



Smallholder Pig Farming for Rural Livelihoods and Food Security in North East India

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ABSTRACT

Smallholder pig farming is an important livelihood resource for the poor and tribal people in India. However, the smallholder pig farms are faced with a number of problems. The present study thus aimed to build up the capacity of the smallholder pig farmers by some interventions on knowledge build up, pig variety replacement, shelter management and veterinary services in Tripura, a State of North East India. Two-stage stratified random sample survey on 178 smallholder tribal farmers using pre-designed, semi-structured questionnaires was conducted to collect information before and after the interventions. The majority of the beneficiaries (83.71%) belonged to either low or medium income groups, of which 14.04% of the beneficiaries were the poorest group in the present study. After the shelter management and adoption of improved husbandry practices, a good and very good conditions in and around the pig shelters were recorded among 71.34% and 24.16% of the beneficiaries, respectively. Non-descriptive, local pigs (50%) were replaced by high yielding indigenous or exotic or crossbred pigs in the study area. Previously, 86.51% of the farmers reared pigs for fattening purpose, while 92.13% of the farmers practiced breeding of sows for piglet production after the intervention. The present interventions have brought significant impact ($p < 0.05$) on rearing factors as well as socio-psychological factors. The implementation of 'piglet production farming system' augmented food security by 148 days.

Keywords: Smallholder pig farms, shelter management, piglet production, food security, Tripura, north east India

An important share of the global human and livestock populations are found within smallholder mixed-crop-livestock systems, which contribute significantly towards the increase in livestock production (Oosting *et al.*, 2014). Smallholder pig farming contributes to the livelihood in many ways- income from products, insurance against drought, emergency cash requirements, household nutrition, manure for crops etc. besides direct and indirect employment potential to the farmers in the world (Lemke and Valle, 2008). About 56% of the world's pigs originate from such system, each producing 2-5 head per year (Riedel *et al.*, 2012). Smallholder pig farming

is an important livelihood source in many South East Asian countries like China, India, Vietnam, Thailand, Singapore, Malaysia, Indonesia, Philippines, Cambodia, etc. In fact, China's small-scale pig keepers are the largest community of pork producers worldwide. About 50-80% of all pigs produced in China originate from smallholder farms (Neo and Chen, 2009). Similarly, smallholder pig farming is an important livelihood resource for either small or marginal farmers with less than 1 hectare of land and especially tribal people in India (Vision 2030, 2011). The pig population in India is only 10.29 million, which is just 1.05% of the world's pig population of 977.02

million (FAOSTAT, 2014). Though India is sharing only 5.23% of total pork meat production in the world, North Eastern Hill (NEH) region of India is contributing 28.0% of India's total pig population. Interestingly, about 50% of the country's pork is consumed in the NEH region by the way of own production as well as procurement of live pigs from other parts of the country.

The system of pig production in NEH Region of India is unique and traditional (Das and Bujarbaruah, 2005). Rearing pigs and eating pork are the part of the culture of the people. Households rear pigs because they grow fast, there is a ready market and proven demand and are highly prolific which can result in the quick generation of income. Despite its importance, the smallholder pig farms are faced with a number of problems like poor technological back up including rearing with non-descriptive pigs, unbalanced nutrition, poor management, lack of knowledge about production and marketing systems (Kumaresan *et al.*, 2007, 2009). The Smallholder pig farming system is always facing challenges and thus offering ample opportunities for its improvement for better livelihood.

The rapid change in increasing market-oriented agricultural production and the ongoing trend towards improved productivity and thus higher earnings from pig farming keep the market attractive even for small producers. Food from local sources is highly preferred by rural as well as urban citizens. Taken together, these aspects suggest that small pig producers are very important for Indian meat sector. There are enough opportunities to improve smallholder pig production systems. The recent past knowledge about general characteristics of smallholder pig production systems with challenges and opportunities tempted us to undertake some need based interventions on the prevailing pig farming systems for building up the capacity of the smallholder pig farmers, particularly the tribal farmers in Tripura, a state of north east India. The aim of the study was to demonstrate smallholder pig farmers how they could rear pigs in a better way under low cost management system and get maximum profit out of it. The objectives of the present study were (i) to improve knowledge and practice level on pig rearing, (ii) to replace the non- descriptive pigs by high yielding, quality pigs, (iii) to provide the benefits of pig shelter and other management practices (iv) to assess the impact of smallholder pig farming on socio-psychological-economical conditions of the farmers.

MATERIALS AND METHODS

The experimental protocol and animal care were met in accordance with the National guidelines for care and use of Agricultural Animals in Agricultural Research and Teaching as approved by the Ethical Committee for Animal Experiments (ECAE) of ICAR Research Complex for NEH Region, Barapani, Meghalaya, India.

Study area

The present study was conducted on disadvantaged tribal dominated 14 villages in 5 districts (West Tripura, Khowai, North Tripura, South Tripura and Dhalai) of Tripura (longitude: 91°30'E; latitude: 23°45'N), a State in north east India. The average annual rainfall of the study area is 2100 mm.

The climate is hot and humid with temperature ranging from 10°C in winter to 35°C in summer. A climograph is presented in Fig. 1.

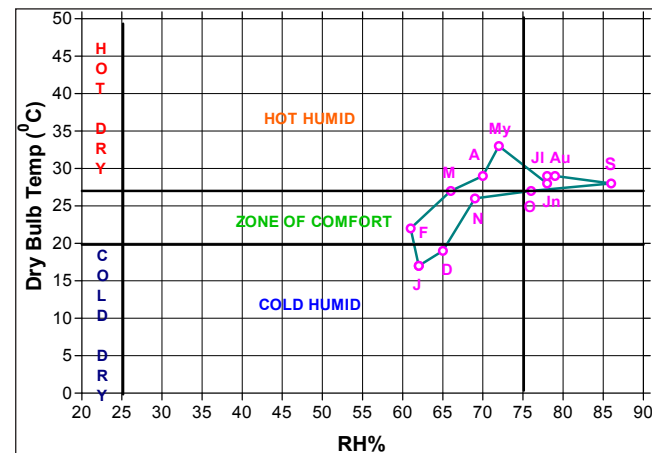


Fig. 1: A climograph of Tripura, a State of North Eastern Hill region of India showing average monthly dry bulb temp (°C) and average monthly relative humidity (%). J, F, M, A, My, Ju, Jl, Au, S, O, N and D stand for January, February, March, April, May, June, July, August, September, October, November and December, respectively.

Two-stage stratified random sample survey was conducted for the collection of various data in the present study. Within the districts, gram Panchayats (village council; a village based rural self Government in India) were allocated based on number of smallholder pig farms and interest of the farmers. Within the Gram Panchayat,

villages were chosen randomly as strata-1. Within each selected village, a minimum of 10% of pig rearing farmers was randomly selected as strata- 2.

The farmers and activities

A total of 178 tribal pig rearing farmers was selected in the present study. We organized various activities majorly on four areas involving 178 pig farmers for improvement in smallholder pig farming system during 5 years period between June 2011 and May 2016 viz., (a) knowledge improvement by formal as well as informal way to educate the farmers for better care and management of their pigs, (b) shelter management, (c) pig breeding program for the production of piglets of improved variety for ready availability of piglets in the locality to meet the huge demand of piglets, (d) pig health management by extending veterinary treatment services time to time for better health and production of the pigs and piglets.

Training

The selected 178 farmers were called in six groups at ICAR Research Complex for North Eastern Hill Region, Tripura Centre, Lembucherra, West Tripura for imparting hands on training for 3 days. The training covered technical know-how of making pig shelter, pig farm management practices like cleaning with disinfectant solution, use of lime powder to kill the organisms, care of piglets for growth, care of growing animals, pregnant animals, feeding of concentrate feeds along with local feed stuffs, disease prevention strategies, first-aid treatment, record keeping and pig farm economics. The farmers were also educated by informal way as and when visited in the farmer's field.

Shelter management

We aimed at changing the attitude and primitive practices of pig rearing by introducing the concept of pig shelter management. Each tribal farmer was supported with technical as well as financial inputs for making either semi-permanent half-walled pig house with brick-cement (as shown in Fig. 1), or low cost, locally available bamboo made pig shelter (as shown in Fig. 2). The pigs were maintained in these houses.

Supply of quality piglets and pig breeding program

A pair of improved variety (indigenous black coloured Ghungroo, Large White Yorkshire, Meghalaya Khasi x Hampshire cross, Ghungroo x Hampshire cross or Ranci local x Tamworth cross) female and male piglets at 3- 4 months of age were provided to 178 tribal farmers to rear and allow breeding between female and male pigs for the production of piglets and making availability of quality piglets in the locality. The farmers were motivated to adopt the 'piglet production farming system'.



Fig. 1: Semi- permanent pig shelter made with brick- cement at farmers' field in Tripura



Fig. 2: Bamboo- made, low- cost pig shelter at farmers' field in Tripura

Pig health management

Vaccination against swine fever and deworming against parasitic infestation were done at regular intervals. General treatment of the pigs was done, as and when necessary.

Collection of data

A two-stage survey was done to collect data. At the beginning of execution of different activities, a total of 178 tribal pig rearing farmers were interviewed face to face by visiting every household and using pre-designed, semi-structured questionnaires along with personal observations on the socio-economic profile, management practices in pig farming. After one year from the date of execution of different activities, another household survey was conducted on 178 beneficiaries to collect data for assessment of the impact of different interventions like training, shelter management, pig farming with quality piglets and health care on pig farming system including socio-psychological factors. Some statements were set to know the farmers' attitude toward pig farming and placed before the farmers to express whether they were agreed or not with each statement. Each statement was classified as a "yes= 1" or a "no= 0" based on whatever the farmer had identified it was noted. Data on economics (feed cost, gross and net income) was collected from the beneficiaries. Economics in smallholder pig farming was calculated based on the recurring cost of feed item and selling price of fatter pigs and piglets. A unit of one female and one male pigs was considered for calculating the daily feed cost and their selling price as fatter pigs at the end of the year. The actual selling price of one piglet was taken into consideration. The cost of daily food items for a 4- 5 members' family was noted. A conversion rate of 1 USD= 65 INR might be used to convert Indian Rupee to US dollar.

Statistical analysis

The socio-economic profile of the respondents attending the pig rearing intervention has been tabulated with their corresponding frequency level and relative percentages. Data on economic benefits was analyzed using t-test to determine the effect of interventions. The perception of impact of pig rearing intervention on socio-psychological factors among the respondents was analyzed. The perception indices (PI) were computed by multiplying the

frequency count of each cell of a degree of change with its corresponding weight. By adding all the values of each cell together the score of PI was calculated. The PI ranged from 0 to 100 in this particular case where 0 indicated no improvement and 100 implied maximum improvement. The impact of various pig rearing interventions over different factors was assessed using the nonparametric Wilcoxon Z Statistic.

RESULTS

Socio-economic profile of the farmers

Socio-economic status of the beneficiaries is presented in Table 1.

Table 1: Socio-economic conditions of the pig farmers (n= 178)

Sl. No.	Profile	N	% of the farmers
1	Education		
	i) Illiterate	29	16.29%
	ii) Can read and write	74	41.58%
	iii) Primary level	38	21.34%
	iv) Secondary Level	31	17.41%
	v) Higher Secondary level	6	3.38%
2	Family size		
	i) Upto 4 (Small)	53	29.78%
	ii) 5- 6 (Medium)	74	41.57%
	iii) More than 6 (Large)	51	28.65%
3	Family type		
	i) Joint	36	20.22%
	ii) Nuclear	142	79.78%
4	Land holding (1 kani = 0.16 hectare)	39	21.91%
	i) Upto 1 kani	97	54.49%
	ii) Between 1 and 2 kani	42	23.60%
	iii) More than 2 kani		
5	Income sources		
	i) Crop + livestock	45	25.29%
	ii) Crop + livestock + off-farm	50	28.09%
	iii) Crop + livestock + non-farm	33	18.53%
	iv) Crop + livestock + off-farm + non-farm	50	28.09%
6	Income (annual) (1 USD= 65 INR)	25	14.04%
	i) Low (upto INR 24,000.00)	124	69.67%
	ii) Medium (INR 24,000.00 to INR 44,000.00)	29	16.29%
	iii) High (above INR 44,000.00)		

The majority of the beneficiaries (41.58%) did not have a formal education, but could read and write their names. Around 16.29% of the respondents were illiterate and 21.34 % of the beneficiaries acquired primary level of education, while 17.41 and 3.38% of the beneficiaries had secondary and higher secondary levels of education in the study area.

The majority of the family (71.35%) belonged to small and medium family size groups, while 79.78% of the beneficiaries had a nuclear type family. About 54.49 and 23.60% of the farmers had 1-2 kani (1 Kani= 0.16 ha) and more than 2 kani land, respectively, out of which $\frac{3}{4}$ land was rain fed. The majority of the beneficiaries (69.67%) were from the medium income group who had the annual

income between INR 24,000.00 and INR 44,000.00, while 14.04% of the beneficiaries had the lowest annual income. Only 16.29% beneficiaries belonged to the high income group with annual income of above INR 44,000.00.

Impact of pig shelter

Making a pig shelter brought a great impact in the locality as shown in Table 2. Previously, only 6.75% of the farmers had permanent pig shelter in the study area. The farmers kept their pigs either under a tree tying with a rope (39.32%), or in a temporary shelter like a small enclosure with bamboo or cut woods (53.93%). After interventions, all 178 farmers established a permanent shelter like either medium cost with cemented floor and brick, cement

Table 2: Impact of pig shelter, pig varieties and pig health management on pig rearing practices of the farmers (n= 178)

Sl. No.	Particular	Before joining the program			After joining the program		
		Criteria	N	%	Criteria	N	%
1	Farmers' practice in regards to pig housing facilities	i) No housing: pigs are kept under a tree tying with a rope	70	39.32%	i) Permanent shelter: Medium cost with cemented floor and brick cement made half wall and roof with corrugated tin	83	46.62%
		ii) Temporary shelter: A small enclosure with bamboo or cut woods	96	53.93%	ii) Permanent shelter: Low cost with cemented floor and bamboo made full wall and roof with corrugated tin	95	53.38%
		iii) Permanent shelter	12	6.75%			
2	Farmers maintained sanitation and cleanliness	i) Poor condition	148	83.14%	i) Poor condition	8	4.50%
		ii) Good condition	21	11.80%	ii) Good condition	127	71.34%
		iii) Very good condition	9	5.06%	iii) Very good condition	43	24.16%
3	Farmers reared different type of pig varieties	i) Non-descriptive, local pigs	89	50.00%	i) Indigenous descriptive Ghungroo pigs	27	15.17%
		ii) Exotic pigs	4	2.24%	ii) Exotic White Yorkshire pigs	32	17.98%
		iii) Crossbred pigs	85	47.76%	iii) Different crossbred pigs	119	66.85%
4	Purpose of pig rearing	i) Fattening purpose	154	86.51%	i) Fattening purpose	14	7.87%
		ii) Breeding and piglet production	24	13.49%	ii) Breeding and piglet production	164	92.13%
5	Farmers vaccinating the pigs	i) Vaccination	43	24.16%	i) Vaccination	157	88.20
		ii) No vaccination	135	75.84%	ii) No vaccination	21	11.80
6	Farmers deworming the pigs	i) Deworming	16	8.99%	i) Deworming	172	96.62%
		ii) No deworming	162	91.01%	ii) No deworming	6	3.38%
7	Farmers access to veterinary treatment for sick pigs	i) Access to veterinary treatment	51	28.66%	i) Access to veterinary treatment	163	91.58%
		ii) No/ less access to veterinary treatment	127	71.34%	ii) No/ less access to veterinary treatment	15	8.42%

Table 3: Impact of the programmes on economic benefit and food security

Particular	Before joining the program	After joining the program
Selling practices	Fattener pigs (Two numbers)	Piglets + Foundation stock (one sow and one boar) #
Gross income (INR)	18680.00 ^a ± 280.9	42740.00 ^p ± 959.7
Feed cost for two pigs during one year period (INR)	16430.00 ^a ± 223.9	17670.00 ^p ± 141.4
Net income (INR)	2251.00 ^a ± 113.7	25070.00 ^p ± 970.0
Gross return for every INR spent on pig farming	1.13 ^a ± 0.01	2.43 ^p ± 0.06
Daily food cost for a 4- 5 members family (INR)	155.6 ^a ± 1.37	179.9 ^p ± 1.81
Food security for a 4- 5 members family (days)	14.50 ^a ± 0.72	162.50 ^p ± 6.79

Value of foundation stock was calculated. ^{p,a}Means for different groups with different superscripts within a row differ (p<0.0001)

made half wall and roof with corrugated galvanized iron sheet, or low cost with cemented floor and bamboo made full wall and roof with corrugated galvanized iron sheet. Previously, the majority of the farmers (83.14%) had poor condition of the surrounding area where the pigs were sheltered. After adoption of an improved shelter management system, the majority of the farmers maintained sanitation and cleanliness in and around the pig shelter. A good condition in and around the pig shelter was recorded among 71.34% of the beneficiaries, while 24.16% of the farmers maintained a very good condition in and around the pig shelter in the present study.

Impact on pig production system

Table 2 shows the present status of different category of pig varieties, viz. indigenous Ghungroo pigs, exotic Large White Yorkshire pigs and different crossbred pigs in the study area. Earlier, 50% of the farmers had non-descriptive, local pigs. After joining the program, 15.17, 17.98 and 66.85% of the farmers reared indigenous Ghungroo pigs, exotic Large White Yorkshire pigs and different crossbred pigs, respectively in the study area. In the past, 86.51% of the farmers reared pigs for fattening purpose, while 92.13% of the farmers practiced breeding of sows for piglet production after joining the program.

Impact on pig health management

The impact of pig health management has been depicted in Table 2. The farmers (75.84%) reported that the pig mortality was high previously, because of lack of vaccination, no deworming practice (91.01%) and no/

less accessibility to animal treatment facilities (71.34%). After joining the program, 88.20 and 96.62% of the farmers received vaccination and deworming facilities, respectively. Access to veterinary treatment for pigs among the farmers was increased from 28.66% to 91.58%.

Impact on economic benefit and food security

The impact of the programs on economic benefit and food security is presented in Table 3. Before joining the program, the average cost of feed was calculated as INR 16430.00 ± 223.9 during a one year period. In previous years, two fattener pigs were sold at INR 18680.00 ± 280.9 and thus there was a net income of INR 2251.00 ± 113.7.

After adoption of a piglet production farming system, though the average cost of feed was increased to INR 17670.00 ± 141.4 during a one year period, there was an average gross income of INR 42740.00 ± 959.7 at the end of the year from selling of piglets at 2- 3 months of age along with the consideration of total value of one sow and one boar (foundation stock). Thus, a net income of INR 25070.00 ± 970.0 was calculated. This present net income was 11.13 times more than the previous year net income from smallholder pig farming. For every INR spent on pig production, the corresponding gross return from pigs was INR 1.13 ± 0.01 and INR 2.43 ± 0.06 for ‘fattening pig farming system’ and ‘piglet production farming system’, respectively.

Considering the daily cost of INR 155.6 ± 1.37 for food items for a 4- 5 members’ family, the previous net income (INR 2251.00 ± 113.7) from pig farming was contributing 14.50 ± 0.72 days food security (Table 3). After adoption

Table 4: Perception of impact of pig rearing intervention on socio-psychological factors among the respondents

Sl. No.	Criteria	Perception Index (PI)	Rank
1	Knowledge gain	100.00	1
2	Improvement in livelihood	97.01	2
3	Dissemination of knowledge	83.58	3
4	Feeling of security	69.40	4
5	Confidence in pig rearing	56.42	5

of piglet production farming system, the farmers could get 162.50 ± 6.79 days food security from the annual net income of INR 25070.00 ± 970.0 . Thus, the food security was increased by 148 days.

Impact on socio-psychological factors

Table 4 shows the level of improvement on a major five socio-psychological factors that have also been ranked. There was a strong positive impact of training on the beneficiaries in regards to knowledge gain. All the beneficiaries (100%) reported to gain knowledge on pig farming and practices. About 66.18% of the pig beneficiaries reported that the learned information on pig farming disseminated to other farmers in the villages. More than 90% of the beneficiaries informed the positive impact of the whole programs on their livelihoods. From the results of Wilcoxon Z statistics (Table 5) for all the factors, it was found that they were highly significant (as $\alpha=0.000<0.05$) showing the significant impact of the pig rearing intervention on the pig farmers.

DISCUSSION

Several fields based studies on traditional smallholder pig farming systems have been reported in many South East Asian countries like India (Kumaresan *et al.*, 2007, 2009; Nath *et al.*, 2013), China (Riedal *et al.*, 2012) and Lao People's Democratic Republic (Phengsavanh *et al.*, 2011) indicating general household information, farm characteristics, including available feed resources, performances of the pigs, pig health status, marketing system, constraints and opportunities for development. In the present study, an attempt has been made to improve smallholder pig farming system by some need based interventions on pig husbandry practices in Tripura, a state of north east India for the first time.

Socio-economic profile of the farmers

According to Notenbaert *et al.* (2009), a sound exploration of smallholders' full situations, including social, natural, and technical aspects, was required to successfully support their development. In a study in China, about 50% of smallholder pig farming household members had finished primary school (Riedel *et al.*, 2012). In the present study, the majority of the beneficiaries (57.87%) were either illiterate or officially just literate who could only read and write his/ her name. Rest (42.13%) had formal education from primary level to higher secondary level (12th standard) of education. It was necessary to understand the level of knowledge for making training modules as well as judging the perception level of the beneficiaries about pig farming.

Mostly, the beneficiaries belonged to the nuclear type family (79.78%), of which 71.35% beneficiaries had family members upto 6. Smaller family size had the sufficient justification to continue with the smallholder pig farming system and not to drive for medium or large size pig farms. The farmers relied on family labour to manage few pigs under the smallholder pig farming system. Thus, the farmers continued with the small scale pig farm as a family business generation after generation in a traditional manner. The same feature of the smallholder pig farmers was reported elsewhere (Mutua *et al.*, 2010). Because of limited land holding capacity, the pig farmers were engaged with crop production as well as off- or non-farm activities. Typical South East Asian crop-livestock mixed farming systems (Devendra and Thomas, 2002) were prevalent for ages in the present study area. The majority of the beneficiaries (83.71%) belonged to either low or medium income groups, of which 14.04% of the beneficiaries were probably the poorest group in the present study. Previously, very poor rural dwellers were benefited from livestock rearing (Steinfeld *et al.*, 2006).

Impact of pig shelter

Traditionally, the pigs were kept in a small bamboo, woods or tin enclosure or in a small shelter or tying with a rope under a tree. This type of rural setting practices was reported earlier (Waiswa, 2005). The improper and unhygienic condition of management system was always posing to a threat of the occurrence of various pig diseases resulting less economic return. The housing facility probably reduced the piglet mortality. In a report of FAO (2010), several measures were suggested to address disease outbreaks in smallholder pig production systems. The introduction of pig shelter brought a change in animal care, management and welfare in a better way. Compared to the traditional system, the farmers could recognize many advantages of keeping pigs in the separate pig house. For example, animals could be kept cleaner, feeding was easy and became less waste of feed, and manure could be collected as well as used more usefully. The pig shelter was cost effective, highly durable and could go upto 4 years without any repairing. The establishment of semi-permanent pig shelter with brick-cement or locally available bamboo made low-cost pig shelter became an asset to the beneficiaries.

Impact on pig production system

The bulk of the pig population (72.0%) in India is of indigenous and non-descriptive type (Vision 2030, 2011). These local pigs are similar to other local pig breeds in neighbouring countries such as China, Thailand, Malaysia and Indonesia (FAO, 2009). The performance of local pigs was obviously lower than that of the exotic or crossbred pigs (Phonepaseuth *et al.*, 2010). Earlier, 50% of the farmers had non-descriptive, local pigs. After our intervention, all the selected farmers started to rear indigenous Ghungroo pigs, exotic Large White Yorkshire pigs and different crossbred pigs. Besides, the majority of the farmers (92.13%) adopted breeding practices of sows for piglet production. In one way, it helped to preserve the quality pig germplasms in the village and in another sense, there was an easy availability of good quality piglets within the village. Under smallholder pig production, very few farmers kept breeding boars resulting decrease in a loss of pig breeding capacity in the village (Kagira *et al.*, 2010; Riedel *et al.*, 2012). The current approach towards piglet production farming system helped to increase the availability of quality piglets to meet the huge demand of piglets in the locality.

Table 5: Impact of pig rearing intervention over different factors

Sl. No.	Factors	Wilcoxon Z Statistic	Significance at P=0.05
A) Rearing factors			
1	Housing structure (temporary/ permanent)	-8.000	0.000
2	Type of pig varieties (local/ improved)	-8.124	0.000
B) Socio-psychological factors			
1.	Confidence in pig rearing	-6.880	0.000
2.	Self image in community	-6.786	0.000
3.	Self reliance/ independence	-6.924	0.000
4.	Feeling of security (Economic/ general)	-7.189	0.000
5.	Ability to take risk	-6.908	0.000
6.	Ability to understand and solve problems	-6.606	0.000
7.	Ability to try new ventures	-6.882	0.000
8.	Hope	-6.815	0.000
9.	Overall satisfaction	-7.168	0.000
10.	Communication skills	-7.032	0.000
11.	Participation in group activities	-6.839	0.000
12.	Information utilization behaviour	-6.839	0.000

Impact on pig health management

There was very less awareness for vaccination or routine deworming of the pigs and thus parasitic infestations was very common in pigs under smallholder system. Though the swine fever outbreak was common, a few numbers of farmers (37.8%) took initiative to vaccinate their pigs against swine fever (Kumaresan *et al.*, 2009). This was true in the present study also. This type of rearing system seemed to have bad effects on human as well as animal health and welfare. Diseases, such as swine fever in pigs had a devastating effect sometimes. Disease risks such as swine fever wiped out pig herds during periods of outbreak and parasitic infestation led to stunted growth and reduced market value of pigs (Ouma *et al.*, 2013). The main constraint on smallholder pig production was high disease-related losses (Riedel *et al.*, 2012). The problem of diarrhoea in piglets was common in many smallholder pig production system and caused considerable economic loss to pig farmers (Tuyen *et al.*, 2005). Disease and diarrhoea occurrence in the smallholder pig production might be related to the observed poor hygiene, and lack of disease preventive measures (Phengsavanh *et al.*, 2010). Effective disease prevention through sufficient access to veterinary treatment, vaccination and deworming was the key issue for improving pig production in the present study.

Impact on economic benefit and food security

A common feature of the smallholder pig farming system in the NEH region of India was practiced by most of the farmers to bring one/ two local, non-descript or crossbred piglets at the age of 2-3 months from the market, while fattening of the animals was taken up to 10- 14 months before they were sold. The farmers were less aware of marketing through piglet production. A lack of boars for service was common among the smallholder pig farmers (Lanada *et al.*, 2005).

However, the role of boars in pig herds was discussed earlier (Langendijk *et al.*, 2002). In the present study, we encouraged the pig farmers for keeping both male and female pigs and allowing them for mating and ensuring the production of piglets and achieving much more profit from a simple practice of pig breeding. The previous net income obtained from fattener pigs was much less than the present net income from the piglet production farming system. This clearly showed that the economic condition

of the people was uplifted after following the technology of piglet production farming system. The implementation of 'piglet production farming system' augmented food security by 148 days and it was very important to the farmer families belonging to the lower economic status. Earlier, such type of small intervention has brought wealth and improved the standard of living of resource- poor tribal farmers (Halder *et al.*, 2005).

Impact on socio-psychological factors

To the best of our current knowledge, there was no report on the impact of technological interventions on socio-psychological factors of the smallholder pig farmers. One question we wanted to address was whether farmers' likely response to technological interventions with different sets of values, attitudes and objectives. The smallholder pig farming sector remained uncared, unattended, limited access to technology, information and services (Ouma *et al.*, 2013). In the present study, the beneficiaries were able to utilize information and technical knowledge in managing pig farms in a better way. The newly emerging trend towards improved productivity of smallholder pig farms as well as huge demand of quality piglets attracted the smallholder pig farmers to gradually adopt improved management practices and particularly, practice with 'piglet production farming system'. The technological interventions were necessarily paramount for influencing both economic factors/ drivers, such as income, pig varieties and pig house as well as, non- economic factors like knowledge gain, communication skill, confidence etc.

CONCLUSION

The present study attempted to build up the capacity of the smallholder tribal pig farmers in resource limited areas of Tripura, a State of north east India. Simple and small interventions enhanced the productivity of smallholder pig farms, augmented economic benefits and improved practical knowledge as well as various socio-psychological factors of the smallholder pig farmers. The shifting from the traditional 'fattener pig production system' to 'piglet production farming system' has brought a substantial change in income generation and food security in the tribal families. Indeed, it was a small and humble intervention on pig farming system approach intended to make a difference in the lives of smallholder pig farmers. This model might be a showcase to view the

profitability and success of the smallholder pig farmers in search of alternative sources of income for a livelihood and sustainability of rural smallholder pig farming system.

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