTs that includes push notifications to personal mobile phones in the form of audio and text messages, and several other interactive programmes, both virtual and on ground, aided by a toll-free helpline to support address queries of fishermen. Figure 1 shows information and advisories accessed by fishermen through various ICTs.

While all the fishermen in the intervention group received information at least through one ICT, only 45% of the control group fishermen received information. The push notifications have had significant reach among fishermen in the intervention group who subscribe to information services as compared to the control group who do not subscribe to these services. Among the basket of ICTs, audio message to personal mobile phones of fishermen is highly prevalent among intervention groups as these are the primary medium through which notifications are sent by the program. Toll-free numbers are made available by RF and

few other organizations while field programmes were conducted to demonstrate best practices in fishing. Both helpline and field programmes are the secondary medium of information for fishermen in the intervention group.

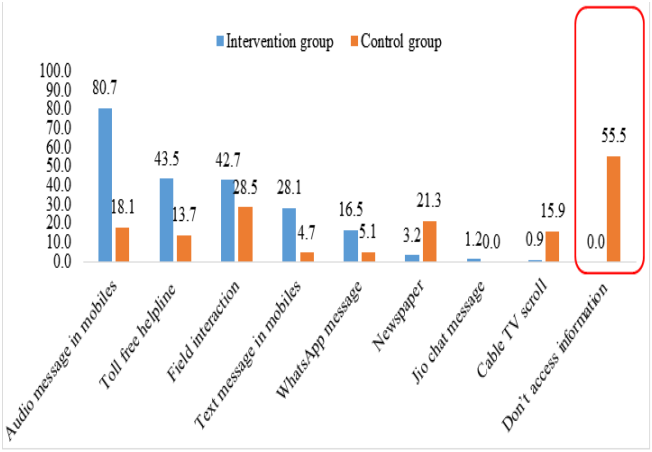

Fig.1: ICT platform through which information received by fishermen (in %)

Figure 2 provides survey findings on the use of major advisories received by fishermen. While the advisories are generated by government organizations, its reach among fishermen is low as only 39% and 10% respectively for early warning and PFZ advisories, as indicated by the control group fishermen. Information services intervention has increased the reach of these advisories to 99% and 45% for early warning and PFZ, respectively. Further, the use of these advisories is almost the same in both the groups. In particular, the fishermen need early warning advisories every day to plan their voyage and hence its use is universal when notified in the form of the audio message.

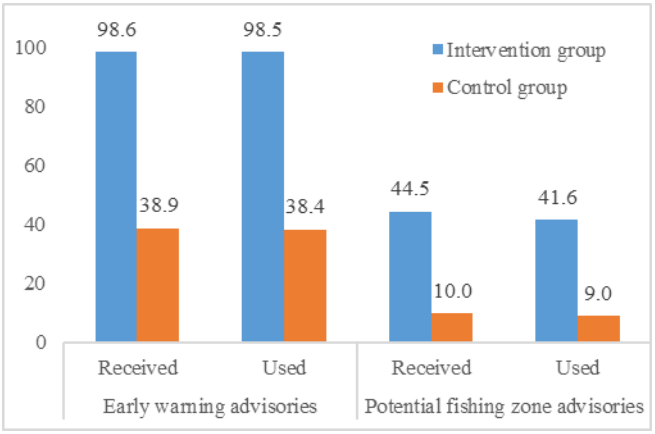

Fig. 2: Adoption of advisories on early warning and potential fishing zone (in %)

Binary logistic regression analysis

Binary logistic regression analysis was used to measure the association between the use of potential fishing zone advisories (dependent variable) and independent variables (Table 2). The dependent variable is dichotomous where '0' denotes fishermen not using PFZ advisories and '1' denotes fishermen using PFZ advisories. Independent variables include use of ICT platform, type of boat used for fishing, ownership of the boat, and background characteristics of fishermen such as age, education and annual income from fishing. The experimental design is used as one of the independent variables to attribute the likelihood of impact created by ICT based intervention in improving access to PFZ advisories.

Impact of ICTs on the use of PFZ advisories

Among various ICTs, audio messages to personal phones and WhatsApp are the two medium through which PFZ advisories are disseminated to fishermen. Hence, the regression analysis limited these two mediums of information dissemination. Additionally, the status of using toll-free helpline is included as the fishermen call the number to get clarifications on the queries from the program implementation team. Results show that WhatsApp as a medium of information significantly impacts the use of PFZ as the fishermen using WhatsApp are 11-times more likely to have used the advisories. The callers of toll free helpline are 7-times more likely to have used PFZ as compared to those who did not call toll free helpline. The results are statistically significant with p-value < 0.001. The results also indicate that audio messages as a medium of information do not contribute to the use of PFZ.

Impact of boat type and ownership on the use of PFZ advisories

As compared to non-motorized boaters, the motorized and mechanized boaters are 2-times and 3-times more likely to have used PFZ advisories, respectively, with p-value < 0.001. The PFZ advisory generated by INCOIS is beyond 10 km from the shore and are aimed at conserving and managing ecologically sensitive areas of the ocean. The fishermen using non-motorized boats are often not equipped to go too far for fishing as compared to motorized and mechanized boaters, and hence the use of PFZ is more among the later boater categories.

In case of boat ownership, the boat owners are 2-times more likely to have used PFZ advisories as compared to fishermen who worked as laborers, with p-value < 0.001. As compared to laborers, the boat owners are more empowered to make decisions and hence the likelihood of using PFZ advisories is better among the owners.

Impact of ICT intervention on the use of PFZ advisories

The experimental design variable used in the regression analysis denotes two groups of fishermen, i.e. the intervention group and the control group. Use of these indicators as independent variables supported in measuring the impact created by ICT based intervention (referring to the intervention group) in comparison with a regular situation without any ICT intervention (referring to the control group). Results from the regression analysis show that as compared to the control group, the fishermen in the intervention group are 4-times more likely to have used PFZ, with p-value < 0.001.

Impact of confounding variables on the use of PFZ advisories

Among the three confounding variables used, education and annual income of fishermen show significant association with the use of PFZ advisories. The results are statistically significant with p-value < 0.001. Age of the

fishermen does not show any association with the use of PFZ.

Table 2: Result of binary logistic regression finding association with the use of potential fishing zone advisories

Independent variables	Used PFZ advisories		
	Odds Ratio	95% Conf. Int. Lower	Upper
Use of Information and Communication Technologies			
Did not use audio message*			
Used audio message	1.032	0.751	1.420
Did not use WhatsApp*			
Used WhatsApp	11.768 [a]	8.383	16.520
Did not call toll free helpline*			
Called toll free helpline	7.935 [a]	6.268	10.046
Type of boat used for fishing			
Non-motorised boat*			
Motorised boat	2.705 [a]	1.686	4.338
Mechanised boat	3.010 [a]	1.864	4.859
Boat ownership			
Labourer*			
Owner	2.601 [a]	2.079	3.256
Experimental design			
Control group*			
Intervention group	4.572 [a]	3.020	6.923
Age of fishermen (cont.)	1.000	0.988	1.011
Educational status			
Illiterate*			
Up to secondary education	1.246	0.886	1.752
Higher secondary and above	0.499 [b]	0.321	0.776
Annual income from fishing (cont.)	1.000 [a]	1.000	1.000
Constant	0.005 [a]	0.002	0.012

** Reference category denoted as 1.000*
[a] P-value < 0.001; [b] P-value < 0.01; [c] P-value < 0.05

Analyzing the impact of intervention on the livelihood of fishermen

One of the major outcomes of the program is to improve the livelihood of fishermen by increasing fish catch thereby their income level. For analyzing the impact of intervention, Propensity Score Matching (PSM) analysis is used. Advantage of PSM is it eliminates most of the bias attributable to observable covariates (Paul and Donald, 1983). The covariates that were used for balancing properties between fishermen who received ICT intervention and fishermen who did not receive are age, education, ownership of boat, type of boat used for fishing and information from other sources; other than RF in case of intervention group fishermen.

Table 3 illustrates the matching estimate result. The algorithm that estimated propensity score generated five-blocks that ensured the mean propensity score is not different for treatment and control in each block. The unmatched estimate shows that the fishermen in the intervention group are 28 percent more likely to get additional fish catch as compared to fishermen in the control group. After balancing the covariates, the matching estimates denoted by average treatment effect shows that the additional fish catch increased by 26 percentage points among the intervention group fishermen. The findings from the propensity score matching indicated the livelihood of fishermen from the intervention group have had significant impact by receiving ICT intervention

Table 3: Results of Propensity Score Matching of intervention effect on additional fish catch

Sample	Treated	Controls	Difference	S.E.	T-stat
Unmatched	0.38	0.10	0.28	0.02	18.10
Average Treatment Effect on Treated	0.38	0.12	0.26	0.02	12.38
Average Treatment Effect on Untreated	0.10	0.36	0.26	.	.
Average Treatment Effect			0.26	.	.

Treated on support – 3,011 samples
Untreated on support – 1,094 samples

CONCLUSION

The findings of the study showed that, the ICTs have immensely contributed in improving the livelihood of marine fishermen in India. The adoption rate of critical information such as sea safety and fish shoal is better among fishermen who received it. Use of ICTs mediated by a development intervention presented in this article has demonstrated the success of reach of information to fishermen. More than half of the fishermen who are not part of ICT intervention do not access any information. The features of ICTs in rural development are widespread presence, diversification, delocalization, decentralization, flexibility, speed, and openness and clarity (Ali, 2015). Reliance Foundation's ICT intervention had similar advantages, particularly in reaching out to a huge number of fishermen and across multiple geographical locations.

Among the basket of ICTs, the fishermen communities have had maximum benefit by obtaining livelihood related information through WhatsApp. The program disseminates information on PFZ majorly through audio message to mobile phones and WhatsApp. The advantage of information dissemination through WhatsApp than other mediums is that the implementation team was able to form a homogenous group of fishermen using WhatsApp. This homogeneity is based on craft type and fish landing center. Thus, the group is given relevant information on PFZ based on distance from the shore. Using this information, the mechanized boaters can reach to a farthest distance for fish catch while the ones with traditional non-motorized boats would only be able to reach a nearby location as allowed by the capacity of the boat.

The binary logistic regression analysis found that the fishermen who are beneficiaries of ICT intervention show four-times higher odds of using PFZ advisories as compared to the fishermen in the control group who are not subject to the ICT intervention. Further analysis found that the fish catch among fishermen receiving advisories from ICT intervention increased by 26 percentage points as compared to the fishermen who are not subject to ICT intervention.

These findings indicated the success of ICT intervention in improving the livelihood of marine fishermen in India.

Physical interventions in general are subject to challenges such as engagement of human resource, time and effort, investments, etc. For reaching a huge number of beneficiaries, there will be corresponding increase in effort and resources. Use of ICT as a medium of intervention and engagement is a mileage. In particular, when the ground level operations under physical interventions are likely to setback during crisis and emergencies such as COVID-19, the use of ICT has relative importance as it could overcome these challenges, and continue engagement with the needy population while also connecting to marketing needs.

While the fishermen need information seamlessly and up to date, this calls for the application of advancements in data science. One crucial step taken by Reliance Foundation in this front is the introduction of "Machli Application" an Artificial Intelligence / Machine Learning based mobile application that provides up to date information on Ocean State Forecast and Potential Fishing Zone in any internet-enabled smartphones. Available in Google Play Store, Machli can be downloaded in any android-based mobile phones for sustainable access to sea weather and decision making in fishing livelihood.

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