Pig breeds, breeding systems and supply and demand for genetic materials in Nagaland, India

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Pig breeds, breeding systems and supply and demand for genetic materials in Nagaland, India

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Acronyms

AI	Artificial insemination
FGD	Focus group discussion
ICAR	Indian Council of Agricultural Research
NEIDA	North East Initiative Development Agency

Acknowledgements

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Study purpose

The Tata funded program, 'Enhancing sustainable livelihoods of marginal communities through targeted livestock research' (01-04-2015 to 31-03-2018), is pursuant to a funding agreement with NEIDA. The Trust selected this pig value chain development initiative as its priority in Nagaland. This ILRI study, carried out with the support of Le Thi Thanh Huyen, will provide valuable insights on pig breeds and breed development in northeast India. It focuses on the mapping of pig breed types, identification of a breeding system, and supply and demand of breeding materials in Nagaland. Specifically, this study will comprise the gathering and synthesising of information on 1) pig breed/crossbreed types in different agro-ecology/production systems in the study sites; and 2) supply and demand for pig germplasm/breeding services within the study site, particularly by smallholders. The information gained from this study will be documented and presented back to stakeholders by ILRI in a validation workshop and will be used to help inform further pig breeding/genetics.

Introduction

Livestock production plays an important role in smallholder livelihood in India. The livestock sector contributes about 32% of total agricultural output (Suri 2012). Most livestock population is raised by resource-poor small farmers in marginal and landless areas. According to Department of Animal Husbandry and Dairying (2003), small farmers own 63–66% of the buffalo and small ruminant population, and more than 70% of pigs, cattle and poultry. The intensification was mainly with poultry and dairy, while still at low level in pig production. Pork is one of the major meats consumed in India after poultry meat (Suri 2012); it is mainly consumed, as well as produced, in the northeastern states (Kumar et al. 2007; Wright et al. 2010; Suri 2012; Patr et al. 2014). The increase in demand on pork due to the urbanization might increase the incomes of smallholder pig keepers and enhance for poverty alleviation in marginal areas (Seth et al. 2014).

The northeast of India is known as a hilly region characterized by a high proportion of tribal and poor people in India, with 35% of the population living below the poverty line, higher than the national average (26%) (Wright et al. 2010). Livestock production brings a major source of income for farmers in this region, even though the productivity is low (Kumar et al. 2007; Deka and Thorpe 2008; Patr et al. 2014). More than 25% of pig population is kept in the northeast of India. In which, Nagaland state has the highest density of pig (Deka and Thorpe 2008). The deficit of commercial slaughter pigs in Nagaland that resulted from the high demand for pork, while low productivity and intensification of pig production is an opportunity for enhancing the development of pig production in the region for improving livelihood of marginalized farmers. However, systematic studies on the pig sub-sector are necessary (Wright et al. 2010). Appropriate interventions on technical, institutional and policy initiatives for the improvement of breeds, feed availability, disease control, and food safety should be implemented (Kumar et al. 2007).

Nagaland was proposed to share about 17% of pig population in the northeastern region of India (Kumar et al. 2007). Pigs accounted for 55% of the total livestock population in Nagaland (Patr et al. 2014) and were a main livelihood activity for 90% of the people in Nagaland state (Njuki et al. 2010; Fahrion et al. 2014), with more than 50% of the pigs being crossbred (Kumar et al. 2007). The replacement of crossbred pigs was to meet increased demand for pork by the growing population and family income. The maintenance of the indigenous pigs in Nagaland resulted from the preference of tribal people both for taste of the meat, as well as the adaptability of these pigs to the local conditions. Local pigs are reared mainly under extensive and scavenging systems with low inputs and low productivity (Zaman et al. 2013; Fahrion et al. 2014; Pankaj Seth et al. 2014). The introduction of exotic germplams aimed to improve the productivity of local breeds (Birthal and Taneja 2006). However, the lack of breeding farms, value chains and appropriate policies are reasons slowdowning the piggery development (Borkotoky 2011; Pali et al. 2013). Breeding policies have been mainly focused on ruminants (Department of Animal Husbandry and Dairying 2003). Breeding policy for pigs was initially concerned with improving productive and reproductive performance, meat quality and adaptability traits (National Livestock Policy 2013). This is expected from crossbreeding between high performance exotic germplasm with commendable local pig breeds. However, there is little available information on livestock production in general and pig production in particular in Nagaland (Fahrion et al. 2014). Most pigs, especially local pig breeds, in Nagaland are not described (Borkotoky 2011; Zaman et al. 2013). This study focuses on the analysis of pig breeds and crossbreed types in different agro-ecology systems in Nagaland, as well as the identification of supply and demand for pig germplasm and breeding services within the study site by smallholders in order to provide appropriate recommendations for policymakers in developing breeding policies on pig sector in the Nagaland state.

Materials and methods

Study area

Nagaland is one of eight states in the northeastern region of India. The state has an area of 16,579 km^2 with 11 administrative districts. It is one of the smallest states in India. It shares borders with Assam in the west and north, Arunachal in the north, Myanmar in the east and Manipur in the south. The state is mostly mountainous with more than 50% of the state being forest. The state can be distinguished into three regions, inclusive of high land (>1500 m.a.s.l.), middle land (800–1500 m), and lowland (< 800 m a.s.l.). The population was 1.978 million people in 2011 with literacy rate of 80%, a bit higher than the average rate of the whole India of 73% (Department of Veterinary and Animal Husbandry 2012). Ninety per cent of the population in Nagaland belongs to 16 tribes with different sub-tribes. The state suffers from water scarcity during winter season due to a lack of major rivers and only few water bodies (MART. 2011).

Nagaland has a monsoon climate with high level of humidity. The average annual rain fall ranges from 1800–2500 mm, mainly from May to September. The average of temperatures ranges from 11–32°C. People's livelihoods are mainly based on agricultural activities with the major crops including rice, corn, millets, pulses, potatoes, and livestock production as a major source of family income with pigs as the most important species.

Methods

Different approaches were used to depict different information on pig breeds and their distribution, supply to and demand from smallholders of genetic materials. These are summarized in table 1.

General information on pig production in Nagaland was depicted from gathering relevant reports and a statistical book.

Pig breed types and their distribution in Nagaland were gained by a participatory mapping exercise where participants were experts inside and outside of the state, those knowledgeable on pig breed-type distribution and genetic material flows in or out from Nagaland. The workshop was organized by the Department of Veterinary and Animal Husbandry in cooperation with the project. The participants included officers from Department of Veterinary and Animal Husbandry, scientists from Indian Council of Agricultural Research (ICAR)—National Research Centre on Pig, ICAR—all India, Coordinated Research Project on Pig, local pig breeders and development organizations. The participatory mapping exercise entailed: (1) defining the major breeds and crossbreed types in the state (including identifying the maternal and paternal lines contributing to the crossbreed types) as well as the production system(s) they are found in; (2) agreeing on and depicting a representation of the geographical distribution of the breed/crossbreed types for the different production systems on a supplied detailed map; (3) interrogating and refining the map. Key discussions/explanations that emerged as part of the process were recorded.

Table 1: Summary of the obtained information and collection approaches

Obtained information	Tool used	Number of participants
General information on pig production in Nagaland	Secondary data collection	
Pig breed types and their distribution	Expert participatory mapping exercise	20
Flow of genetic material into/out-of backyard pig farming and smallholder pig systems and demand for pig germplasm and breeding services by smallholder pig keepers	Focus group discussions with smallholder pig keepers including Venn mapping for characterizing the flow of pig germplasm and identifying gaps in the supply of pig germplasm	116
Breeding operation of breeding farms	Key person interviews	7

Smallholder information on supply and demand of breeding pigs and services was obtained via focus group discussions (FGDs). Six FGDs were performed in six villages of three districts representative of all ecological zones of Nagaland state as per the suggestion by the Department of Veterinary and Animal Husbandry, including: Indisen and Dobagoan villages (lowland Dimapur district); Tanhai and Totok villages (midland Mon district); Khutsami and Chesezu villages (highland Phek district). The smallholder meetings were organized by the Department of Veterinary and Animal Husbandry. Participants of each FGD comprised 7–14 men and 7–13 women smallholder pig keepers, with FGD activities performed in separate men's and women's group. The FGD activities are described below.

The sources and flow of pig germplasm was characterized by a Venn mapping exercise. Briefly, different sources of pig germplasm were depicted as circles on a chart, with distance of the circle to the 'smallholder circle' representing the convenience in approaching and the size of the circle representing the importance or the magnitude. The flow of genetic material between the different sources and the smallholders was then depicted by arrows, with width of the arrow representing the amount of the material.

Gaps in the supply of pig germplasm were determined from a facilitated discussion on: current availability, accessibility and demand for various breeding services; whether the breeding services were providing the desired products at desired prices; advantages and disadvantages of the different breeding services; and suggestions for future improvements of breeding services.

In addition, constraints to and opportunities for pig production in general including on breeding issues, were also elucidated through a facilitated discussion.

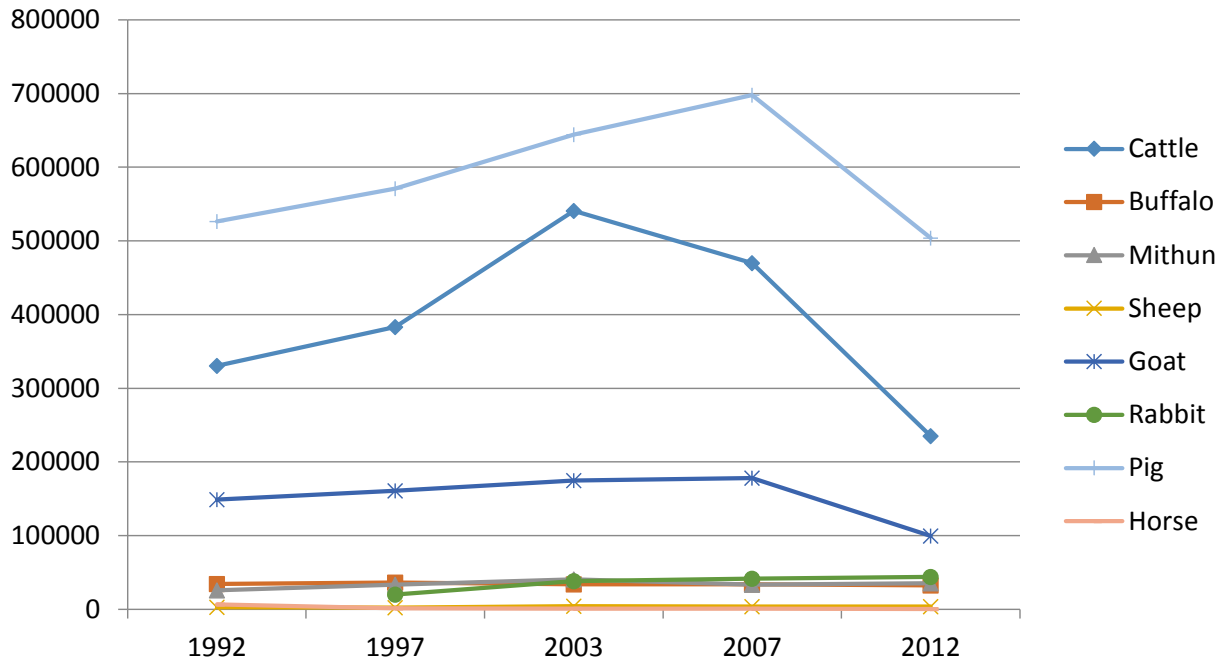
Pig breeding operations of breeding farms in Nagaland were obtained by interviews with key informant representatives of two state breeding farms, and two private breeding farms in Kohima and Dimapur; and a research breeding centre in Dimapur.

Results and discussions

General information on pig production in Nagaland

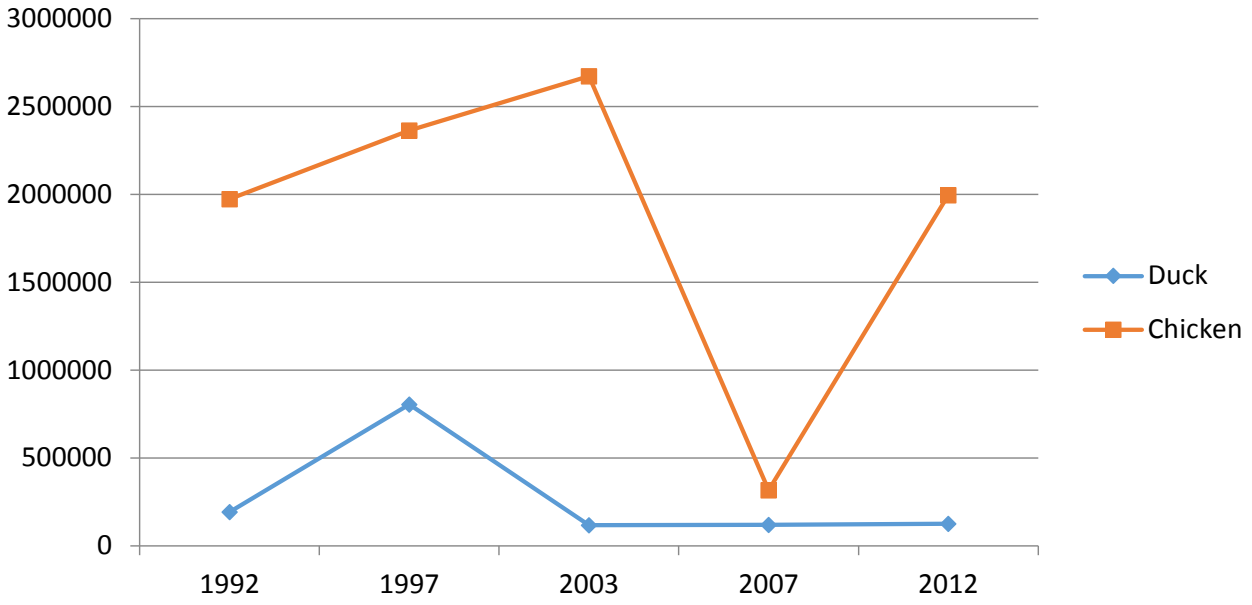
Nagaland state belongs to eastern Himalayan zone where the productivity of land is poor and water resources are scarce. Agriculture is the main activity of the Nagaland state and accounts for more than 70% of total income. Livestock production is one of main contributors to the agricultural sector of the state (Department of Veterinary and Animal Husbandry 2012). However, agricultural products are mainly for self-subsistence and internal consumption. These products are mostly sold when family need cash, not for regular income generation. Livestock production is an important activity around the year but on a low scale. Poultry is reared in scavenging systems, mainly local breeds. Cattle are not a popular species in the state nowadays. They are mainly free ranging in the forest. Pigs are the most important livestock species in Nagaland in terms of providing meat, especially during festivals and other occasions such as wedding feasts, birthday parties, community feasts, funerals, etc. (MART 2011). Changes in numbers from 1992 to 2012 of livestock and poultry are presented in Figure 1 and 2. The numbers of buffalo, horse, Mithun (a type of mountainous cattle—*Bos frontalis*), sheep, and rabbit are the lowest and have not changed much over time. The highest number is for pig, followed by cattle and goat. The numbers of three latter species had reduced during the period from 2007 to 2012 (Figure 1), especially for cattle. The numbers of chicken fluctuated a lot, while those for duck were quite stable during 20 year period.

Figure 1: Livestock population in Nagaland (1992–2012).



(Mithun: *Bos frontalis*)

Figure 2: Poultry population in Nagaland (1992–2012).



Source: modified from Department of Veterinary and Animal Husbandry (2012)

According to Department of Veterinary and Animal Husbandry (2012), Nagaland state had a total of 146,690 pig farms of different farm types, including mainly smallholder farms (backyard farming) and household enterprises (146,307 farms), and 383 non-household enterprises (research, state, and private commercial (industrial) farms). The later farm types were concentrated mostly in Kohima, Peren, Phek, and Mon districts and also in Zunheboto, Kiphire and Dimapur districts. Dimapur had the highest number of household farms and enterprises, following by Mon, Peren, Phek, Zunheboto, Mokokchung, Kohima (Table: 2).

Table 2: Numbers of different pig farm types in Nagaland state, by district

Districts	Household farms (backyard farming) and household enterprises	Institution and non- household enterprises
Dimapur	22,594	10
Kiphire	11,121	12
Kohima	13,668	130
Longleng	4518	0
Mokokchung	13,825	0
Mon	16,516	48
Peren	14,377	87
Wokha	9769	2
Phek	13,047	63
Tuensang	12,107	2
Zunheboto	14,765	29
Total	146,307	383

Source: Synthesized from Department of Veterinary and Animal Husbandry (2012)

Pig breeds kept in the state of Nagaland are exotics and their crossbreds, admixed breeds and indigenous breeds. Data in 2012 showed that indigenous breeds accounted for 24% of the total pigs of the state (Table: 3). The districts Tuensang, Kiphire, Mon, and Zunheboto owned the highest number (highest share) of indigenous pigs. While in Mokokchung, Kohima districts, the majority of pig breeds are exotic and their crossbreds.

Table 3: Number of pigs in 2012, by breed and district

Districts	Total pigs	Indigenous pigs	Exotic/ crossbred pigs	Percentage of indigenous pigs among total pigs (%)
Dimapur	69,561	10,872	58,689	16
Kiphire	43,836	17,938	25,898	41
Kohima	53,928	3768	50,160	7
Longleng	10,891	2899	7992	27
Mokokchung	0	0	50,920	0
Mon	47,155	18,582	28,573	39
Peren	16,232	3837	12,395	24
Wokha	48,592	13,932	34,660	29
Phek	45,315	7110	38,205	16
Tuensang	57,567	23,971	33,596	42
Zunheboto	59,691	20,060	39,631	34
Total	503,688	122,969	380,719	24

Source: Synthesized from Department of Veterinary and Animal Husbandry (2012)

Pig breed types and their distribution

There were various breeds kept in the Nagaland state. Table 4 summarizes the major breeds, and their distribution and use in the state identified by the experts. Large Black breed (LB) and its crossbreds were the most popular breeds, following by Burmese Black breed (BB) and their crossbreds. Crossbreds of LB with indigenous (local) breeds were prevalent on smallholder farms. The prevalence of pig breeds in the current study is not different from the finding of Njuki et al. (2010) and Patr et al. (2014). The indigenous Naga local pig was more available in remote districts (Patr et al. 2014). According to Njuki et al. (2010) LB pigs were kept by 54% of households in four districts of Mokokchung, Wokha, Phek and Kohima. However, currently number of breeds in the current study increased due to an increase in population of different crossbred types of exotic breeds. Rahman et al. (2008) also report a high percentage (92%) of farmers in Aizawl district, Mizoram, a mountainous region of India kept crossbred pigs. Crossbreds were preferred there for better growth performance, health, large litter size, low mortality rate and higher back fat thickness than the indigenous breeds.

Table 4: Major pig breeds and their distribution in Nagaland

Breeds	Use	Prevalent systems and zones	Note
Indigenous Ghungroo	Mainly used as dam, as commercial pig; sometimes as sire.	Household farms, mainly in Dimapur and Kohima districts.	New introduced to Nagaland from West Bengal; Looks like Large Black; Only this indigenous breed was identified.
Naga local Indigenous breed(s), named by local regions (Tenyi Vo, Suw-wo, Local…)	Dam, sire, produce special dish fatteners.	Prevalent in household farms in remote region.	Decreasing in population. 1–3 pigs/ farm; Tenyi Vo is under process for breed registration Might be different breeds/ genotypes/ phenotypes, not yet identified.
Large Black (LB)	Mainly sire, sometime dam, or commercial; produce crossbred commercial pigs.	The most popular breed; In all production systems and zones.	High fat content, good performance, preferred colour and meat quality; Crossing with any breed types available.
Burmese Black (BB)	Sire or dam to produce crossbred commercial pig.	Popular breed after LB. All systems and zones.	Preferred colour, good litter size, and produce good crossbreed. Breeding piglets mainly come from Manipur and Myanmar. Crossing with any breed types available.
Hampshire (HS)	Sire, dam	Only in state/research breeding farms.	
Large Black x Naga local Indigenous (LB x local)	Sire, dam, commercial fatteners.	All systems and zones; on smallholder farms.	Synthetic breeds; large litter size, meat flavour, mothering ability.

Breeds	Use	Prevalent systems and zones	Note
Hampshire x Ghungroo	Sire, dam, commercial fatteners.	In research farms; just newly introduced to farmers.	Synthetic breeds.
Hampshire x local Naga Indigenous (HS x local)	Sire, dam, commercial fatteners.	In research farms; just newly introduced to farmers.	Synthetic breeds.
Burmese Black (BB) crosses	Sire, dam, commercial fatteners.	Mainly in Phek, Kiphire, Tuensang.	Where farmers can access to BB pigs.

Source: expert mapping workshop (2015)

There were major flows of piglets from Myanmar, Manipur, Assam, and Meghalaya to state breeding farms then to private farms and smallholder farms. Such genetic material flows were also reported by Wright et al. (2010). High demand for pork resulted in the gradually replacement of crossbreds for indigenous breeds in the Nagaland state. According to Wright et al. (2010), piglets imported from Assam are mainly LB crosses, while those from Manipur and Myanmar are generally BB crosses. The percentages of crossbreds increase from remote villages to near towns villages, while it is vice-versa for the indigenous breeds (Deka and Thorpe 2008; Wright et al. 2010).

Figure 3 presents the distribution of pig breeds in Nagaland state. More details on pig breeding systems are presented as follows:

Current pig production systems:

- Breeding farms: 11 farms (state breeding farms; research, and private farms)
- Commercial farms: few
- More than 90–95% is smallholder farms, mainly backyard small scale, prevalent scale is 2–3 pigs/farm
    - Intensive: confined, stall fed; high level of inputs for feeds such as purchased feed additional to own feed; better husbandry and health management (housing, health care)
    - Semi-intensive: fenced; semi-confined; medium feed inputs
    - Extensive: Mainly local breeds, low levels of feed resources, low levels of husbandry and health care inputs; less organized, low productivity.

The East zone (Mon, Longleng, Tuensang, and Kiphire districts):

In general, major pig breed types in this zone were crossbreds of exotic with Naga local indigenous breed(s). They were kept in extensive or semi-intensive systems (about 50/50%). Crossbred of LB x local accounted about 50% of pig population; BB x local accounted for about 30%; Hampshire (HS) x local accounted for 15%, and the remaining 5% is Naga local indigenous breed(s). The distribution of pig breed types in these districts is detailed as follows:

Description in the map	Breed types
Zones of one breed (blue, red, yellow)	Blue colour in the map: LB x local as a major breed; Red: BB x local as a major breed; Yellow in the map: Local as a major breed.
Zones of two breeds (pink colour)	In Tuensang: HS x local (50%); LB x local (50%). In Kiphire: BB x local (60–60%); LB x local (30–40%). In Tizit: HS x local (60%); LB x local (40%)
Zones with more than two breeds (black colour)	BB x local (45%); LB x local (45%); Naga local indigenous breed(s) (10%)
State breeding farms	In Tuensang village: keeping mainly HS pig, supplies piglets for fattening and for research. In Tizit: keeping exotic breeds to produce commercial fatteners (90–95%); breeding pigs to local breeder (5–7%).

Note: HS: Hampshire; LB: Large Black; BB: Burmese Black

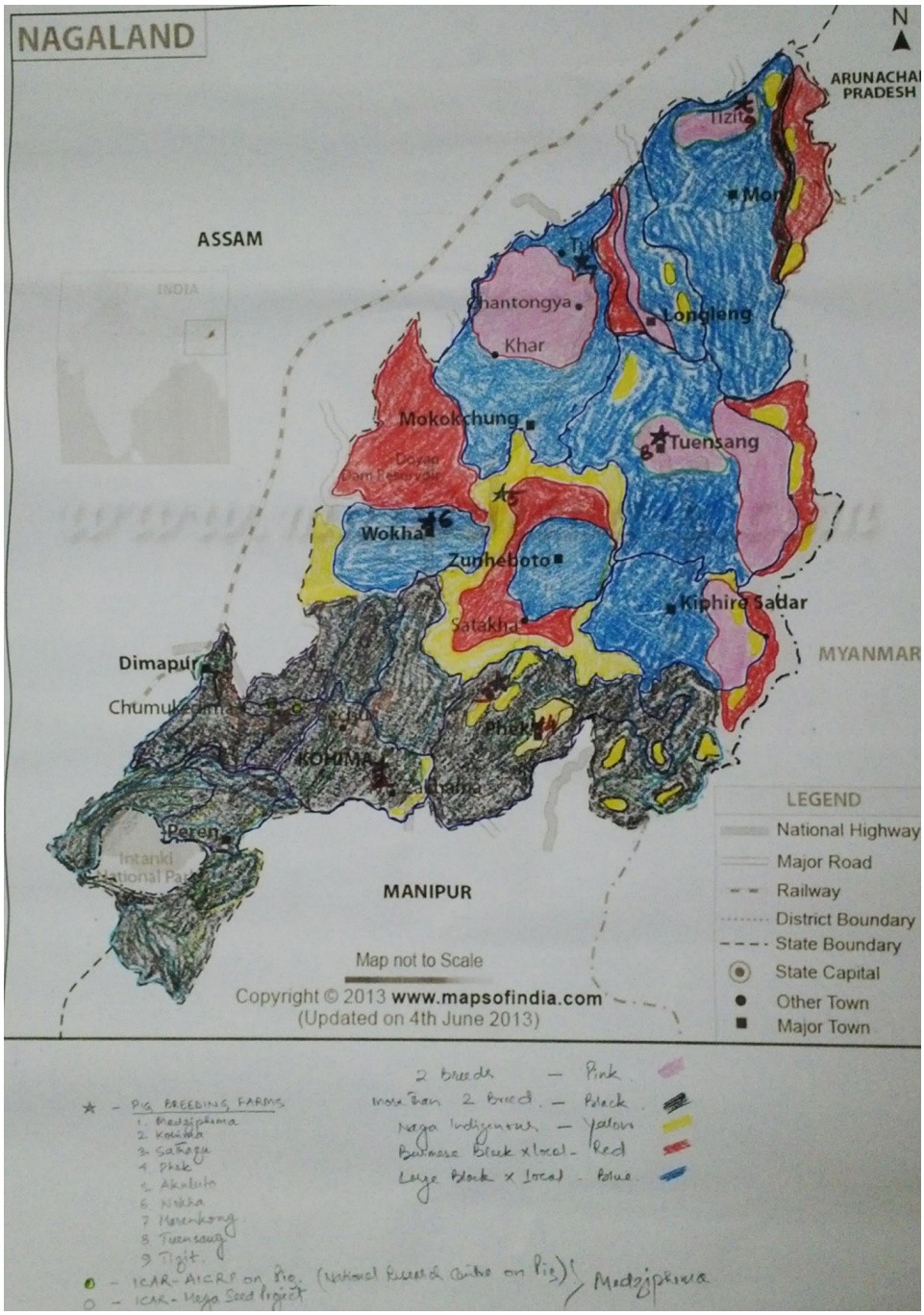
West zone (Wokha, Zunheboto, Chantongya, and Mokokchung):

More than 90% of intensive farms of the state concentrated in this zone. Major breed types contained of LB x local, BB x local, and indigenous breeds. The crossbred BB x local was more concentrated around towns. The distribution of the breeds was also different between districts, as follows:

Districts	Breed types
Changtongya	LB x local (30%); BB x local (70%)
Wokha	LB x local (20%); BB x local (30%); and Naga local indigenous breed(s) (unidentified) (50%).
Zunheboto	50% indigenous breed (Suw-wo); 40% BB x local; and 10% LB x local.
Mokokchung	LB x local (70%); BB x local (30%).

Note: HS: Hampshire; LB: Large Black; BB: Burmese Black

Figure 3: Map of distribution of pig breed types in Nagaland.
Source: Expert mapping workshop (2015).



There was a reduction in percentage of households keeping LB pigs in Mokokchung district if compared to the figure of 84% of households keeping LB reported by study of Njuki et al. (2010), and replaced by the prevalence of crossbreeds of LB x local and BB x local.

South zone (Dimapur, Kohima, Phek, and Peren districts):

There were six different breeds/crossbreed types in this zone, including: Ghungroo, LB, HS, BB, and crossbreds/admixed breeds of these breeds, and Naga local (few). Smallholder pig production systems made up mainly of intensive and semi-intensive systems (70–80%, concentrated in the West and South of the district), and extensive system shared only 20–30%. Fattening farms accounted about 80%, especially along border with Assam state, and only 20% were breeders. The distribution of the breeds was different between districts as follows:

Districts	Breed types
Dimapur	Ghungroo (70%); LB (15%); HS (15%); BB (10%); crossbreds and admixed breeds of these breeds (40%); Naga local indigenous pigs (few)
Peren	- The northern district: LB and HS (30–50%); and crossbreds of these breeds (50–70%).
	- The North and North West nearby the national park: BB (30–50%); HS (20%); and their crossbreed (30%).
	- The East of the national park: Naga local indigenous breed(s) (50%); HS (40%), and crossbreeds (10%).
	- The South of the national park: HS (40%); unidentified crossbreeds (50%); and Ghungroo (10%).
	- Three breeding farms (one state farm and two research farms): HP x local Naga pig; HS; LB; Ghungroo.
Kohima	- Part along the border with Manipur: LB (30%); Naga local indigenous breed(s) (15%); Ghungroo (10%); Crossbreds/admixed breeds of these breeds (50%).
	- Part along the border with Dimapur: Ghungroo (20–30%); HS (15%); LB (5%); their crossbreeds/admixed breeds (50%).
	- Part having border with Whokha: Naga local indigenous breed(s) (30%); LB (20%); and their cross breeds (50%).
	- Part having border with Phek: Crossbreds (50%); BB (40%); and HS (10%).
	- A composite piggery farm: HS (most); LB; and few Naga local indigenous pigs
Phek	- Part along the border with Manipur and Kohima: LB (50%); Crossbreds (nearly 50%); very few local Naga pigs.
	- Main part in the North and centre: Crossbred (un-identified) (60%); Naga Local Indigenous pigs (30%); HS (10%), and few BB.
	- Part along border with Manipur and Myanmar: BB (50%); HS (10%); Crossbreds (40%).
	- One piggery centre.

Note: HS: Hampshire; LB: Large Black; BB: Burmese Black

The abundance of breeds and crossbreeds in this zone might result from different flows of pig breeds that came from Assam, Manipur and Myanmar along the borders. If compared to the findings in 2010, 62% of the households in Kohima district kept the large black breed and 73% of households in Phek kept indigenous breeds in the study of Njuki et al. (2010), there were reductions in keeping LB and indigenous breeds but increases in keeping crossbreeds. Deka and Thorpe 2008 also reported that there was very few indigenous pig in Dimapur.

The supply and demand for breeding pigs and breeding services and constraints to and potential of smallholder pig production

Supplies of genetic materials and breeding services:

Pig production was a common activity of most farmers in the investigated villages with more than 70–95 % of total households in the villages keeping pigs except in Tan Hai village (30%). The percentages of household keeping pigs had not changed much when compared to the past as reported by Deka and Thorpe (2008) and Wright et al. (2010). Higher percentages of pig keepers were found in the highland villages, Phek district. Table 5 summarizes general information on pig keeping in the investigated villages. Pig keeping was on a low scale in all villages with an average of 2–4 pigs/farm, this is in accordance with report of Patr et al. (2014). MART (2011) explained by the low scale of

production due to limitations of feed and family labour, while a lot of care and high volume of feed and water were required for pigs. Pig fattening was more common among pig keepers compared to keeping sow for reproduction, and this is also reported by Deka and Thorpe (2008). Pigs were fed with wild leaves, available vegetables, yam, and purchased wheat bran and rice polish and maize meal. All were cooked and mixed with high volumes of hot water and additional of kitchen wastes. Feeding pigs was similar in all villages and has not changed for many years (if compared to reports of Rahman et al. 2008; and MART 2011; Patr et al. 2014). After more than one to two years raising, pigs were slaughtered and sold in the village or along the road, i.e. pork mainly served for local consumption. In some villages near towns, live pigs might be sold to the butcher or collectors. Long time fattening and pork for local consumption were also described by other authors (e.g. Rahman et al. 2008; Wright et al. 2010; MART 2011; Patr et al. 2014).

Rahman et al. (2008) explained that considering consumer preference for high back fat content, farmers rear the animals for even more than one year. Among sow keepers, very rare cases kept two sows, most of them kept only one sow. Both local and crossbred pigs were found in the investigated highland villages. In midland villages farmers kept crossbreeds and maybe local breeds. Only crossbred pigs were kept in the lowland villages. Pigs with black colour or black with a white patch were preferred by farmers, this is in accordance with report of Rahman et al. (2008). Farmers identified pigs based on pig's body size and colour. Medium size crossbreds with black colour or black with a white patch, long nose, round and short body were more prevalent than the large size crossbred pigs with short nose, long body, and higher growth rate and fat. Pigs might be named with local names. For instance, in Totok village, a large size crossbred fattener was named as Miry pigs to be differentiated from local pigs. While in Dobagoan village, where no local pigs were raised, all black crossbred pigs were described as 'local pigs'.

It could be seen that in general, pig production management and marketing practices in Nagaland have not changed much during the last over 10 years even though the demand for pork has increased.

Table 5: Summary of the information on pig keeping in investigated villages

Villages*	Indisen (Dimapur)	Dobagoan (Dimapur)	Tan Hai (Mon)	Totok (Mon)	Khutsami (Phek)	Chesezu (Phek)
Location	Lowland		Midland		Highland	
Distance to town (km)	5–7	5–7	19–20	13–15	11–15	3–4
Total households	-	> 200	137	537	104	450
Percentage of pig keepers	70	> 80	30	60–70	Almost all	> 95
Type of pigs	Mainly fattening; 10 households kept sows	Both, fattening and reproduction sow	Fattening, very few initial trials on reproduction sow***	Local reproduction sow and crossbred fatteners	More reproduction sow than fattening	More fattening; 25% kept sows
Total pigs/ farm (min–max)	2–4 (1 kept 20 fatteners; some kept 5–6)	3.8 (1–13)	1.8 (1–7)	1.5 (1–3)	1.8 (1–9)	- 1–15
Pig breeds*	Medium size crossbred	Medium size crossbred (farmer call local because of black colour)	60% large size, and 40% medium size crossbred.	Local sow (>50%); and large size crossbred fatteners (local name Miry pigs)	crossbred (LB x Local) sow ; Local sow (fewer)	Local pigs (45–50%); few crossbred sows and fatteners
Availability of boar service	2–3 boar keepers; Inside and outside village	2 boar keepers; Inside and outside village	No boar service in villages around	No boar service in villages, only in town, self-subsistence of breeding Local pigs	In or outside the village.	Boar service 3–4 km away. mainly self-subsistence of local breeding pigs

*Crossbreds: black or black with white patch; medium size: long nose, round and short body; large size: short nose, long body, higher fat rate, higher growth rate.

***No boar service in Tan Hai village for the last 2 years, female pigs were sold without reproduction. Only one household have tried to have a boar service from town.

In accordance with report of Wright et al. (2010) and Pali et al. (2013), the current study found that there were no artificial insemination (AI) practices in all investigated villages. This is in contrast with the situation in Mizoram, a mountainous region of India where 75% of farmers applied AI practices (Rahman et al. 2008; Wright et al. 2010). In the current study, keeping sows depended on boar available (boar service and self-supply). Knowledge of raising and managing breeding boars was very limited in almost all villages, especially in Mon district. Boar services were used only for crossbred sows, while self-subsistence of boar was for local sows. Out of six investigated villages, village boar services were not available for farmers far away from town in midland Mon district. There has been no training on pig breeding so far in all investigated villages. Figures 4 and 5 illustrate pig breeding activities in the lowland Dimapur district and highland Phek district.

Figure 4: Genetic material flows in Dimapur district.

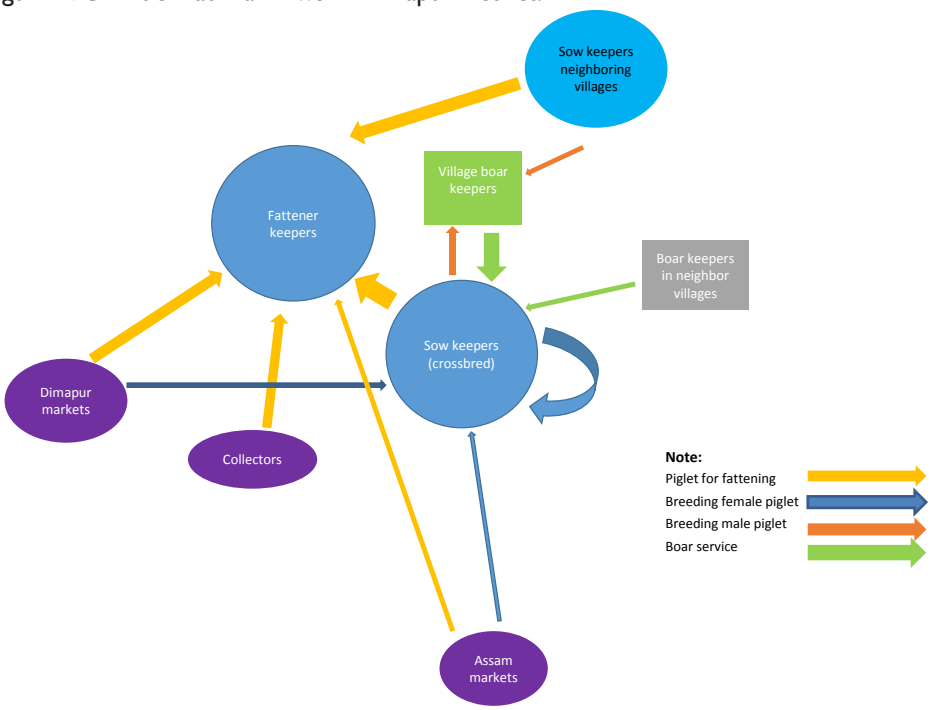
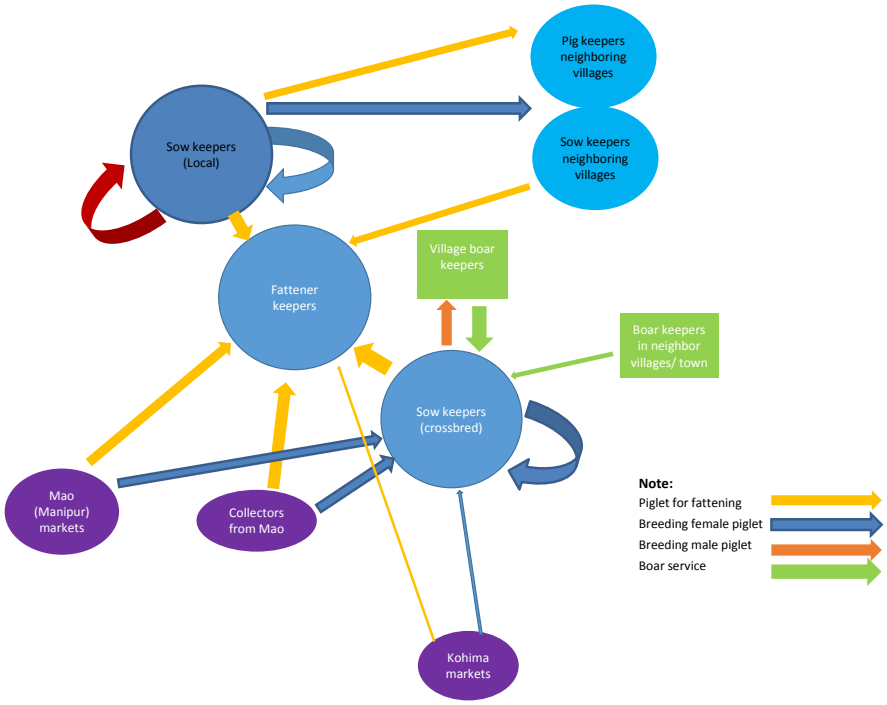


Figure 5: Genetic material flows in Phek district.



Farmers were aware that village boar keepers played an important role in keeping crossbred pigs, particularly in the lowland villages. The availability of boar keepers impacted the percentage of sow keepers in the villages, and therefore, reduced the dependence on piglet suppliers (both for breeding and fattening) far away from the villages. There were 2–3 boar keepers in the villages those provided natural mating service for sows in the villages and sometimes in nearby villages. Difficulty in accessing the boar service and high transport cost were the major reasons for not using the boar service for sows while in study of Njuki et al. (2010), the major reason was to avoid disease risk. In the lowland villages, sow keepers mainly self-produced breeding female for replacement. Other small flows of breeding piglets might come from collectors, markets in Dimapur and Assam. These village sow keepers provided male pigs used as breeding boar to village boar keepers and piglets for fattening to fattener keepers. When piglets were not available in the village, fattener keepers bought piglets from neighbouring villages, or from Dimapur market. In nearby town villages, some collectors from Dimapur might come to the village to sell piglets and to buy fattened pigs. Piglets for fattening might also bought from Assam market but rearly. Accordantly, Wright et al. (2010) reported that smallholder sow keepers supplied about 70–90 % of piglets in Nagaland, only 10–30 % was imported from Assam, Manipur and Myanmar and less than 1% from the veterinary and animal husbandry Department's pig farms. Patr et al. (2014) report that 93% of farmers did trading piglets in the local market and only 6% of them collected piglets from organized farms.

In the highland Phek district, farmers kept both local and crossbred sows. Local breeding pigs were self-supplied. Boar services were not applied to local sows. Local male pigs mated with mother sows or sows of neighbouring farms. These local sow keepers used their farm produced piglets for self-replacement on the farms as also mentioned by (Wright et al. 2010). The local sow keepers were also a source of supplying piglet for fattening and breeding within and to outside villages. Breeding activities and genetic material flows of crossbred pigs were similar with the lowland Dimapur district. In addition to farm own produced breeding crossbred piglets for replacement, other flows of piglets came from market in Mao (Myanmar), collectors from Mao, and small flow from Dimapur markets. Village boar keepers selected male pigs from sow keepers for replacement similarly in Dimapur district. Pigs were estimated for their weight when sold alive. Rahman et al. (2008) also found that the price system in Nagaland was based on measurement of girth, body length and general appearance of the pig. In near town village Chesezu, most pig trading activities occurred in the village. Similar flows of genetic materials marketed were also described by Deka and Thorpe (2008). This implies the flows of pig breeding materials were quite stable and had not changed much over time. Deka and Thorpe (2008) estimated about 1000–1500 piglets were monthly bought from Manipur to Phek and neighbouring districts and about 300–500 were imported from Myanmar.

In Mon district, no boar services existed in the villages. The reasons for not keeping boar were inefficiency and lack of knowledge on raising and managing boar. In Tan Hai village, one tried keeping a boar bought from Mon town; however, a mated sow gave birth with nine piglets, but eight died. Because of this incident no one tried anymore. In Totok village, farmers might feel shame when walking with breeding boar along village. Without boar services in the village or villages around, few farmers used the boar service from Mon town for their crossbred female pigs to produce piglets; however, it was inefficiency due to very high transport costs. For example, a farmer in Tan Hai village used the boar service from Mon town but with a very high transport cost (INR 1000 for service cost and INR 4500 for transport cost). In Tan Hai village, some female pig keepers waited for 2–3 years if no one in the village kept boars, they sold those female pigs as fatteners. A lack of boar services was one of major reasons of fattening crossbred pigs in Tan Hai village while many farmers wanted to keep reproduction sows. While in Totok village, more than 50 % of pig keepers kept local pigs with self-subsistence of breeding pigs (boar and sow), even though local pigs were considered a very low productive breed. Little capital available to invest in feeding and breeding piglets was also a reason to keep local pigs of farmers. Piglets were bought in Mon town from collectors or directly from Assam (more than 40 to Mon). Piglets were mainly used for fattening, some for breeding. Similar with the finding of Patr et al. (2014), people preferred male pig than female. Male pigs were preferred for more tasty meat, higher growth rate, heavier weight, and can be castrated. Farmers did not know how to castrate female pigs, therefore, it was more difficult for them to manage female pigs when the pigs were in heat. This was mentioned by farmers in all investigated villages. Rahman et al. (2008) reported that, in Mizoram region, castration was practiced by all farmers as compulsory for raising fatteners and increased growth rate.

The price of boar services was similar for all villages, about INR 800–1000 or one piglet per service, this was much higher than compared to service price of INR 50–700 in 2010 (Wright et al. 2010). For sow keepers, current boar service price was acceptable because they could get about INR 3000 for a 3-month piglet. Farmers in Mizoram state used AI for their sow (INR 100 per insemination) and took advantages in terms of improved progeny and reduced cost of rearing breeding boars (Rahman et al. 2008). Kadirvel et al. (2013) reported a farrowing rate of 78.44% and litter size of 7.86 ± 0.65, similar with natural mating when applying AI to smallholder pig production in tribal areas. The growth rate of crossbred piglets obtained through AI was higher than one from natural boar mating. The author concluded that AI service could bring different benefits to the tribal farmers, including timely availability of superior germplasm to produce crossbred piglets; reduced mating (INR 1000–1200) and transport costs (INR 300–400) and prevent inbreeding.

Table 6: Prices of pigs and breeding service in investigated villages

Items	Indisen (Dimapur)	Dobagoan (Dimapur)	Tan Hai (Mon)	Totok (Mon)	Khutzami (Phek)	Chesezu (Phek)
Boar service	INR 1000 or one piglet/ service	INR1000 or one piglet/ service	from Mon town: INR1000 / service and 4500 transport cost	Self-service for local pig	INR 800 or one piglet/ service	INR 1000 for 1 piglet / service
3 month piglet (same for fattening and breeding)	INR 3000	INR 3000	medium size: INR 1000; large size: INR 3500	Large size: INR 2500–3000 Local pigs: INR 2500 for male and INR 2000 for female.	INR 2000–3000 Rupees for local and INR 5000 for crossbred	Local: INR 3000; Crossbred at age of 5–6 months: INR 7000–8000
Pork and finished pigs	INR 170 / kg LW	INR 160 /kg LW	INR 200 / kg pork; INR 160–170 / kg LW.	2–3 years of Local pig at 50–60 kg priced INR 10,000–11,000 / head; INR 200 / kg local pork; INR 180 / kg Miry pork.	INR 200 / kg pork for local > 20kg and crossbred; INR 230 / kg for pork of local pig < 20 kg	INR 200 / kg pork or LW, local or crossbred

In all villages, in the current study, same prices were for piglets for fattening and breeding. Prices of finished pigs were similar in all villages, ranging from INR 160–170/kg LW and INR 180–200 INR/kg pork (Table: 6). Compared to pork price of INR 120 /kg in the last years (Rahman et al. 2008; MART. 2011), prices of pigs and pork have increased.

In Totok village (Mon district) and Chesezu village (Phek), prices for pork were the same for live pig. Pork of local pigs was preferred by farmers due to the better taste, and less fat compared to crossbreds. However, the price of local pork was just a bit higher than crossbred pork, even in the highland Chesezu village. Fahrion et al. (2014) also found that even though demand for pork was higher than for other meat, the prices of fat and lean meat were not different, and head and legs had the same price as pork. No premium price could be seen, while low productivity of local pigs were reasons for giving up keeping local pigs in many villages in lowland and highland districts.

Local pigs were looked different between villages. In Totok and Khutzami villages, local pigs were small body. Local pig in Chesezu village had larger size and higher growth rate (Table: 7 and annex for more details). All local pigs had behaviour like wild pigs (scavenging, holding the ground, building net by themselves from leaves when farrowing).

In Khutzami, female group complained for small number of teats of the local sows (10 teats), weakness of piglets. Borkotoky et al. (2014) also describe the local Naga pigs with 10 teats only. In Totok, 1–2 piglets might die before weaning. Only farmers in Chesezu villages were satisfied with the performance of their indigenous pig breed if not confined. Their local pig was also preferred by farmers in neighbouring villages. Compared to the performance of local Naga pigs reported by Borkotoky et al. (2014), age of first farrowing of local pigs in Chesezu was a bit earlier (8 months compared to 12.7 ± 5.5 months); Litter sizes of local pigs in Khutzami and Chesezu villages was bigger (8–12 piglets/ litter compared to 5.8 ± 2.3; or 7 reported by Njuki et al. (2010); Farrowing interval of local pig in Chesezu was shorter (4.5 months compared to 10.1 ± 3.4), while local pigs in Totok and Khutzami villages had similar interval of farrowing. Reproductive performance of large size local breeds in Chesezu was better than local Naga pigs. Ages at first mating of local boars in all investigated villages were similar as reported by Borkotoky et al. (2014). Kumaresan

et al. (2007) reported the similar performance of nondescript local pig in Mizoram under low input system of tribal farmers as age at first farrowing of 12 months, litter size at birth of 7.4 and at weaning of 5.2 and weight at 9 months of 33 kg. Phengsavanh et al. (2010) report a similar litter size (7 piglet/litter) of a local pig breed in the north of the Lao People's Democratic Republic under traditional low input smallholder farm, but high mortality of piglet (50%) due to low nutritious level in feed.

Table 7: Performance of indigenous/local pigs (in midland and highland villages)

Items	Totok (Mon)	Khutzami (Phek)	Chesezu (Phek)
Performance of Local sow			
Age at first farrowing (months)	12	8–10	8
Number of piglets/first litter	3–5	5–6	5–6
Number of piglet/litter	6–7	8–12	8–11
Farrowing interval (months)	10–12	10–12	4.5
Weight of piglets at birth (kg)	0.3–0.5	-	-
Age of sows at culled (years)	3–4	4–5	6–7
Weight at 3 months (kg)	5–6	4–5	5–7
Local boar			
Age of first mating (months)	4	3–4	3–4
Fatteners			
Age at sold (year)	2–3	1–3	1–2
Weight at sold (kg)	44–45 (25 kg at 1 year)	40–45 (1 year)	80–100 (1 year)

In general, performances of crossbreds, both sows and fatteners seemed to reduce from the lowland to the higher land villages. In Chesezu, farmers just stated kept crossbred pigs in 2012. This crossbred was bought from Mao area (where most of the old and original villages are situated along borders of Manipur and Myanmar). Except the indigenous pig in Chesezu village had performance comparative with crossbred pig, in other villages, both reproductive and productive performances of crossbred pig were over than the local pigs (compared Table 7 to Table 8). Male group in Chesezu explained for the preference of Local pigs that was for better benefit from low inputs in terms of capital and labour for keeping Local pigs. While more capital invested to breeding piglets and feed as well as more labour required for crossbred pigs, especially when farrowing. Crossbred boars had the first mating at 8 months and were culled after 3–5 years similar with the report of Wright et al. (2010).

Table 8: Performance of crossbred pigs

Items	Indisen (Dimapur)	Dobagoan (Dimapur)	Tan Hai (Mon)*	Totok (Mon)**	Khutzami (Phek)	Chesezu (Phek)**
Performance of crossbred sow						
Age at first farrowing (months)	15	-	-	-	12	9
Number of piglets/first litter	5–7	5–7	6	-	5–6	5–6
Number of piglet/litter	8–14	9–14	-	-	10–11	8–12
Farrowing interval (months)	6	6	-	-	10–12	
Estimated weight of piglets at birth (kg)	0.6–0.7	0.3–0.5	0.5	-	-	-
Age of sows at culled (years)	5	3–4	-	-	3–4	-
Estimated weight at 2 months (kg)	4–5	4–5	4–5	-	8–10 (3 months)	-
Crossbred fatteners						
Age at purchased (months)	2	2	3	3	3	5–6
Estimated weight at purchased (kg)	4–5	4–5	7–8	8–10	8–10	40–50
Age at sold (years)	1.2	1.3–1.5	2	2– 3	1	1
Estimated weight at sold (kg)	120–140	170	130–150	150-200	70–80	150

*Only one sow gave the first farrowing: 50% of piglet died before weaning (3 out of 6)

**No crossbred sows in Totok village; new introduced crossbred sows in Chesezu

In this study, crossbred sows had the first farrowing at about 12–15 months and were culled at the age of 3–5 years that is similar with the finding of Rahman et al. (2008) and Wright et al. (2010). Except sows bought from Mao region had earlier age at first farrowing of 9 months. The farrowing intervals of 6 months and may be 10–12 months were in accordance with the studies of Rahman et al. (2008) and Wright et al. (2010). Litter sizes found in the current study

were higher than seven as finding of Rahman et al. (2008). Weights of pigs sold in this study (more than 120 kg) were higher than one reported by Rahman et al. (2008) (90kg). Long time fattening of pigs was explained by farmers in the current study for reaching good finished weight of more or less 130–150 kg. Deka and Thorpe, (2008) explained the major reasons of low growth rate of crossbred pigs were poor feeding.

Demand of smallholders on genetic materials and breeding services

There were very few studies on demand of smallholder on pig genetic material and breeding services so far, particularly no studies on this have been implemented in Nagaland and other regions of India.

Common demands on genetic materials and breeding services from all investigated villages:

All farmers wanted to improve their knowledge on pig breeds and breeding operations. So far, they just learned from their experience about the performance of the pig breeds available in their places under local husbandry conditions. Farmers had no idea about the potential of these breeds, no comparison with other breeds, and no information on AI activities. These resulted in a high demand for training courses on pig breed, and breeding activities as well as AI operations with support from the government.

Techniques in raising and management of breeding sows and boars and breed selection, including castration techniques (especially for female pigs) were demanded by farmers in all villages in order to be active in the supply of breeding pigs and breeding services as well as piglets for fattening. While Nagaland tribes were living in the hill tops; therefore, high costs were required for transportation to get services from towns.

Medium size crossbreds were preferred for their more tasty meat, cheaper cost of piglets, and larger availability than compared to the large size one. The large size crossbred pigs had short nose, long body, and higher growth rate—those traits were preferred by farmers. Even though large size crossbred pigs had meat with higher fat content and less tasty compared to the medium size one, the market for this pork was still good, farmers wanted to fatten this pigs for sale.

The accessibility to trusted sources of suitable breeding gilts and boars for nicer and bigger litter size was desired by farmers in all villages.

Higher growth rate of crossbred pigs to reduce time of selling finished pigs to less than one year was expected by all pig keepers. For instance, the male group in Tan Hai village (Mon district) expected a good sow breed with 12 piglets at birth, mortality rate of less than 10%, good milking sow, body weight of 150–160 kg at 2–3 years, and about 1 kg/piglet at birth.

A reduction in feed consumption ratio of crossbred pigs was also a concern of farmers.

Black pigs (or not much white colour) were preferred by almost all pig keepers. This is also reported by Patr et al. (2014) and the reason was a reduction of the effect of skin infection.

Demand for genetic materials and breeding services of specific villages:

Farmers in Dimapur and Mon districts wanted to increase the number of teats and mothering ability of crossbred sows. Medium size crossbred pigs were preferred for good fat rate (with fat but not too much), tasty meat, and cheaper price for fattening and breeding piglets compared to large size crossbred pigs.

Male groups in Mon and Phek districts wanted support in breeding pigs (boar, sow, feed, training, construction of stable). For instance subsidies for purchase of breeding sows/boars, for housing of boar and sows, and one year feed subsidy.

Local indigenous pigs with small size, with preferred traits of tasty meat, low input requirement were chosen by poor farmers in midland and highland villages but given up by others who wanted to keep crossbreed pigs for better productivity. A female group in Totok village found that even with improving feed quality for this local pig, farrowing interval was not changed. In addition, they accepted small litter size of this local breed due to small body size of the sow, while male group was not satisfied with performances of local pigs (and also crossbred). They expected to increase local performance with heavier weight, bigger litter size up to 10–12 piglets, bigger weight at birth, and 2 liters per year, as well as increased body weight of local boar by 50%. Male group in Khutzami village (Phek) also found that few teats in local mother sows caused weakness and death in piglets and that the lack of availability of this local pig in the villages was a cause of concern.

A type of indigenous pigs in highland Chezusu village with bigger size, better productivity and mothering ability compared to the local small body size ones, and as well as good meat, was preferred by farmers and nearby villages. This local pig seemed to overcome the disadvantages in terms of low productive and reproductive performances of the local small body pigs.

Farmers expected to change scavenging behaviour of local pigs, i.e. can keep them confined but not reduce their reproductive performance. The solution for inbreeding in local pigs was also expected. A male group in Khutzami was aware that a reduction in performance of local sow resulted from inbreeding. They expected local boar from outside villages for refreshing for better and stronger piglets.

Other demands related to pig production:

All investigated villages demanded veterinary care (deworming, vaccination, knowledge on pig health care) and veterinary services.

In all villages, available services or training on castration of female pigs were very important and in need.

Appropriate policies with financial assistance and housing subsidy and technology were requested.

Pork was mainly for local consumption. The local market for pork and the skill of weight estimation were suggested by farmers in midland and highland villages. Premium for local pig/pork should be considered for tasty meat and long-time of rearing.

Other constraints and potential of smallholder pig production

Major constraints

- Disease: farmers did not want to increase production scale because of epidemic fear: e.g. swine fever in Dobagoan: frequency of every two years, incidence of 10–15% pigs died-buried.
- Vaccination as national program, one per year, but many farmers did not want it because they thought that vaccination caused sickness in pigs, diarrhea.
- Concentrate feed was costly and not readily available.
- Poor housing.
- Difficulty in getting veterinary medicine; veterinary services are not always available; and poor services.

- Local pigs need free ranging but this is currently forbidden, so farmers are giving up keeping (also due to the low growth rate). Free ranging practice is discouraged in many villages across Nagaland due to a better sense of cleanliness; also the availability of better performing pigs could be the reason for marked decline in the indigenous pig population.
- A lack of capital to invest in good breeding pigs and feed. Farmers in some midland villages have given up keeping local indigenous pigs due to very low growth rate, even though meat is very tasty, but same price as larger sized breeds.
- Large size crossbred pigs were fatter, but the pork was not as tasty as smaller sized and local pigs. Exotic and crossbred pigs have proven feed conversion efficiency, better growth rate and litter size, but when it comes to consumer preferences for pork, it is the indigenous pig meat because of its flavour and juiciness.
- Farmers in midland and highland still lacked experience in keeping crossbreds.

Almost all of the above constraints were also mentioned by other authors over time (e.g.: Deka and Thorpe 2008; Njuki et al. 2010; Borkotoky 2011; MART 2011; Suri 2012; Patr et al. 2014).

Potential

- Pig keeping as bank savings: For example, a crossbred fattener could bring about INR 11,000 in cash for farmers in Dimapur after 12 months rearing with the utilization of family labour, wild leaves, farm produced feed and purchased concentrates.
- Sale of pigs as additional income generation to meet basic requirements such as treatment, tuition fees, kitchen and other household needs.
- Easy to borrow money with pigs as collateral, e.g. for school fees, a farmer can borrow money before selling pigs.
- Family labour utilization: Women at home for raising poultry, pigs (innate knowledge of Naga women to raise pigs with 70% of rural pigs being raised by women in Nagaland).
- High local demand for piglets and pork of all breeds.
- Availability of local feed (vegetable, leaves).
- In lowlands, learning experience from large-scale farms.
- In some midland and highland villages, pigs are also needed for engagements, Christmas, etc.
- Many farmers wanted to raise fatteners, potential for an increase in raising sows and boars.

Income generation for essential needs form pig production and the potential for the development of pig marketing due to high pork demand were also mentioned by other authors, e.g.: Njuki et al. (2010), Wright et al. (2010) and Seth et al. (2014).

Brief overview in breeding operation of pig breeding farms

In general, pig breeds kept on the visited farms are driven by the preferences of smallholder farms. All visited breeding farms kept HS and LB sows, those were preferred and in high demand by smallholders, especially HS for good growth rate and medium size, and their crossbreeds. All farms owned one to some boars for natural mating with their sows. Previously, the Nucleolus state pig breeding farm in Dimapur kept Large White (LW) and Yorkshire (Y) but farmers preferred black to white pigs (reduce skin problem caused by mosquitoes). Even though LW and Y were better in mothering ability but with a long nose, white colour, these breeds were not preferred by smallholders. Local indigenous pigs (named Tenyi Vo by visited farms) and Ghungroo were kept only by the research centre and a state

breeding farm mainly for study purpose. These farms were big suppliers of piglets both for breeding and fattening. Table 9 summarizes major information on the visited breeding farms.

Table 9: some information on visited breeding farms

Items	Research centre	State breeding farm	Private breeding farm
Number of sows	ICAR-AICRP on Pig, Nagaland Centre. 30 (Hampshire-2, Up-graded Naga local indigenous (named Tenyi Vo) (75%)-16, Up-graded Tenyi Vo (50%)-10 and Pure Tenyi Vo-2)	14–28 (mainly LB and HS; and some young sows of LB x HS; HS x LB)	8 sows (1 pure HS, 2 crossbred of LB and rest are crosses of HS) 21 sows of different breeds and crossbred types (black, white, mix, pots, reddish colours)
Number of boar breeds	5 (Hampshire-3 Tenyi Vo-2) HS; LB; HA x LB; LB x HS; few Tenyi Vo; Ghungroo, and their crosses with LB and HS.	3–9 (HS; LB) Mainly HS (most preferred) and LB (some might not purred) and their crossbreeds Might be few Local Tenyi vo for study	1–2 boars (cross LB x HS, 1 pure LB) HS; LB; HA x LB; LB x HS
Total piglets sold/ year	900, mainly HS and crossbreds of HS, following by LB and crossbred of LB.	200–600–650	40–50–200
Price of piglets sold	INR 1500–3000 per weaner depending on the type of breed and level of subsidy	INR 3000 /2–3 month piglet	INR 3000–4500/2-month piglet, if male castrated: INR 500 more

Note: HS: Hampshire; LB: Large Black.

Output of state breeding farms included piglets for breeding and fattening. Private farms also sold finished pigs to butchers or slaughtered pigs in addition to piglets. Their customers were smallholder farms from different districts such as Dimapur, Kohima, Mon, Phek and Peren or agencies of programs providing pigs to the poor. Smallholder farms selected piglets based on colour and outside appearance. Pure breeding sows and boars of private farms originated mainly from governmental breeding farms. The research centre provided processed liquid semen and training on performing AI for a numbers of farmers in the villages around. Processed liquid semen was sold to farmers and veterinarians, particularly from Kohima and Dimapur. Liquid semen of farmer's preference is available on demand and 20–30 doses (80–100ml pouch) is sold every month. The life of fresh semen was about one week at 15°C.

Almost all visited farms have recorded data on performance, treatment, deworming, and feed consumption.

On these breeding farms, HS and LB sows had similar reproductive performance, and not much different between governmental and private farms (Table: 10). Deka et al. (2013) also report a similar litter size of 7–9 piglets for LB pigs introduced by a project and raised under smallholder farms. Kumaresan et al. (2007) reported the similar performance of Hampshire pig in Mizoram under low input system of tribal farmers as age at first farrowing of 15 months, litter size at birth of 10 and at weaning of 8.3 and weight at 9 months of 50.5 kg. Kaushik et al. (2013) report performance of pigs raised at National Research Centre on Pig with the birth of 1.3 kg for Hampshire and 1.1 kg for crosses between Hampshire and Ghungroo; and 8.0 kg and 7.3 kg at 45 days, respectively.

It could be seen that, the reproductive performance of crossbreds raised under smallholder farms were quite comparable with performance of exotic in organized breeding farms (Tables: 8 and 10). This is a potential for developing pig breeders in the villages with enhancing in the quality of boar and feed for better growth rate of offspring for fatteners.

Table 10: Performance of pigs on breeding farms

Items	HS of state breeding farm	HS of private farm	LB of state breeding farm
Age of first farrowing	16 months	18 months	18 months
Piglets born alive	7–8–9	9–10 up to 15	7-8
Farrowing interval	6–7 months	6 months	7 months
Age at culled	3–4–5 years 3 years for boar	-	3–4 years 3 years for boar

Average performance of sows of different breeds on a private breeding farm in Dimapur was 9–12 piglets/litter, 30% of piglets died before weaning.

All farmers mentioned swine fever and diarrhea in the piglets as threatening disease. High feed cost was considered as the biggest constraint of all private farms. High demand from smallholders represented the biggest potential for private breeding farms. Support from government was expected by these farms.

Recommendations

The aggregation of different solutions should be considered in order to improve breeding quality and services for the development of pig sector in the Nagaland state.

Improvement of germplasm quality

Given that a large number of piglets were locally supplied, only small volume from breeding farms, therefore, it is difficult to identify and control the quality of pigs. The establishment of great-grandparent, grandparent and parent stock herds should be considered. The roles of breeding farms, both governmental and private sector with financial support should be enhanced to improve the quality and quantity of breeding pigs. Enhancing the linkage of breeding units (government and private sector, from state to communal and village levels) is required. A program making improved pig germplasm available for smallholders via the introduction of quality pig germplasm has been initiated by ICAR under the Mega Seed Project on Pig at Nagaland through artificial insemination techniques. Patr et al. (2014) also recommended the establishment of breeding units at each district to meet demand for quality pig germplasm.

Leroy et al. (2015) stated that the extent of crossbreeding coexistence with extensive systems might result in introgression risks for the indigenous population and the erosion of local genetic resources. Given that the pig population in Nagaland state contained large numbers of different crossbreds and a reduced number of unidentified indigenous pig breeds, it was important to identify and evaluate the performance of indigenous breeds and different crossbreds of exotic x indigenous or smallholder systems with different levels of inputs, and then create breeding programs aimed at increasing the availability and accessibility of good genetic quality animals of the most appropriate sow breed types. The establishment of a synthetic (stabilized) potential indigenous by exotic sow line should also be considered. Currently, only an indigenous Ghungroo pig was identified and investigated (Sahoo et al. 2015). Other indigenous breeds such as one in Chesezu villages, a local breed preferred by farmers, were still unknown.

The quality of boar and boar services need to be improved. A subsidy is needed for boar keepers to get good breeding boar with performance testing.

Improvement of germplasm accessibility

The establishment of AI stations, both governmental and private, and the building up networks of communal veterinarians performing AI techniques is necessary in order to provide good quality semen of both exotic and potential indigenous breeds to pig breeders and producers. Kadirvel et al. (2013) demonstrated the feasibility and potential benefit of AI techniques to smallholder backyard pig production system in tribal rural areas.

Linkages in the breeding system from government–private–district–village–farm levels should be strengthened through the establishment of veterinary workers at communal and village levels in order to reduce the distance from breeding farms and AI stations to smallholder pig breeders and producers. Results of an initial program in Cambodia show that increased veterinary extension to village animal health workers provides an accessible, market-based, animal health

'treatment and reporting' service linked to livestock smallholders across Cambodia, (Stratton et al. 2015). This is also applicable for introducing AI services to villages.

Increase smallholder pig keepers access to breeding animals, breeding services, other inputs (feed, animal health-care, housing, waste management and training) and markets, by establishing and supporting co-operative groups of pig breeders and producers cooperating with state or private breeding and marketing actors as suggested by Valle Zárate and Markemann (2010) and FAO (2011).

Implementation of policies supporting and controlling pig breeding units and breeding operations

Appropriate policies for each period supporting different stakeholders are required. Policies encouraging financial support to governmental and private breeding farms in building up great-grandparent, grandparent and parent stock pig herds in the state should be considered. Policies for encouraging and managing AI stations and boar services need to be implemented, also with financial support for high quality breeding boars.

The establishment of smallholder breeding zones for potential local breed(s) with subsidies from government (in capital for breeding selection, for keeping breeding boars; or support of state breeding farms/AI stations in providing good quality local boar semen) to improve genetic quality and be active in supplying good germplasms in villages. The encouragement of extending the potential crossbreed and local breed suitable for specific regions and systems as in initial cases of the Ghungroo breed and crossbred of LB and HS breeds should be implemented.

Policy in using breeding boars, both for artificial insemination and natural mating is required

As more and more farmers have started giving up rearing small-sized local pigs due to poor performance, it is recommended that conservation programs be implemented in remote areas for these breeds. To ensure the sustainability of the conservation efforts, arrangements should be put in place to market meat from these animals at a premium price.

A certification system should be implemented step by step for better quality breeding boars and sows for organized farms (both governmental and private farms, and AI stations). This should go along with building capacity of smallholder farmers seeking certified breeding animals.

Improvement of breeding knowledge

Training courses for farmers on breed selection and breeding are necessary to improve the knowledge of farmers and boar keepers on breed use and breeding management.

Training courses for key farmers as village veterinary workers on breed selection and breeding practices—including performing AI, disease treatment, and castrating pigs—need to take place for the availability of breeding services in villages.

Training for farmer on marketing, and on calculating benefit when raising pigs for sale, should be considered.

Improvement of market linkage

Short food supply chains of crossbred pork/pigs and high price niche markets for specialty local pork with the formation of smallholder cooperatives of pig breeders and producers are suggested in line with Herod et al. (2010) and Huyen et al. (2015).

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