# Pig breeds and breeding operations in Nghe An province, Vietnam, with a focus on the smallholder pig sector

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# Pig breeds and breeding operations in Nghe An province, Vietnam, with a focus on the smallholder pig sector

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# Contents

# Tables

# Figures

# 1. Study purpose

The CGIAR research program 'More meat, milk and fish by and for the poor' (Livestock and Fish CRP; http://livestockfish.cgiar.org/), has selected the Vietnam pig meat value chain as one of its priority value chains for development. As part of the assessment activities being undertaken of this value chain by the Livestock and Fish CRP, a scoping study was commissioned on the use of pig genetic resources in Nghe An province (a focus site of Livestock and Fish activities in Vietnam). The information gathered from this study will be made available to relevant stakeholders to assist them in decision-making on the use of pig genetic resources in the province, and will be used to help inform further Livestock and Fish CRP activities on Vietnam pig breeding/ genetics.

# 2. Introduction

Pig production, comprising a significant number of smallholder farmers, plays an important role in Vietnam. Approximately 80% of Vietnam's pig herd are currently owned by smallholder farmers (Lapar et al. 2003; FAO 2005; Lemke et al. 2008) and the smallholder pig sector is expected to remain competitive in the future (Lapar et al. 2012). In 2007, employment in smallholder pig production contributed 5.5% to the national GDP (ILRI 2011).

Smallholder pig production systems in Vietnam traditionally focused on indigenous breeds, recognised for their prolificacy and adaptability to low-input conditions. For instance, the Mong Cai, a prolific, robust, and disease-resistant breed, has been heavily promoted in Vietnam as a sow line (Huyen et al. 2005; Lemke et al. 2006; Hau 2008; Herold et al. 2010; 2008; Roessler et al. 2009).

However the decentralized structure of Vietnamese breeding systems and the common use of artificial insemination (AI)—as part of ongoing socio-economic development—has supported the spread of exotic pigs in Vietnam, making crossbred pigs and exotics dominant in the country. Local pigs now account for less than 30% of the national pig herd, mostly in rural and remote areas (Huyen et al. 2005).

It has been shown that smallholder pig breeding in Vietnam has been influenced by a range of actors and factors (Roessler et al. 2012), including smallholder boar farmers, village and district level medium-sized commercial pig farms, private breeding companies and relevant legislation.

It is generally considered that the management of the pyramid-shaped decentralized organization of breeding systems—including that of national and provincial level breeding farms and AI stations, private enterprises and joint stock companies, and district level breeding operations—has not been optimal, particularly in remote rural areas (Lemke et al. 2008; NIAS 2014). It is well recognised that improved pig management—including on breeding issues—is critical to improving the production and productivity of the smallholder pig sector (Haussner, 2014; Lakew et al, 2014, Lapar et al. 2012).

This study analyses pig breeding operations and the demands of smallholder pig producers in Nghe An province of northcentral Vietnam, a province that has developed rapidly over the last decade. The study was highly participatory in nature, involving a large range of stakeholders. Specifically, it gathers and synthesises information on:

1. Policies related to pig genetic resource use in the province;

2. The different pig production systems within the province, and breeds used within them;

3. All breeding operations supplying live animals or germplasm into or out-of the province. and

4. Demand for pig germplasm and breeding services within the province, particularly by smallholders.

Finally, the report concludes with a number of recommendations for improving smallholder access to appropriate pig genetic resources.

# 3. Materials and methods

## 3.1 Study area: Nghe An province

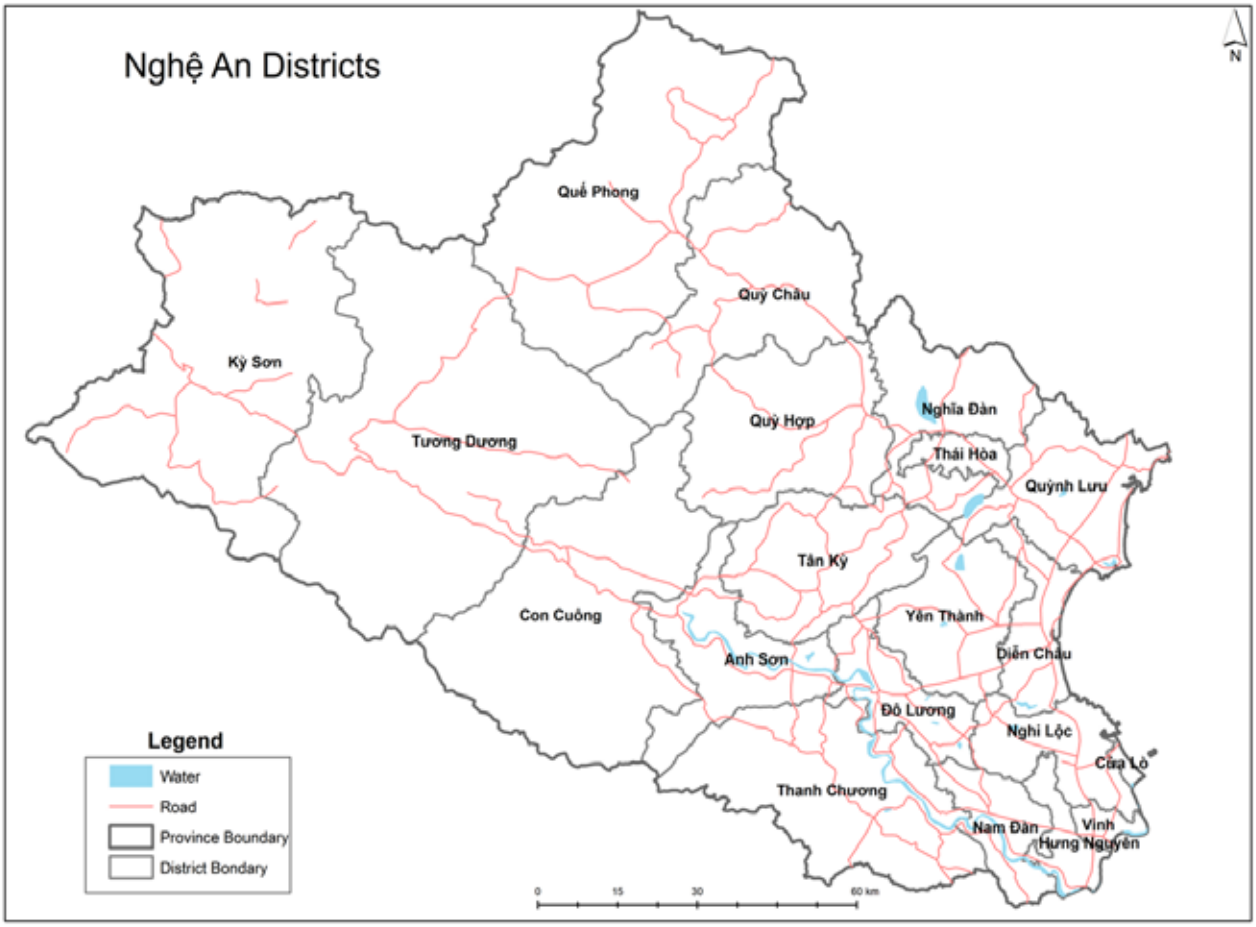
Nghe An province is located in the North Central Coast region of Vietnam, situated between 18°34'48" and 19°59'49" North and 103°52'24" and 105°29'53" West. Eighty-three percent of the landmass of the province is covered by hills. Sloping land of 20 to 25 degrees account for 80% of the total area, with 38% at an altitude of more than 250m above sea level.

The climate in Nghe An is divided into dry (March to August) and rainy (September to February) seasons. Average annual rainfall varies from 1500 to 1600mm. Average temperatures range from 23 to 25oC, with an average maximum of 42.7oC and minimum of 0.5oC, and average humidity varies between 80 and 85% (Statistic Year Book of Nghe An province 2014). The total landmass of The Nghe An province is 1,648,997 ha, accounting for 32% of the total area of North Central Coast region and 4.98% of Vietnam, including 75.8% agricultural land, 7.8% non-agricultural land, and 16.4 % unused land.

The human population in 2014 was 2,978,207 people (Statistic Year Book of Nghe An province, 2014). The population comprises more than 20 ethnic groups: 86.65% Kinh, 9.42% Thai, 1.97% Tho, 0.94% Kho-Mu, 0.91% H'Mong, 0.018% Muong, and 0.092% other minority ethnic groups (a provincial survey on 1/4/1999).

The province has 17 districts, 3 towns and a city, including: 5 high mountainous districts (Que Phong, Quy Chau, Con Cuong, Tuong Duong, and Ky Son); 6 middle mountainous districts/towns (Quy Hop, Tan Ky, Thanh Chuong, Anh Son, Nghia Dan, and Thai Hoa town); and 10 delta districts/towns (Do Luong, Nam Dan, Dien Chau, Yen Thanh, Nghi Loc, Hung Nguyen, Quynh Luu, Vinh city, Cua Lo town, and Hoang Mai town). See Figure 1 for a detailed map.

Figure 1: Map of Vietnam showing Nghe An province (top), and map of Nghe An province showing the district boundaries and names (bottom).




# 3.2. Methods

This study collected a variety of information on pig breeds and breeding operations in Nghe An province, as summarized in Table 1 and described in more detail below.

Table 1: Summary of information types and collection tools employed in the study.

| Type of information collected | Tools used |
|---|---|
| Information on policies relevant to pig genetic resources | Key-person interviews with representatives of different stakeholder groups (the provincial breeding centre, district breeding and AI stations, the veterinary department, animal husbandry office) |
| | Secondary data collection |
| Distribution of pig breeds/crossbreeds in the province | Expert participatory mapping exercise |
| Pig breeding operations in the province | Key-person interviews, with representatives of different stakeholder groups (the provincial breeding centre, district breeding and AI stations, private breeding companies and farms, private AI stations, village boar keepers, Mong Cai sow keepers, AI service providers) |
| Flow of genetic material into or out-of smallholder pig systems and demand for pig germplasm and breeding services by smallholder pig keepers | Focus group discussions with smallholder pig keepers, with separate male and female groups |
| Validation of findings, and development of recommendations | Feedback workshop with various stakeholder representatives (the provincial breeding centre, district breeding and AI stations, animal husbandry office, Nghe An Department of Agriculture and Rural Development). |

## Information on policies relevant to the use of pig genetic resources

General information and policies related to pig breeding in Nghe An province were gathered from interviews with government personnel, including representatives from: Nghe An Department of Agriculture and Rural Development (DARD); the provincial breeding centre which has a mandate to implement, support, and develop policies regarding pig breeding programs for the province; district breeding and AI stations; the veterinary department; and the animal husbandry office.

Secondary data collection on policy was undertaken through the review of relevant reports, including annual reports on livestock production and the plan for livestock development (Nghe An DARD 2012; Nghe An DARD 2014; Nghe An statistic Department 2014; Animal Husbandry office—Nghe An DARD 2014), and the annual reports on livestock breed and breeding operations of the province. (Provincial Breeding Centre, 2012; 2013a-b; 2014a-c).

## Distribution of pig breeds/crossbreeds in the province

Information on pig breeds/ crossbreeds used by different pig production systems and their distribution in Nghe An province were obtained by undertaking a participatory mapping exercise with a group of 16 experts on pig breed-type distribution in the province. The participants included veterinarians, technical staff of the animal husbandry office, technical staff of the state and private breeding centres, agricultural extension staff, and staff of the AI station. The participatory mapping exercise entailed:

1. Defining the pig production systems in the province and the major breeds and crossbreeds within these systems—including identifying the maternal and paternal lines contributing to the crossbreeds;
2. Depicting on a detailed map the geographical representation of the distribution of breed/ crossbreed types for the different production systems;
3. Recording key discussions/explanations that emerged as part of the process.

## Pig breeding operations in the province

Information on pig breeding operations in the province was ascertained from interviews with various key informants, as summarized in Table 2 and described below.

**Breeding companies (provincial breeding centre, private breeding companies, private farms).** Information on breeding companies was ascertained via semi-structured interviews with owners and/or staff of the breeding companies. The information gathered included: a general description of the breeding operation; a detailed account of the breeding strategy employed; an account of the breeding materials (live animals, semen) distributed by the breeding company (what and to whom); and an account of the perceived strengths and weaknesses of the breeding operation. In total, nine breeding companies were interviewed, comprising: the provincial breeding centre; Thai Doung, a commercial company breeding great-grandparent (GGP) and grandparent (GP) exotic pigs; three breeding farms with GP herds in Do Luong and Nam Dan districts; and four breeding farms with parent stock (PS) pigs in Do Luong and Quy Hop districts.

**AI companies (district breeding and AI stations; private AI stations).** Information on AI companies was obtained via semi-structured interviews with district breeding staff, and public and private AI station managers and owners. Information gathered included: a general description of operations; boars kept for semen production—breed-types and means of sourcing; semen collection, processing and insemination practices; customer information; the demand for semen and AI services; staff and equipment; and perceived strengths and weaknesses. In total, information was gathered on ten AI companies, comprising two district breeding and AI stations (in Do Luong and Quy Hop districts) and eight at private AI stations (five in delta districts Do Luong, Nam Dan, and Yen Thanh, and three in mountainous districts Tan Ky and Quy Hop).

**AI service providers (sole operators).** Information from individual AI service providers was also obtained via semi-structured interviews. Information gathered included: a general description of operations; semen sources and insemination practices; customer types and demand for services; equipment and staff; and perceived strengths and weaknesses. In total, six service providers were interviewed (three in Do Luong district and three in Quy Hop district).

**Village boar keepers.** Information from village boar keepers was obtained via semi-structured interviews with the boar keepers. Information collected included: data on boars kept and their sources; the frequency of use of boars and biosecurity practices; customer type and demand; and perceived strengths and weaknesses. Five boar keepers were interviewed (two in Do Luong district and three in Quy Hop and Tan Ky districts).

**Members of smallholder Mong Cai breeding group.** Information from Mong Cai breeding groups was obtained via semi-structure interviews of representative group members, including one member of a Mong Cai breeding group in Do Luong district, one member of a Mong Cai breeding group in Quy Hop district, and one member of an autonomous breeding group. Information was collected on: the general operations of each group; objectives, activities, regulations and membership; pig ownership, including sources and markets; and perceived strengths and weaknesses.

Table 2. Number and type of key informant interviews undertaken to gather information on pig breeding operations in the province.

| | Districts within Nghe An province | | | | | | |
|---|---|---|---|---|---|---|---|
| Key informants | Vinh | Do Luong | Yen Thanh | Nam Dan | Quy Hop | Tan Ky | Total |
| Provincial officers | 5 | | | | | | 5 |
| Staff of provincial breeding centre | 1 | | | | | | 1 |
| Thai Duong breeding farm | | 1 | | | | | 1 |
| Private breeding farms | | 3 | | 1 | 3 | | 7 |
| Staff of district breeding and AI stations | | 1 | | | 1 | | 2 |
| Private AI companies | | 1 | 1 | 3 | 1 | 2 | 8 |
| AI service providers | | 3 | | | 3 | | 6 |
| Village boar keepers | | 2 | | | 2 | 1 | 5 |
| Mong Cai breeding smallholders | | 2 | | | 1 | | 3 |

**Smallholder information on supply and demand of breeding pigs and breeding services.** Smallholder information on the supply and demand of breeding pigs and services was obtained via focus group discussion (FGDs). These were performed in two delta districts (Do Luong and Yen Thanh) and two mountainous districts (Quy Hop and Tan Ky), resulting in four FGDs in total. Participants of each FGD comprised seven to nine male, and seven to nine female, smallholder pig keepers. The FGDs were undertaken in separate men's and women's groups. Details of exercises undertaken during the FGDs are given below, and photos of the FGDs are given in Annex 1.

**Characterizing the flow of pig germplasm.** The sources and flow of pig germplasm were characterized by a Venn-mapping exercise. Briefly, different sources of pig germplasm—the provincial breeding centre, district breeding/AI stations, private breeding stations/ farms, private AI stations/ farms, sole AI service providers, and smallholder pig keepers—were depicted as circles on a chart. The distances of the circles to the 'smallholder circle' indicated the ease of smallholder access to pig germplam source (with a shorter distance indicating easier access). The size of the circle indicated the importance of the pig germplam source to the smallholder (with a larger circle indicating a more important source). The flow of genetic material between the different sources and the smallholders was then depicted by arrows, with the width of the arrow representing the amount of the material sourced (wider arrows for a higher amount of material).

**Identifying gaps in the supply of pig germplasm.** 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; the advantages and disadvantages of the different breeding services; and suggestions for future improvements of breeding services.

**General issues on pig production.** The issues on smallholder pig production, including the strengths and weaknesses, were also elucidated through a facilitated discussion.

## Validation of findings and recommendations to improve breeding services for smallholder pig keepers in Nghe An province

The major findings of the study were presented for validation and discussion to a group of 15 pig breed and breeding experts in the province, including representatives from Nghe An DARD, the provincial breeding centre, and district breeding and AI stations. In addition, these experts developed a series of recommendations to improve breeding services for smallholder pig keepers in Nghe An province. These recommendations were based on consideration of a number of aspects related to the likely success and expected impact of the recommended intervention.

# 4. Results and discussions

## 4.1 General information and policies related to pig breeds and breeding in Nghe An province

### Overview of pig production in Nghe An province

In 2015, the total pig herd in the province numbered 971,876; with pigs in the delta districts of the province accounting for 55.7% of this number. The recent trend (since 2006) has seen a reduction in the total pig herd of the province, particularly in the delta districts, due to disease outbreaks and an increase in the cost of feed and other inputs. The decrease in the pig population from 2005 (when the total population was estimated at 1,170,154) was 2.8% annually between 2005 and 2010, and 4.6% annually between 2011 and 2013. In contrast, the pig population in some mountainous districts has been increasing. The percentage of sows in the total provincial pig herd was 19.4% in 2014 (up from 16% in 2005), and higher in the delta region compared to the middle and high mountainous regions (24.1%; 15.4%; and 11.3%, respectively). Table 3 provides more details on pig herds in the various districts of Nghe An.

Table 3: Pig numbers in various districts of Nghe An province, over time.

| District | Total pigs 2005 | Total pigs 2010 | 2014 | | |
|---|---|---|---|---|---|
| | | | Total pigs | Fatteners | Sows |
| 1. Delta region | 771,640 | 701,492 | 513,507 | 389,269 | 123,500 |
| Vinh City | 23,777 | 21,056 | 12,057 | 11,047 | 1000 |
| Cua Lo town | 9234 | 4023 | 2084 | 1795 | 287 |
| Dien Chau | 158,777 | 129,761 | 64,217 | 49,793 | 14,302 |
| Yen Thanh | 156,332 | 142,251 | 121,232 | 95,529 | 25,573 |
| Quynh Luu | 151,308 | 155,560 | 86,119 | 67,877 | 18,193 |
| Hoang Mai town | - | - | 21,497 | 18,753 | 2742 |
| Nghi Loc | 81,701 | 68,407 | 40,767 | 30,508 | 10,203 |
| Hung Nguyen | 48,978 | 32,669 | 22,542 | 18,890 | 3626 |
| Nam Dan | 59,634 | 49,318 | 38,573 | 28,058 | 10,415 |
| Do Luong | 81,899 | 98,447 | 104,399 | 67,019 | 37,159 |
| 2. Middle mountainous region | 287,541 | 339,299 | 318,424 | 269,003 | 48,954 |
| Thanh Chuong | 86,162 | 114,789 | 115,582 | 89,748 | 25,632 |
| Anh Son | 58,844 | 59,861 | 54,437 | 44,753 | 9627 |
| Nghia Dan | 50,844 | 54,039 | 37,406 | 32,651 | 4706 |
| Thai Hoa town | - | 12,210 | 11,383 | 8945 | 2425 |
| Tan Ky | 50,443 | 55,344 | 47,594 | 45,834 | 1692 |
| Quy Hop | 41,248 | 49,056 | 52,042 | 47,072 | 4872 |
| 3. High mountainous region | 110,973 | 128,783 | 139,945 | 123,953 | 15,807 |
| Quy Chau | 19,391 | 24,154 | 23,536 | 19,236 | 4235 |
| Que Phong | 20,652 | 24,820 | 28,435 | 22,326 | 6059 |
| Con Cuong | 22,169 | 25,730 | 30,107 | 28,526 | 1525 |
| Tuong Duong | 24,982 | 26,334 | 29,186 | 27,493 | 1686 |
| Ky Son | 23,779 | 27,745 | 28,681 | 26,372 | 2302 |
| Total | 1,170,154 | 1,169,574 | 971,876 | 782,225 | 188,261 |

Source: synthesized from Nghe An GSO (2013; 2014)

In general, pig production in Nghe An province can be divided into industrial farms and smallholder farms. Industrial farms keep at least 20 sows or 100 fatteners of exotic breeds, and invest heavily in production, whilst smallholder farms operate on a smaller scale (see section 4.2 for more details). In 2013, there were 174 industrial farms mainly located in the delta districts, which jointly kept about 30% of the total pig herd of the province.

Pig breeds/crossbreeds used in the province vary by region and the type of pig production system, and largely comprise local breeds and local by Mong Cai crossbreeds in the mountainous regions, and Mong Cai, Mong Cai by exotic crossbreeds, and exotic breeds (in fewer numbers) in the delta districts.

Pig production in the Nghe An province increased from 130,193 tons of live weight in 2010 to 135,397 tons in 2013. Typical pig products were mainly slaughtered fatteners and small amount of commercial piglets for slaughter. About 98–99% of slaughtered fatteners were consumed within the province and only 1–2% (mainly exotic pigs) was exported to other provinces with higher price (by 10,000–20,000 VND/kg live weight) compared to the internal market. Commercial piglets for slaughter were exported to China, Hong Kong, Taiwan, and Malaysia, but only in small and unstable amount (e.g. 241 tons in 2013). The trading of pigs for breeding purposes was not documented.

More details on the various pig production systems and type of breeds kept, resulting from this study, are given in section 4.2.

## Policies relevant to the use of pig genetic resources within Nghe An province

The various policies relevant to the use of pig genetic resources within Nghe An province are summarized below.

The key points of the Decision 07/2005QD-BNN issued on 31/01/2015 by the Ministry of Agriculture and Rural Development (MARD), governing the use of breeding boars are as follows:

- Breeding boars require a recorded pedigree, a quarantine certificate from a veterinary office, and a quality certificate for the breed (issued by MARD for boars used for AI, and by the authority at district level for boars used for natural mating.
- Boars used for AI must be monthly performance tested for semen quality, and the quality of semen reported every 6 months to MARD. All boars used for natural mating must be performance checked annually. Boar keepers have to register with the communal authority.
- A minimum of four boars must be kept by an AI station. The minimum area for keeping a breeding boar is 5 $m^2$ for the local breed and 6 $m^2$ for the exotic breed.
- The maximum frequency of use of boars is twice weekly for AI boars younger than two years, thrice weekly for AI boars older than 2 years, and thrice weekly for natural mating boars.
- The earliest age of use for AI or natural mating is 8 months for local boars and 10 months for exotic boars.
- AI boars should not be used for more than three and a half years, and natural mating boars for not more than three years.
- The quality of boars used for AI at public-sector stations or foreign-owned farms is controlled and certified by the Department of Agriculture. The quality of boars used for AI at provincial or district breeding stations is controlled by the province-level DARD, with reports on the quality of these boars sent annually to the Department of Agriculture. At district level, DARD controls the quality of boars used for natural mating, and sends these reports to the provincial DARD on an annual basis.

The key points of the Decision 73/2012/QD-UBND issued on 08/10/2012 by the Nghe An People's Committee, replacing the Decision number 68/2010 on 01/9/2010, on managing breed production and trade in Nghe An province are as follows:

- All above mentioned policies of MARD Decision number 07/2005QD-BNN for breeding boars were adopted.
- AI stations register with the provincial DARD, and boar keepers register with the communal DARD.

- That boars are vaccinated against swine fever, pasteurellosis, foot and mouth disease and some other diseases in accordance with regulations.

The key points of the Decision 09/2012/QD-UBND issued on 04/02/2012 by the Nghe An People's Committee and the Resolution 125/2014/NQ-HDND issued on 16/7/2014 by the the Nghe An People's Council in relation to policies supporting agriculture and rural development in the period from 2012 to 2015, including support to pig production and subsidies for the master (nucleus) herds, are as follows:

- The subsidy for each exotic gilt of GP or PS herd with an average weight of 60 kg/pig is VND 650,000. The subsidy for each exotic boar with an average weight of more than 70 kg is VND 1.5 million. There is one subsidy per lifetime of animal for the GP or PS farms raising at least 30 GP sows. Half of the subsidy for exotic boars is used for replacements by the district breeding and AI stations (in accordance with the plan for replacement of breeding animals developed at the beginning of each year).
- Subsidies for the master breeding herds of VND 200,000 for a Mong Cai gilt; and VND 450,000 for an exotic GP pig, with one subsidy per lifetime, implemented in alternate regions of the district depending on budgetary limitations. (Circular number 148/2007/TTLB/BTC-BNN&PTNT).
- It was noted that between the period 2010–2013, subsidies were given for master breeding herds of the Mong Cai breed in 10 districts (with 3628 Mong Cai gilts and 32 Mong Cai boars), and for exotic GP pig herds in five districts (with 2433 exotic gilts).

The key points of the Decision 09/2012/QD-UBND issued on 04/02/2012 by the Nghe An People's Committee in relation to policies supporting establishment of economically efficient demonstration farms in the mountainous districts are as follows:

- Subsidies for imported GP and PS herds: VND 1 million for a gilt weighting 60 kg on average, for a maximum of 50% of total number of imported breeding pigs and not more than VND 100 million per farm (Article 2, Resolution 125/2014/NQ-HDND).
- A subsidy of VND 2 million for an exotic boar weighting more 70 kg on average, for exotic GP and PS farms keeping at least 30 sows (Article 2, Resolution 125/2014/NQ-HDND).
- A subsidy of 50% of the price for exotic boars used as replacements at district breeding and AI stations (Article 2, Resolution 125/2014/NQ-HDND).

In addition, the Decision 50/2014/QD-TTg issued on 04/9/2014[1] by the Prime Minister on policies supporting and enhancing the efficiency of smallholder livestock production and AI services in the period 2015–2020 includes government provision for the following subsidies:

- Annual subsidies for AI services: 100% of semen doses for the AI of sows on smallholder farms (not more than two doses a time; and not more than five doses per sow per year).
- A once-off subsidy for smallholders purchasing breeding boars: 50% of the value of the boars used for natural mating in the poor regions (not more than VND 5 million per boar more than 6 months of age; not more than three boars per smallholder farm).
- A once-off subsidy for waste management system: 50% of value of a bio-system for livestock waste treatment (not more than VND 5 million per system per smallholder farm).
- A once-off subsidy for AI service providers: 100% of the training budget on AI techniques (not more than VND 6 million per person); a once-off subsidy of 100% of the value of a liquid nitrogen tank (not more than VND 5 million per person).

Other pig production-related policies include: a 10-year tax free status for large-scale commercial pig farms (with PS pigs; production of fatteners or slaughtered piglets); a subsidy of 20–30% of the investment value of infrastructure construction for livestock farms in a concentration zone for livestock farms; a credit program from different banks and other sources (companies, associations, etc.) for smallholder pig production; and the cooperation of private companies with local agricultural extension service systems in innovation transfer programs to smallholder pig producers.

1. At the time of time this decision had yet to be implemented as it was still awaiting the issuance of the relevant guiding circular.

Whilst there are many policies, rules and regulations related to breeding and breeding services (as described above), many have only been partially implemented. This partial implementation was attributed, by key informants, to: inadequate support from the relevant authorities and/ or a lack of appropriate implementation plans; a lack of cooperation between the different authorities at provincial, district and communal levels; and the lack of penalties for non-compliance.

## Key programs/projects on pig breeding/ productivity implemented in the province.

Key programs/ projects on pig productivity—including breeding—implemented in the province between 2005 and 2013 include:

- The 'leanization' national program (which started in 1990 and has been widespread since 2000) undertaken by Nghe An DARD, with the aim of producing leaner pigs via the importation of exotic pig breeds and the use of AI.
- The application of innovations in storing pig semen at the district breeding and AI stations of Thanh Chuong, Yen Thanh, Do Luong, and Vinh city, undertaken by Nghe An DARD between 2012 and 2013.
- The establishment of demonstration wild and black pig farms in the western districts (of Quy Hop, Tan Ky, Thanh Chuong, Anh Son, Con Cuong, and Tuong Duong) with 30 pigs per farm, conducted by Nghe An DARD in 2013.
- The Livestock Competitiveness and Food Safety Project (LIFSAP), funded since 2010 by the International Development Association (IDA) of the World Bank and the Vietnamese government, implemented in Nghe An for MARD via the Nghe AN DARD. The total project budget is USD79 million, of which the Nghe An budget is USD5.4 million. The project builds demonstration pig farms in accordance with the Vietnamese Good Agriculture Practice (Viet GAP) program for bio-safety. Under this project and over a five year period: 6584 farmers were trained in 189 training workshops; four zones of good animal health practice (GAHP)—in Dien Chau, Nam Dan, Do Luong and Nghi Loc districts—were established, comprising 599 farmers in 30 groups (mostly pig keepers, but with a small number of poultry keepers); 877 biogas systems and 90 system of manure compost were installed; upgrades were made to 36 open markets facilitating the sale of the livestock; 12 slaughterhouses were constructed; and pig stables built for 512 farmers. The plan for 2015 in Nghe An is to establish an additional GAHP zone in one more district, with 200 farmers in 10 groups.
- The project 'improving the quality of pig breeds in phases 2006–2010', implemented by the Department of Livestock Production in cooperation with the National Institute of Animal Sciences (NIAS) and the Institute of Agriculture Science for Southern Vietnam, establishing demonstration boar breeding farms and using AI, and importing frozen semen and live pigs of exotic breeds.
- In addition, various national programs for the poor in the remote areas (programs such as 30 A and 135) also provided some breeding pigs to smallholder farmers in these locations.

## Proposed plans for the pig breeding and production systems in Nghe An province

The plan proposed to the province by an Agriculture and Irrigation Planning Committee of Nghe An DARD (2014) for pig breeding and production in different locations in the 2015–2020 period was as follows:

- The establishment of a zone for exotic breeds and their crossbreeds:
    - Exotic breeds to be kept around towns and the city, the delta districts, and some communes of the two low mountainous districts (Thanh Chuong and Nghia Dan).
    - GP pig herds to be kept by the district breeding and AI stations, and private breeding companies/farms in seven delta districts (Do Luong, Dien Chau, Yen Thanh, Quynh Luu, Nam Dan, Hung Nguyen and Nghi Loc).
    - PS pig herds to be kept on industrial farms and suitable large-scale family farms in the above two mountainous and seven delta districts.
    - Commercial pigs to be kept on smallholder farms.

- Mong Cai by exotic crossbreeds that are 50% to 62.5% exotic to be used in the delta districts and some communes of other districts (Thanh Chuong and Nghia Dan, Tan Ky, Anh Son, and Quy Hop districts) and Thai Hoa town; Mong Cai by exotic crossbreeds that are 25% to 50% exotic to be used along national roads and around towns and city.

- The establishment of a zone for the Mong Cai breed:
  - Maintenance and development of the Mong Cai breed via development of a Mong Cai specialized zone.
  - Pure Mong Cai pigs to: (1) provide sows to the delta districts of the province, as well as selected low mountainous districts (Thanh Chuong and Nghia Dan); (2) produce slaughter piglets for export to selected districts/ locations (Dien Chau, Yen Thanh, Quynh Luu, Do Luong, and Thanh Chuong districts, extending to the border areas of Nghi Loc and Nam Dan districts with Do Luong and Thanh Chuong districts); (3) produce F1 sows (Mong Cai by exotic) for the delta districts, low mountainous districts and some communes of the high mountainous districts.
- The establishment of a zone for commercial exotic fatteners:
  - Encouraging the establishment of industrial farms and cooperatives keeping more than 1000 fatteners in 11 districts (Nam Dan, Hung Nguyen, Nghi Loc, Dien Chau, Yen Thanh, Quynh Luu, Do Luong, Nghia Dan, Thanh Chuong, Anh Son, and Tan Ky).
- The improvement of district breeding and AI stations and the encouragement of pig farms importing good breeds and good pig semen, especially, from high performance breeds in the world.

## 4.2 Distribution of pig breeds/crossbreeds, and the production systems in which the different breeds are used

Participants from the mapping exercise on pig breed /crossbreed distribution identified breeds/ crossbreeds of boars in the province as Yorkshire, Landrace, Yorkshire by Landrace; L19 (from the crossing of white Duroc boars with Yorkshire sows); terminal sire 402 (from the crossing of Pietrain boars with Yorkshire sows); and PiDu (from the crossing of Pietrain boars with Duroc sows) (Nghe An DARD 2014; and the participatory mapping exercise of this study). Boars of the breeds Duroc, Yorkshire, Landrace, and PiDu were mostly used for AI.

It was estimated that about 3% of the total provincial sow population are exotic breed-types, including a synthetic line (a cross between four or five breeds) from a pig breeding program run by the National Institute of Animal Sciences of Vietnam in Hanoi (formerly managed by a private pig breeding company, the Pig Improvement Company). The participants also highlighted a small number of purebred Yorkshire, Landrace, Duroc, and Pietrain pig breeds, and other crossbreeds between these pure breeds.

Indigenous and indigenous by exotic crossbred sows were estimated to account for about 97% of sows in the province, including mainly Mong Cai sows, Mong Cai by exotic (F1) crossbred sows, and backcrossed sows produced from F1 sows with exotic boars. Local breeds of sows also exist in the mountainous districts, namely L'n H'Mong (in English, H'Mong pig) alternatively called L'n M'o (Meo pig) (after the name of a minority ethnic group H'Mong/ Meo); L'n C' ('grass pig') alternatively called L'n Nít ('small pig'), and Sao Va pig (after the name of a waterfall in Tien Phong commune, Que Phong district, where the pig breed was found). Sows that are crosses of the local breed with the Mong Cai breed can also be found (often as F1 crosses, or as backcrosses with the Mong Cai). In addition, the mountainous areas have an unidentified sow breed.

The mapping-exercise participants divided Nghe An province into three major zones of pig breed distribution, as shown in Figures 2 and 3, with further definition of the systems and breeds given in tables 4 and 5. The three major zones of pig breed distribution were defined as:

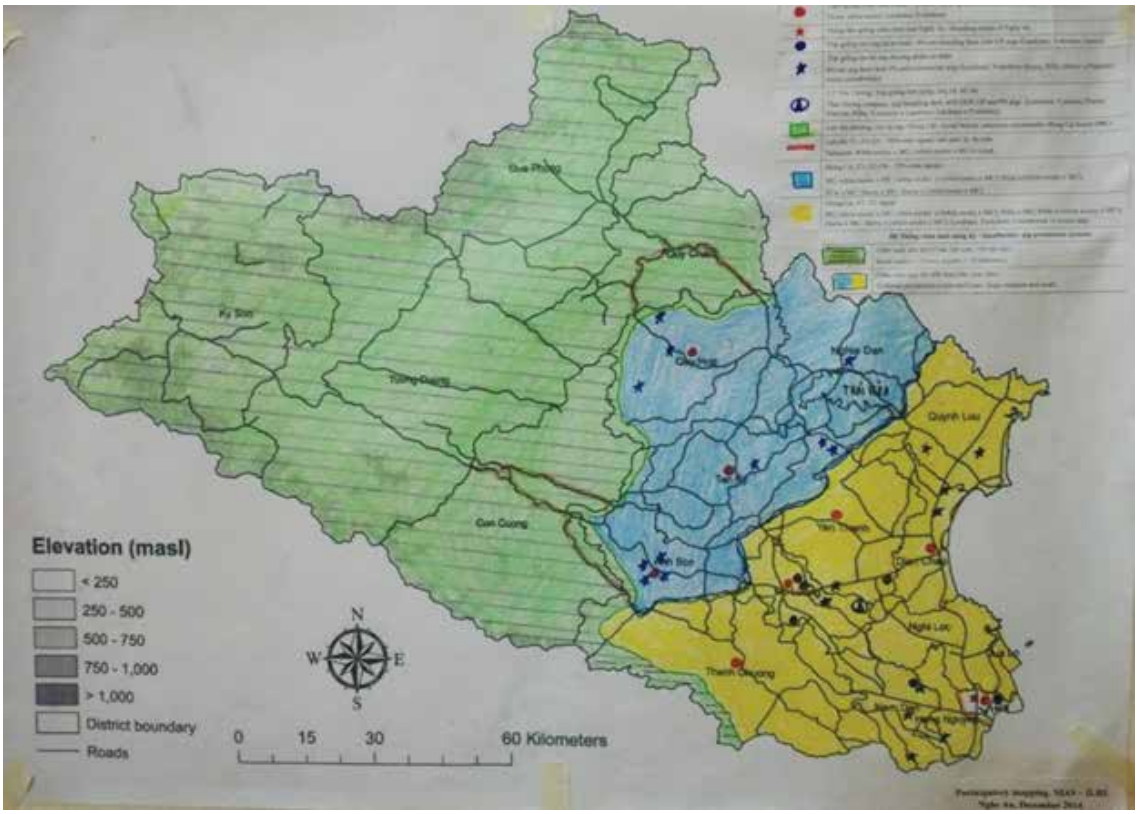
**Zone 1** (green colour on Figure 1) contains all five high mountainous districts, the border area of Thanh Chuong and Laos, and the border areas of the low mountainous districts with the high mountainous districts. The pig production systems within this zone are mainly small scale, with very few larger-scale smallholder farms and no industrial farms. The breeds kept are mainly local breeds and their crosses with Mong Cai, through crosses with exotic breeds can be found in some specific areas (mainly along the national roads and around some towns). Some pure Mong Cai exist (provided by provincial programs), but no pure exotics. Breeding sows/gilts were mainly imported from the delta districts of Do Luong, Dien Chau and Yen Thanh. Additionally, a small number of breeding sows are produced in Ky Son, Con Cuong and Tuong Duong districts and traded between farmers.

**Zone 2** (blue colour on Figure 1**)** contains five low mountainous districts (Nghia Dan, Tan Ky, Anh Son, Thai Hoa, and Quy Hop). The pig production systems within this zone are mainly small and medium scale (estimated to account for 95% of pig keepers in the zone), with few large-scale and industrial (5%). The main sow breeds kept are the Mong Cai and Mong Cai by exotic crossbreed (typically 50 to 75% exotic), and the main types of fatteners a cross of these sows with exotic boars. Pure exotic pigs are kept on some industrial farms as sows, boars and fatteners.

**Zone 3** (yellow colour on Figure 1) contains seven delta districts and the low mountainous Thanh Chuong district. The pig production systems within this zone are mostly small and medium scale (85% of pigs keepers), with the remainder large-scale and industrial (15%). Breeds of sows and fatteners are as for zone 2, but with pure exotic sows and commercial fatteners of pure exotics, or crosses between pure exotics, also kept. The exotics are kept by industrial farms, and a small number (about 10%) of smallholder farms.

The finding in this study that indigenous sows and their crossbreeds accounted for the majority of the sows in the province aligns with that reported in Leda et al. (2015). In addition, the distribution of pig breeds in the current study was similar with the finding of Lemke et al. (2007) in northwest Vietnam, where Mong Cai sows and their crossbreds with exotic boars were more prevalent in the advantaged (wealthier) regions, while local sows and their crossbreds were more prevalent in the remote regions. Finally, the distribution of pig production systems and pig breeds reported here coincides with the Nghe An DARD (2014) proposed plan for pig production systems and breed zones.

Figure 2: Map of pig breeds/ crossbreeds and production systems in Nghe An province




Note: breed formula of (A x B) = (sire x dam)

| Symbols | Explanation |
|---|---|
| | Small scale smallholder pig production (< 5 sows, piglets; < 10 fatteners)<br><br>Local breeds; unknown crossbreeds; Mong Cai breed. |
| | Mix of different production scales and types: large, medium and small.<br><br>Mong Cai; white exotic by Mong Cai; white exotic by (white exotic by Mong Cai); PiDu by (white exotic by Mong Cai); PiDu by Mong Cai; Duroc by Mong Cai; Duroc by (white exotic by Mong Cai) |
| | Mix of different production scales and types: large, medium and small.<br><br>Mong Cai, F1, F2; white exotic by Mong Cai; white exotic by (white exotic by Mong Cai); PiDu by Mong Cai; PiDu by (white exotic by Mong Cai); Duroc by Mong Cai; Duroc by (white exotic by Mong Cai); Landrace; Yorkshire; crossbreeds of exotic pigs |
| | Fatteners: White exotic by Mong Cai; (white exotic by Mong Cai) by local.<br><br>(Along national roads, around towns) |
| | District breeding and AI station (Boars: Landrace; Yorkshire; Duroc; Mong Cai)<br><br>(Note: white exotic: Landrace; Yorkshire) |
| | Nghe An animal breeding centre |
| | Private breeding farm with GP pigs (Landrace; Yorkshire; Duroc) |
| | Private pig farm with PS and commercial pigs (Landrace; Yorkshire; Duroc; PiDu (Duroc by Pietrain); exotic crossbreeds) |
| | Thai Duong company: pig breeding farm with GGP, GP and PS pigs (Landrace; Yorkshire; Duroc; Pietrain; PiDu; Yorkshire by Landrace; Landrace by Yorkshire) |
| Note: breed formula of (A x B) = (sire x dam) | |

Table 4: Major breeds/crossbreeds in the pig production systems, as indicated by the participatory mapping workshop

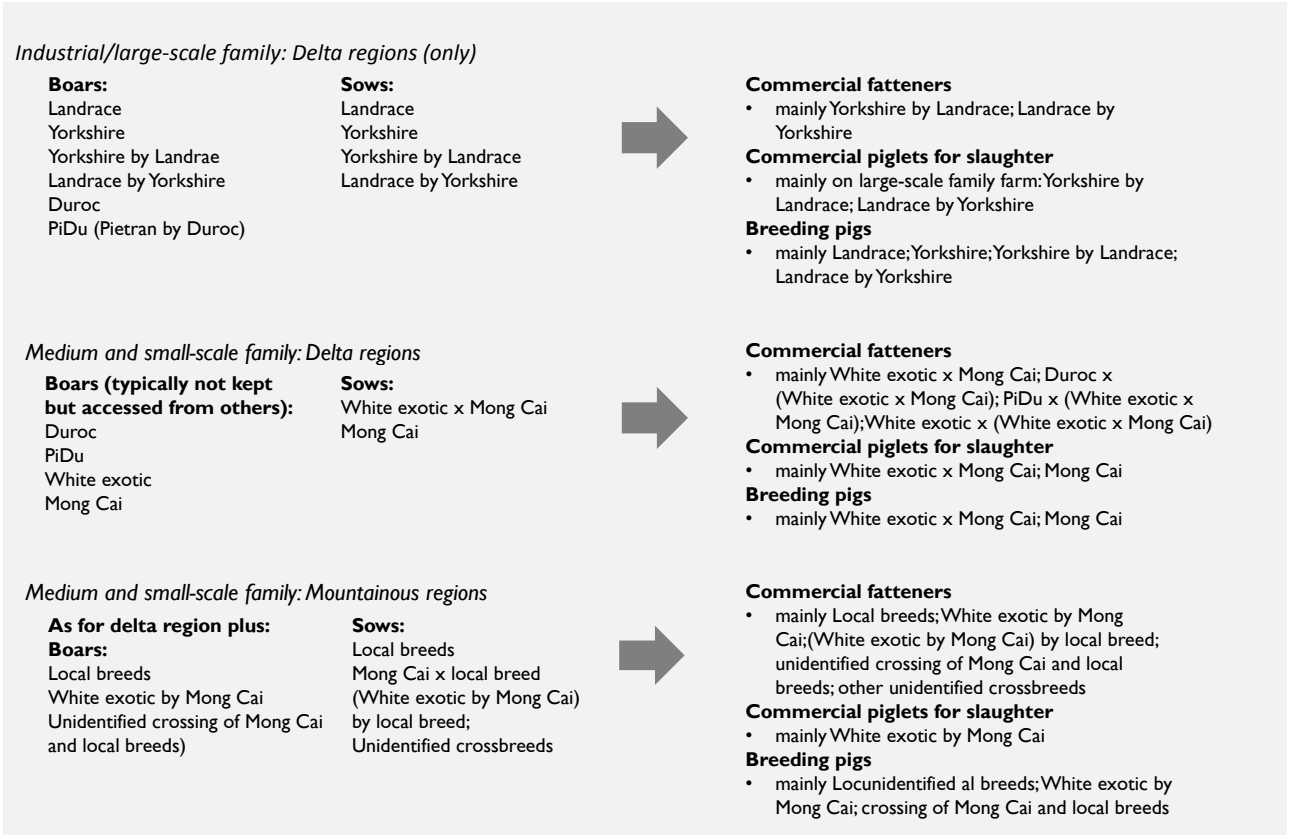
| Breed/crossbreed* | Type of use in the indicated pig production system | |
|---|---|---|
| | Industrial/large-scale family | Medium- and small-scale family (smallholders) |
| Exotic breeds and their crossbreeds | | |
| White exotic breeds: Landrace, Yorkshire | Used as sows and boars | Rarely used |
| Duroc | Mainly used as boars; on some breeding farms and AI stations | Used as boars; only kept by the village boar keepers or AI providers |
| PiDu | Used as boars by the Thai Duong breeding company; some breeding farms in Do Luong and Thanh Chuong districts; still quite new. | Used as boars; only kept by the village boar keepers or AI providers; preferred by farmers keeping Mong Cai and Mong Cai crossbred sows to improve lean meat rate. |
| Pietrain | Rare use, as sows by the Thai Duong breeding company | Not used |
| Yorkshire by Landrace<br>Landrace by Yorkshire | Used as F1 sows and boars (PS), and as commercial fatteners | Rare use in medium smallholder farms in the delta districts |
| Local breeds and crossbreeds | | |
| Mong Cai | Pure boars kept by breeding stations | Used as sows, prevalent |
| White exotic x Mong Cai | Rare | Used as sows, prevalent. Accounts for the majority (80–90%) of Mong Cai by exotic sows. |
| Duroc x (White exotic x Mong Cai);<br>PiDu x (White exotic x Mong Cai);<br>White exotic x (White exotic x Mong Cai) | Not used | Used as commercial fatteners, prevalent |
| (White exotic by Mong Cai) by local breed; Unidentified crossbreeds | Not used | Prevalent in the high mountains, as sows and commercial fatteners |

*Breed formula of (A x B) = (sire x dam). PiDu is a Pietran by Duroc cross.

Table 5. Major production systems defined during the participatory mapping exercise

| Production system | Number of pigs kept and outputs |
|---|---|
| Industrial farms | More than 20 sows, and/or more than 100 fatteners, with outputs including breeding pigs and/ or commercial fatteners. |
| Large-scale smallholder/family farms | 5 to 20 sows, and/or 20 to 100 fatteners, with outputs including breeding pigs, commercial fatteners, and/or commercial piglets for slaughter. |
| Medium-scale smallholder farms | 3 to 4 sows, and/or 10 to less than 20 fatteners, with outputs as breeding pigs, commercial fatteners, and/or commercial piglet for slaughter. |
| Small-scale household farms | 1 to 2 sows, and/or less than 10 fatteners, with outputs as breeding pigs, commercial fatteners and /or commercial piglet for slaughter. |

Figure 3. An overview of the main breeds and crossbreeds used in the different systems




*Breed formula of (A x B) = (sire x dam)

# 4.3 Breeding operations

The Nghe An province has a number of state and private pig breeding operations, as described below.

## Breeding centre of Nghe An province.

Some (but not all) provinces of Vietnam have a government funded breeding centre. Nghe An is one such province, with the breeding centre located in the provincial capital, Vinh city. In collaboration with Nghe An DARD, the breeding centre formulates, promotes and provides training on policies (both national and provincial) related to livestock breeds and breeding, including for pigs. On an annual basis, the Nghe An provincial breeding centre verifies the quality of pigs bred by the major pig breeding operations in the province, as well as boars in use by district breeding and AI centres. In addition, it coordinates the payment of subsidies for the keeping of master herds of Mong Cai and exotic breeds. The centre also proposes and oversees the implementation of district-level programs aimed at breed conservation within the province. However, the reach of the centre does not extend to all breeding operations and services within the province, given the considerable trading of breeding animals within the private sector.

The provincial breeding centre previously kept a pig herd with 100 GP pigs of Yorkshire, Landrace, and Meishan breeds; however, this collapsed in 2010 due to porcine reproductive and respiratory syndrome (PRRS). Subsequently, Nghe An DARD proposed that 200 GP exotic sows and 20 GP exotic boars be kept under the management of the provincial breeding centre, with the aim of providing 1000–1200 PS exotic gilts to the PS pig farm stations in the province. At the time of publication, this proposal was awaiting approval by the People's Committee of Nghe An province.

## District breeding and AI stations

There are eight district AI and breeding stations in Nghe An province (four in the delta districts: Do Luong, Yen Thanh, Dien Chau, Quynh Luu; and four in the mountainous districts: Thanh Chuong, Quy Hop, Tan Ky and Anh Son districts) under the governance of the provincial breeding centre. Each district breeding and AI station keeps four to six boars total—of Landrace, Duroc, Yorkshire, PiDu, and pure Mong Cai breeds—to meet the demand for fresh semen for AI of sows on smallholder farms (medium and small farms). In total, across all district AI and breeding stations, there were 45 boars (36 exotic and 9 Mong Cai boars) supplying sufficient semen (about 100,000 doses) for AI of about 20% of the total sows of the province. The stations have a network of staff offering AI services to the smallholder farmers.

The head of the district breeding and AI station is the decision-maker for the purchase of new boars, with a part subsidy (up to 50% of the value of the animal) provided by, and subject to the approval of, the provincial breeding centre. Boars are generally sourced from state breeding farms in the north (e.g. the NIAS pig breeding station, the Hung Yen breeding farm, or less commonly in the south (such as the Bing Thang breeding farm). In addition, the stations implement programs for purebred Mong Cai, where they establish groups of farmers keeping purebred Mong Cai (Mong Cai breeding groups—aimed at maintaining breed numbers rather than breed improvement) and distribute young breeding animals born into these herds to other farmers or programs. The Mong Cai breeding groups receive a subsidy (for keeping the master Mong Cai herd) and are under a contractual agreement (which the station makes on behalf of the Nghe An breeding centre).

Two AI stations were visited as part of the study, one in the delta district of Do Luong and the other in the mountainous district of Quy Hop. For the Do Luong station, the selection criteria for exotic boars were appearance (straight and strong legs, cambered back, more than 12 even teats, and big and even testes) and sperm quality (active sperms of more than 70%, sperm density of more than 3.5 billion/ ml, semen volume of more than 200ml); while the selection criteria for Mong Cai boars were appearance (strong and straight legs, the back not too deflective, walking using hooves; more than 12 even teats) and semen volume (more than 100 ml). For the mountainous Quy Hop station, boars were selected based on their appearance and sperm quality information provided by the supplier. The Do Luong station sourced exotic boars from Thai Duong breeding company and the NIAS pig breeding station, and sourced Mong Cai boars from a breeding program in another district. The Quy Hop station sourced boars from the Thai Duong breeding company and Do Luong station. Boars were first used at 8 to 11 months of age for exotic boars, and 5 months of age for Mong Cai boars, and last used at about 3 years of age. More information on the boars kept at the two district breeding and AI stations, and boar and semen use, are given in Annex 3.

Boars were used more frequently in the delta districts in comparison to the mountainous districts, due to higher smallholder demand in the former. The total number of doses supplied per month per station were 30,000 in the delta Do Luong district, and 9,000 in the mountainous Quy Hop district. The price of semen was VND 25,000 per dose for the white exotic boars, and VND 30,000 per dose for Mong Cai, Pi Du and Duroc boars, a somewhat higher price than that charged by private AI stations. The repeat rate of AI was said to be about 15%. It is noteworthy that none of the stations indicated requests by farmers for certified boars or boar performance data—the stations felt the farmers trusted the boars of the breeding station.

At the district breeding and AI stations visited during the study, the quality of semen was regularly checked every three to four days for volume, concentration (even distribution), and activity (even movement). Fresh semen was typically used within 24 hours with remaining amounts discarded, though in some cases it was used for up to 48 hours.

Records on the boars and semen included boar identification (ID) and breed, date of semen collection for AI, quality of semen (volume, concentration, and activity), and amount of doses produced, used and remaining. In addition, the time at which the semen was delivered to the AI service provider was also recorded. Information on AI customers was recorded by the technical AI staff.

Information on staffing and equipment at the stations is provided in Table 6. Station equipment for semen acquisition and processing was simple, and similar between the two stations.

Table 6: staffing and equipment of the visited district breeding and AI stations, by district

| Items | Delta Do Luong district | Mountainous Quy Hop district |
|---|---|---|
| Total number of staff | 16 | 9 |
| Number of people trained to take semen from boar | 1 | 1 |
| Number of people trained to process semen | 1 | 1 |
| Number of people trained to perform AI | 12 | 1 |
| Staff with formal training in animal breeding/quantitative genetics | 1 | 1 |
| Main centre facility | Twelve stable apartments with an automatic drinking system; microscope, machine counting sperm, equipment for preparation of semen doses. | Stables; microscope, a fridge, equipment for preparation of semen doses, a thermometer; a broken heater. |

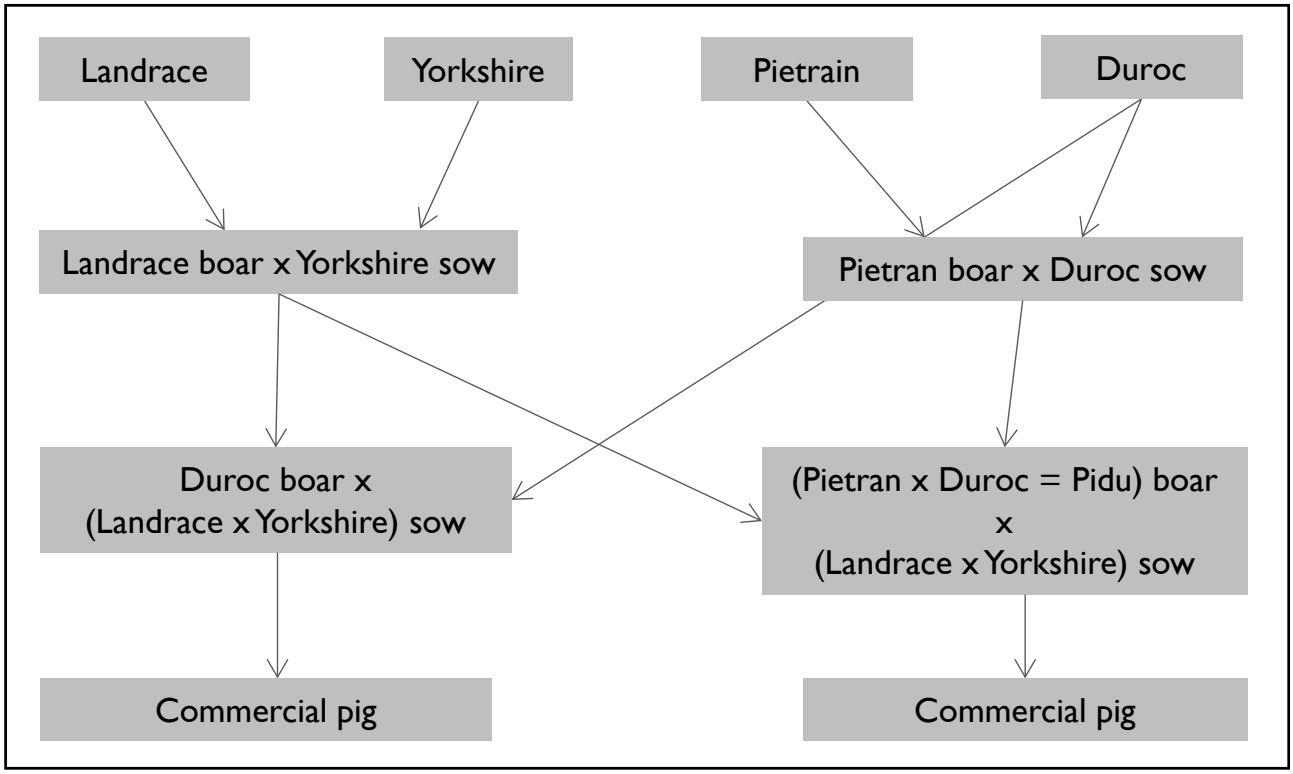
The perceived major weaknesses and strengths of district breeding and AI stations, as highlighted by station staff, were as follows. For Do Luong, major weaknesses were government management of breeding, price competition with the private sector, and low subsidies. It was noted that the station competed with unregistered and low quality private AI stations and village boar keepers that provided AI or natural mating at a lower price. In contrast, in Quy Hop station, the main weaknesses named were a lack of trained /educated staff at the breeding station (no one graduated from the university; three staff graduated from junior high school), and lack of the equipment. Strengths seen by the Du Luong stations were the high prestige of the station, the good quality of boars and semen, and the possession of boars of different breeds. For Quy Hop station, strengths named included high demand from farmers and staff job satisfaction.

## The exotic breeding pig company (Thai Duong) with GGP and GP herd

Thai Duong exotic pig breeding company is a unique breeding farm in Nghe An province as it keeps a GGP pig herd. It is located in Do Luong district, with the farm currently owning 100 sires and 3000 sows, of which 30% are GGP and GP pigs. Thai Duong is still a quite new model in Nghe An province in particular, and in Vietnam in general, as in the past state-owned enterprises played a crucial role in genetic improvement for commercial pig farms by maintaining the exotic breed nucleus and providing grandparent and parent stocks, while private enterprise focused on commercial production (Lemke et al. 2008). The company has two other breeding farms (Thanh Hoa province and Ba Vi district, Hanoi city), commercial farms, and also produces feed for their own pigs, as well as for commercial purposes.

The breeding farm was established in 2003 through the importation of animals from Canada, Denmark and the United States of America, with the importation of new animals (from Denmark) still continuing. According to Mr Trung, the lead breeder within the company, pigs imported from abroad were selected by company breeding staff and breeding professors at Hanoi University of Agriculture (HUA). Company feed production was also under the management of a professor on nutrition at HUA. The company received support in terms of subsidies from DARD (in line with Decision number 09/2012/QD-UBND of Nghe An province issued on 04/02/2012 and Resolution 125/2014/NQ-HDND in relation to policies supporting agriculture and rural development in the period from 2012 to 2015).

Figure 4. Breeding structure followed by Thai Duong breeding company




Breeds kept comprise Landrace, Yorkshire, Duroc, and Pietrain, with commercial progeny produced following the crossing structure shown in Figure 4. A breeding program is utilized, with the aim of producing commercial pigs with good and strong body, high lean meat rate, high daily weight gain, a low feed conversion ratio (2.2–2.4 kg feed/ kg weight gain), large shoulder and rump, and red meat (darker colour pork). The Herdsman software was used to facilitate recording individual animal performance and perform genetic evaluation. Breeding animals were selected based on an index, with consideration to maintaining an acceptable level of inbreeding. Full details are given in Annex 2.

The company provides both breeding boars and sows to industrial farms and large-scale family farms, and boars to district breeding and AI stations, private AI stations, and boar keepers in Nghe An and other provinces. In addition, the company produces commercial pigs for their own farms in Nghi Loc and Nghia Dan districts. Currently, both Duroc and PiDu boars are in demand by farmers for mating with Mong Cai sows to produce black or black patched crossbred progeny with a high lean meat growth rate. On average, each year the company sells 200–300 Duroc boars, 200–300 PiDu boars, 100–150 Landrace boars, and more than 8000 Landrace by Yorkshire (LY) gilts/ sows. Prices of pigs at 130 days of age were VND 25 million per boar, and VND 6 million for a LY gilt. All sows and boars sold were sold with a pedigree book giving the ID, breed, birth of date, original producer, IDs of dam, sires, and of GPs on both mother's and father's sides, as well as relevant information on their performance as requested by the buyer. If an infertile animal was sold, the purchaser would be compensated with a replacement animal. The company also provides training and support to farmers on breeding and husbandry techniques. Pigs transportation (which is usually by truck) is directly arranged by the buyer and organized at his or her expense; buyers may be located in or outside the province.

The major weaknesses of the company named were: a lack of equipment, such as a sperm counting machine (currently microscopes are used); inability to increase herd size (to meet demand) due to constraints imposed by local authorities on environmental protection grounds; and low government subsidies in relation to the high cost of importing GGP pigs. The strengths named by the company were the: use of a suitable software system for the management of pig performance data and evaluation of breeding values; production of own feed for commercial use and sale; good market for PS and commercial pigs; good veterinary care; good odour control and access to an improved waste treatment system.

## Private breeding farms/company

Private breeding farms in Nghe An province with GP herds numbered six in total and were located in the delta districts. Three GP farms were visited, one in Nam Dan district and the other two in Do Luong district (see Annex 4 for a detailed description). All three of these farms received financial support from DARD (in line with Decision number 09/2012/QD-UBND of Nghe An province issued on 04/02/2012 and Resolution 125/2014/NQ-HDND). These farms kept Landrace and Yorkshire dam and sires, to provide PS pigs (sow and boars—including crosses of Landrace and Yorkshire) to industrial farms, large-scale family farms, and a number of smallholder farms in the delta districts and other low mountainous districts, and Duroc and PiDu boars, for commercial pig production. The main output was commercial pigs purchased by traders (based within the same district or from neighbouring districts). In addition, one breeding farm in Thuong Son, Do Luong district, cooperated with Thai Duong (use of breeds, feeds and management techniques) so they could provide breeding pigs to Thai Duong customers.

Breeding pigs of these farms originate from the NIAS pig breeding station and Thai Duong; the state breeding farms in the northern provinces, and from breeding farms in the south. It is noteworthy that all farms had attempted to purchase boars (with a preference for Duroc) from various sources, including the south, with the aim of increasing the lean meat percentage and improving the appearance of the commercial herds. The selection of breeding animals was mainly based on appearance of the pigs and some performance indicators, such as piglets per litter and piglet weight at birth and at weaning. Whilst the farms kept written records on pig performance, no software was used to aid selection.

Weaknesses named by the private GP breeding farm owners included: difficulties in accessing the good/trusted sources of GP pigs; high production costs; unstable input and output prices; poor infrastructure (poor roads, lack of electricity, lack of capital for biogas systems); difficulties in the use of credit (high interest rates; complicated procedures); hot weather (adversely affecting pig reproduction and performance), pig diseases (including PRRS); and high competition from larger breeding farms. The main strength named was government support (subsidies).

In addition to the private breeding farms keeping GP herds, there are a number of farms keeping PS herds in the delta and low mountainous districts. Four such farms were visited, one in Do Luong district, three in the mountainous Quy Hop district (see Annex 5 for a detailed description). These farms mainly kept Landrace and Yorkshire sows, and Duroc and PiDu boars, for production of commercial crossbreeds. Additionally, some farms kept Yorkshire or Landrace boars for production of replacement breeding animals in their own herd. The origin of pigs was mainly from Thai Duong or a provincial breeding centre in Ha Tinh province. Farms focused on the production of commercial crossbreeds, but also sold boars to village boar keepers and gilts as breeding animals to smallholders. In addition, farms in the mountainous districts occasionally sold piglets for fattening. Breeding pigs were selected based on ‘own experience’ and recorded data was limited.

Weaknesses and strengths highlighted by the PS farmers were similar to those named by GP farms, but with an additional weakness of limited knowledge regarding pig breeds and breeding, and an additional strength of land availability and access to markets (for both breeding pigs and commercial fatteners).

## Private AI stations

The province has an estimated 50 private AI companies. These private AI companies supply semen to AI service providers and, in some cases, also performed AI services themselves. Collectively, these companies keep about 170 boars, and produce sufficient semen (about 150,000 to 170,000 doses) for AI of about 30% of the total sows of the province. It was noted that in some districts the number of private AI companies had decreased in recent years, due to the reduction in the number of sows.

Almost all of the visited private AI stations kept Duroc and/or PiDu boars for use by smallholders for production of lean black (or black patched) commercial progeny. Some stations also kept Yorkshire and/ or Landrace boars for the production of white commercial progeny. The delta stations kept about four boars (in line with the MARD Decision number 07/2005QD-BNN issued on 31//1/2005 governing the use of breeding boars), while the interviewees at the mountainous stations only kept one to two boars. The origins of boars used by the private AI stations of the delta were mainly northern provincial breeding centres or southern breeding companies, whilst the origins of boars in private AI stations of the mountainous districts were Thai Duong or private breeding farms in Do Luong district. All purchased boars had a pedigree book. The information source for boar purchase (breed, price and source of the boars) was other AI stations and the television. In general, boars were first used for AI at 8–9 months of age, and last used at 2.5–4 years of age. Semen quality was checked for colour using a microscope, even distribution and density, and normal sperm activity. The frequency of checking semen quality was higher in the delta stations (each time) in comparison with every week or month in the mountainous stations. Boars were used two to three times per week in the delta stations and three to four times per week in the mountainous stations (with the higher frequency in the mountainous stations largely attributable to the lower number of boars kept). Semen for AI is produced from a single boar, and sows were either mated once or twice depending on the practice of the AI provider. Semen price ranged from VND 15,000 to 30,000 per dose (40-50 cc); and AI service price, including for semen, was about VND 100,000. The stations supplied between 1200 and 2400 doses of semen annually, with an apparent higher demand for the use of semen from the private AI stations in districts without a district breeding and AI station. It is noteworthy that almost all private AI companies—especially those in the mountainous districts—did not meet the requirement of monthly performance testing of AI boars for semen quality (as regulated by Decision 73/2012/QD-UBND issued on 08/10/2012) and a minimum of four boars (as regulated by Decision 07/2005/Q'-BNN). Annex 6 provides more detail on the visited AI stations and their boar use.

Information generally recorded by AI stations on produced semen included ID of boar, date of semen collection, number of doses produced, quality, and the name of the purchaser. AI conception rates reported by the station ranged from 80% to 95%. AI stations received feedback by telephone or in person from farmers on the success rate (or otherwise) of AI and the quality of the offspring.

Staffing and equipment of the visited private AI stations is summarized in Table 7. Staff numbers were generally low (one person) and the equipment for processing semen was very basic, particularly in mountainous districts where some stations might share a common microscope (Table 7).

Table 7: staffing and equipment of the visited private AI stations

| Items | Delta districts (Do Luong, Nam Dan and Yen Thanh) | Mountainous districts (Quy Hop and Tan Ky) |
|---|---|---|
| Number of people trained to take semen from the boar | 1 | 1 |
| Number of people trained to process the semen | 1 | 1 |
| Number of people trained to perform AI | 1 | 1 |
| Main facility | Microscope, equipment for preparation of semen doses, cooling boxes, fridge. | Microscope (might be shared between several stations), equipment for preparation of semen doses, cooling boxes, fridge. |

The major weaknesses of AI operations varied between districts, but commonly included: low demand for AI (particularly in Do Luong where there is currently only one private AI station compared to five–seven in 2008, attributed to the reduction in pig numbers); high purchase price of boars, difficulty in accessing boars (particularly for AI stations located far from breeding stations); lack of information on available boars; a preference of some farmers for natural mating (due to the belief that AI can harm sows, and that natural mating results in larger litter sizes); low quantity and quality of semen due to hot weather at certain stations; price competition with state-run stations and village boar keepers; and difficulties in accessing semen processing material which needed to be sourced from Hanoi. However, it was felt that smallholders are increasingly choosing to use AI, due to the availability of quality AI services and increased smallholder knowledge on AI.

## AI service providers

AI service providers were found to be both veterinarians and the farmers themselves. Most veterinarians performing AI owned a veterinary or feed shop, and performed AI as an additional source of income. Some veterinarians were contracted by district breeding and AI stations, and only used semen from the district station, whilst others worked freely. The veterinarians contracted by district breeding and AI stations performed more AI than those that weren't contracted (with semen usage of, on average, 150 doses a month and 90–120 doses a month, respectively, in the delta; and 40 compared 30 doses a month, respectively in the mountainous district). They also received good semen prices from the district breeding and AI stations (VND 5–10,000 per dose), and were able to return unused semen to the station. On occasions, the contracted veterinarians sub-contracted to other AI service providers.

A decrease in the demand for AI services in recent years was reported by the AI service providers. This was attributed to a reduction in sow numbers, and an increase in the number of village boar keepers, as well as farmers undertaking AI themselves. Demand was reportedly higher in the delta districts compared to the mountainous districts. The reasons for choosing AI service, as stated by the AI service providers, were diverse and included: the unavailability of boars; the small body size of local sows compared to exotic boars; the prevention of sexually transmitted diseases; and the belief that AI produced stronger and better growing piglets and larger litter sizes in comparison to natural mating. This findings were similar to those presented in Haussner (2012) on AI practices in northwest Vietnam. The customers of AI service providers were mainly smallholder farmers keeping Mong Cai or Mong Cai by exotic crossbred sows, typically within a distance of 5km of the service provider, but up to 30 to 40km away.

Typically, the AI service provider selected the breed of boar to be used, based on requests from farmers for a particular colour offspring. It is of interest that in the mountainous region black piglets were often requested, as these are similar in colour to the local pigs (often sought by various programs supporting the poor). Semen for AI is produced from a single boar, and sows were either mated once or twice depending on the practice of the AI provider. In the delta districts, AI fees (including semen) ranged from VND 40,000 to 60,000 if semen from exotic white boars was used, and VND 60,000 to 80.000 if semen from Mong Cai and Duroc boars was used. Repeat services were often charged at the cost of semen only. In the mountainous districts AI fees were higher, due to the distances that needed to be travelled, ranging from VND100,000 to 250,000, with a repeat AI service fee of VND50,000 if distances were far. The reported AI conception rate was 80 to 90%.

The main weaknesses indicated by AI service providers were an increase in the number of village boar keepers (who often had a close relationship with farmers), and limited understanding of AI by smallholder pig keepers. In addition, AI service providers in the mountainous regions indicated difficultly in accessing farms due to bad roads and distance.

## Village boar keepers

The interviewed village boar keepers, in general, kept two to three boars of white exotic, Duroc and PiDu breeds, to meet the demand of smallholder farmers for either white or black piglets. Whilst some boar keepers in the mountainous districts previously kept Mong Cai boars, this is no longer the case due to the low frequency of use. Boars could travel up to 10 km for mating in the delta districts and up to 25km in the mountainous districts, typically transported in a carriage pulled behind a motorbike. Boars were kept for regular cash income in the delta districts, and additional income in the mountainous district (where they were the third to fifth most important source of family income). None of the village boar keepers interviewed had received specialized training in animal breeding or animal health care.

Boars were mainly sourced at about three months of age from the Thai Duong breeding company, district breeding and AI stations, and could be from private breeding farms (GP and PS herds) or from those born into the herds of village boar keepers (the latter being more common in the mountainous districts). Village boar keepers typically did not request information on boar pedigree or performance when sourcing new boars, as there was no requirement from their customers (the smallholder pig keepers) for this information. Boars were first used for servicing at 6 to 8 up to 12

months of age, and last used at 2.5–3 years in the delta districts and up to 3–5 years in the mountainous districts. On average, boars were used for servicing every one to two days; however, use up to five times per day was reported for the mountainous districts. The price for servicing was VND 60,000 in the delta district (for those travelling up to 10km) and VND 70,000 to 200,000 in the mountainous districts (for those travelling up to 10 and 25km, respectively). Conception rates were reported to be about 90%, and repeat services were generally provided free of charge. The main customers were small-scale household farms keeping Mong Cai or Mong Cai by exotic crossbred sows, as larger farms preferred to use AI or their own boars.

The major constraint experienced by the visited village boar keepers was the difficulty in purchasing boars, including due to cost and a lack of information on sourcing boars. In the mountainous district, additional constraints faced included the fact that village boar keepers were only paid after the farrowing of a sow, bad roads, long distances, a lack of feed for the boars, as well as unstable demand by farmers for black or white progeny. Nevertheless, the boar keepers, both in the delta and mountains, considered the business to be a profitable one due to the high demand by smallholder farms. Additional information from the interviewed village boar keepers and breeds they keep is given in Annex 7.

## Mong Cai breeding groups

Mong Cai breeding groups were established in 10 districts of Nghe An province by the provincial breeding centre and district breeding and AI stations. The aim of these breeding groups is to ensure availability of purebred Mong Cai to use as sows, either within in the province or for export to other provinces. Members of Mong Cai breeding groups receive financial support from the province for keeping Mong Cai sows (in accordance with Decision number 09/2012/QD-UBND of Nghe An province issued on 04/02/2012 and Resolution 125/2014/NQ-HDND). Group membership numbered 30-40 farmers in the delta districts, and 50-60 farmers in the mountainous districts, but was subject to change on an annual basis depending on the budget available for the group.

Members of Mong Cai breeding groups sign a contract with the district breeding and AI stations. The station performs inspections to confirm that the piglets are Mong Cai and also provides support, for instance in relation to husbandry and breeding practices. Group members are responsible for the construction of pig stables, raising their own Mong Cai sows, and marketing the piglets. Breeding stations sometimes collect breeding gilts from their members and give them to poor households (as part of programs to support the poor) or introduce customers to farmers. Other customers, traders and collectors sell Mong Cai in the mountainous districts or slaughter piglets for export.

The main constraint cited by breeding group members was the limited market for Mong Cai (both commercial fatteners and commercial piglets for slaughter – and thus also breeding Mong Cai), with most farmers individually seeking market outlets. It is noteworthy that there were few or no common activities between members of the breeding groups, including related to marketing.

In addition, there are some autonomous Mong Cai breeding groups, such as a small group established in Do Luong district. Within this group, the farmers exchanged information on pig production, health care, and input and output markets. Whilst the group leader indicated that there was a preference among customers for Mong Cai by exotic cross-bred sows, the demand for good pure Mong Cai sows was still considered reasonable.

Farmers appreciated Mong Cai sows because of their good reproductive performance, and adaptability to the local environmental and husbandry conditions. Less favourable traits of the Mong Cai included their poor growth rate, high fat, and short bodies. Consequently, farmers received low sales prices for commercial fatteners and commercial piglets for slaughter and faced difficulty selling them. This experience is consistent with that reported previously (Huyen et al. 2005). Nevertheless, the meat of local breeds is often preferred by consumers (Huyen et al. 2005; Lemke et al. 2007; Roessler et al. 2008).

# 4.4 Smallholder information on the supply of and demand for breeding pigs and breeding services

Smallholder information on the supply of and demand for breeding pigs and breeding services, as obtained through the focus group discussions, is summarised below.

## Supply of breeding pigs and breeding services to smallholder pig keepers

Figure 5 summarises the supply of breeding pigs/ semen and breeding services to smallholder pig farms in Nghe An province. Smallholder farmers in the delta districts received pig germplasm from the district breeding and AI stations, private AI stations, AI service providers, village boar keepers, private breeding farms within and outside of Nghe An province, other smallholders from the same district type, and breeding pig traders (who collect breeding piglets and sell them to farmers). Smallholder farmers in the mountainous districts received pig germplasm from the same sources with the exception of private breeding farms. They also received pig germplasm from smallholder farmers in the delta districts.

AI was reported to be used by about 70% of farmers in the delta districts and less than 50% in the mountainous districts depending on the communes. The sources of semen included the district breeding and AI stations (of own or neighbouring districts) and private AI stations (particularly for smallholder farmers who could not access a district station). Breeds said by the smallholders to be available for use as AI sires matched well with those actually available. It was also reported that in the delta district of Yen Thanh, some feed companies such as Dabaco, Green Feed and CP provided fresh exotic pig semen free of charge to the large-scale smallholder farmers who regularly consumed a large amount of the companies' feed. AI service providers used by the smallholders included those from district breeding and AI stations, veterinarians and the smallholders themselves. AI conception rate was said to be greater than 80%, in line with that reported by the AI service providers.

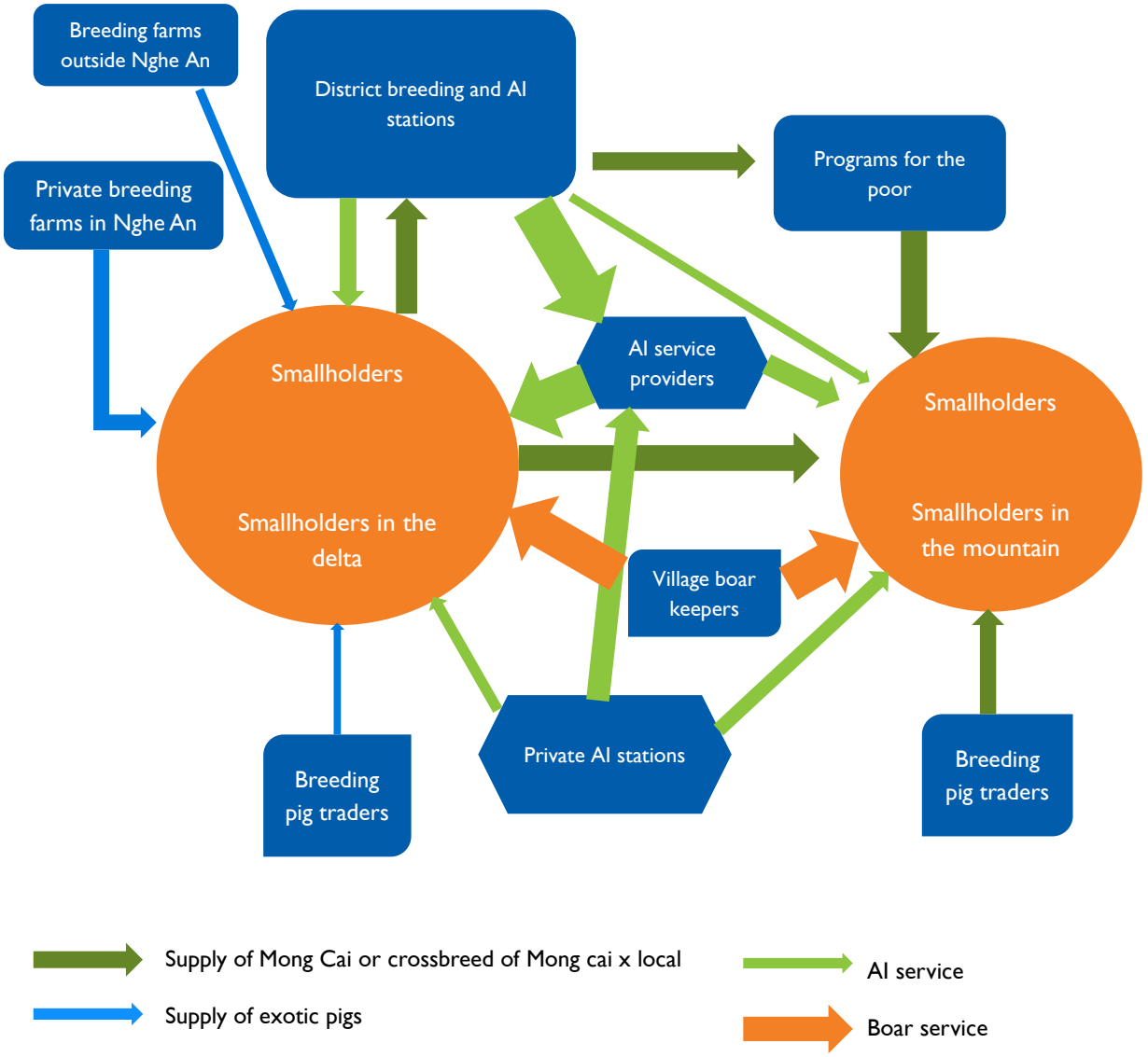
Boars for natural mating were used mainly by small-scale household farms. The quality of piglets was often considered poor, with piglets of unexpected colours and uneven body weights. In some cases, farmers used a boar service for their sows if they failed to conceive using AI. More farmers in mountainous districts—particularly those in isolated rural communes—used the village boar services as compared to their counterparts in the delta (for many reasons including: custom; a lack of access to AI services; a lack of knowledge; and a close relationship with boar keepers). Many farmers believed that they should use natural mating for their Mong Cai sow if they wanted to get pure gilts for replacement. Farmers in remote locations keeping local breeds primarily used their own local breed boar or a local borrowed breed boar.

The main sources of smallholder breeding sows—Mong Cai, Mong Cai by exotic crossbreed, or a local breed—were born on farm or obtained from neighbours; farmers preferred these sources because they knew the origin of the animal and for disease avoidance. This finding is similar to that reported previously (Leda et al. 2015 and Roessler et al 2009). In the delta districts, exotic breeding gilts or exotic piglets for fattening were supplied mainly by private breeding farms (primarily the Thai Duong breeding company, and the PIC breeding farm of NIAS). In the mountainous districts, smallholders reported buying breeding sows (as well as piglets for fattening) from collectors who collected breeding pigs from the delta districts/ provinces; these animals were generally of unknown origin and without pedigree records.

Additionally, the focus group discussion participants commented that thousands of black pigs had been provided in remote areas of the mountainous districts as part of programs for the poor, and that these pigs were not the local breed, but black pigs from a cross of Mong Cai, or Mong Cai by exotic crossbred, sows with PiDu or Duroc boars. This was considered to have had a negative effect on pig production in the remote region, given the fit of local breeds to traditional pig rearing/ husbandry practices and local environmental conditions.

The main weakness cited by smallholders in relation to accessing good breeding animals was their lack of ability to acquire animals from state breeding farms or private breeding companies, due to their small-scale of production, and high purchase and transport cost of these breeding animals (as also reported by Lapar et al. 2012). It was noted that this was not the case in 2000 when state extension and research centres were the most important suppliers of breeding animals, especially exotic breeds, and smallholders accounted for about 45 to 60% of the customers of breeding centres (Lemke et al. 2008).

Figure 5: Supply of breeding pigs/semen and breeding services to smallholder pig farms in Nghe An province




Note: This diagram does not include how the various breeding farms and stations—which supply smallholder farmers—gain access their breeding material. This is discussed in the text.

## Demand for breeding pigs and breeding services by smallholder pig keepers

A number of key recommendations emerged from the study groups, including the need for: 1) improved access to good quality exotic boars/ semen to produce commercial progeny with a high lean meat rate; 2) improved access to good quality Mong Cai by exotic sows to produce commercial progeny of higher lean meat rate; 3) assistance with the identification of good quality breeding boars/ semen; and 4) reduced prices for breeding animals/ semen, particularly for Duroc and PiDu breeds, otherwise only available from breeding farms outside the province. It was noted that the only means farmers had to determine the quality of the boars was by the quality of their progeny (colour, number of piglets, body weight), as no proof of the breed or quality of the boar/ semen was provided, particularly by private sector operators. Some groups also had specific requirements; for example two groups (the male group in Do Luong and the female group in Tan Ky) expressed a wish for Mong Cai by exotic sows with higher weight gain and longer body length, such that they would have better appearance and sell more easily. The groups in Do Luong asked for better and more stable semen quality and price, and farmers in the delta region indicted that they would like better access to exotic sows and exotic piglets for fattening. Further, better access to information on breeding pigs was also requested by a number of groups.

### Gender differences in the supply of and demand for breeding pigs and breeding services

The indicated supply of and demand for pig breeds and breeding services did not noticeably differ between the men and women's groups, (of the focus group discussion), with one exception. This was that the men's groups tended to have more discussion on the role of large breeding companies/ groups supplying genetic material, in comparison to the women's group.

### Technical training courses relevant to AI techniques, pig breeds and breeding

Farmers noted that training courses on pig AI and pig breeds/ breeding had been provided by the agricultural extension services and veterinary stations (a sub-department of the veterinary and animal health department) at both district and commune levels. These, however, appeared to be more frequent in the delta districts than in the mountainous ones, and were only open to a limited number of participants.

Farmers requested additional training on pig breeding, including classifying pigs by breed (as they currently only classify as local, exotic or crossbred based on colour). Further, two female groups specifically asked for this training to be performed at commune level. It is worthwhile noting that a survey by MARD (2003) showed that farmers were willing to pay for training and extension services as long as they were useful and oriented towards meeting their requirements.

## 4.5 Overall synthesis in relation to smallholder access to genetically improved animals

Most smallholders in the delta and low mountainous districts benefit from the use of a crossbreeding scheme, the most common of which is Mong Cai or (Landrace/Yorkshire x Mong Cai) sows crossed with Duroc or PiDu boars. The use of this crossbreeding scheme has resulted in commercial progeny with significantly improved productivity. Therefore, the focus of future work should now move from implementing the crossbreeding scheme to refining it, in particular to ensuring that breeding animals used by smallholders as part of the crossbreeding scheme are of appropriately high genetic merit. With respect to this, it should be noted that:

1. The most direct access for smallholders to genetically improved boars is via the use of AI services offered by district breeding and AI stations, and potentially by private AI stations which, in turn directly source their boars from breeding programs[2].
2. Smallholders who access their boars from village boar keepers have much less control over boar genetic quality, as the latter access their boars from a variety of sources, including from other village boar keepers.
3. Smallholders largely access sows from their own herds or from those of their neighbours and are, thus, utilizing sows of unknown and probably of variable—genetic quality.
4. No genetic improvement of the Mong Cai breed is currently occurring.

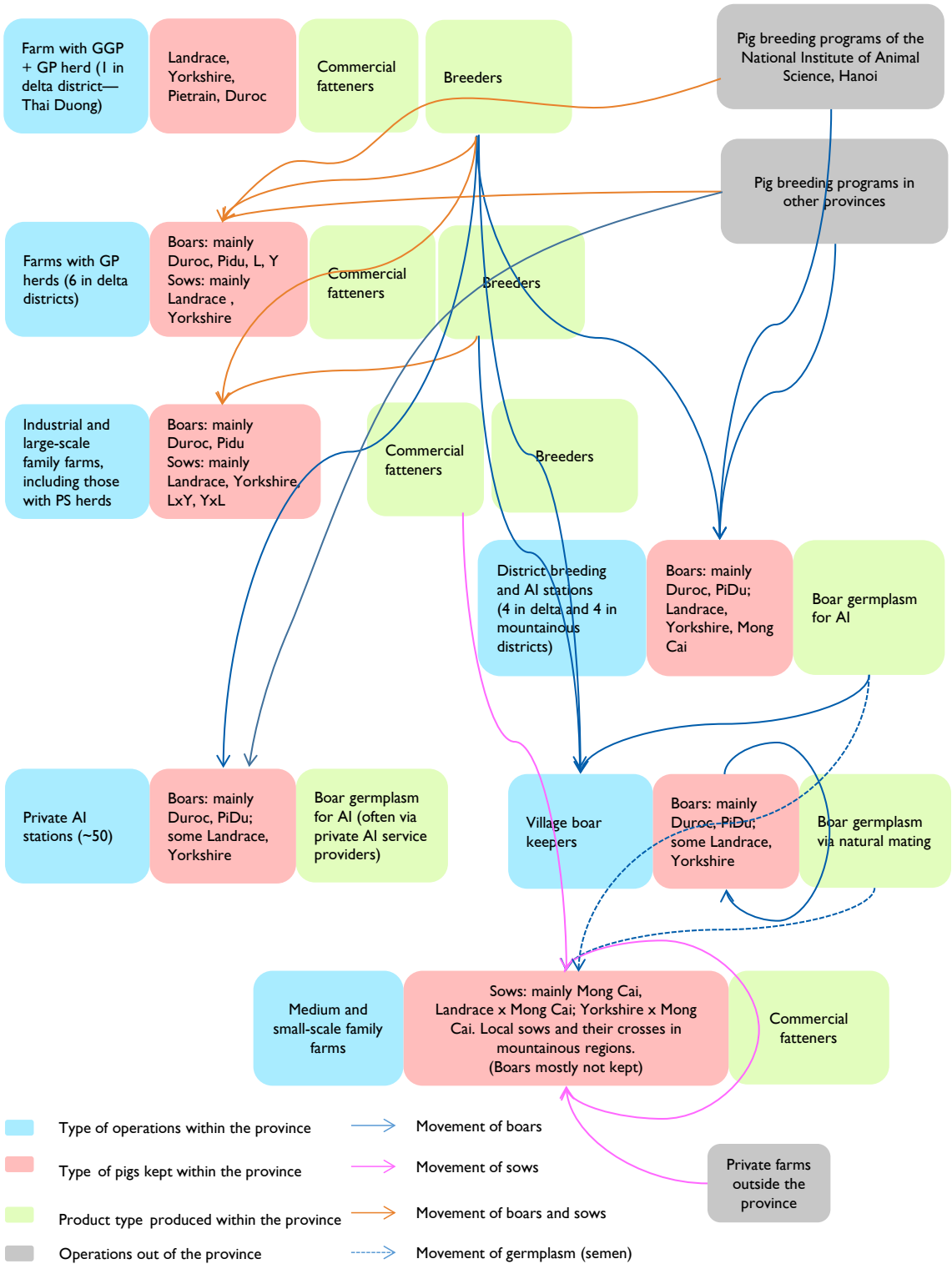
(See Figure 6 for an overview)

2. However, these breeding programs may not necessarily have had the supply of breeding pigs to smallholders in mind when setting their own breeding objectives.

In addition, attention should be paid to the overall sustainability of the crossbreeding scheme, given that the keeping of exotic pigs is currently subsidized.

While smallholders in the high mountainous areas are utilizing local breeds, and/or their crosses with Mong Cai and to a lesser extent with exotic breeds, no genetic improvement of local breeds or Mong Cai is currently occurring. Therefore, there should be a focus on evaluating the potential for, and if appropriate on enabling the, wider-spread use of the main crossbreeding scheme, and/or adding value to the keeping of local breeds—for example, by strengthening niche markets for local pork products.

Figure 6. Overall synthesis of pig germplasm movement for the main crossbreeding scheme utilized in the delta and lower-mountainous districts.



## 4.6 Validation of findings, and development of recommendations

A workshop with representatives of the various stakeholder groups was held to validate study results, and to formulate recommendations to address the various weaknesses related to pig breeding identified as part of this study. Key discussion points are summarized below:

**Policy implementation.** The difficulty of farmers in accessing breeding services and related support—as indicated during the focus group discussions with smallholder pig keepers—was attributed to the weak implementation of the relevant policies and regulations on breeding by the authorities, from national to local levels. A key contributing factor to this was seen as the lack of penalties for breaking regulations. For instance, whilst the quality and conditions of village boar keepers and AI stations are checked annually by district and provincial authorities, unsuitable activities are only criticized at the time of verification and no follow-up action is taken. A limited provincial budget to support the implementation of relevant policies was also seen as a critical factor explaining weak policy implementation.

In addition, it was noted that whilst there are provincial-level plans for pig production, including aspects relevant to industrial and smallholder farms (mainly related to suggestions on breeds/ crossbreeds) and on market development, the plan was not backed up by a full complement of supporting policies or implementing guidelines. Interventions at district and communal levels in relation to the implementation of the plans were considered to be insufficient. Further, it was noted that there was a lack of district-level plans on breed use and breeding. It was also noted that there was no circular to guide the implementation of Decision 50/2014/QD-TTg (see above).

**Quality of breeding pigs.** The (perceived) low quality of breeding pigs was attributed to poor management and a lack of cooperation between different functional offices, resulting in lack of control over the various breeding programs/ activities. For example, it was noted that many programs supplying breeding pigs to poor farmers in the rural and remote areas were carried out by different associations/ unions (such as farmer unions, women unions, the banks, etc.,) with limited oversight by the functional offices. Further, there was a need to ensure the identification of the most suitable pig breeds/ crossbreeds for the long-term development of the sector in Nghe An province.

**Farmer knowledge.** It was considered that farmer knowledge on pig breeds and breeding was poor; they have limited awareness of the effect of low quality breeding animals.

**Farmer preferences**. In scavenging system (within a fenced area), some farmers expressed a preference for sows with bigger litter sizes (12–14 piglets/ litter). As pigs are sold per head, and not per kg of live weight, this would allow them to sell many more piglets, supplying city markets for scavenging pigs.

**Market information.** It was noted that there was no study or survey that accessed the market demand for pig production within or outside Nghe An province. Such information was considered essential in developing long-term plans for the pig sector, including plans on breeding.

**Cooperatives.** It was also noted that there were no major cooperative groups of pig breeders or pig producers within the province—there were only some autonomous cooperatives of cattle and chicken producers. It was felt that such groups would be beneficial in relation to the common purchase of inputs, and the common marketing of outputs.

# 5. Recommendations to improve the quality of breeding boars and sows used by smallholder pig keepers

A number of recommendations to improve the genetic quality of breeding boars and sows used by smallholder pig keepers arose from the feedback workshop, or were drawn from the overall study data.

Recommendations arising from the feedback workshop are to:

1. Strengthen the long-term pig production and breeding plans through more appropriate policies and implementation guidelines. In particular, the plan should recognise the needs of specific regions, give increased consideration to farmer needs and preferences, and link to market demand. The plan should also be assessed at periodic intervals, and adjusted as needed.
2. Improve the implementation of the pig breeding policies and regulations, including the application of penalties for breaking the regulations.
3. Improve the services provided by public and private AI stations in terms of quality of boars, equipment and service network.
4. Improve the knowledge of farmers and boar keepers on breed use and breeding management.

Other recommendations drawn from the study (by the authors) are to:

1. Evaluate the performance of Mong Cai versus Mong Cai by exotic crossbred sows (the latter with varying levels of exotic blood e.g. 25%, 50% and 75%) for smallholder systems, and implement breeding programs to avail the most appropriate of these. The establishment of a synthetic (stabilized) Mong Cai by exotic sow line should also be considered.
2. Implement a certification or other incentive system for high quality breeding boars and sows, and raise awareness among smallholder farmers of the benefits of such a system. The nature of the system and how it would be regulated and funded requires additional discussion with stakeholders, however it could start simply and build over time.
3. Implement a conservation program for the local breeds in the mountainous area, given the admixed (unstructured) crossing of these breeds with other breeds. The nature of the conservation program needs to be discussed with stakeholders, but consideration should be given to ex-situ conservation options (such as storage of germplasm in a biorepository/ genebank) as well as in-situ conservation options (for example, in cases where there is the potential for a niche market for a local breed product (Halimani et al. 2012)).
4. Ensure that programs supplying breeding animals to the poor—such as those commonly implemented in remote regions—are supplying pig breed-types that are appropriate and that the breed-type is made known to the program recipients. A regulatory role in this area could be provided, for example, to the provincial breeding centre and/ or the district breeding and AI centres.

5. Establish mechanisms to better connect the various stakeholders/ actors in pig breeding and pig production, including both the public and private sectors and from within and outside the province, for the co-creation and implementation of solutions to the various constraints regarding pig genetic resource use (as also suggested by Lapar et al. 2012).

6. Increase smallholder pig keeper demand for, and access to, good breeding animals and services, as well as other inputs (feed, animal health care, housing, waste management and training) and markets, by increasing their negotiating power and forming beneficial alliances (such as, but not limited to, farmers organisations), (O'Sullivan 2000 and Huyen et al. 2015).

7. Undertake a market study for pig products produced in the province, and share the results of this study with the various stakeholders such that they can make better informed decisions on their level of investment in good breeding animals. This study should also consider market competition between smallholder farms and larger-scale producers, and whether promotion of different outputs from these systems for specific markets would be advantageous.

# 6. Concluding comments

Improving the quality of breeding boars and sows used by smallholder pig keepers is important in optimizing pig production and productivity, and strengthening the smallholder pig sector. This study presents a thorough description of the pig breeding operations and the demands of smallholder pig producers in Nghe An province, produced in conjunction with stakeholders and from which a series of recommendations have been drawn. Follow-up activities—with stakeholders—will focus on prioritising the recommendations and, should resources be availed, the implementation of the most significant ones.

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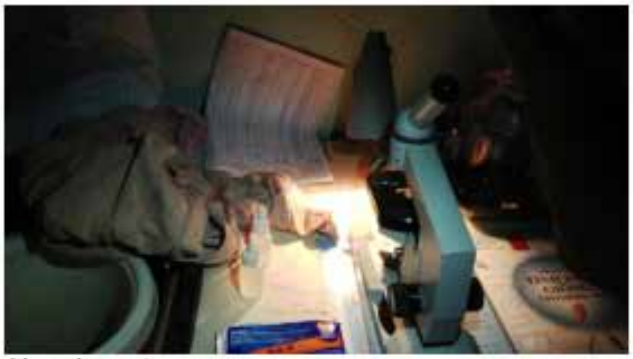
# Annexes

## Annex 1 Photographs from focus group discussions and field work

Focus group discussions (women and men groups)



AI equipment

Boars for natural mating

Mong Cai sow

Large farm with local pig and wild boar

Mong Cai piglets

Exotic sow and piglets


Pedigree book for breeding boar from a State breeding farm (national level)


Pedigree book for breeding boar from a research breeding centre and a private company

# Annex 2. Summary information on the boars kept, and boar and semen use, at two district breeding and AI stations

| Items | Delta Do Luong district station | Mountainous Quy Hop district station |
|---|---|---|
| Number of boars and breeds | 8 (2 Yorkshire; 3 Landrace; 2 PiDu; and 1 Mong Cai) | 5 (1 Yorkshire; 1 Landrace; 1 PiDu; 1 Duroc; and 1 Mong Cai) |
| Age of boars (years) | 1–3 | 1–3 |
| Origin of boar | Thai Duong, Thuy Phuong pig breeding station of NIAS, Quang Ninh Mong Cai breeding station | Thai Duong; Do Luong breeding station |
| Age of the boars at the time of purchase | 5 months for Mong Cai boar; 8–9 months for exotic boars | 10–11 months |
| Price of boars at the time of purchase | VND 8 million for a Mong Cai boar;VND 17 million for an exotic boar | VND 4 million for a Mong Cai boar;VND 18–20 million for an exotic boar |
| Paper enclosed with boars at the time of purchase | Pedigree book with information on performance, quarantine certificate, and vaccination | Pedigree book |
| Age at first use for semen production | 4–5 months for Mong Cai boar; 8–9 months for exotic boar | Ready for AI when purchased |
| Age at last use for semen production | 3 years for Mong Cai boar; 3.5 years for exotic boar | 3 years |
| Frequency of use of the Mong Cai for AI (day/ month); (doses/time) | 30 days/month; 10 doses/ time; 10 months/year (3600 doses per boar per year) | In accordance with smallholder demand; produced about 200 doses/year; and consumed about 120 doses/year |
| Total semen doses per year | 30,000 doses/year | 9000 doses/year |
| Price of semen (VND /dose) | VND 25,000 for white exotic;VND 30,000 for Mong Cai and PiDu | VND 25,000 for white exotic;VND 30,000 for Mong Cai, Pi Du and Duroc |
| Where semen distributed | Smallholder farms within the district | Smallholder farms within the district |

# Annex 3. Selection criteria for breeding animals used by Thai Duong

The criteria used by Thai Duong breeding company for the selection of new breeding pigs was given as follows. For Landrace: furled ears, long and thick body, lean meat rate of 65%, daily weight gain of 700–800g (at 4–5 months of age), pure white; for Yorkshire: erect ears, long and thick body, lean meat rate of 65%, daily weight gain of 700–800g, pure white; and for Duroc: reddish hair, lean meat rate of 65–70%, daily weight gain of 900–1100g, back fat thickness of 14 mm, red meat.

Selection of breeding pigs (GGP and GP) from within the companies own animals was as follows. Female breeding pigs were fist selected at birth based on having a birth weight of 1.4 kg, more than 14 even teats for GGP or more than 12 teats for GP and PS pigs, a pure white colour, appearance as per the breed standard, even legs, thick body, strong and thin hairs (believed by some to be associated with higher growth rate). They are again selected at 28 days of age (at weaning) based on having a weight of 7 kg or more, at 70 days of age based on having a weight of 30 kg or more, and at 150-155 days of age based on a having a weight of 95-100 kg or more. In addition, the breeding females were required to have clear imaged and even external sexual organs, even teats, pink skin, thin hairs, strong legs, and a straight back. The selected sows had more than 12 piglets per litter, all teats were active in the lactation period, and 2.3 litters per year per sow. Male animals were selected at birth (with the requirement for a slim belly and other features similar to the female pigs), and at 28, 70 and 155 days of age, with weight of the selected male pigs at 155 days of age of 95-100 kg or more. At 128 days of age and about 80 kg, the males were trained for AI and checked for semen quality; moreover, back fat thickness was checked at around 128 to 150 days of age. Male and female animals were also selected considering relatedness, with the aim of keeping the inbreeding coefficient of any animal to less than 0.05.

# Annex 4: General breeding operations undertaken at the three visited GP breeding farms

| | In Yen Son, Do Luong district | In Thuong Son, Do Luong district | In Nam Xuan, Nam Dan district |
|---|---|---|---|
| Foundation | 2006 | 2012 | 2004 |
| Scientists in animal breeding | 1 diploma, 2 junior high school degree | 1 diploma; All technical staff were trained by Thai Duong company | 2 diploma; 1 junior high school |
| Pig herds | In 2006: 110 GP sows C1050 (synthetic Yorkshire sire by synthetic Landrace dam) and C 1230 (synthetic Landrace sire by synthetic Meishan dam), and 2 L19 GGP sires (white Duroc boar by Yorkshire) from PIC farm of NIAS to produce PS pigs for farm own and for sale.<br><br>In 2013: 20 GP sows C1050 and 1 GGP sire L19 from PIC but the quality of progeny was low (less than 11 piglets/litter; uneven birth weight).<br><br>Current herd:60 GP sows and 90 PS sows; 3 new purchased GGP sires from Kim Long breeding company in Binh Duong province—south Vietnam (1 Landrace, 2 Duroc: replacing for L 19). | Current herd: 152 GP sows Landrace and Yorkshire bought from Thai Duong company; and 60 PS sows LY (Landrace by Yorkshire); 6 GGP sires (2 Yorkshire; 1 Landrace; 3 Duroc) bought from Amavet company in Hanoi (of Taiwan).<br><br>The production on the farm: 50% was selected as PS pigs; and 50% as commercial pigs.<br><br>Feeding, stables and animal husbandry followed the systems of Thai Duong. | Current herd: 22 GP sows Yorkshire; 1 GP sire Landrace those bought from Kim Long breeding company in Binh Duong province—south Vietnam; 150 PS sows LY (Landrace by Yorkshire); 2 PS boars PiDu.<br><br>In 2004: Beginning with: 30 GP sows, then increased to 70 GP sows from PIC station of NIAS, then changed to Kim Long breeding company following an advertisement by this company on animal breeding, veterinary medicine and feed.<br><br>New plan: Just ordering 20 GP sows and 30 PS sows, the breed with high lean meat rate (breed not yet decided) from Thuy Phuong breeding station of NIAS. Planning to buy a new sire from Amavet company. |
| Breeding objectives | PS sows with high lean meat rate, high reproductive performance, and good disease resistance.<br><br>Commercial pigs: lean meat, good smell, disease resistance, and meeting the preference of customers in terms of meat quality and colour. | PS sows with high reproductive performance, even piglets, high numbers of piglets (at birth, at weaning, and up to 30 kg). | High lean meat rate and high production rate, good appearance (long body), nice meat, high growth rate. |
| Scientists in animal breeding | 1 diploma, 2 junior high school degree | 1 diploma; All technical staff were trained by Thai Duong company | 2 diploma; 1 junior high school |
| Problems in pig breeding | Some sows and boars had a problem with arthropathy (viem khop) | Long time period between farrowing and next heat (more than 28–42 days), particularly in the summer, with 20 % of sows; foetal death (affecting 10% of the sows and 50% of their foetuses); piglets became weaker after weaned, for unknown reasons, with no solution. | Opened stables, sows depended a lot on the weather. |

| | In Yen Son, Do Luong district | In Thuong Son, Do Luong district | In Nam Xuan, Nam Dan district |
|---|---|---|---|
| Foundation | 2006 | 2012 | 2004 |
| Scientists in animal breeding | 1 diploma, 2 junior high school degree | 1 diploma; All technical staff were trained by Thai Duong company | 2 diploma; 1 junior high school |
| Outputs | Sale of PS gilts: more than 100 MN01 and more than 100 MN02 at the age of 4–5 months to family farms and smallholder farms raising 5–10 sows in Do Luong, Anh Son, Tan Ky and Thanh Chuong districts. Price received was market price of commercial pigs with about VND 100,000 additional selection fee paid for each.<br><br>Enclosed: technical guides, training and consultant via phone; pedigree book, quarantine certificate, other required information related to the performance of the pigs. | PS (mainly LY, YY; and LL) sows were sold to the customers of Thai Duong: farms, family farms, traders; 200 sows sold in 2013; 19 boars sold to village boar keepers in Do Luong, Dien Chau and Anh Son districts. Breeding pigs sold at 6–7 months of age at a market price for commercial pigs and a breeding fee of VND 1.5 million/ sow and VND 3 million/ boar.<br><br>Commercial pigs, piglets for fattening sold to Ha Tinh province, Vinh city, Do Luong and Nghi Phu districts.<br><br>Provided semen for AI to customers, about 800 doses/ year. Also imported semen from Thai Duong.<br><br>Enclosed: Technical AI training and exploiting semen. Customers did not ask for any records. | PS gilts were sold mainly to medium smallholder farms raising 5–10 sows in Nam Dan, Do Luong, Thanh Chuong districts: 20–45 gilts/ month to family farms, medium farms and smallholder farms according to the order (10–15 gilts sold each time. Gilts were sold at 30–35 kg, VND 110,000–120,000/kg.<br><br>Provided PS pigs to breeding programs in Hung Nguyen–Nam Dan district: 400 PS sows in 2013; 150 sows in 2014;<br><br>Landrace boars were sold to village boar keepers in Nam Dan, Do Luong, Thanh Chuong, and Nghi Loc districts, about 30 boars/ year at 70–80 kg or 20 kg. Currently, the price for commercial pigs is VND 50,000/ kg LW, then the price of boar is VND 70,000/ kg LW. Farmers wanted Landrace boar to use for black sow or Mong Cai sows for producing white progeny.<br><br>Semen of boars were sold to persons performing AI and directly to farmers in Nam Dan district. |

# Annex 5: General operations of the four visited PS farms producing piglets for fattening

| | One farm in delta Do Luong district | Three farms in Quy Hop mountainous district |
|---|---|---|
| Foundation | 2009; supported by the province (as a commercial farm with more than 100 pigs). | Farm 1:2007; farm 2: 2011; farm 3: 2007 |
| Staff | 3 persons working on the farm, 1 graduated from primary veterinary school. No one with training in animal breeding | No one with training in animal breeding |
| Pig herds | 40 sows, in which 20 are going to be replaced: 30 exotic sows (LY) from Thai Duong, and 10 crossbred sows (F2 and F3) of Mong Cai dam with white exotic sire bought from smallholder farms in Quynh Luu district; 1 Duroc boar bought from Thai Duong; 170 fatteners. | Farm 1: 20 sows Yorkshire bought from a breeding station in Ha Tinh province; 1 PiDu boar bought from a private breeding farm in Do Luong district. Sows and boars had pedigree books at the time of purchase. Boar and sows for producing commercial fatteners, sometimes the farm could sell piglets to smallholders for fattening.<br><br>Farm 2: 40 PS sows (Landrace and Yorkshire) bought from Thai Duong, and 2 Duroc boars from Que Phong district for producing commercial fatteners and also piglets sold for fattening<br><br>Farm 3: In 2007 kept 12 exotic white sows of unknown origin. It replaced all sows in 2012. Currently: 16 white exotic sows bought from a breeding station in Ha Tinh and PIC of NIAS; and 3 boars (1 Duroc and 1 PiDu bought from Thai Duong company, and 1 Du 75 (75% blood share of Duroc and 25% of Pietrain) bought from a private breeding farm in Thanh Hoa province). The farmer did not know exactly which breed of sows she had; she only knew that they were white exotic PS sows, tall, with long bodies, mating at more than 100 kg. On average, price of a sow 80 kg was VND 6 million and of a boar 50–60 kg was VND 12–15 million. |
| Breeding objectives | Increase in PS sows from good farm produced pigs;<br><br>Production of commercial fatteners. | Farm 1 and 2: High lean meat rate, high growth rate fatteners.<br><br>Farm 2: Increase in PS sows from good farm produced pigs and production of commercial fatteners. |

| | One farm in delta Do Luong district | Three farms in Quy Hop mountainous district |
|---|---|---|
| Foundation | 2009; supported by the province (as a commercial farm with more than 100 pigs). | Farm 1:2007; farm 2: 2011; farm 3: 2007 |
| Weaknesses | A lack of information on good breeding stations for good sows and good fatteners (low feed conversion rate, high growth rate). | A lack of sources for PS pigs in the district. PS pigs were bought in Ha Tinh province. |
| | The farm wanted to buy good PS sows from the state breeding station, but given the small number it would have faced high transportation costs. | A lack of information trusted breeding stations/ farms providing good PS. |
| | F2 and F3 of Mong Cai were quite reproductive with 12–15 piglets/ litter but commercial fatteners had a low growth rate: 475–80 kg at 4 months of age, while 90–95 kg with exotic breeds. | The GP pig station needs to be officially identified and informed by the province. One of the farms bought 20 PS pigs from Thai Duong, but 10 were culled due to bad performance. Other stations, such as CP and PIC, were far from the district, and did not provide trusted information. |
| | Do not know which sow breed could produce good gilts and commercial fatteners. | High feed cost. |
| | Lack of breeding education. | |
| | Lack of capital for good breeding pigs. | High cost of breeding pigs (VND 8 million/ sow at 100 kg). |
| | | Small scale, knowledge on sow raising needs to be improved. Local veterinarians still need to improve knowledge on pig health care. |
| | | It is very difficult to establish a GP pig farm in the district due to low education, and a lack of awareness by farmers regarding price and quality of breeding pigs. Only the large farm accepted higher price for higher quality pigs. Further, local smallholder farms wanted to use and were used to using farm-produced sows. |
| | | Poor infrastructure, bad roads. |
| | | Complicated procedures related to the use of credit. |
| | | Farm 3: Experience of breeds and breeding, learning by doing, took time and lead to a lot of failures. In the beginning, they did not know how to select breeding pigs. |
| | | The quality of PS sows were not so good, many unproductive pigs. |
| | | Up to 40% of sows had an abortion during hot weather. |
| | | Breeding boars were expensive. |
| Advantages | Available market for commercial pigs. | Land available. |
| | Policies supporting large-scale commercial farms. | Available market for lean meat pigs and inputs (feed). |
| | | Policies supporting large-scale commercial farms. |
| | | Increase in the demand by smallholders for breeding gilts and boars, as well as piglets for fattening of lean meat breeds. |

# Annex 6. Summary information of the boars and semen used by the visited private AI stations

| Items | Delta districts (Do Luong, Nam Dan and Yen Thanh) | Mountainous districts (Quy Hop and Tan Ky) |
|---|---|---|
| Number of boars | 4/ station | 1–2/ station |
| Breeds | Landrace, Yorkshire, and PiDu; one station in Yen Thanh district kept only Duroc. | PiDu; Duroc; Landrace |
| Age of boars (years) | 0.5–2 | 1–3 |
| Origin of boar | Mainly from state breeding farms/station in the north (e.g. sow from An Khanh breeding station) or the south (breeding stations in Binh Phuoc, and Binh Duong provinces); Between approximately 400km and more than 1000km away.<br>- One AI station bought one boar from a private breeding farm—a corporate Thai Duong farm; 3 other boars from GP dams were crossed with farm own GP sires.<br>Information from TV and colleagues. | From Thai Duong company and private breeding farm in Dai Son commune, Do Luong district, the distance of 80km. |
| Age of the boars at the time of purchase | 5–9 months; a station in Do Luong bought a 2-month boar. | 6–9 months |
| Price of boars at the time of purchase | VND 14–21.5 million/ boar<br>(VND 7.5 million for a 2-month boar) | VND 14 million for a PiDu boar at 6 months;<br>VND 22 million for a Duroc boar at 9 months;<br>VND 13 million for a Landrace boar at 9 months |
| Papers given the with boars at the time of purchase | Pedigree, one with performance testing records, including on age, weight, number of teats, daily weight gain, feed conversion ratio, back fat thickness and semen quality (volume, activity, percentage of abnormal sperm; and total sperm moving straight in the semen liquid etc. if requested by buyers). | Pedigree |
| Age at first use for semen production | 8–9 months | 8–10 months |
| Age at last use for semen production | 2.5–4 years (one at 2.5; 3 at 3.5–4 years) | 3 years |
| Frequency of use for AI of exotic boar | 2–3 times/ week; 15–20 doses/time | 3–4 times/ week; 3–6 doses/ time according to demand (using about 30 doses per month per boar) |
| Price of semen (VND /dose) | - Nam Dan (without district AI station): a GP breeding farm sold semen to person performing AI with VND 40,000/ 100 cc; or VND 15,000/ 30–40 cc. Another AI station sold semen to person performing AI: VND 30,000/ 40-50 cc; to smallholder farmers: VND 40,000/ dose.<br>- Yen Thanh: VND 30,000/ 30–40 cc<br>- Do Luong: VND 20,000/ dose | VND 100,000/ AI service (VND 30,000–40,000/ semen dose plus service fee) |
| Where semen distributed | Mainly persons performing AI and farmers within the Nam Dan district, including some farms in neighbouring Hung Nguyen and Nghi Loc districts. | Mainly smallholder farms within the five surrounding communes of those keeping a sow F1 of Mong Cai. |

# Annex 7. Summary information on the boars used by the visited village boar keepers

| Items | Delta Do Luong district | Mountainous Quy Hop and Tan Ky districts |
|---|---|---|
| Number of boars and breeds | 2–4; Yorkshire, or/and Landrace, Duroc | 2–3; Landrace, Duroc; PiDu; Du 75 (75% of blood share from Duroc, and 25% of Pietrain) |
| Age of boars | 0.5–2 years | 2 months–3 years |
| Origin of boar | Thai Duong; private breeding farms in Nam Dan, Do Luong, and Do Luong AI station. | Thai Duong; private breeding farms in Thanh Hoa province and Dien Chau district; one selected from farm produced progeny (Duroc sire by F1 of Mong Cai sow) |
| Age of the boars at the time of purchase | 3 months | 2–3 months |
| Price of boars at the time of purchase | VND 8.5 million for an Yorkshire boar from Thai Duong; VND 100,000–120,000/kg LW for Yorkshire or Landrace; VND 150,000/kg LW for Duroc | VND 7–12 million; one boar bought from Dien Chau private breeding farm at VND 2.7 million |
| Papers enclosed with boars at the time of purchase | Quarantine certificate | One private breeding farm asked the pedigree of boars. Others did not. |
| Age at first use of the boars | 5–7 months | 6–8 months up to 12 months |
| Age at last use of the boars | 2.5–3 years | 2–5 years |
| Frequency of services | Every 2 days up to twice a day | Every 2 days; but rarely 1–5 times/day depending on demand |
| Price of a service (VND ) | VND 60,000 within a distance of <10km; repeated service: VND 30,000 | VND 70,000–120,000/service depending on the distance within 10km; VND 120,000–200,000/service within a distance of 25 km |
| Where the service is undertaken; major customers | Three surrounding communes (<10km away); smallholder farms, mainly with Mong Cai sows or sows F1 of Mong Cai sows | <10–25 km; smallholder farm with five sows, mainly with Mong Cai sows or sows F1 of Mong Cai |

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