Baseline study on impact assessment of artificial insemination in pigs in Nagaland

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Baseline study on impact assessment of artificial insemination in pigs in Nagaland

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Foreword

This report provides the baseline status of pig farmers in the northeast Indian state of Nagaland including Dimapur and Phek districts. The farmers in Dimapur represent the larger farming community of the lowland areas of the district, while the farmers in Phek represent the farming community of the hill zone of the state. The results are a comparative assessment of the various farm and farmer characteristics between the two districts. The analyses of the primary data collected from the two districts draw conclusions and make recommendations for introduction of artificial insemination (AI) for smallholder pig farmers in Nagaland state.

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1. Introduction

1.1 Background

Nagaland is home to a sizeable proportion of the country's pig population. It is ranked seventh in India in terms of pig population, followed by Meghalaya state (Livestock census of India 2012). According to Deka and Thorpe (2008), the northeast comprises more than 25% of the total pig population in India and the density of the pig population is highest in Nagaland. Prior studies point out that per capita consumption of pork in Nagaland is also the highest in the country. (Njuki et al. 2010; Patra et al. 2014a). Pig production and marketing is an integral part of the livelihood strategies of about 80% of households among the varied ethnic groups in the state (Deka and Thorpe 2008). The importance of the subsector supports the introduction of suitable interventions to enhance pig productivity, farmer incomes and nutritional security.

Studies have shown that the pigs reared by Nagaland farmers are relatively unproductive indigenous breeds (Njuki et al. 2010). Breeding boars used by farmers in the state are mostly poor-quality crossbreds and their progeny tend to be unproductive. Huyen et al. (2017) further observe that the pig population in Nagaland contains a large number of crossbreeds and a lower number of unidentified indigenous pig breeds, which makes identification and evaluation of quality pig stock traits a challenge. A pig breeding program should be aimed at increasing the availability and accessibility of good genetic quality animals of the most appropriate sow breed types.

Moreover, breed improvement may be easier if breeders adopted could undergo artificial insemination (AI) instead of natural mating (NM) methods. Kadirvel et al. (2013) explicates the feasibility and potential benefits of introducing AI techniques in smallholder pig production systems in tribal rural areas. Farmers are offered a choice of semen from different exotic breeds to improve germplasm. The crossbreeding of indigenous pig stock with exotic breeds benefits farming communities compared to following NM methods which rely upon indigenous breeds or poor-quality crossbred pigs. Furthermore, using NM methods are a challenge due to the abysmally low number of breeding boars in the locality. Patra et al. (2014b) observe that the indiscriminate use of the limited number of breeding males available in Nagaland leads to a decline in reproductive performance (may cause inbreeding depression) and overall productivity of the farm suggesting that the introduction of AI may address the problem of breeding boar deficiency in the region. In addition, breeding boars may also transmit infection from one sow to another. Thus, the present study is an attempt to collect and analyse the baseline information for future experiments and the pursuance of AI in the state. Given appropriate institutional mechanisms to provide the required infrastructure, it would be practically feasible to carry out AI if it shows positive results in terms of litter size at birth, weight of the piglets, interfarrowing period etc.

1.2 Objectives of the baseline study

The baseline study was conducted to establish basic information on farm and farmer characteristics in relation to the rearing of pigs. The specific objectives of the baseline study are to:

1. understand the baseline status of pig production and management systems in Nagaland;
2. understand the baseline status of pig breeding and breeding services in Nagaland; and
3. examine the technical, infrastructural, logistic, knowledge and attitudinal, and socio-economic factors that may influence adoption of artificial insemination in pigs in Nagaland.

1.3 Organization of the report

The report is organized into eight sections including the introduction. The second section deals with methodology used in the study. The subsequent sections present the results of the field study; household characteristics are presented in section three. Section four presents the farming characteristics, focusing on the baseline farming system, animal disease and disease- prevention practices. The fifth section deals with the discussion on access, usage and outcome of the breeding services. Factors that are likely to have an influence on breeding services are discussed in section six; factors influencing farm productivity are analysed using linear ordinary least square (OLS) estimation technique in section seven. Finally, section eight concludes the report.

2. Methodology

2.1 Sample selection and sampling techniques

The study was undertaken to understand the baseline status of pig breeding and rearing systems in Nagaland. Multistage sampling technique was used to select the sample households for the study. The study purposively selected two sample districts in the state, namely Dimapur and Phek. The selection of the districts was guided by the understanding that diverse geo-economic conditions—such as topography, access to market, and access to farm inputs and veterinary services—may support different pig breeding and rearing conditions. Keeping in mind that these differences may have important bearing on rearing objectives, farm size and production practices, Dimapur district was selected as a lowland district of the state with an urban centre facilitating market access to pig production inputs and outputs and access to other farm management services. Phek district was purposively selected as a hill area based on the assumption that it would lack sound market infrastructure which would act as a constraint on pig production activities. However, pig farmers in some TATA trust-funded project villages, managed by the Chakhesang Women Welfare Society, had access to a certain amount of external facilitation, the impacts of which the study also tried to capture.

Following the selection of districts, sample villages were also purposively selected. The selection of villages was guided by the availability of sizeable breeding units in the villages. Information about the villages was gathered through consultation with district and Nagaland Department of Veterinary and Animal Husbandry Services officials. Sample households were subsequently selected randomly. A list was prepared based on discussions with the village chairperson, veterinary field assistants and livestock service providers of the concerned villages. Then, 30–40% sample farmers from each sample village were interviewed in September–October 2017 using a structured and pretested questionnaire.

A total of 240 sample households were interviewed from both districts (120 from Dimapur and 120 from Phek district). The number of sample villages in Dimapur (nine) is relatively more than the number in Phek district (only four). This is because the villages in Phek have relatively fewer farms with at least one breedable sow to experiment with AI. That said, the density of breeding farms in the Phek district project villages is higher and, therefore, each village represents a greater number of sample farms (see Table 1).

Table 1: Sample households selected by village and district

District	Village	Households
Dimapur	Aoyimkum	10 (4.17)
	Lengrijan	10 (4.17)
	Aoyimti	16 (6.67)
	Fourth mile Diphupar	17 (7.08)
	Ralan	5 (2.08)
	Indisen	18 (7.50)
	Diphupar B	27 (11.25)
	Sodzulhou	8 3.33)
	Sovima	9 (3.75)
Phek	Pfutseromi	28 (11.67)
	Thipuzu	31 (12.92)
	Tsupfume	35 (14.58)
	Sakraba	26 (10.83)
Total		240 (100)

Note: Figures in parentheses indicate percentage of the total.

2.2 Analysis

The data generated to understand the baseline status were analysed using simple tabular analysis such as mean, ratio and percentage. For a more in-depth understanding on factors influencing the farm productivity, an OLS (log linear) technique was employed. This micro-econometric analysis was carried out in the statistical software STATA 14.
A number of explanatory variables were identified that were likely to affect farm productivity and the survival of piglets until the age of weaning. The OLS regression model used to identify the factors of farm productivity measured as the log of litter size per sow has the following functional form:

$$LnY_i = \alpha + \beta_1 AGE + \beta_2 EDU + \beta_3 EXPRINCE + \beta_4 STALLFED + \beta_5 CONCENTRAT + \beta_6 CLEAN + \beta_7 VACCINATN + \beta_8 DEWORM + \beta_9 DISTANCE + \beta_{10} VETCONTCT + \beta_{11} TOPOGRPHY + \mu_i$$

Table 2: Description of variables and hypothesized relation with the litter size at weaning and at birth

Variable name	Description	Measurement	Variable type	Hypothesized relations
AGE	Age of the household head	Years completed	Continuous	+
EDU	Education of the household head	Years completed	Continuous	+
EXPRINCE	Number of years since first started rearing pigs	Years completed	Continuous	+
STALLFED	Farmers rearing pigs in a stall-fed condition	1=stall-fed 0=otherwise	Dummy	+
CONCENTRAT	Farmers feeding concentrate to the animal	1=feeding concentrate 0=otherwise	Dummy	+
CLEAN	Cleanliness of the farm	1=clean 0=otherwise	Dummy	+
VACCINATN	Whether the farmer vaccinated the farm animal during last 12 months	1=vaccinated 0=otherwise	Dummy	+
DEWORM	Whether the farmer dewormed the farm animal during last 12 months	1=dewormed 0=otherwise	Dummy	+
DISTANCE	Distance of the farm to the breeding boar	Kilometre	Continuous	-
VETCONTCT	Whether the farmer contacted the veterinary service provider during last 12 months	1=contacted 0=otherwise	Dummy	+
TOPOGRPHY	Whether the location is plain	1=plain 0=otherwise	Dummy	+

A brief description of the explanatory variables focusing on their rationale is presented below.

AGE: Farmer's knowledge may be positively correlated with age of the household head. As his or her age increases, s/he may also have better contacts with extension personnel which may contribute towards better farm management. The pig productivity may therefore increase with the farmer's age.

EDU: The higher the education of the farmer, the better the ability to absorb new knowledge on better farming practices. Thus, there may be a positive association between level of education and farm productivity.

EXPRINCE: As experience increases, farm management capacity of the farm owner also increases, leading to a positive association between years of farming experience and pig productivity.

STALLFED: If a farm is managed in stall-fed conditions, the chances of the animal catching disease become minimal, in contrast to animals reared in an uncontrolled environment, hindering farm productivity. Thus, there may be a positive hypothesized relationship between keeping pigs in a stall-fed condition and number of piglets born.

CONCENTRAT: Feeding of protein-rich concentrate to farm animals may result in better performance of the sows which in turn deliver a relatively larger number of piglets. This also may contribute towards improved piglet survival rates. Therefore, there may be a positive hypothesized relationship between the feeding of concentrate and the number of piglets born.

CLEAN: The likelihood of sows and piglets contracting a disease is lower when they are reared in a cleaner environment. Thus, it is expected that cleanliness of the farm would be positively related with the number of piglets born and the rate of their survival.

VACCINATN: If animals on a farm are vaccinated against disease, their productivity would be expected to increase. Thus, vaccination is positively correlated with the size of piglets born.

DEWORM: Similar to vaccination, there is a hypothesized positive relationship between deworming and the number of piglets born and their survival until the age of weaning.

DISTANCE: Distance of the farm to a breeding boar is negatively correlated with pig productivity. The farther the farm is from a breeding boar, the greater the likelihood that the servicing capacity of the boar would be reduced, resulting in a lower number of piglets born.

VETCONTCT: Having contacted a veterinary service provider on disease-related issues may help prevent the occurrence of disease among the piglets or sows, leading to a positive correlation between the two.

TOPOGRPHY: Farmers located in the lowland zones are in many ways better off in terms of access to conveyance facilities, veterinary services, farm inputs etc. compared to farmers in the hill zones. Thus, topography is positively correlated with the dependent variable.

3. Household characteristics

3.1 Farm owner characteristics

The study considered gender of the farm owner instead of household head based on the understanding that household head, even if male, is unlikely to make any farming decisions. Collecting information on personal characteristics of the farm owner's influence on farm activities may be instrumental. Thus, information on gender, age, education, training participation, experience, source of livelihood and credit access of the farm owner is presented in Table 3. Out of 240 sample farmers across districts, 70% of the farm owners are male. The proportion of female farm owners is relatively more in Phek district (32.5%) compared to Dimapur, with 27.5%. The average age of farm owners is 48 years across districts. Farm owners in Phek district are relatively younger than the farm owners in Dimapur. The level of education attained by farmers in Dimapur is higher (almost 9 years) than farmers in the Phek district (6.45 years). Education may be higher in Dimapur because schools are easier to access compared to Phek. Out of a total 240 sample farmers, 25% were participating in a training program during the 12 months preceding the survey. The rate of training participation is much higher in Phek district (44%) compared to Dimapur (6.67%). The reason for the higher rate of training participation in Phek is related to the number of interventional projects ongoing at the time of the survey. Farm owners' average years of experience rearing pigs is 13.54 years; the average years of pig-rearing experience are almost the same for both districts. Access to credit is important for farm improvement, including adoption of new technology such as AI or buying exotic high-yield breeds. In the study sample, however, only 6.67% farmers reported accessing credit during the 12 months preceding the survey. Farm owners in Phek accessed credit more than farmers in Dimapur, again, due to ongoing credit intervention programs in Phek.

Table 3: Farm owner characteristics

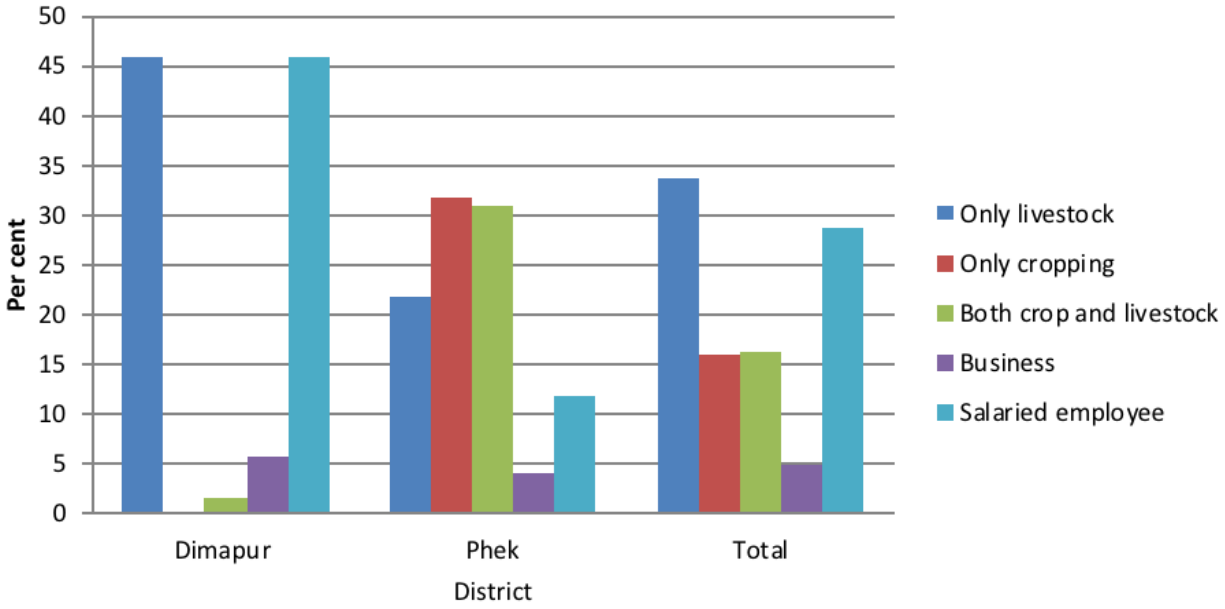
Particulars	Dimapur	Phek	Total
Gender (%)			
Male	72.5	67.5	70.00
Female	27.5	32.5	30.00
Age (years)	51.08	45.92	48.49
Education (number of years in school)	9.13	6.45	7.79
Participation in training program (%)	6.67	44.17	25.42
Experience with piggery (years)	13.98	13.11	13.54
Main source of livelihood (%)			
Only livestock farming	45.83	21.67	33.75
Only crop farming	0	31.67	15.83
Both crop and livestock farming	1.67	30.83	16.25
Business	5.83	4.17	5.00
Wage earner	0	0	0
Salaried employee	45.83	11.67	28.75
Access to credit (%)	0.83	12.50	6.67

Source: Field survey 2017

3.2 Livelihood strategy

Table 3 and Figure 1present the livelihood strategy of the sample farm owners. The different topography of Dimapur and Phek districts seems to influence the livelihood strategies of farmers in the two districts. The majority of farmers in Dimapur are either salaried employees or purely livestock farmers (almost 46% derive their income from both sources). Farmers reporting only livestock rearing or salaried employee as the source of livelihood in Phek are 21.67% and 11.67%, respectively. Since most of the farmers in Phek are engaged in shifting cultivation, 31.67% of farmers reported crop farming as their dominant source of livelihood. None of the sample farmers in Dimapur reported crop income as their dominant source of livelihood. The proportion of farmers reporting both crop and livestock farming as the primary source of livelihood is almost 31% in Phek but only 1.67% in Dimapur. None of the farmers reported wage earning as a primary source of livelihood. Almost 46% of sample farmers in Dimapur reported salaried employment (either private or public) as the primary source of livelihood. Close proximity of the sample farmers to the town in Dimapur increases the opportunity for salaried employment.

Figure 1: Livelihood sources for farmers in Dimapur and Phek district of Nagaland.



3.3 Size of pig holdings

The present study emphasized the implementation of AI among smallholders in Dimapur. Table 4 presents data on the average size of pig holdings among smallholders, which is almost 4 across type of animal. The farm size is relatively larger in Dimapur (almost six) than in Phek (almost two). The selection criteria for sample farmers included at least one sow on-farm. Across the two districts, the average number of sows is 1.25 with 1.51 in Dimapur and 1 in Phek.

Table 4: Average herd size of the farmers according to type of pigs

Type of pigs	Dimapur	Phek	Total
Sows	1.51	0.99	1.25
Boar	0.06	0.01	0.03
Fatteners	0.87	0.33	0.06
Piglets	2.38	0.35	1.36
Grower	1.34	0.33	0.84
Total	6.14	1.99	4.07

Source: Field survey 2017

4. Farming characteristics

4.1 Farming system

Table 5 presents the farming system characteristics of the sample farmers. Almost 58% of farmers are rearing pigs for both breeding and fattening purposes across districts. The majority of farmers from the Phek district—56.67%—reared pigs only for breeding purposes, while 42.5% kept pigs for both breeding and fattening purposes. The face-to-face interaction with the farmers revealed that with project intervention of from TATA Trust, a transition occurred among farmers from rearing pigs for fattening purpose towards breeding purpose. However, farmers, from Dimapur exhibit a different farming system with more emphasis given on rearing pigs for both breeding and fattening purposes (almost 74%).

The baseline study indicates that farmers rear pigs in fully stall-fed condition in both the districts. Only 4.58% farmers across districts rear pigs in a partly stall-fed condition. This finding is consistent with Njuki et al. (2010). As far as the housing condition is concerned, more than 92% of the sample farmers across districts have concrete floors; however, some farmers in Phek district report wood-plank floors in their pig sheds.

Feeding of protein-rich and high-value concentrate is important for higher farm productivity and disease resistance. However, only a few farmers across districts (almost 9%) feed concentrate to their animals, with 14.17% of the more commercially oriented farmers in Dimapur compared to 4.17% in Phek. The average volume of concentrate fed per adult animal across districts is 1.18 kg/day. Price of concentrate varies due to transportation problems (Table 5). Average price/kg of concentrate in Phek is higher by three Indian rupees (INR) over the price in Dimapur. Most of the farmers purchased feed ingredients such as wheat bran, rice bran, rice polish and oil cakes in a very nominal proportion. The average volume of concentrate ingredients feeding per adult animal per day by the farmers in Dimapur and Phek are 1.44 kg and 1.31 kg, respectively.

Table 5: Baseline characteristics relating to farming system of the sample farmers

Particulars	Dimapur	Phek	Total
Rearing objective (%)			
Only breeding	25.83	56.67	41.25
Only fattening	0	0.83	0.42
Both breeding and fattening	74.17	42.50	58.33
Pig rearing system (%)			
Fully stallfed	96.67	94.17	95.42
Partly stallfed	3.33	5.83	4.58
Fully scavenged	0	0	0
Type of floor (%)			
Concrete	99.17	85.83	92.50
Earthen	0	0.83	0.42
Wooden plank	0.83	13.33	7.08
Farmers feeding concentrate feed (%)	14.17	4.17	9.17
Average volume of concentrate fed/adult animal (kg)	1.07	1.47	1.18
Average price of concentrate fed (INR)	26.06	29.00	26.73
Farmers feeding concentrate ingredients (%)	94.17	98.33	96.25
Average volume of concentrate ingredients fed/adult animal (kg)	1.44	1.31	1.37
Average price of concentrate ingredients	19.77	22.50	21.16
Average volume of nonconventional feed fed/adult animal (kg)	2.84	2.95	2.89
Cleanliness of the farm (%)			
Very clean	14.17	6.67	10.42
Clean	61.67	75.83	68.75
Dirty	24.17	17.50	20.83

Source: Field survey 2017

Similar to the higher price of concentrate in Phek, the price of concentrate ingredients is also higher in Phek. Boiling and feeding of nonconventional feed such as green leaves, vegetables etc. by mixing with concentrate or concentrate ingredients is a common practice for all of the farmers. The average volume of nonconventional feed fed daily per adult animal is equivalent to almost 3 kg across districts. Categorization was done by visually inspecting the farm conditions of the sample households in the order of very clean, clean and dirty. Almost 69% of farms are clean across districts; 20.83% are classified as dirty. Only 10.42% of the total farms are categorized as very clean across districts. Farms in Dimapur are relatively cleaner than in Phek (Table 5).

4.2 Animal diseases and prevention practices

Data on the occurrence of common animal diseases on-farm animal during the 24 months preceding the survey were recorded during the interview. Almost 57% of farmers in both districts reported that they did not experience any animal disease occurrence during the 12 months preceding the survey. The remaining farmers reported that the common diseases which occurred were swine fever, worm infestation, skin disease, and symptoms of reproductive and respiratory problems. A higher proportion of animals in Phek were afflicted with worm infestation, skin disease and reproductive problems than in Dimapur. However, swine fever incidence is higher in Dimapur than in Phek (Table 6).

Table 6: Most common disease occurrence on-farm during the 24 months preceding the survey (in %)

Disease	Dimapur	Phek	Total
No disease	57.50	57.50	57.50
Swine fever	15.00	6.67	10.83
Foot-and-mouth disease	0	0	0
Worm infestation	11.67	15.83	13.75
Skin disease	9.17	21.67	15.41
Reproductive problems	1.67	5.00	3.33
Respiratory problems	1.67	0	0.83

Source: Field survey 2017

Table 7 presents the level of efforts undertaken for preventative measures of disease control in the two surveyed districts of Nagaland. Almost 42% of farmers in Dimapur vaccinated their animals, mostly against swine fever compared to 36.67% in Phek. Almost 53% of farmers across districts deworm their newborn animals (56% in Dimapur and 51% in Phek).

Table 7: Preventive measures undertaken for disease control on-farm (in %)

Preventive measures	Dimapur	Phek	Total
Vaccination			
Yes	42.50	36.67	39.58
No	57.50	63.33	60.42
Deworming			
Yes	55.83	50.83	53.33
No	44.17	49.17	46.67

Source: Field survey 2017

5. Breeding services: access, usage and outcomes

5.1 Access to and usage of breeding services

Farmers in the two surveyed districts reported predominant use of the NM method for breeding. Only one farmer from Dimapur district reported using AI, carrying the semen from the Indian Council of Agricultural Research Complex for the North Eastern Hill (NEH) Region, Jharnapani (Nagaland). The farmers using NM services most commonly access the boar from neighbour farmers located in a radius of within two kilometres (km). Almost 8% of farmers across districts access boar service from a distant farmer located in a radius more than 2 km. Almost 5% of sample farmers are found to have their own boar for servicing both their own sows and other sows in the neighbourhood. The average distance of farms from a breeding boar is 0.94 km across districts (1.05 km in Dimapur and 0.83 km in Phek). The number of boars kept for breeding purposes in the villages of Dimapur is relatively more than in Phek. Servicing capacity of the boar is constrained when a higher number of sows is brought for mating. In this regard, boar availability is unfavourable in Phek compared to Dimapur (see Table 8). This finding is consistent with Patra et al. (2014).

Repeat breeding as a problem is experienced by 22.92% of farmers across the districts. The average number of services required per conception is 1.14–1.15 in Dimapur and 1.13 in Phek. The average servicing cost for NM is INR1,075.63 across districts. However, none of the farmers are charged for repeat service in Dimapur, but 2.50% of farmers are charged in Phek with an average charge of INR933.33. Accessing breeding services is constrained in Phek compared to Dimapur. Almost 61% of farmers in Dimapur reported that accessing breeding services is very convenient, while in Phek, only 0.83% of farmers report it as very convenient. In Phek, almost 77% of farmers consider accessing breeding services as somewhat convenient. Inconvenience of accessing breeding services may also be related to the number of person days spent in organizing the breeding service. In Phek, farmers on average spend 0.79 person day in organizing one breeding service compared to 0.09 person day in Dimapur (Table 8).

Table 8: Access and usage of breeding services by the sample farmers

Particulars	Dimapur	Phek	Total
Breeding method used (%)			
NM	99.17	100	99.58
AI	0.83	0	0.42
In NM, ownership of the boar (%)			
Own	8.33	1.67	5.00
Neighbour	83.33	90.00	86.67
Distant farmer	7.50	8.33	7.92
Average distance of the farm from the breeding boar (km)	1.05	0.83	0.94
Average number of services per conception	1.15	1.13	1.14
Average cost of the service (x)	1088.75	1062.50	1075.63
Farmers being charged on repeats (%)	0	2.50	1.25
Average cost on repeats	-	933.33	933.33
Convenience of the breeding service (%)			
Very convenient	60.83	0.83	30.83
Convenient	35.00	76.67	55.83
Not convenient	4.17	22.50	13.33
Average number hours spent for organizing breeding service (hours)	0.67	2.80	1.74
Number of persons engaged in organizing breeding service	1.04	2.05	1.55
Person days spent/breeding service	0.09	0.79	0.44

Source: Field survey 2017

5.2 Outcome of breeding services

Table 9 presents the genetic outcomes of the use of NM services. The average age at which the animal on-farm comes to first mating is 9.91 months across districts (9.96 in Dimapur and 9.86 months in Phek). The average age at which the first farrowing takes place is almost 4 months later across districts (13.90 months). The average litter size at birth is 8.28 with a maximum of 16 and minimum of two. Farmers report that some piglets die before weaning due to disease infliction emanating from either management problem of the farm or from reproductive problems. Average litter size at weaning indicates that almost one piglet dies before the weaning age of 59.73 days on average across districts. In the sample farms, the average weight of the piglets at weaning is 7.19 kg across districts (7.17 kg in Dimapur and 7.21 kgin Phek), while the average inter farrowing period of the sows across districts is 6.19 months (Table 9).

Table 9: Genetic outcomes of breeding services used by the sample farmers

Particulars	Dimapur	Phek	Total
Average age at first mating (months)	9.96	9.86	9.91
Average age at first farrowing (months)	14.12	13.67	13.90
Average litter size at birth (number)	8.72	7.82	8.28
Average litter size at weaning (number)	7.51	6.71	7.12
Average age of the piglets at weaning (days)	59.47	60.00	59.73
Average weight of the piglets at weaning (in kg)	7.17	7.21	7.19
Average inter farrowing period (months)	6.24	6.15	6.19

Source: Field survey 2017

6. Factors of breeding services

6.1 Farm and management characteristics

Several farm and management factors such as availability of veterinary service providers, conditions of input and output transportation facilities, availability of farm input and extension contacts may affect the outcome of breeding services. In Dimapur, 90% of farmers reported that veterinary service providers are easily available compared to 37.5% of farmers in Phek. Almost all the farmers in Dimapur find a service provider in need. However, in Phek district, almost 11% of farmers reportedly never got a service provider on call (Table 10).

The study reveals that NM is done mostly at the sow owner's doorstep by bringing the boar to the farm. However, there are a few cases where sows are carried to the boar owner's premises in a vehicle. In this case, the cost of transportation and hired labour of breeding boar/sows is incurred by the farmer concerned. Across districts, the transportation cost is approximately INR389. The average cost of transportation in Dimapur is relatively much lower (INR100) than in Phek (INR750). Again, apart from the monetary cost, breeding services also involve the time spent in carrying the boar by the family members. The average time spent on transportation of the boar is 37 minutes across districts. The time requirement of boar transportation in the hills (Phek) is higher by almost 12 minutes (Table 10).

In sampled villages in both districts, the roads are mostly gravel. However, the magnitude of earthen roads in Phek district is much higher at 40% compared to 5% in Dimapur. Concrete/blacktop roads are present in the sample villages of Dimapur. Furthermore, almost all of the farmers in Dimapur reported that public conveyance is easily available, while for almost 57% of farmers in Phek, availing public conveyance is a constraint towards smooth conduct of breeding services.

Easy accessibility of veterinary services is important for adoption of improved breeding practices such as AI. The present study reveals that almost 32% of farmers across districts have easy access to veterinary services such as doctors and medicines when the farm animals fall sick. Access to such services in Phek district is reportedly much lower compared to Dimapur; almost 27% of farmers from Phek reported that veterinary services are inaccessible compared to 9% from Dimapur. Additionally, access to farm input primarily in the form of feed and fodder resources is favourable in Dimapur compared to Phek. Almost 88% of farmers in Dimapur reported that they had easy accessibility to concentrate and/or concentrate ingredients for their animal, while only 10% of farmers in Phek easily accessed farm inputs. The majority of farmers (almost 78%) in Phek reported that farm inputs are somewhat accessible, while 10.67% of farmers did not have access to farm input at all, compelling them to rely upon nonconventional feeds. It is well documented in earlier studies (Moanaro et al. 2011; Patra et al. 2014a) that due to remoteness and inaccessibility, the rural hill farmers have evolved into a self-sustainable local resource-based production system in which pigs are mainly dependent on local vegetation, crop residue and kitchen waste. Availing extension services is important for improved farming practices. In this context, contacting the veterinary support staff for consultation relating to animal diseases and breeding-related problems may encourage the farming community towards adoption of improved piggery farming practices such as AI for breed improvement. However, only 28% of

farmers across districts were found to have contacted veterinarians during the 12 months preceding the survey. Like with previously discussed factors, Dimapur district again displays more favourable conditions compared to Phek.

Table 10: Baseline condition of breeding factors relating to farm and management

Particulars	Dimapur	Phek	Total
Availability of service providers			
Easily available	90.00	37.50	63.75
Not so easily available	9.17	51.67	30.42
Unavailable	0.83	10.83	5.83
Average cost of transportation of the boar/sows (INR)	100.00	750.00	388.89
Average time spent in transportation of the boar (minutes)	30.98	43.05	37.01
Road condition (%)			
Black top road	21.67	2.50	12.08
Gravel road	73.33	57.50	65.42
Earthen road	5.00	40.00	22.50
Easy availability of public conveyance (%)			
Yes	97.50	43.33	70.42
No	2.50	56.67	29.58
Access to veterinary services (%)			
Easily accessible	62.50	0.83	31.67
Not so easily accessible	28.33	71.67	50.00
Inaccessible	9.17	27.50	18.33
Access to farm input (%)			
Easily accessible	88.33	10.00	49.17
Not so easily accessible	11.67	78.33	45.00
Inaccessible	0	11.67	5.83
Contacted the veterinarians on breeding-related problems during last 12 months (%)			
Yes	39.17	16.67	27.92
No	60.83	83.33	72.08

Source: Field survey 2017

6.2 Perception factors

Table 11 presents the various factors farmers perceive to be important in adopting AI technology over NM. These factors are ranked in the order of their severity. Poor conception rate, i.e. poor result of NM and the need for repeat breeding services are not considered to be severe problems by the majority of farmers across districts. Only 12.5% and 12.08% of farmers consider poor conception rate of NM and the need for repeat breeding services, respectively, as severe problems. Similarly, the problem of long-farrowing interval due to NM is endorsed by only 11% of farmers across districts. Access to pure-breed boar may be an important factor to affect adoption of AI. If NM is impeded due to low or inadequate boar services in the village, farmers will develop a strong inclination to AI and they may also benefit from AI. The rate of boar ownership in Phek district is low in comparison to Dimapur, indicating that a boar has to service a large number of sows in the neighbourhood (Table 8). In this case, the capacity of the boar may be constrained. Almost 28% of farmers across districts agree that there is a lack of exotic pure-breed boars in their neighbourhoods and almost 16% express a neutral view (Table 11). This observation is important relative to the diffusion of AI in the state. Also of interest is that the low number of breeding boars may restrict fattening farms from becoming breeder farms. Adequate knowledge of NM breeding system is ranked as second in terms of severity (Table 11). Most of the farmers (60%) across districts agree that NM charges are significantly high and this perception

together with the lack of pure-breed boars in the locality of the farmers contributes to an almost 89% expressed preference for AI (see Table 11).

Table 11: Baseline perception of the farmers relating to the breeding system (in %)

Particulars	Disagree	Rank	Neutral	Rank	Agree	Rank	Don't know	Rank
Poor conception rate, i.e. poor result of NM	72.08	II	8.75	VI	12.50	VI	6.67	V
Too much repeat breeding through NM	73.75	I	7.08	VIII	12.08	VII	7.08	IV
Long-farrowing interval due to NM	50.00	III	19.58	I	11.25	VIII	19.67	III
Lack of exotic pure-breed boar is the major hurdle	22.92	IV	15.83	III	27.92	IV	33.33	II
AI service provider is not available	2.08	VII	8.77	V	15.42	V	73.75	I
I have adequate knowledge of NM breeding system	15.83	VI	12.92	IV	65.42	II	5.83	VI
High cost of NM is the major hurdle in adopting the practice	19.17	V	18.33	II	60.00	III	2.50	VII
I prefer to use AI the next time	2.08	VII	8.33	VII	88.75	I	0.83	VIII

7. Factors influencing farm productivity

Table 12 presents the factors influencing litter size at birth per sow as an indicator of productivity of the pigs. The coefficient of multiple determination (R^2) is 0.4317 indicating that the explanatory variables (X_1, X_2…….X_n) included in the OLS (linear) regression model explain 43.17% of the variations in the dependent variable. The model is checked for the problem of multicollinearity and the mean variance inflation factor (VIF) of 1.29(see Appendix Table A1) points out the absence of such problem in the model. The number of observations in the model is lower than the sample observation as the sows of the remaining observation of the sample did not deliver piglets until the survey was carried out. Except distance of the farm from the breeding boar, all of the significant variables show conformity with the hypothesized relation presented in Table 2. Consequently, the variable-wise regression results are indicated as follows: age of the household head is significant at 5% probability level indicating that as the age of household head increases, farm productivity also increases. The implication is that aged farmers have better contacts with extension agents and their experience translates to higher pig productivity in the study districts. The positive and statistical significance of the variable is further supported by the finding that experience of household head is also positive and significant. Animals reared in a fully stall-fed condition leads to higher litter size per sow as there is a positive statistical significance (at 1% probability level) association between pig productivity and fully stall-fed rearing.

Table 12: Factors influencing pig productivity (log of litter size at birth per sow)

Variable	Coefficient	Std. Error	t-value
AGE	0.0017**	0.0007	2.45
EDU	0.0015	0.0017	0.86
EXPRINCE	0.0013*	0.0008	1.67
STALLFED	0.1191***	0.0359	3.31
CONCENTRAT	0.0503***	0.0176	2.86
CLEAN	0.0244	0.0163	1.50
VACCINATN	-0.0084	0.0163	-0.52
DEWORM	0.0644***	0.0174	3.70
DISTANCE	0.0060**	0.0023	2.54
VETCONTCT	0.0172	0.0166	1.04
TOPOGRPHY	0.0086	0.0153	0.56
CONSTANT	0.6048***	0.0544	11.12
F value (11)	12.03		
Prob>F-Stat	0.000		
R-Squared	0.4317		
Number of obs.	221		

Note: *, ** and *** indicate significance at 10%, 5% and 1% probability level

Concentrate feeding is significant ($p<0.01$) to influence positively the pig productivity indicating that litter size per sow increases when animals are fed concentrate. Preventive measures such as deworming may significantly ($p<0.01$) result in higher litter size at birth due to disease prevention. The other significant variable such as distance of the farm from the breeding boar is compared against the hypothesized relationship with the dependent variable. The possible

explanation is that the mean distance across districts is only 0.94 km which may not lower the servicing capacity of the boar but further increase in the distance may lower the capacity as the quadratic relation of the same variable shows negative sign.

8. Conclusion

This report provides the baseline status of farming systems and use of breeding services in the two districts of Nagaland, namely Dimapur and Phek. The study is based on simple tabular and regression analysis of 240 sample farmers (120 from each district) collected using multistage sampling techniques. The baseline study shows that farmers in Nagaland largely rely on NM by predominantly accessing the breeding boar of their neighbourhood. The study also reveals that availability of boar services in the remote and hill districts is a constraint in terms of higher service cost and person-power requirement. Sixty per cent of farmers consider the cost of breeding services very high coupled with the problem of repeat breeding. Almost 89% of farmers have, thus, expressed preference for alternative breeding methods such as AI. In the hill district, the cost in terms of labour hour is significant due to transportation issues and inadequate availability of the breeding boar. Furthermore, the sample hill district, namely Phek, is constrained in terms of accessing veterinary services, higher transportation and labour hour cost in availing breeding services, accessing farm inputs such as concentrate feeds and lack of extension support. Using NM, farmers are found to have an average litter size at birth equivalent to 8.28 across the study districts with a maximum of 16 and a minimum of two. Raising productivity thus becomes an important area of concern for improving the livelihoods of farmers. Higher productivity of the pigs (litter size per sow) is significantly and positively influenced by age and experience of the farm owner, stallfeeding of the pigs, feeding concentrate and deworming of the farm animals and hence intervention regarding these issues could lead to higher productivity. Finally, the present study broadly suggests that intervening to improve breeding services among farmers could lead to increased productivity of the piggery subsector in Nagaland, thereby improving the welfare of farmers.

Appendix

Table A1: VIF of the explanatory variable

	VIF	Tolerance
AGE	1.36	0.7357
EDU	1.22	0.8213
EXPRINCE	1.29	0.7776
STALLFED	1.21	0.8257
CONCENTRAT	1.38	0.7244
CLEAN	1.42	0.7064
VACCINATN	1.19	0.8406
DEWORM	1.41	0.7083
DISTANCE	1.05	0.9524
VETCONTCT	1.27	0.7846
TOPOGRPHY	1.38	0.7252
Mean VIF	1.29	

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