RESEARCH PROGRAM ON Livestock More meat, milk and eggs by and for the poor

Rapid assessment of breeds and breeding operations for potential interventions on livestock genetic improvement in Son La Province, northwest Vietnam

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I. Background

'Livestock-led interventions towards equitable livelihoods and improved environment in the northwest highlands of Vietnam (LI-CHAN)¹ is a focal project of the CGIAR Research Program on Livestock 'More meat, milk and fish by and for the poor'². The project aims to improve the livelihoods and diets/nutrition of ethnic communities in Son La, a northwestern province of Vietnam, through sustainable livestock solutions. This approach will identify, test and evaluate interventions to address challenges around the sustainable intensification of livestock production. These interventions will be tailored to different farm types in Mai Son District. This paper describes the results of rapid assessments undertaken to determine potential interventions on livestock genetic improvement in the project sites for beef cattle, pigs and chickens. These suggested interventions will be further discussed with project stakeholders and beneficiaries for final selection.

The main activities of the study comprised:

- i. identifying and summarizing key policies on livestock genetic improvement/breeding at district, province or national level that impact the project district(s), including an assessment of the level of policy implementation;
- ii. identifying and summarizing key (prior, current or planned) programs/projects on livestock genetic improvement/
 breeding operating in the project district(s);
- iii. tabulating the main breeds and cross-breeds used within the project districts for beef cattle, pigs and chickens;
- identifying and documenting livestock breeding operations operating in, or impacting on, project districts for
 (i) breeding companies (provincial breeding centres, private breeding companies, private farms); (ii) artificial
 insemination (AI) companies (district breeding and AI stations and private AI stations); (iii) AI service providers
 (sole operators); (iv) village bull/boar keepers; and (v) farmer groups for beef cattle, pigs and chickens.
- v. mapping the supply of breeding animals and breeding services to smallholder livestock keepers within the project districts for beef cattle, pigs and chicken; and
- vi. accessing stakeholder views on constraints and opportunities for livestock genetic improvement within the project districts as well as their opinions on best-bet interventions on livestock genetic improvement.

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I <u>https://livestock.cgiar.org/countries/vietnam</u>

^{2 &}lt;u>https://livestock.cgiar.org</u>

2. Study area and methods

2.1. Study area

Son La Province is in the centre of northwestern Vietnam on national road 6 (Hanoi–Son La–Dien Bien), about 320 km from Hanoi. The 14,174 km² province has a 250 km borderline with Laos to the south. It ranks third in terms of natural habitat cover in the whole country, which accounts for 39% of the land cover in the northwestern area. The terrain is steeply rugged and mountainous with an altitude of 600–700 metres above sea level (m.a.s.l.). Altitude decreases from the northwest to the southeast, with valleys interspersed among the mountains. Arable land is often narrow and sloping. The climate is continental tropical monsoon and influenced by topography. The cold and dry winters last from October to March, whilst the remaining months are hot, humid and rainy. The average temperature is 21.50C (20C–370C). Average annual rainfall is 1,400 mm with an average of 118 rainy days per year (80% of rain falls between June and September). Average annual humidity is 80–82%. The population of the province in 2019 was 1,252,700 (88 people/km2) unevenly distributed between urban and rural areas. Some 88% of the population lives in rural areas (Son La Statistical Yearbook, 2020). Son La currently comprises 12 ethnic groups: Thai, Kinh, Mong, Muong, Dao, Kho Mu, La Ha, Xinh Mun, Khang, Lao, Tay and Hoa. Ethnic minorities account for 83.7% of the population of Son La Province, of which the Thai people comprise 54.7%. The ethnic majority in Vietnam (Kinh) comprise 16.3%.

This assessment focused on the district of Mai Son (see Figure 1) within Son La Province, specifically Chieng Luong commune, located in the lowlands and intermediate highlands, and Chieng Chung commune, located in the highlands. The study sites were selected based on their range of poverty levels, livestock and farming systems and ethnic groups, and because the two communes contain highland, intermediate and lowland farming systems with year-round accessibility.

Chieng Chung and Chieng Luong are the communes in Zone 2^3 of Mai Son District (based on the determinant criteria for difficult villages and ethnic minority communes of Decision 50/2016/ QD-TTg, issued on 3 November 2016).

³ Communes in ethnic minority and mountainous areas are categorized into three zones: Zone 3 communes have extremely difficult socio-economic conditions; Zone 2 communes have difficult socio-economic conditions but have been temporarily stable; the remaining communes are Zone 1. Zone 2 communes must fulfil one of the three following criteria:



Figure 1: Mai Son District, Son La Province, Vietnam.

Chieng Chung commune is 40 km from the district centre and is 1,000–1,200 m.a.s.l. It comprises 15 villages with 1,316 households/6,121 people of five main ethnic groups: Thai, Mong, Kinh, Tay and Nhang. The natural land area of the commune is 7,249 ha (forestry land: 72.1%; agricultural land: 20.0%; other specialized land areas: 7.9%). The main crops are paddy rice and upland rice (130 ha), maize (50 ha), cassava (90 ha) and beans (12 ha). Livestock comprises 280 buffaloes, 400 cattle, 3,000 pigs, 844 goats and 18,000 poultry. A number of livestock programs/projects have been undertaken in the commune including a nutrition project to distribute Lac Thuy laying chickens to households of pregnant women and children under 24 months of age, and support to poor households to raise cattle in remote villages through the national Program 135⁴ supporting the poor.

Chieng Luong commune comprises 24 villages, of which five are specially disadvantaged and belong to Program 135. The population comprises more than 10,000 people of five ethnic groups: Thai, Kinh, Mong, Kho Mu and Xinh Mun. The land area is 11,506 ha, including both lowland and intermediate highland villages. Main crops are rice (86 ha), maize (924 ha), sugar cane, coffee, fruit trees (228 ha), sachi peanut (*Plukenetia volubilis*) (6 ha) and China grass (*Boehmeria nivea ramie*) (6 ha). Livestock comprise 2,106 buffaloes, 1,086 cattle, 4,818 pigs, 4,233 goats and 35,730 poultry. In 2019, Program 135 supported poor and near-poor farmers with more than 30 cattle in total, at a value of 10 million VND per poor person⁵ and 7 million VND per near-poor person.

b) The percentage of poor and near-poor households ranges from 15% to 55%.

⁴ Program 135 originated from Decision 135/1998/QĐ-TTg issued on 31 July 1998 by the prime minster, "Program on socio-economic development of communes with extreme difficulties in ethnic minority and mountainous areas". Decision 07/2006/QD-TTg was issued for the second phase. Since 2012, the program has continued with the National Target Program for Sustainable Poverty Reduction in accordance with Decision 1489/QĐ-TTg, issued on 8 October 2012.

⁵ The poor: income of 700,000 VND/person/month (USD 30.5)) in rural areas and 900,000 VND/person/month (USD 39.1) in suburban areas. The near-poor: income of 1 million VND/person/month (USD 43.5)) in rural areas and 1.3 million VND/person/month (USD 56.2) in suburban areas (Decision 59/2016-QĐ-TTg issued on 19 November 2015 by the prime minister for standardization of the poor 2016–2020).

a) The rate of poor and near-poor households is at least 55% according to the multi-dimensional poverty line for 2016–2020,å and fewer than three of the following six conditions are met: (i) the main axis of the road to the People's Committee of the commune or the inter-commune road has not been concreted according to new rural criteria; (ii) the schools do not meet the national standards; (iii) the national criteria for commune health is not met; (iv) there is no commune culture and sports centre; (v) at least 20% of households do not have hygienic drinking water; and (vi) at least 40% of households do not have hygienic latrines.

c) The percentage of poor and near-poor households is below 15% but there is at least one extremely difficult village.

2.2. Methods

Data was collected in July and August 2019 using secondary information, key informant interviews at provincial, district, communal and farm levels, small expert group discussions at provincial and district levels and focus group discussions with farmers of Chieng Chung and Chieng Luong communes following the methodology described by Marshall and Huyen (2016).

Table 1: Summary of information collected and tools used in the study

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Type of information collected	Tools used	Key contact
Key programs, projects, policies relating to prior, current or planned, national, provincial and district livestock genetic improvement and breeding in the project districts	Key-person interviews	Vice-director of Son La Department of Agriculture and Rural Development (Mrs Cam Thi Phong)
Assessment of the level of policy implementation at national, provincial and district levels		Son La Department of Animal Husbandry, Veterinary Services and
Constraints and opportunities to livestock genetic improvement within the project districts, and opinions on best-bet interventions		Head of Mai Son Department of Agriculture and Rural Development
Introduction of contacts for relevant information and related reports/documents		(mr Cam van Thang)
Major livestock production systems in Son La Province and Mai Son District	Small group expert discussion (district	Veterinarians, technical staff of Mai Son Centre of Agricultural Services,
Major breed and cross-breeds types and their use for different production systems, including advantages and disadvantages for beef cattle, pigs and chickens	level)	Animal Husbandry office, agricultural extension officers and artificial insemination service providers (10
Constraints and opportunities to livestock genetic improvement within Mai Son District	Small group expert discussion (provincial level)	Animal husbandry and veterinary officers from Son La Department of Animal Husbandry, Veterinary Services and Aquaculture (4 participants)
Opinions on best-bet interventions on livestock genetic improvement		
Details of the specific breeding operations for pigs, chickens and	Key-person interviews	Minh Thuy company (grandparent
beef cattle (see Table 2)	Semi-structured questionnaire	(GP) pig farm) Loc Phat company (great grandparent (GGP) pig farm)
		Dung Hue (a private breeding chicken farm)
		An agricultural extension centre on importation and distribution of beef cattle semen
		Private AI units
		Village boar keepers
		Smallholder farms keeping exotic and local boars and selling breeding piglets in Chieng Luong and Chieng Chung communes in Mai Son District
The perceived demand for germplasm/breeding services; opinions on the different breeding services including availability, strengths and weaknesses, and improvements needed; and awareness and use of certified boars (pigs) or bulls (cattle) in relation to pigs, chickens and beef cattle	Focus group discussions	Smallholder farmers at both Chieng Chung and Chieng Luong communes, with one group of female and one group of male farmers per commune (7–8 farmers per group, see Table 2).

Venn mapping was used to identify the importance of different breeding units to smallholder farms. During the Venn mapping exercise, the smallholder farmers and different breeding units (breeding/AI stations, private breeding stations/ farms, private AI stations/farms, AI service providers, smallholder farms) were drawn onto a chart (as circles). Circle size was used to indicate the importance of the unit as a supplier of breeding material to the smallholder (the larger the circle, the more important), whilst the distance between the smallholder circle and the breeding unit circles was used to indicate accessibility (the shorter the distance, the easier the access). Arrows were used to show the movement of

breeding material, with the width of the arrow indicative of the amount of material sourced through that route (the wider the arrow, the greater the amount sourced). Upon completion of the Venn diagram, gaps in supply of livestock breeds and breeding operations were identified.



Focus group discussions (2019)

Additionally, smallholder farmers were questioned on their reasons for keeping different livestock species, scoring 0 (not important) to 10 (most important) for each reason. Further, the importance of breeding constraints in comparison to other constraints to livestock production, such as health, feed, markets and policies, were identified. Finally, the involvement of farmers in any projects and their learning around livestock genetic improvement, as well as their opinions on best-bet interventions on livestock genetic improvement, and why and how the interventions should be implemented were also identified during the focus group discussions.

Table 2: Number of stakeholders participating in the key-person interviews and focal group discussions

Interviewed stakeholders	Male	Female	Total
Provincial experts	2	2	4
District experts	5	5	10
Farmers in Chieng Luong (lowland and intermediate highland villages)	8	7	15
Farmers in Chieng Chung (highland)	8	7	15
Breeding farms	5	0	5
Al station/household	2	I	3
Village boar keepers (exotic and local)	2	0	2
Other interviews (Mai Son Department of Agriculture and Rural Development, Centre of	2	2	4
Agriculture Services; Son La Department of Animal Husbandry, Veterinary Services and			
Aquaculture)			
Total	34	24	58

3. Results

3.1. Key policies, programs and projects concerning livestock genetic improvement in Son La District

In general, farmers and local authorities at district, communal and village levels have been strongly supported in implementing the national and provincial policies and programs related to livestock development, especially commercialization of diversified livestock production and the introduction of high-performance breeds to improve performance and quality, e.g. lean-meat pig breeds, high-quality beef breeds and high-fertility chicken breeds.

Son La People's Committee Decision no. 3477/QD-UBND issued on 19 December 2014 approved a plan to implement an agricultural extension program for breeding, including AI for 1,400 Zebu cows and specialized beef cattle, support with breeding boars and building 10 models of parent chicken stock breeders and egg incubators in 10 districts. The Son La Agricultural Extension Centre has coordinated with local authorities and other stakeholders to implement breeding operations at different locations. National and provincial policies and programs have been implemented in the province to support livestock genetic improvement for smallholders, especially for the poor, focusing on support with breeding animals (mainly beef cattle, pigs, chickens and goats), breed selection and support for AI (beef cattle and pigs) (see Table 12 in Annex for further detail).

Decision no. 296/QD-UBND of the Son La People's Committee issued on 16 February 2017 approved the project Approving the Livestock Development Planning of Son La Province until 2020 and the project has further plans to 2030. Aims of the plan are (i) to focus on advantageous and competitive livestock products such as milk, beef, goats, pigs and bees as well as develop branded local special livestock products; (ii) to improve added value, disease safety and food safety in the livestock sector; controlling serious diseases for sustainable farmer livelihoods and poverty reduction, while adapting to the climate change; and (iii) to attract investment in sustainable livestock development.

Other major approved plans related to genetic improvement include the following.

- Development of pig production in family farms "gia trai" with over 10 sows and/or 50 to 500 fattener pigs in 12 districts and cities but concentrating on Thuan Chau, Mai Son, Song Ma, Phu Yen districts as well as Son La city. Exotic pig and crossbreed (Yorkshire, Landrace and Duroc) numbers to be increased with simultaneous conservation of domestic pig breeds (e.g. Mong Cai) and local breeds (black, and white and black), resulting in lean meat breeds comprising 55% of the total population and the remainder being local breeds.
- Development of chicken production in farms and family farms concentrating on Moc Chau, Mai Son, Phu Yen, Song Ma and Thuan Chau districts as well as Son La city. The planned breed structure is for 60% chickens for meat and 40% garden chickens. Super-egg chicken breeds such as Goldline and Egyptian chickens, ISA, BE and Sasso breeds for meat and backyard chickens (Tam Hoang, Luong Phuong) will be encouraged; while the conservation of indigenous chicken breeds (Ri, black H'Mong) is to be enhanced.
- Development of industrial beef farms and family beef farms with 10 or more cattle concentrated in the districts of Moc Chau, Van Ho, Song Ma, Thuan Chau, Quynh Nhai, Bac Yen and Mai Son. The plan is to increase the percentage

of imported high-yield cattle breeds from 30% Zebu cows in 2020 to 45–55% by 2030, and increase the percentage of beef cattle slaughtered in herds from 25.4% in 2020 to 30.5% by 2030.

Develop establishments to produce and supply breeding animals from 2020 to 2030:

- i. establish one provincial centre for producing and supplying breeding livestock and poultry and build a supply point for breeding buffalo and AI in most districts and Son La city;
- ii. invest in a breeding group of 50 boars for every two to three communes, ensuring each district has 4–5 breeding farms (parent and GP herds);
- iii. ensure each district and Son La city has one to two farms supplying commercial poultry;
- iv. build one to three incubators of 10,000–20,000 eggs in Son La city and Thuan Chau, Song Ma, Mai Son, Moc Chau and Phu Yen districts; and
- v. build and develop breeding farms to supply quality goat breeds in each district and Son La city and implement the selection and re-establishment of good breeding females between districts.

3.2. Livestock production systems and breeds used

3.2.1. Cattle

Table 3 summarizes the major cattle production systems in Mai Son District.

Table 3: Major cattle production systems in Mai Son District

,		
Systems	Description	Prevalent locations
Cooperative	Four cooperatives with 50–150 cattle and buffaloes	Chieng Mung and Chieng Sung communes
	Stall fed (purchased and grown forage, silage, rice straw)	
Stall-fed	Cut-and-carried grass (natural and grown grasses)	Hat Lot town and central communes along road
smallholder	Accounts for 30% of household farms	6
	Prevalence of 2–3 cattle/farm though some households with more than 15 cattle	Chieng Chung and Chieng Mai communes
Free grazing	Grazing in pastures on hill tops	Chieng Chung, Chieng Luong, Muong Bang and
	Accounts for 20% of household farms	remote communes where natural pastures/ grasslands available
Semi-grazing	Tended grazing during day supplemented with cut-and-carried grass (natural and cultivated), rice bran, cassava and banana plants in the afternoons and on rainy days	All localities





A forage grass field in Chieng Luong commune.



Forage grass grown on a pond side.





Forage grass grown along village road sides.

Bananas grown for stems for animal feed.

Cattle are mainly kept by smallholder farmers along road 6 (Hat Lot and Co Noi communes and Hat Lot town) under a semi-grazing, free-grazing or stall-fed system depending on the ecology of the region and the availability of natural pastures. Cattle breeds mainly comprise local Yellow cattle, 20% of which are crossbreeds (Laisind or Brahman crossed with local Yellow). Brahman is considered a suitable breed for genetic improvement due to its nice coat and colour, high carcass rate and ease of feed selection compared to Laisind (which needs concentrate supplement). Son La Agricultural Extension Centre has signed contracts to produce Brahman crossbreeds through Al of selected large-frame Yellow cows with agricultural service centres in Yen Chau, Song Ma, Mai Son, Muong La, Moc Chau, Thuan Chau, City, Van Ho and Phu Yen districts. The project aims to improve the body size of the small local Yellow cattle as well as push beef farming towards more intensive methods, improve forage growing and improve the provision of technical services.



Stall-fed cattle production in Chieng Chung commune.



Cattle housing in Chieng Chung commune.





Natural pasture for grazing.

3.2.2. Pigs

Smallholder pig production is the most prevalent system in Son La Province in general and in Mai Son District in particular. Farms raising exotic pigs are mainly concentrated in lowland villages and towns along road 6. The province has only two GGP and GP breeding farms, but these farms mainly supply parent pigs to their own branched farms to fulfil their production capacity. Table 4 summarizes the major pig production and breeds used in Son La Province. Mai Son District has almost all farm types and breeds except for GGP and GP farms.

Table 4: Maior	pia production	systems and	breeds used	l in Son La	Province

System	Description	Prevalent breeds	Prevalent locations	
Industrial farms				
GGP farm	Loc Phat company	L, Y, Du	Chieng Sinh commune (Son La city)	
	TMR* feed			
GP farm	Minh Thuy company TMR feed	L, Y, Du	Yen Chau District	
Contracted farms with	Two reproduction farms with 250–1,200	Exotic breeds of CP	Chieng Mung commune, Hat Lot	
Charoen	sows and 10–21 boars, producing 7,000–	LT and TL sows	town and Hat Lot commune (Mai Son	
Pokphand Group of	30,200 pigiets/ year	PiDu boars	District	
Thailand (CP)	Two fattening farms each with 2,000–		Chieng Sinh commune (Son La city)	
	3,000 fatteners/year		Moc Chau District	
	TMR feed			
Cooperatives	Hung Cuong cooperative with 200 sows	GF 24 (imported	Co Noi commune (Mai Son District)	
	and 4 boars, producing 2,800 piglets/year	from Green Feed	Muong La District	
	It Ong cooperative with 8,000 fatteners	company, USA)		
	per patch	Duroc x LY or YL)		
Parent farm producing	Farms of CP, Minh Thuy company and Loc Phat company with hundreds of sows and more than 1,000 fatteners	LY, YL (parent pigs)	Co Noi, Chieng Chung and Chieng	
fatteners		Duroc x LY or YL	Mung communes	
		PiDu x LY or YL	Hat Lot town (Mai Son District)	
	TMR feed		Son La city	
Other private farms	20–100 sows or more than 200 fatteners	LY; YL (parent pigs)	Co Noi and Hat Lot communes (Mai	
(Ministry of Agriculture	Comprising 5–8% of all pig farms	Duroc x LY or YL	Son) Son La city	
and Kural Development Resolution 27/TT- BNN)		PiDu x LY or YL	Moc Chau and Van Ho districts	

Household farms				
Large-scale family farm	10–20 sows for self-producing fatteners	LY; YL (parent pigs)	Along road 6	
(not yet meeting the criteria of Resolution	and 10–50 fatteners; or more than 50 fatteners of exotic crossbreeds	Duroc x LY or YL		
27/TT-BNN)	Crop by-products and compound feeds	PiDu x LY or YL		
Medium-household farms	10–15% of all pig farms <50 fatteners (average of 20–30 pigs) of crossbred exotic breeds; might be with several sows for self-producing fatteners	LY; YL (parent pigs) Duroc x LY or YL PiDu x LY or Yl	Along road 6 near towns Some in intermediate-highland villages	
	TMR and compound feeds			
Smallholder farms	<20% of all pig farms I–5 sows and approximately 10 fatteners plus piglets, local breeds and crossbreeds	Duroc x LY or YL PiDu x LY or YL	Intermediate highland zones In more remote villages and in highla	
	Rice bran, maize meal and local feed resources	Local Ban and/ or crossbreeds of	villages	
	Kept in pens or free ranging in very remote villages	Mong Cai x Ban or Duroc or PiDu x Ban		
	60–70% of all pig farms			

Notes: L: Landrace; Y: Yorkshire; Du: Duroc; PiDu (Pietrain x Duroc); LY: (Landrace x Yorkshire); YL: (Yorkshire x Landrace); A x B = sire x dam. * TMR = total mixed ration; CP = Charoen Pokphand Group of Thailand.

Landrace and Yorkshire breeds are mainly used as dams and sires to produce crossbred maternal sows. Duroc and PiDu are used as terminal boars to produce lean meat commercial fatteners. Some private farms who keep more than 100 crossbred fatteners buy piglets for fattening from industrial farms. As buying breeding pigs is difficult and expensive, many farmers select commercial pigs and keep them as breeding sows. The growth rate of local crossbreed pigs is lower than exotic pigs: exotic pigs are weaned at 21 days and raised for 6–7 months and may reach 120–130 kg in weight; local crossbreeds may only reach 80–90 kg after the same period. The local breed (Ban) are dominant in remote villages and are very small (30–45 kg as one-year-olds).



Feeds of local pigs.

3.2.3. Chickens

Chickens are mainly raised on smallholder farms under free, semi-free or garden scavenging systems from some dozens up to about 100 chickens. Breeds include unidentified mixed genotypes of Ri, Mia, Choi, Luong Phuong, Lac Thuy and Hmong. Some farmers still want to raise white exotic chickens for more than six months to obtain a high body weight for both meat and eggs. Some smallholder farms in Mai Son District have more than 200 chickens (garden scavenging) in Na Bo, Chieng Sung, Co Noi and Hat Lot communes and Hat Lot town; and some farms have 1,000–4,000 chickens under garden scavenging systems. A contracted farm of CP in Chieng Ngan commune in Son La city has 20,000 meat chickens (707 CP breed); and Dung Hue private farm in Hat Lot town, Mai Son District, has 200,000 chickens of different breeds – Hyline hens, crossbreeds of Luong Phuong with Choi and Mia for meat, and Egyptian chickens, D3000 and D16

(National Institute of Animal Science, Vietnam) for eggs. This farm has been acting as a breeding farm, supplying chickens to smallholder farms in Son La Province, particularly Mai Son District.

3.3. Breeding operations

On average, demand across the whole province was for more than 280,000 breeding pigs and 663,000 poultry of all kinds annually between 2016 and 2019. Breeding farms within the province supply about 30% of that demand.

3.3.1. Cattle

On smallholder farms, Yellow cattle or mixed crossbreeds of Laisind and Yellow cattle mainly mate naturally in the pastures. For cattle kept in barns, farmers can ask for a good bull from neighbours for one or two days for their cows.

An Al program through the Centre of Agricultural Services provides 100 to 250 doses per year in Mai Son District of crossbred Brahman or Brahman semen to cross with Yellow cows. The frozen semen straws are imported from the Centre for Large Ruminants of the National Institute of Animal Science, in Tu Son District, Bac Ninh Province under the provincial budget. In 2019, of the 100 cows artificially inseminated, 60 cows achieved conception. Cows in program communes (along road 6) were checked for size and reproductive performance. Given the limited number of semen straws and poor road conditions in remote communes, the Al was concentrated in communes near towns and along road 6.

3.3.2. Pigs

Pig breeding farms

Pig breeding operations vary between farm types. Table 5 summarizes breeding structures in different breeding farms in Son La Province.

Breeding farm	Pig breeds used and breeding formulas			
Breeding farms (GP, GGP herds)	Yorkshire x Yorkshire and Landrace x Landrace			
	Y L			
	Y x L and L x Y			
	YL LY			
	YL and LY: maternal sows to produce commercial pigs			
Fattening farms with parent herds	Duroc x YL or LY PiDu x LY or LY			
	Commercial pigs			
Private breeding household farms	Duroc x YL or LY and PiDu x LY or LY sows crossed with or AI of Du or PiDu boar or unidentified breed			
	Ban or crossbred of Ban (with Mong Cai or PiDu) x Ban			
	In remote villages, Ban male x Ban sow			
Private breeding household farms raising	Wild sire (W) x Ban dam (B)			
wild boar	W sire x WB			
	W sire x WWB			
	W sire x WWWB			
	WWWWB (4WB) used as parent boar and sow			
	W sire x 4WB sow and 4WB boar x other Ban sow to produce commercial Wild–Ban pigs			

Table 5: Breeding structures in different breeding farms in Son La Province

Note. L: Landrace; Y: Yorkshire; Du: Duroc; PiDu (Pietrain x Duroc); LY: (Landrace x Yorkshire); YL: (Yorkshire x Landrace); A x B = sire x dam.

Loc Phat GGP farm

This private breeding company was established in 2007 with housing construction following the design used by CP. This is the second farm in Son La Province to have imported super lean meat pigs from CP (two-breed crossing) with an aim of closed production from birth to off-taken to reduce animal health risks. In May 2007 the company imported three Yorkshire sires, three Landrace sires, 28 Landrace dams and 28 Yorkshire dams from France (Axiom company) (a total of 62 GGP pigs). The company now owns 1,000 GP dams, 20 GP sires and 500 parent pigs. Some 121 Duroc sires were imported from CP. The software program obtainable from vicapig.com of Vietnam is used to manage inbreeding in the herd. For incorrect matings, the pigs are culled and sold commercially. Semen imported from Amavet company is used to refresh the herd. The breeding formulas presented in Table 6 for GPP breeding farms and fattening farms with parent herds are relevant for Loc Phat farms.

LY or YL are used as maternal sows and Du as terminal boars to create commercial pigs of Du x LY and Du x YL. In general, some 100 pigs are replaced each year. Gilt and GP sire selections are described in Table 6.

Table 6: Criteria for sele	Table 6: Criteria for selection of glits and GP sires on Loc Phat farm			
	Selection criteria			
Gilts				
General selection	Straight and compact legs, weight >70 kg, large vulva and at least 14 even teats (GP, 16 teats)			
At birth and at weaning	Based on weight			
At 30 kg	Using appearance and growth rate			
At 70kg	Using appearance and growth rate			
GP sires				
At birth and at weaning	Based on weight: the first selection is for the best five male piglets/litter, then the best three at weaning			
At 70 kg	Based on appearance			
At 35 weeks	Based on a semen check inclusive of the volume and density			

Table 6: Criteria for selection of gilts and GP sires on Loc Phat farm

Commercial crossbreeds of Du x LY and Du x YL are 62% lean meat.

Formerly, the smaller PiDu breed (<100 kg) was also used as a terminal boar for producing commercial fatteners; however, current market demand tends to favour larger slaughtered pigs of 120 kg, making the Duroc more suitable.

In 2018, Loc Phat company sold approximately 150 GP pigs (at 12 million VND per GP dam of 100 kg) and semen of GP L and Y sires (at 300,000 VND per dose) to farms who raised more than 20 sows in Son La city and central Mai Son District. Additionally, the company sold 500 parent pigs to farmers in Son La city (the price for a sow is the price of fatteners + 2.5 million VND as a breeding fee (if the buyer buys 10 or 20 sows they may get one bonus sow) and 10,000 commercial piglets for fattening. However, they are still not meeting the demand in Son La Province (the GP dams, parent sows and piglets for fattening are mainly sold to farms belong to the company). Additionally, 6,000 fatteners were sold to traders in Son La, Dien Bien and Lai Chau provinces and Hanoi city in 2018. Some certified boars and Duroc semen were sold to farmers in Son La city (at a cost of 50,000–70,000 VND/dose).



View from camera on a farm of the Loc Phat company.

Minh Thuy GP farm

The farm is located in Ta Vai Bridge, Yen Chau District. It was established in 2013 exclusively using Landrace, Yorkshire and Duroc and their crossbreeds. At time of the interview, the farm held 1,296 sows (including 113 gilts), of which 961 were parent sows of LY and YL, 145 were GP Landrace dams, 176 were GP Yorkshire dams and 14 were GP Duroc dams. The farm has three sire types (24 Duroc, 6 Landrace and 7 Yorkshire). Breeding formulas are similar to that of Loc Phat. The breeding objective is to produce a parent herd of YL and LY breeds with a good appearance and cross them with a Duroc terminal boar with a high lean meat rate to produce three crossbred commercial pigs.

LY and YL parent sows had 12–13 weaned piglets/litter. Detailed criteria for selection of sows are given in Table 7. Criteria for boar selection are long legs, walking on straight hooves that are bunched together, no osteoarthritis and even testicular bags. Three to four boars were selected from each litter through six periods as for sow selection.

Sows	Selection criteria
General selection	More than 12 even teats, no small teats, long legs, walking on straight hooves that are
	bunched together, no osteoarthritis, no respiratory issues
Six stages of selection	
At birth	Strong, weight 0.8–0.9 kg, no abnormalities
At weaning	No osteoarthritis, weight 7.2–7.5 kg
At 9 weeks	About 20 kg, selection of strong pigs as breeding sows and of weak pigs and those who eat
	little as fatteners
At 12 weeks	About 40 kg, continuous selection
At 17 weeks	About 80 kg and using sow selection criteria
Final selection	Using sow selection criteria, then mate/Al if in oestrous every three weeks

Table 7: Criteria for selection of sows on Minh Thuy farm

Each year the farm imported 12–13 Landrace and Yorkshire sires from Taiwan. Normally, semen and sows from the farm were sold to Minh Thuy's fattening farms. Previously, extra semen doses of Du, L and Y (500–600 doses/ year) were sold to farmers in Yen Chau and Mai Son districts, particularly in Co Noi commune (Mai Son District) and smallholders around Yen Chau District for 50,000 VND/dose. However, due to a serious disease problem, semen sales were stopped to reduce contact with other pig farms.

For the management of breeding herds on the farm, ear ID at birth is made for date of birth, and identity of father and mother. The farm replaced 50% of the pigs every year (culling 600 sows in 2018 (those at 8th–9th litters)). Sow selection is related to mating date, menstrual cycle and sires used.

Household farms mainly buy commercial pigs from Minh Thuy farm for fattening though some pigs are also selected as breeding sows or boars.

A private breeding household farm in lowland Chieng Luong commune: Exotic pigs

This is one of a number of private smallholder farms in the region raising exotic pigs. The farm was established in 2015 with seven sows bought from Loc Phat company (LY and YL) to produce commercial pigs: Du x LY or YL and PiDu x LY or YL. Sows are crossed with boars of other farms. These crossbreed piglets are sold to other smallholders for fattening or as breeding animals. Those pigs sold to smallholder farmers as breeding animals are good-looking crossbred Duroc sows with large buttocks and shoulders, long bodies and at least 12 even teats. The selection is made with female pigs five months after their first season. Only 50% of smallholder farmers who purchased breeding pigs from this farm sent feedback that they were satisfied with their sows so in some cases pregnant sows were sold to ensure reproductive performance (10 pregnant sows were sold to smallholders in the villages and surroundings in 2018). The farm owner understands that smallholder farmers buy selected female commercial pigs from the farm to use as breeding sows due to their low cost and easy accessibility.

Prior to an outbreak of African swine fever, the farm selected about two gilts from each litter to sell as breeding animals to smallholders in the commune. Female pigs aged five months were sold as sows for a higher price than fatteners (an additional 1,000–2,000 VND/kg live weight). Pregnant pigs were sold for an additional 500,000 VND as a mating fee. Previously, breeding boars provided a natural mating service; however, following the African swine fever outbreak they were restricted to only producing semen for AI to avoid disease transfer.



Exotic pigs on private household farm in Chieng Luong commune.

A private breeding farm in highland Chieng Chung (with wild boar and local Ban pigs)

The farm was established in 2010. The farm owner bought a small wild male piglet and kept it as a boar, who then mated with Ban sows. The breeding objective is to create a local pig with a high level of genetic contribution from the wild boar, a stable phenotype and productivity to produce commercial herds. The fourth generation (4WB) is kept as the parent herd (see Table 5). The 4WB pigs have wild boar features including three hairs in one hold, the tip of which divides into three white ends. The price of a pig (<20 kg) is 120,000–150,000 VND/kg live weight). The 4WB sows show quite a good reproductive performance, e.g. five piglets/litter for a WB sow compared to 10–12 piglets/litter at birth and 9–10 piglets/litter at weaning for a 4WB sow. 4WB sows also show a good growth rate and can eat different kinds of feeds. Currently maternal breeds comprise 4WB sows and pure Ban sows; and paternal breeds comprise wild boar and 4WB boars. The farm owns 52 pigs, with six sows (two 4WB and four Ban) and two boars (one 4WB and one wild boar). Natural mating is used. In 2019, one boar and eight sows were sold to a farm in central Mai Son (180,000–200,000 VND/kg live weight) The farm owner is self-taught and continues to learn.



A private farm with wild boar and crossbred wild boar and Ban sows in Chieng Chung commune.

Al stations

Al station in Hat Lot town

This station is owned by a veterinarian of the Mai Son Centre of Agricultural Services. He obtained support from a government breeding program for breeding boars. At time of the interview, the station owned six boars aged 2–5 years for semen collection, four of which were PiDu provided by the government program and which originated from Dabaco company, whilst the remaining two Taiwan Durocs were bought by the owner himself from Amavet company (about 400km away)) at a cost of 30–42 million VND (as one-year-olds). The station owner himself bought the additional boars based on the typical features of the breed: big buttocks and shoulders, short hair and polished cockroach-wing-coloured skin for the Taiwan Duroc. He selected the PiDu based on yellowish hair, a long body and big buttocks. The first semen was produced at 14 months by the Duroc boars and 12 months for PiDu boars. Semen quality is checked every week. The boars will be culled when productivity declines significantly. Semen is collected from two boars/day giving 10–20 semen doses/day for sale at 50,000 VND/dose. On average, the station serves about 10 sows/day, i.e. 3,000–4,000 sows/year. The semen of the station is distributed to farms and households in Mai Son, Yen Chau, Bac Yen, Muong La and Song Ma districts and Son La city.

The PiDu boars are of good quality, providing nice piglets with big buttocks and shoulders, reaching 130 kg six months after weaning at 21 days. The Taiwan Duroc boars provide piglets with big buttocks and shoulders, muscle, as well as a high growth rate (fatteners of 130–140 kg six months after weaning at 21 days). The Duroc piglets obtain a higher price than the PiDus (an additional 1,000–2,000 VND/kg). Taiwan Duroc boars are preferred by pig farms given their good productivity, the high price for fatteners (>2,000 VND/kg) and high lean meat rate. Semen from PiDu boars is preferred by households keeping Ban pigs to produce black piglets. No customers have asked for certified boars. The station only keeps records of date of vaccination, age, date of import and health status of the boars. The station also provides training and guidance for customers performing Al. Of the two technical staff at the station, only one can provide training on semen collection.

A private Al unit in Chieng Luong commune

This private station belongs to a communal veterinarian in Phu Luong, a lowland village of Chieng Luong commune, who has been keeping boars for six years. At the time of interview, the unit kept two Duroc boars and one PiDu aged between two and four years. In 2017 and 2018, the boars were used for natural mating and served about 1,000 sows in the region. Since January 2019, after the outbreak of African swine fever, the boars have been used for Al only. To select the first boar, the owner visited a range of breeding farms up to 400 km away and Minh Thuy farm (Mai Son District) and decided to buy the Duroc breed in Hai Duong Province for its lean meat. The PiDu boar was selected for its large buttocks and shoulders though the body is shorter than the Duroc breed. In general, a boar is selected based on tall and long body, dry fauces, small neck, large and compact buttock and semen quality (strong, evenly distributed sperm). Boars were bought at 8–9 months and cost 22–30 million VND. Boars were certified at purchase, but during servicing, boar certification is never requested. First use for semen production is at 10 months. Customers mainly come from Yen Son, Chieng Pan and Phieng Khoai communes (Yen Chau District) and Co Noi commune (Mai Son District). The price depends on the distance to perform services (near: 150,000 VND/two doses and service; far: 250,000 VND/two doses and service; semen only: 50,000 VND/dose, two doses/sow). Sperm density is checked at each collection. Date of semen collection and customer contact details are recorded to provide a one-month guarantee.



Boar of a private AI station in Chieng Luong commune.

Village boar keepers

The practice of keeping boars to provide natural mating services was found in the highland Chieng Chung commune, where it is a side activity used to serve the family-owned and neighbouring sows. Both Ban and crossbred boars are found. For example, a communal veterinarian of Chieng Chung keeps a four-year-old Ban boar. Between 2009 and 2015, he has kept a bull through an agricultural extension program for natural mating with selected local cows and received 200,000 VND/service. However, with the end of the program he disposed of the bull as it was not economically efficiently. Since then, he has kept a Ban boar to serve the high demand in the commune for Ban sows. The Ban boar was bought at the remote Mong village aged six months and weighing 7 kg for 700,000 VND. The boar was selected based on physical appearance – smooth hair and skin, long head, long nose, small ears, straight back, even hooves, black colour – and the reproductivity of the mother sow (number of piglets/litter). The appearance of mother was also checked. This Ban boar performed his first mating aged 18 months and might be stopped from serving aged five. Annually, the boar serves three family-owned sows and eight other sows, with a performance of 9–12 piglets/litter. The boar is walked to the sows' farms (up to 2 km). The fee is 100,000–150,000 VND/service. The most important livelihood activities for this farmer are cattle, pigs, coffee and poultry production. The farmer wants to raise an exotic-Ban crossbred boar

to cross with Ban sows to increase the lean meat rate so gain a higher price for the fattener piglets. However, he lacks information about pig breeds and places to buy.

Another boar keeper in Chieng Chung commune keeps a boar of unknown breed aged three years for serving the familyowned crossbreed and Ban sows and about 10 neighbouring sows. This boar keeper bought a weaned piglet litter from a smallholder in Chieng Mai commune (10 km away), then selected a male as a breeding boar to service crossbred sows to produce lean meat fatteners. Selection is made based on large appetite and ability to eat a variety of food, long body, tall legs, black hair, even buttocks and cheeks and long nose hairs. The farmer's former boar is white with black spots, but as smallholder farmers did not like to mate him with black pigs, this boar was culled after six years. Both boars were bought from known smallholders and the productivity of mother sows checked. On this farm, pig production, including boar service, is the second-most-important family income after coffee.



Local boar in Chieng Chung commune.

3.3.3. Chickens

Smallholder chicken production

Smallholder chicken production in Son La Province involves local or unidentified mixed crossbreeds, natural mating and hen self-hatching.

Dung Hue private breeding farm

Dung Hue farm is the only private breeding chicken farm in Son La Province. Initially (2014), the farm focused on developing parent herds and a hatching service. Sales to collectors fluctuated between 60,000 and 200,000 chicks/ month. From 2016, the farm also raised super-egg breeds with the purchase of 2,000 parent stock of Luong Phuong breed from the National Institute of Animal Science and more than 20,000 super-egg chickens (Hyline, Jafa, CP, Hoa Phat and Isabrown breeds), 700 Egyptian hens for eggs, and several dozen Choi (fighting cocks) and Mia cocks for crossbreeding with Luong Phuong hens. In addition, the farm is still raising 10,000 white chickens per year. One cock is kept for 10–12 hens. Production capacity of the farm is 16,000 eggs/day. The hatching rate is more than 80%. The farm also owns two hatching machines (with a capacity of 27,000 eggs per patch). More details on chicken breeds and their uses are described in Table 8.

Breed and crossbreeds	Characteristics and use
Luong Phuong	Big and high growth rate but low disease resistance
	Used as maternal hens
Crossbreed of Choi cock with Luong Phuong hen	Good and tasty meat with high egg production and big body (2 kg at 75 days) and for good price (60,000 VND/kg)
	Dual-purpose commercial chicken
Crossbreed of Mia cock with Luong Phuong hen	Productivity of 220 eggs/year as Luong Phuong breed (pure Choi: 60–85 eggs/hen/year; pure Mia: 150 eggs/hen/year)
	Dual-purpose commercial chicken
Jafa and Hyline super-egg breeds	Big and nice pink eggs
	Production of commercial eggs
CP breed	80–90% reproduction rate but small eggs
	Production of commercial eggs

Table 8: Chicken breeds and their uses on Dung Hue farm

The farm produces commercial chickens to supply breeding programs in the province and also sells to smallholders in Yen Chau, Mai Son and surrounding districts. Chicken are supplied at 10 days of age (0.3–0.5 kg) to district programs, at one week for white chickens and two weeks for coloured chickens. Many farmers prefer the crossbreed of Mia with Luong Phuong.

3.4. Supply of breeding animals and breeding services to smallholders

Livestock production has multi-functions on smallholder farms, and different species have different roles. For instance, cattle and buffaloes play an important role as insurance for the family and provide manure for fruit trees and crops; pigs have high social and cultural value in the highlands and provided income in the lowlands as well as provided manure for crops; chicken and other poultry are the main protein source for the family. Goats are kept by some farmers for income generation. The visions of men and women differ in terms of income generation from pig production. The female farmers in Chieng Chung commune wanted to develop local pig production for income, while the men did not see much economic value in local pigs. The female farmers also felt threatened by potential diseases to the exotic herds but the male group hoped to increase the biosecurity of smallholder farms in pig production (Table 13 and Table 14 in Annex).

3.4.1. Cattle

Famers can pay 100,000–200,000 VND per successful service from a good neighbouring bull. Criteria for selection of good cattle and buffalo are degree of tameness, nice appearance, big compact body and long legs, big ears, even teats and large buttocks (good for grazing cattle climbing on slopes). Some households in lowland villages in Chieng Luong commune have started raising crossbred Brahman cattle bought from breeding collectors in Kim Son, 3–4 km away, for 15 million VND for a calf of eight months. These crossbred cattle are fast growing but have a high age of first mating (25–27 months) and long calving intervals.

Male farmers expressed concerned about finding quality breeding cattle in the region; while female farmers were concerned about the high price of breeding calves (20–25 million VND for a one-year-old calf and 35 million VND for a two-year-old buffalo).

3.4.2. Pigs

Chieng Chung commune highland villages

Figure 2 describes the demand and supply of breeding services for smallholder pig farms in Chieng Chung commune. The female farmer group was satisfied with the current services, performance and quality of sows (Ban sows with 10–12 piglets/litter, mortality before weaning: 1–2 piglets/litter, use of Ban boar for 2–3 years; and crossbreed sows with up to 15 piglets/litter, mortality before weaning: 2–3 piglets/litter, use of boar for four years). Both crossbred sows and boars have been selected from commercial litters. Agents with fresh semen were considered somewhat distant but the price (40,000 VND/dose) was considered acceptable as farmers could perform AI themselves (with a success rate of 90%). The male farmer group was concerned about a lack of breeding support services and low breed quality, as well as disease transmission threatening the use of the village boar for natural mating.

Figure 2: Demand and supply of breeding services for smallholder pig farms in Chieng Chung commune.





piglet for fattening

Legend: Arrows represent movement of pigs, e.g. (top left yellow arrow to same box) movement of gilts from one Ban pig smallholder to another Ban pig smallholder; thickness of the arrows represents the level of the service or movement; percentages represent percentage of smallholders in the study keeping that type of pig.

Chieng Luong commune, lowland and intermediate highland villages

In general, farmers raise one to two Ban sows; among farmers in the lowland villages raising crossbreeds, a few raise hundreds of pigs per year but on average they raised 20–30 fatteners/patch and have up to 100–150 pigs/patch; they only sell breeding piglets when lacking space indoors to keep them. The male farmer group did not attribute much significance to the differences in breeding services and pig performances between the lowland and highland villages (more breeding support services are available and pigs perform better in the lowland than highland villages), whereas the female group did.

Figure 3 outlines the supply of breeding services and materials in Chieng Chung commune as described by the female farmer group. Although it is easy to buy local Ban pigs it is difficult to buy crossbreeds or exotic breeds due to lack of breeding sources, information and local availability. Performance of local breeds and their crossbreeds is low at 5–8 piglets born alive/litter and five piglets surviving to weaning; while white crossbreeds show higher performance (12–13 piglets/litter (though 17–24 piglets born alive/litter farmers cull piglets to fit with number of teats of the sow) and a low mortality rate). Before the African swine fever outbreak, boars were mainly used for natural mating, then after the outbreak only for Al. Breeding pigs are selected using the following criteria: (i) white gilt: 12–16 teats, large buttocks and shoulder, long legs, tamed, larger than others in the litter; (ii) local gilt: tall, big, long body, black and smooth hair, eating diversified feeds, strong, large buttocks and shoulder, 8–12 even teats; and (iii) local boars: the biggest and strongest of the litter.

Lowland villages (Lan Quynh, Phu Luong, Y Luong) **Highland villages** Breeding farms in other provinces Village boar service nen for Al units 40,000 200,000 VND/ VND/dos Boars stations Ban pig keepers successful service within Son La from other District communes Households raising exotic pigs (6-30 sows and or Ban boars 20-200 fatteners)80% from other communes 200 000 VND/ successful Other households service raising exotic pigs Ban pig keepers Households raising Ban (stall-fed sows and pigs (1-2 sows; 5-7 a boar; 1–2 semifatteners (with a boar) scavenging sows) Breeding farms in Mai Son District gilt boar piglet for fattening

Figure 3: Demand and supply of breeding services for smallholder pig farms in Chieng Luong commune.

Legend: Arrows represent movement of pigs, e.g. (mid-bottom left yellow arrow to same box) movement of pigs from one exotic pig farmer to another smallholder; thickness of the arrows represents the level of the service or movement; percentages represent percentage of smallholders in the study keeping that type of pig.

3.4.3. Chickens

On the smallholder farms, hens hatch their eggs naturally. Broilers or one-day chickens could also be bought at an agent in Mai Son town or Son La city. Normally 2–3 cocks are kept for about 10 hens. The male farmer groups were not satisfied with the quality of current chicken breeds; while the female group in Chieng Luong complained about the high price of some

breeds such as Tam Hoang, Dong Tao and Choi, and they raised a need for suitable and good breeds for eggs. Farmers selfselected from their farms to produce replacement hens and cocks, selecting for yellow feet, height, big body, good maternal care of chicks, smooth feathers and an average egg-laying frequency of 15–18 eggs/period (range 10–20).





Household poultry raising.

Local chicken and pig houses.

3.5. Stakeholder views on constraints and opportunities and suggestions for livestock genetic improvement

Tables 9 to 11 show stakeholders' views on the constraints, potential and interventions for genetic improvement.

Table 9: Views of provincial and district officers on constraints and potentials in genetic improvement

	Provincial level	District level					
Constrair	nts						
General	Poor communal veterinary resources	Communal vets and livestock officers lack information and					
	High disease incidence	knowledge on genetic improvement					
	Little available capital and poor knowledge about genetic improvement	Farmers unaware of the importance of good breeding animals, which require higher input costs					
Specific		Dependence on sourcing breeding pigs and chickens from the Red River Delta region, which is distant					
Potential							
General	High demand on breeding animals and their improvement						
	Supported policies/programs at provincial and district levels						
Specific	Farmers learn from other farmers and actively extend grass	High demand for good breeding pigs and cattle					
	growing for cattle	Consumption preference for local pigs and chicken					
		Land available for garden-scavenging chickens					
		Many farmers can perform AI on pigs after training					

Table 10: Views of breeding service providers and farmers on constraints and potentials in genetic improvement

	Breeding service providers	Smallholder farmers					
Constrain	ts						
General	Lack of information	Selection of breeding animals based mainly on					
	Dependence on breeding animals from other lowland provinces	experience with poor knowledge of animal breeds					
	Farmers unaware of the importance of good breeding animals	Disease transfer risk from natural mating					
	Large mountainous area with difficult accessibility and high	Access to vets mainly restricted to village vet workers					
	transport costs to the remote areas	Poor biosecurity conditions					
	Disease transfer risk from natural mating						
	No support from government for breeding farms in the province						
Specific	Sows on household farms are of poor quality due to the use of	High costs for crossbred and exotic pigs					
	commercial pigs as breeding sows	Low quality cattle breeds					
	Fluctuation in desire to keep pigs as disease outbreaks deter	Low reproductive performance of cattle crossbreeds;					
	farmers	lack of knowledge on raising techniques					
	Dependence on buying breeding pigs and chickens from the Red	Support to access breeding animals required					
	River Delta region, which is distant	Suitable and high-quality chicken breeds for eggs					
	Farmers mainly raise chickens for home consumption	required					
		Lack of knowledge on re-establishing pig herds after					
		critical shocks, e.g. disease outbreaks, market shocks					
Potential	Increased demand for chicken and cattle meat and chicken	Farmers want to develop livestock production					
General	production as reduction of pig production and pork consumption						
	National program for lean meat						
Specific	Increasing trend in exotic hig production by smallholders, which	Local breeds have good disease resistance Market for Ban pigs is available					
specific	could lead to restructuring of pig herds; however, there are	Lack of former code and information					
	limited numbers of Al stations and village boar keepers	Lack of forage seeds and information					
	High disease resistance of local pigs						
	Wild and Ban pig production is suitable for local climate, feed and						
	conditions, and there is market demand						



Transporting pigs by truck.

Table 11: Suggested intervent	ions by stakeholders on l	livestock aenetic imp	provement

	General interventions	Specific interventions						
Provincial level	Build capacity for cooperatives and cooperative groups	Smallholder cattle, goat and chicken farmers and large-scale pig farms: support with breeding animals and with technical guidance on livestock and veterinary laws						
District level		State and private breeding services to coordinate support for breeding boars and semen Provide semen for AI in cattle to support improved breeding cows for the poor						
		Provide good quality boars that are ready for semen collection, and support equipment for semen processing to the right people						
Service providers	Increase cattle raising and garden-scavenging chicken production for poor smallholders Introduce professional industrial/intensive pig farms at a suitable scale with standardized biosecurity and environment	Introduce chicken breeds for garden scavenging for meat and eggs Make AI more widely available for cattle and pig keepers to overcome the difficulty of changing farmer behaviour and awareness on purchasing good-quality animals Introduce local pig and cattle crossbreeds to increase productivity and adaptability via AI						
		Improve the capacity of pig keepers to select high-quality sows						
		Support for keeping breeding boars (e.g. technical and breed selection training)						
		Develop an interest group of wild and Ban pig production and develop a market						
Smallholder farms	Incorporate training on breeds, breeding, breed selection into veterinary services by building	Introduce suitable chicken breeds for eggs and meat Provide training on AI for cattle and on selection of local cows to use AI with exotic semen						
	knowledge of village vets Establish linkage groups between farmers on	Support communes with good boars and with raising local breeds						
	cattle and poultry production (on cattle raising for better-off farmers, chicken production for meat and for eggs for poorer farmers and on local pigs where pigs are present	Introduce or support forage production, processing and preservation in cattle programs as well as provide relevant support services (e.g. AI, vet)						
	Support for programs on supply of breeding animals needs to include services and training on breeding techniques							

4. Potential interventions

From the assessments presented above, the following interventions on livestock genetic improvement of cattle, pigs and chickens in Mai Son District are suggested.

- 1. Producer capacity building on breed choice and breeding, including on artificial insemination, for cattle, pigs and chickens and preferably as part of overall producer capacity building efforts.
- 2. Strengthening AI service provision for beef cattle and pigs via training of women and men service providers and ensuring they are linked to semen providers so providing semen of farmer-preferred breeds of high genetic merit.
- 3. Establishment of community-based AI for beef cattle and pigs (i.e. community-level synchronization and subsequent AI resulting in a crop of animals born and potentially marketed at the same time), assuming sufficient market demand exists for these crops of animal and that producers are interested in formulating groups for joint animal marketing. A feasibility study to investigate both these issues would be required.
- 4. Establishment of smallholder or medium-scale breeders of high-genetic-merit chickens (adapted and productive). Here assessment studies are required to determine the (i) feasibility of smallholder breeders supplying chicks to backyard chicken keepers; and (ii) establishing and/or supporting semi-commercial chicken enterprises with a role for medium-scale breeders in chick supply.

As next steps for the LI-CHAN project, the above-suggested interventions will be further discussed with stakeholders and a joint decision made on 'best-bets' that the project will implement. It is important to note that similar assessments are being undertaken for other varied issues relating to sustainable intensification of these systems including on animal health, feed, marketing and environmental sustainability (Notenbaert et al. 2019; Dung et al. 2020; Lee 2020; Atieno et al. 2021; Nga et al. 2021). This is intended to result in identification of best-best interventions in these areas that will be combined to offer tailored 'intervention packages' to the women and men farmers and other value chain actors.

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6. Annex

Table 12: Summary of other policies and programs related to livestock genetic improvement that have been implemented in Son La Province 2011–2019. Policy/program Brief description

Policy/program	Brief description
Decision 490/QĐ-UBND	Plans to support cooperatives and enterprises of organic production in the period of 2019–2020.
28 February 2019	Funds of 825 million VND to support two models of organic pig raising.
Decision 577/QÐ-UBND 11 March 2019	A plan to support enterprises producing and transferring techniques for raising white horses in 2019 (2.1 billion VND).
Guideline 217/HD-SNN	Procedures to register and regulations on breeding livestock sectors in Son La Province in the period
Decision 369/QD-UBND	Standardization of breeding cow and buffaloes to support programs and projects in Son La Province
23 February 2017	in 2017.
Guideline 153/HD-SNN 21 March 2017	Standardization of female buffalo and cows to support projects in Son La Province in 2017.
Guideline 196/HD-SNN 7 May 2016	Selection of buffalo bulls to support smallholder livestock breeding development according to Decision 50/2014/QD-TTg in the period 2016–2020.
Guideline 331/HD-SNN 4 October 2016	Implementation of breeding boar management in Son La Province in the period 2016–2020.
QD 1460/QD-TTg 23 August 2011	Support of 25 breeding cows (380 million VND) in the period 2011-2015.
Resolution 30A/2008/NQ- CP	2017 to May 2019: support of 1,629 breeding cows and 25 breeding female horses to households (41.1 billion VND).
Program 135	Support of 1,406 breeding cows, 54 breeding female horses, 401 breeding pigs and 443 breeding goats to households of districts in Son La Province (19.5 billion VND) in 2017–2019.
	In Mai Son: 80 breeding cows (2017) (942.6 million VND); 185 cows (2018) (3.0 billion VND); 247 cows (2019) (3.0 billion VND).
Program of district economic development	Support of 72 breeding female horses, 195 breeding pigs and 443 breeding goats to households of districts of Son La Province (808 million VND) in 2018 -2019.
Program of poor reduction phase 2	Support of 1,842 breeding chickens and ducks to households in districts of Son La Province (90 million VND) in 2018–2019.
Program for new rural development	Support of 180 breeding cows, 34 breeding female horses, 25 breeding pigs and 100 breeding goats to households (2.7 billion VND) in 2018–2019.
Program of Women Union	Support of 15 breeding cows (270 million VND) in 2018–2019.
Program of AI for cattle	Al for 5.184 cows producing 400 calves in 2018–2019.
Project	Study and conservation of black Hmong chicken in Son La Province; produced 1,000 breeding chickens with extension to the districts of Son La Province, especially to Thuan Chau district 2018–2019.
Project	Application of good breeding procedures (breeding and breed selection, training, forage growing) in crossbred goats and building up commercial goat production farms in Son La. Selection of 200 local she-goats and importation of 20 he-goats of Bach Thao breed 2017–2019.
Agricultural Extension Programs	Demonstration farms with support for AI for cows, exotic boars, reproduction goats, chicken and ducks, and with biosecurity chicken production 2018–2019.
	In Mai Son in 2018: Al for 150 cows.
	Integrated Northern Child Nutrition Improvement Project was implemented in five communes (Ta Hoc, Chieng Mai, Chieng Kheo, Chieng Chung and Chieng Ve communes) and supplied 4,200 breeding chickens and provided chicken raising training courses.

Reason for keeping livestock		Pigs		Cattle, buffaloes		Chickens		Goats		Ducks		Fish	
	F	М	F	М	F	Μ	F	М	F	Μ	F	Μ	
Savings and insurance	6	7	10	10	7	3	10	7	7	3	9	5	
Income from sale of fatteners	10	6	6	10	9	7	0	10	9	7	0	2	
Income from sale of breeding animals	8	4	Ι	3	0	0	3	2	0	0	0	0	
Home consumption of meat	3	5	0	5	10	10	3	3	10	10	10	9	
Home consumption of milk, eggs and other products	-	-	-	-	10	0	-	-	10	0	-	-	
Culture (for festivals, sacrifice, ceremonies, dowry)	10	9	2	7	8	9	0	2	8	0	8	0	
Utilization of available resources	4	9	4	9	8	9	7	9	8	9	9	9	
Manure	5	10	9	10	5	9	5	9	2	8	0	0	
Draught (ploughing fields)	0	0	7	2	0	0	0	0	0	0	0	0	
Transport	-	-	0	2	-	-	-	-	-	-	-	-	
Manure of pigs and cattle as feed for fish	8	-	8	-	-	-	-	-	-	-	-	-	

Table 13: Level of response on reasons for keeping livestock in Chieng Chung commune by gender

Table 14: Level of response on reasons for keeping livestock in Chieng Luong commune by gender (score for highlands in parenthesis)

Reason for keeping livestock	Pigs		Cattle, buffaloes		Chickens		Ducks		Goats		Rabbits	Fish
	F	Μ	F	М	F	Μ	F	Μ	F	Μ	F	Μ
Savings and insurance	5 (8)	10	10	10	0	3	0	3	7	7	0	0
Income from sale of fatteners	6 (2)	10	6	10	7	3	7	3	7	10	8	0
Income from sale of breeding animals	3 (2)	6	2	6	0	0	0	0	3	0	6	0
Home consumption of meat	3 (5)	2	-	2	10	10	10	10	3	2	I	9
Culture (for festivals, sacrifice, ceremonies, dowry)	8	4	9	4	9	10	9	10	8	2	2	8
Utilization of available resources (feed, labour)	2 (8)	7	9	10	8	10	8	10	6	10	2	10
Manure	10	10	10	10	10	7	0	7	7	10	7	0
Draught (ploughing fields)	0	0	10	5	0	0	0	0	0	0	0	0
Transport	-	-	10	6	-	-	-	-	-	-	-	-