



Understanding the intention to adopt artificial insemination technology in pig by tribal farmers

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ABSTRACT

The study used Theory of Planned Behaviour (TPB) to understand the underlying factors for the intention to adopt artificial insemination (AI) technology in pig by the tribal farmers of Nagaland. Responses from a survey of 72 tribal farmers of Nagaland revealed a strong intent to adopt artificial insemination in pig which is driven by strong favourable attitude towards the technology and strong approval from referent groups for the artificial insemination in pig. Perceived behavioural control seems to be the main discriminating drivers among the theory of planned behaviour constructs for the intention to adopt artificial insemination in pig, and are affected by farming context especially distance to artificial insemination provider centre. Farmer's intention to start for pig breeding also positively affects the intention to adopt the technology.

Keywords: Adoption, Artificial insemination, Perceived behavioural control, Pig, Theory of planned behaviour, Tribal farmers

About 70% of the pig population in India is under traditional small-scale pig production system. The small-scale pig production system significantly contributes towards improving the livelihood and food security of the poor and small farmers (Deka *et al.* 2007). However, such system production is plagued with low productivity mainly due to low input driven system and non-descript breeds which have low potential growth rates and mature weight.

The national policies focused on technology led intensification of pig production and underlined the need for improvement of non-descript pigs. The natural breeding practice of pig is constrained by the poor quality germplasm (Deka *et al.* 2018), higher cost of hiring boar (Kadirvel *et al.* 2013), high transportation cost of boar and sow to the place of breeding and possibility of losing the heat period due to non-availability of boar in the locality. The preference of fattening over breeding often leads to early castration of male pigs and subsequently leads to non-availability of breeding boars.

Artificial insemination (AI) in pig has several advantages over natural breeding, like, the efficiency in breeding, effectiveness in introducing of improved germplasm and control of venereal diseases (Whittemore 1993, Maes *et al.*

2008 and Knox 2016). It has the potential to enhance the traditional backyard pig production system (Kadirvel *et al.* 2013 and Patra *et al.* 2014). In this context, the present study attempted to understand the farmer's intention to adopt of artificial insemination technology in pig using Theory of Planned Behaviour (TPB) (Ajzen 1991).

MATERIALS AND METHODS

Theory of Planned Behaviour (TPB) describes behaviour as a function of intention, which in turn is determined by attitude, subjective norm (SN) and perceived behavioural control (PBC). Attitude refers to a person's overall evaluation of a behaviour, i.e. favourable or unfavourable evaluation towards performing behaviour and occurs as a consequence of an individual's belief about various features of the outcome. Subjective norm is the overall perceived social pressure based on the perception of those individuals whose opinions are important to an intention or behaviour. Perceived behavioural control is the extent to which a person believes that how easy or difficult to perform the behaviour is likely to be (Ajzen and Madden 1986).

The TPB constructs are measured in five-point scales to help the respondents to distinguish meaningfully among the options (Hansson *et al.* 2012). Following the recommendation of Francis *et al.* (2004), belief strengths (b_i), motivation to comply (m_i) and control belief (c_i) are scaled in a unipolar way (1 to 5) whereas outcome evaluation (e_i), normative beliefs (n_i) and power of control (p_i) are scored in a bipolar way (–2 to +2).

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The data used in the study were collected in the year 2018 through a household survey conducted in three districts of Nagaland, viz. Dimapur, Peren and Kohima. A multi-stage random sampling technique was used to select villages and farmers. A total of 390 farmers were interviewed from 39 randomly selected villages. Farmers were asked whether they had knowledge about AI in pig and if the response was positive then only the sample was included for this study. A total of 117 farmers were aware of the AI, out of which only 72 were randomly selected as the sample for the present study.

Path analysis was used to understand the causal relationships between different variables. Due to small sample size of the study, model fit was assessed with RMSEA (root mean square error of approximation), NFI (normed fit index), CFI (confirmatory fit index), IFI (incremental fit index) and GFI (goodness of fit index) which are independent of the sample size (de Leeuw *et al.* 2015, Martinovska Stojcheska *et al.* 2016). SPSS AMOS was used to analyze the path analysis.

Also, due to the small sample size, k-means cluster analysis technique was used to identify different clusters of pig farmers with similar characteristics in terms of their opinions toward the adoption of AI in pig (attitude, SN and PBC) (Oparinde *et al.* 2017). The optimal number of clusters was determined by calculating the Calinski-Harabasz pseudo F-statistic (CH).

RESULTS AND DISCUSSION

Descriptive measures of the respondents and their farming system: Majority of respondents were male (89%) with an average age of about 42 years (Table 1). The average family size of the respondents was 5, reaching as high as 9 members per household.

Sampled farmers had completed about 9 years of formal education, and very few reported themselves illiterate. Average land ownership was 2.43 ha. The number of pigs

reared by each respondent was small with an average of about 3 per household to a maximum of about 7 per household. Only 36% reported possessing sow for breeding. Sampled farmers had an average of 11 years of piggy farming experiences. About 47% of the respondents had reported to have access to breeding boar. The maximum number of pigs reared in a year during 2014 to 2018 was about 4, and about 22% of sampled households were rearing breeding sow in 2014. The average distance to AI centre from the farmer's household was about 32 km, and about 38% farmers had reported to having access to good road toward the AI centre.

Farmer's intention to adopt artificial insemination in pig: The calculated score of TPB variables ranged from +19 to +63 for attitude, +9 to +28 for subjective norm and -37 to +45 for PBC (Table 2). The items wise description of TBP constructs are presented as appendix (Supplementary Table 5). The mean attitude score for the farmer towards AI is about 39, which indicate an overall favourable attitude towards the technology. Perception about the relative advantages of AI over natural breeding in term of cost reduction, better litter size, quality piglets, reduction of disease incidence and acceptability of pork strongly contributed towards the favourable attitudes. Subjective norm (SN: 18.32) indicates a strong approval by all the referent groups, more particularly by progressive farmers. Whereas, the low mean score (6.81) and high standard deviation (17.30) of PBC indicate that farmer's control over the ability to actualize the intention to adopt were low and diverse across the sample population. The varying perceptions of behavioural control may be due to difference in individual farming context and situation. With a strong favourable attitude towards AI and prescription about AI from different referent groups, PBC seems to be the main discriminating driver among the TPB constructs for the intention to adopt AI. The high mean score of farmer's intention to pig breeding (11.00) may be due to

Table 1. Household socio-economic and farm characteristics

Variable	Descriptive measure	Mean (Std)	Min	Max
Age	Year	41.78 (4.87)	31	55
Education	Years of formal schooling	9.00 (3.01)	0	17
Family size	Total number of household members	5.39 (1.35)	3	9
Land holding	Hectare	2.43 (1.61)	0.2	8
Experiences in piggy	Year	11.32 (5.29)	3	25
Number of pigs reared (2018)	Number	2.99 (1.17)	1	7
Maximum number of pigs reared in a year during 2014–18	Number	4.42 (1.03)	2	7
Number of breeding sows reared in 2018	Number	0.38 (0.52)	0	2
Number of breeding sows reared in 2014*	Number	0.24 (0.46)	0	2
Distance to AI centre	Km	31.55 (19.45)	7	68
Gender	Sex of the respondent; male=1, 0 otherwise	64 (88.89)**	0	1
Access to breeding boar	Access to breeding boar; 1 if yes, 0 otherwise	34.00 (47.22)**	0	1
Access to good road	Access to good road; 1 if yes 0 otherwise	27.00 (37.50)**	0	1

*The year 2014 was considered as the base year with the assumption that adequate AI dissemination works would have undertaken by then after the introduction of AI in 2011 in the study area; **Frequency and percentage in parenthesis.

Table 2. Description of TPB variables

TPB variable	Possible range of score*	Mean	Std	Min	Max
Attitude	-90 to +90	38.51	8.67	19	63
Subjective norm	-40 to +40	18.32	3.98	9	28
Perceived behavioural control	-50 to +50	6.81	17.30	-37	45
Intention for pig breeding	15	11.00	2.12	7	15
Intention to adopt AI	10	8.24	1.43	6	10

*ATT = $\Sigma(b_i x e_i) = [(5 \pm 2) * 9 = -90 \text{ to } +90]$; SN = $\Sigma(n_i x m_i) = [(5 \pm 2) * 4 = -40 \text{ to } +40]$; PBC = $\Sigma(c_i x p_i) = [(5 \pm 2) * 5 = -50 \text{ to } +50]$.

the perceived higher profit of breeding than the rearing of pig for fattening due to the high cost of feed. The sampled farmers had shown high intent for the adoption of AI (8.24).

Path analysis of factors affecting intention to adopt AI: Path analysis was done to understand the causation of the intention to adopt AI (Table 3). The model fit indices (RMSEA=0.078; NFI=0.94; GFI=0.95; TLI=0.94; IFI=0.8; CFI=0.98) were within the recommended thresholds (Hair *et al.* 2010). The result showed that attitude and perceived behavioural control have a positive and significant ($p < 0.01$) impact on the intention to adopt AI (Table 3). SN was not a significant predictor of the intention to adopt AI. Furthermore, it showed that intention for pig breeding ($P < 0.01$) influenced the intention to adopt AI. The number of breeding sows reared during the survey (2018) and the maximum number of pigs reared in a year during the last five years (2014–18) were also significant determinants on farmer's intention to adopt AI. Attitude, SN, PBC, intention for pig breeding and farms characteristics accounted for

74% of the variance in the intention to adopt AI in pig (Fig. 1). Attitudes toward AI, SN for use of AI, PBC, number of the breeding sows in past (2014) and the maximum of number of pigs reared in last five years (2014–18) positively influenced the intention to rear pigs for breeding purpose. The intent for pig breeding positively predicted the number of breeding sows reared in 2018. Farmers' attitudes towards AI had a positive effect on the capacity to enact the intention, i.e. PBC ($p < 0.01$).

The result of path analysis shows favourable attitude about AI affects the intention of the farmers about rearing pig for breeding purpose ($p < 0.01$), which in turn positively influences the number of breeding sows reared ($p < 0.01$). The high intent for pig breeding is an encouraging sign which highlights the potential of AI technology.

Typology of farmers based on opinion about AI in pigs: The cluster analysis of TPB variables (attitude, subjective norm and perceived behavioural control) categorized the farmers into three distinct groups; CH-statistic is optimal

Table 3. Standardized path co-efficient for intention to adopt AI in pig

Variable	Path	Estimate	S.E.	C.R.	P ($p < 0.05$)	Supported
att	← sn	0.116	0.257	0.98	0.327	No
pbc	← sn	-0.042	0.431	-0.426	0.67	No
pbc	← att	0.56	0.198	5.64	***	Yes
no_sow_18	← no_sow_14	0.19	0.103	2.008	0.045**	Yes
no_sow_18	← max_pig_14_18	-0.045	0.046	-0.469	0.639	No
no_sow_18	← acc_boar	0.054	0.095	0.568	0.57	No
no_sow_18	← int_breed	0.582	0.023	6.151	***	Yes
int_breed	← sow_14	0.206	0.299	3.045	0.002***	Yes
int_breed	← acc_boar	-0.13	0.28	-1.872	0.061*	No
int_breed	← mx_2014_18	0.177	0.135	2.574	0.01**	Yes
int_breed	← att	0.328	0.019	4.073	***	Yes
int_breed	← sn	0.285	0.034	4.253	***	Yes
int_breed	← pbc	0.471	0.009	5.879	***	Yes
int_AI	← att	0.214	0.013	2.664	0.008**	Yes
int_AI	← sn	0.093	0.023	1.376	0.169	No
int_AI	← pbc	0.232	0.007	2.668	0.008***	Yes
int_AI	← int_breed	0.34	0.076	2.982	0.003***	Yes
int_AI	← acc_boar	-0.003	0.17	-0.047	0.962	No
int_AI	← max_pig_14_18	0.156	0.085	2.4	0.016**	Yes
int_AI	← no_sow_18	0.199	0.208	2.59	0.01**	Yes

Significant at *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; att, attitude; sn, subjective norm; pbc, perceived behavioural control; int_breed, intention for pig breeding; int_AI, intention to adopt AI; no_sow_14, number of pig sows reared in 2014; acc_boar, access to breeding boar; max_pig_14_18, maximum number of pigs reared in a year during 2014–18; no_sow_18, number of pig reared in 2018 (during survey).

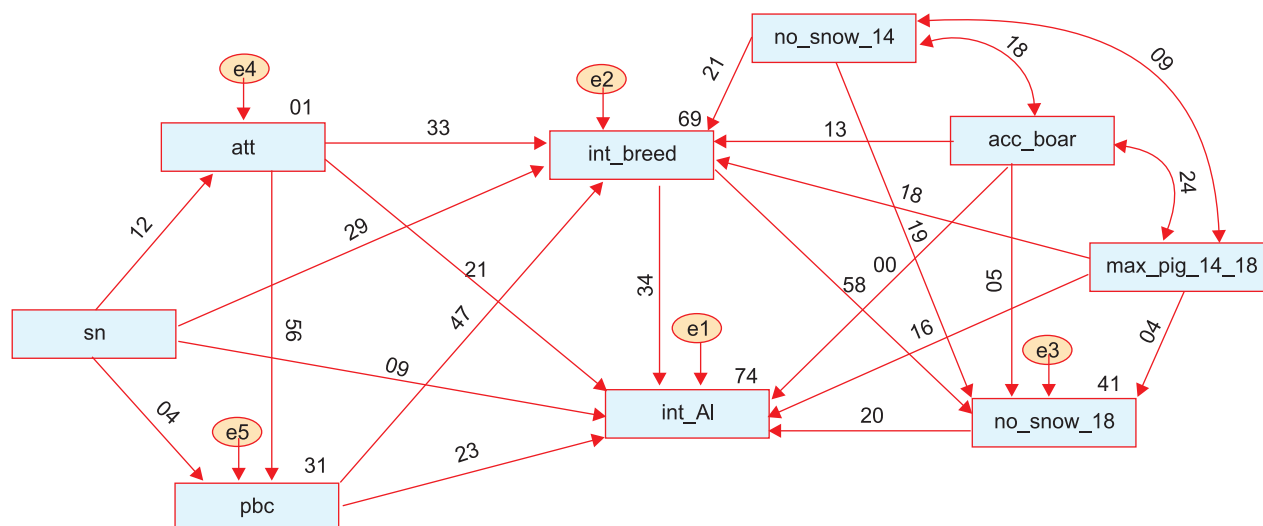


Fig. 1. Pathway analysis of factors affecting intention to adopt AI technology in pig.

(97.90) at three numbers of clusters. The study found that across the clusters, the TPB constructs differed significantly except the subjective norms (Table 4).

Intention for pig breeding and intention to adopt AI also differed significantly across the clusters. Age, farming experiences and breeding sow reared during survey were differed significantly between cluster 1 and 2 and between cluster 1 and 3. Access to breeding boar differed significantly between cluster 1 and 3 and between cluster 2 and 3. Distance to AI centre and access to good road significantly differed across the clusters.

The first cluster (19.44% of farmers) were characterized by farmers having a highly favourable attitude towards AI technology (49.36) and have the strongest control over the ability to actualize the intention for the adoption of AI (PBC:32.64). They also had a low concern about the opinion of the others (SN: 16.43), and are more likely to behave as the “Early adopter” as identified by Rogers (2003). The farmers of this group reared about 3 numbers of pigs with a relatively higher number of breeding sows (past and present). About 71% of households under this cluster reared breeding sow. They were nearest to the AI centre (16 km),

Table 4. TPB variables and socio-economic-farm characteristics by cluster

TPB variable	Cluster 1 (n=14) Mean (Std)	Cluster 2 (n=39) Mean (Std)	Cluster 3 (n=19) Mean (Std)	t-Test
Attitude	49.36 (8.92)	37.13 (6.37)	33.37 (5.47)	Aa, Ba, Cb
Subjective norm	16.43 (3.23)	19.33 (4.34)	17.63 (3.11)	-
Perceived behavioural control	32.64 (6.16)	8.00 (5.79)	-14.68 (8.56)	Aa, Ba, Ca
Intention for pig breeding	13.29 (0.99)	11.13 (1.73)	9.05 (1.61)	Aa, Ba, Ca
Intention to adopt AI	9.79 (0.58)	8.28 (1.17)	7 (1.2)	Aa, Ba, Ca
Age	39.36 (4.16)	41.97 (4.93)	43.16 (4.8)	Ab, Bb
Education	9.21 (4.00)	8.82 (2.5)	9.21 (3.29)	-
Household size	5.5 (0.94)	5.33 (1.34)	5.42 (1.64)	-
Land holding	2.27 (1.65)	2.55 (1.59)	2.3 (1.7)	-
Pig farming experiences	9.29 (3.65)	11.23 (5.57)	13 (5.4)	Ab, Bb
Number of pigs reared (2018)	3.43 (1.16)	2.82 (1.14)	3.00 (1.2)	-
Maximum number of pigs reared in a year during 2014–18	4.86 (1.23)	4.26 (1.02)	4.42 (0.84)	-
Number of breeding sow reared in 2018	0.93 (0.27)	0.31 (0.52)	0.11 (0.32)	Aa, Ba
Number of breeding sows reared in 2014	0.43 (0.65)	0.18(0.39)	0.21(0.42)	-
Distance to AI centre	16.11 (12.41)	31.23 (17.96)	43.58 (19.02)	Aa, Ba, Cb
Gender*	12 (85.71)	34 (87.18)	18 (94.74)	-
Access to breeding boar*	10 (71.43)	13 (33.33)	11 (57.89)	Ab, Cc
Access to good road*	10 (71.43)	15 (38.46)	2 (10.53)	Ab, Ba, Cb

A, One-sided t-test between clusters 1 and 2; B, One sided t-test between clusters 1 and 3; C, One-sided t-test between clusters 2 and 3; Significance level: a– 0.01; b–0.05; c–0.1; *Frequency and percentage in parenthesis: Proportion test between clusters 1 and 2; B, One sided proportion test between clusters 1 and 3; C, One-sided proportion test between clusters 2 and 3; significance level: a– 0.01; b–0.05; c–0.1.

and about 71% of them reported to have access to the good road towards AI centre.

The farmers of the second cluster (54.17% of farmers) also had a favourable attitude (37.13) but relatively lower than the mean attitude score of the first cluster. They were more concerned about others' opinions (SN: 19.33), probably they wait until their peers adopted an innovation. They had a low sense of control to actualize their intention (PBC: 8.00) to adopt AI. About 28% of them had breeding sow. Average distance to AI centre was about 31 km and also had less access to good road (38.46%). The farmers of this cluster probably correspond to the 'Early & Late majority' adopter categories as classified by Roger (2003).

The farmers of the third cluster (26.39% of farmers) also had a favourable attitude (33.37) but were the lowest among all three categories. They had a relatively lower concern about the others' opinion (SN: 17) and were more likely skeptical about AI technology. The negative value of PBC (-14.68) indicated that farmers of this group had the lowest control over to actualize the intention to adopt AI, which can be mainly attributed to the perceived difficulty of acquiring technical knowledge, access to extension services, managing unanticipated commitment, accessibility to AI centre and access to credit. Farmers under this cluster reared about 3 pigs but only 11% of them reared pig sow. Farmers of this cluster were farthest from AI centre (43.58 km) coupled with poor access to good road (10.52%).

Distance to AI centre was more likely to affect the farmer's control to actualize their intention to adopt AI. Acquiring technical knowledge and skill on pig breeding as well as AI technology, access to extension services, managing unanticipated commitment and accessibility to AI centre seems to have affected with more distance to AI centre. The characteristic of AI technology demands a time-bound follow up for uncertain oestrus, limited oestrus period of the sow coupled with the limited storability of AI semen pouch. Moreover, Kadirvel *et al.* (2017) reported that transportation cost for purchase of AI constitutes a major share of overall expenses for its adoption. Hence, distance to AI centre can be a significant determinant for the adoption of the AI technology. Lemke *et al.* (2006) also reported that adoption was more in areas nearer to AI centre.

Farmer's ability to accurately detect oestrus is crucial for pig breeding (Kadirval *et al.* 2017). Farmer's strong belief for the need of technical knowledge and skills related to pig breeding, use of AI, accessibility of technical guidance and their poor enactment capacity to realize the benefit of AI entails the need for accessibility of extension services.

Targeted extension services related to awareness, training and demonstration on AI technology along with breeding related aspect will help in overcoming the difficulties that are likely to be faced by the farmers. Innovative farmers from different villages should be identified, trained and partnered as para-extension workers for the farmer-farmer extension. The nature of the technology demands farmers' easy accessibility to AI centre, so establishing more number

of AI centres will improve accessibility to technology with technical guidance for wider diffusion. Extension strategies should be designed considering the different farming context and the technology characteristics.

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