



Assessing competitiveness of
smallholder pig farming in the
changing landscape of Northwest
Vietnam



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Assessing competitiveness of smallholder pig farming in the changing landscape of Northwest Vietnam

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Acronyms

| | |
|--------|--|
| ACIAR | Australian Centre for International Agricultural Research |
| APAARI | Asia-Pacific Association of Agricultural Research Institutions |
| FGD | Focus group discussion |
| GDP | Gross domestic product |
| GSO | General statistics office |
| IFPRI | International Food Policy Research Institute |
| ILRI | International Livestock Research Institute |
| KII | Key informant interview |
| MARD | Ministry of Agriculture and Rural Development |
| RCA | Revealed Comparative Advantage Index |
| SEP | Swine enzootic pneumonia |
| SRA | Small research activity |
| USDA | U.S. Department of Agriculture |
| VAC | Vietnamese for 'Garden- Fish pond- Animal shed' |
| VNUA | Vietnam National University of Agriculture |
| VND | Vietnamese Dong |
| VFU | Vietnam farmers' union |
| VPM | Vietnam pig sector model |
| VHLSS | Vietnam household living standard surveys |

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Executive summary

Pig raising can offer significant opportunities for improved livelihoods for many households in Northwest Vietnam, one of the poorest and most remote regions in the country (Huyen et al. 2016b). Traditionally, pigs are a key component of agricultural systems in this region and are fed with wild leaves and crop residues to produce a product at a low cost but perceived as high quality. In recent years, intensified production systems have evolved with the introduction of new pig breeds and hybrid maize varieties grown as animal feed. This has led to maize becoming a dominant crop in these mountainous areas, grown on steep slopes and in monoculture, leading to considerable soil erosion and decline in soil fertility (Nguyen et al. 2016). This research aims at identifying major constraints and opportunities in the improved integration of pig and maize production, to improve smallholder income, while making the system more environmentally sustainable by investigating more diverse and profitable crop rotations, as well as improvements to soil fertility through cycling of nutrients and organic matter. The results will form the basis for more in-depth research on the most promising options.

As a starting point, a broad systematic literature review of peer reviewed publications and grey literature on maize and pig production in Vietnam in general, and in Northwest Vietnam in particular, was applied. This was followed by a collection of primary data in March 2017 from four communes in Son La and Hoa Binh provinces. These provinces were selected because they have the largest area of maize and highest population of pigs in Northwest Vietnam. Hoa Binh is also a study site of SafePORK, another ACIAR initiative that seeks to support safer pork production. Within each province, we selected one commune with low and one with high market access.

Data were collected using four different tools:

- i. Value chain mapping with local stakeholders
- ii. Key informant interviews on value chains
- iii. Focus groups discussions with farmers
- iv. Individual interviews with farmers

A total of 165 actors were interviewed, with 39–44 actors in each of the four communes.

Pork remains an important animal-source food in the Vietnamese diet. Demand for pork has increased over time, largely attributed to population growth and rising income (Nga et al. 2015). There is also an increasing demand for higher quality pig products in urban centres, including ‘naturally raised’ pigs (Gautier et al. 2009; Lapar and Toan 2010). However, so far, pig production in the study area seems to be slow in responding to such opportunities.

Results from the field work show that the integrated maize–pig system is widely practiced by farmers in the four communes. The main advantages of this system over a specialised pig farm relying on purchased concentrates were listed as follows:

- I. better control over quality and timely availability as maize feed is available on farm
- II. reduced feed costs by avoiding transport and transactions
- III. potentially producing a product for supplying a niche meat market for perceived high-quality pigs and/or meeting the demand for naturally raised pork based on non-commercial feeds

Yet, several disadvantages were also identified during the survey, such as high labour demand of maize production, difficulties in maize storage resulting in prevalence of aflatoxins in maize, higher fat content of pork produced with maize-dominated feed and longer production cycle of pigs fed predominantly with maize compared to balanced commercial feed. The study results highlight difficulties faced by smallholders in these communes with regard to accessing inputs and services as well as more profitable markets for their pig products. Various options were discussed with stakeholders for value chain improvements such as producer groups (Huyen et al. 2016a), contract farming (Lapar et al. 2007) and a preferred trader system (Scholl et al. 2016). They agreed that collective action allows smallholders to access lucrative markets. However, these organisations tend to deteriorate once external support is withdrawn. On the other hand, contract farming has by design a strong private sector component and tends to be economically sustainable, but often fails to integrate small scale farmers in more remote locations.

In summary, this study has looked at mechanisms to support enhanced integration of pig and maize activities to improve smallholders' income while making the system more environmentally sustainable, by looking at alternative feed production and feeding strategies. With the main farming systems in Northwest Vietnam still being traditional smallholder production, pig producers in this region can take advantage of their relatively 'natural' production practices that have been increasingly valued by specific types of consumers in specific markets. To be able to support such evolution given the existing maize-pig integration advantages, more research is needed on alternative farm produced feeds such as forage legumes, which may complement maize for more sustainable feed production and more balanced diets. For these systems to impact household income through better market integration, new institutional arrangements to link pig farmers to markets are required both for inputs and services including extension, as well as for output markets. New strategies have to be explored because existing strategies for improving market access, which have been successful in other locations and were discussed in this study, show various constraints. A possible combination of some of the discussed approaches, for example a preferred trader system linked to a specialty outlet in provincial and regional towns, organized around producer groups, appears to be worthwhile for investigation. Finally, linkages to SafePORK are foreseen to show that traditionally raised pigs can also provide safe pork.

Introduction and study objectives

Pig keeping offers significant opportunities for improved livelihoods for many households in Northwest Vietnam, one of the poorest and most remote regions in the country. Most of the population belong to ethnic minorities who practice crop and livestock production, often based on traditional practices. Customarily, pigs are a key component of these systems, being fed with wild leaves and crop residues. The resulting product is produced at low cost but is perceived to be of high quality. In recent years, the production systems have evolved with the introduction of new maize varieties, mainly grown as key ingredient in animal feeds for poultry, dairy cattle and pigs. Maize has in fact become a dominant crop in these mountainous areas, purchased by large commercial feed mills. Maize is usually grown on steep slopes and in monoculture, leading to considerable soil erosion and a decline in soil fertility. These issues are being analysed by the ACIAR-funded project on Improving maize-based farming systems on sloping lands in Vietnam and Lao PDR based on crop diversification including the integration of forages. But it remains unclear how best to support the integration of the two components—pig and maize—to improve the income of smallholders while making the system more environmentally sustainable.

Integration of pig and maize in a farming systems context is mainly through production of maize by pig-keeping households and feeding maize grains (processed on farm or off farm) to pigs, thereby limiting cash costs to pig production. Unlike in cattle production, where manure is used to maintain soil fertility on maize plots, this is not generally practised with pig manure. Untreated pig manure might result in a wide range of human health issues in nearby communities, evidenced by increased occurrences of headaches, runny nose, sore throat, coughing, diarrhoea and burning eyes (Wing and Wolf 2000); higher levels of respiratory, sinus and nausea problems (Thu et al. 1997). In recent years, smallholders have increasingly grown maize as a cash crop with immediate benefits when sold. But maize prices have declined and are volatile. As a result, it seems to make economic sense for farmers to increase their returns through pig production by feeding maize grains to pigs, instead of selling the grain to traders and purchasing feed for their pigs. Moreover, using maize as pig feed has been traditionally practised in rural and mountainous areas of Vietnam, albeit using different, mainly local, varieties. New maize varieties and hybrids (or OPVs) of these varieties may require a change in the way pigs are produced, given a likely difference in response of the animals to these new varieties. Although research has been conducted on pig value chains in the northwest region, knowledge gaps such as identifying opportunities to strengthen the integration of pig and maize for increased farm productivity in an environmentally sustainable manner, still remain.

The study objectives were to:

- Assess the current level of competitiveness and profitability of pig farming (commercial, cross-bred or indigenous breed) and other major agricultural activities—especially maize—in the northwest region of Vietnam and identify opportunities to strengthen the integration of pig and maize in these systems.
- Conduct a market study and assess likely changes in the next 10 years, based on past trends and stakeholders' perceptions of future scenarios (risks and opportunities) and analyse implications on growth potential, viability and sustainability of smallholder pig systems in the northwest region.
- Identify market-based incentives and explore institutional/organizational arrangements that will harness these to boost smallholder pig producers' competitiveness, for example, through a branding and certification system as also proposed in the new SafePORK project.

Methodology

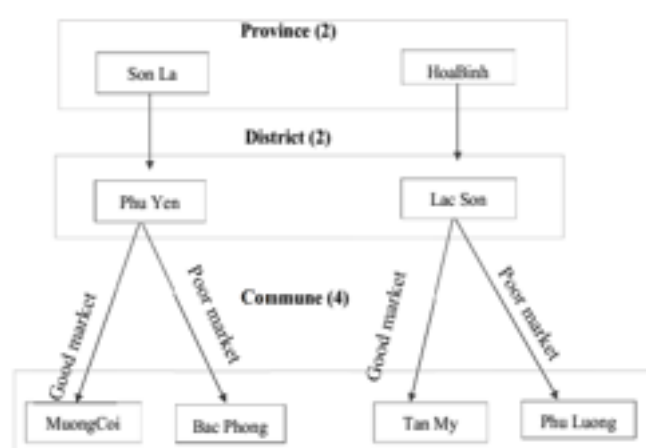
Study sites

Son La and Hoa Binh provinces were selected for the study (Figure 1). Selection of the study sites followed the sequence from provinces to districts and two communes in each district. Initially, the provinces of Son La and Hoa Binh were selected out of the six provinces in the northwest as they showed the highest production of maize and the highest population of pigs in the region. Within each province, one district was selected based on available secondary data and experts' opinions. The selection went through three rounds.

- In the first round, half of the districts in each of the selected provinces were picked based on the relative importance of maize and pig production in their agricultural sectors, according to secondary data. This criterion was defined by the proportion of agricultural land devoted to maize production (maize area/total agricultural land area) and by pig density (pig population/total agricultural land area).
- In the second round, half of the districts selected from the first round were kept using a production scale criterion, specified as the absolute total planted area of maize, the population of pigs and the relative ratio of pig population over maize area.
- In the third round, one representative district was identified from a list of all districts maintained from the second round. The decision was based on consultation with local experts with regards to the prevalence of smallholder farmers engaging in pig and maize production and environmental challenges arising from maize cultivation on sloping land.
- The whole process led to the identification of two districts: Phu Yen district in Son La province and Lac Son district in Hoa Binh province.

Following a similar approach, two communes were selected within each selected district—one with good market access and another with poor market access. The level of market access was determined first by the distance from the centres of the commune to the nearest markets and by road conditions. This was then reviewed with the district Department of Agriculture and Rural Development, considering the number of markets and the frequency of market days in the communes and their vicinity. It should be noted that no political or ethnic barriers were considered in this analysis when analysing farmers' access to local, provincial and inter-provincial markets. Figure 1 shows the detailed steps of the site selection.

Figure 1: Process of site selection



In the two communes of Hoa Binh province, namely Tan My and Phu Luong, the majority of the population are Muong people accounting for more than 90 and 99% of the total residents respectively. The rest belong to other ethnic groups such as Kinh, Thai, Dao and H'Mong (Lac Son district people committee website 2017¹).

In the two communes of Son La province, ethnic minority groups are also predominant. Muong and Dao are the two main groups living in Bac Phong commune. The ethnicity of the residents in Muong Coi commune is more diversified, with about 54% Muong, 28% Kinh, 13% Dao and other ethnic groups such as H'Mong and Tay. Socio-economic information of the studied communes is described in Table 1.

Table 1: Socio-economic information of the studied communes in 2016

| Items | Unit | Hoa Binh | | Son La | |
|--|-------------------------|----------|-----------|-----------|-----------|
| | | Tan My | Phu Luong | Muong Coi | Bac Phong |
| 1. Total natural land area | ha | 3,124.8 | 2,149.5 | 6,492.0 | 4,149.0 |
| 2. Total agricultural land area | ha | 2,773.2 | 421.3 | 4,089.1 | 1,041.8 |
| Maize production area | ha | 743.1 | 205.0 | 3,047.2 | 937.6 |
| 3. Total pigs | heads | 7,467 | 2,700 | 5,050 | 1,800 |
| 4. Pig density | Heads/km ² | 2.69 | 6.41 | 1.23 | 1.73 |
| 5. Average income per capita/year | VND000 | 13,500 | 17,000 | 18,230 | 12,000 |
| 6. Contribution of agriculture in total income | % | 87.3 | 62.5 | 83.0 | 70.0 |
| 7. Household poverty rate | % | 8.9 | 69.6 | 17.3 | 40.8 |
| 8. Population | | | | | |
| Number of households | households | 1,560 | 1,555 | 1,651 | 470 |
| Number of people | persons | 6,189 | 6,837 | 7,223 | 2,517 |
| Population density | Persons/km ² | 2.23 | 16.23 | 1.77 | 2.42 |
| Ethnic minority | % | 90 | 99 | 95 | 99 |

Source: Annual social economic development planning reports of Tan My, Phu Luong, Muong Coi and Bac Phong communes, 2017.

¹ <https://lacson.hoabinh.gov.vn/>

Data collection and analysis

In this study, data collection focused on qualitative data, with some limited quantitative data for the gross margins analysis. The study also referred to secondary data, from various sources, both qualitative and quantitative.

Literature review

A broad systematic literature review of peer reviewed publications and grey literature on maize and pig production in Vietnam in general and in the northwest region in particular was implemented. Literature was sought using web search engines (Google) and keyword tracking. Key words such as “maize”, “pig” and “value chain” guided the search. Other specific search words included “breeding”, “feeds”, “markets”, “farmer groups”, etc. In each search, “northwest” was included to narrow down the search to the context under investigation. Bibliographic references in each reviewed paper was also examined to identify additional papers relevant to the scope of this review. Literature was later categorized into key topics including demand, production and feeding and business models.

Field work

Data collection in the field was carried out using the following techniques:

- value chain mapping meetings with local stakeholders;
- interviews with key informants of value chains;
- focus groups discussions with farmers; and
- individual interviews with farmers.

In each studied commune, one meeting with various actors of pig and maize value chains (input suppliers, producers, collectors, traders, feed mills, local authorities' representatives etc.) was organized. The purpose of the meeting was to introduce the project; identify the different nodes of the maize and pig value chains, including where they link; map the value chains and identify potential key informants among the value chain actors for interviews later. In this meeting, 16 participants were separated into two sub-groups (mixed men and women). One group focussed on pig value chains; the other on maize value chain. Five key informants were identified for in-depth interviews at the end of the meeting. These informants included input and service providers, maize and pig traders, buyers and representatives of local authorities such as local extension workers, veterinary staff and chairperson of farmer unions.

Two focus group discussions (FGDs) were also held in each commune—one for maize, including maize farmers who did not raise pigs as well as those who kept pigs; and the other for pigs including pig keepers who did not grow maize as well as those who grow maize. Both male and female farmers participated in the FGDs. At the end of the FGDs, five farmers were interviewed to get producer specific data on gross margins for the maize and pig enterprises and for other agricultural activities.

In total, the study conducted four value chain mapping meetings of both men and women (two for pigs and two for maize stakeholders), eight FGDs (four for pig farmers and four for maize farmers), 15 key informant interviews (KIIs) with input suppliers, pig traders, butchers/abattoirs' owners, extension workers, veterinary staff and farmer organization leaders and 20 farmer interviews in the four selected communes. Voice recording was made during the value chain mapping and FGD activities. All data collection activities were carried out at local meeting places such as the commune's community development centres and the village's cultural houses. The number of participants involved in each activity is summarized in Table 2 with the gender disaggregation provided in the next sections.

Table 2: Number of participants involved in the study

| Province | Hoa Binh | | Son La | | Total |
|----------------------|----------|-----------|-----------|-----------|-------|
| District | Lac Son | | Phu Yen | | |
| Commune | Tan My | Phu Luong | Muong Coi | Bac Phong | |
| | | | | | |
| Value chain meetings | | | | | |
| Maize | 7 | 8 | 8 | 8 | 31 |
| Pig | 9 | 7 | 6 | 6 | 28 |
| Kills | 5 | 3 | 4 | 2 | 14 |
| FGDs | | | | | |
| Maize | 9 | 9 | 9 | 9 | 36 |
| Pig | 9 | 9 | 7 | 11 | 36 |
| Farmer interviews | | | | | |
| Maize | 3 | 3 | 3 | 3 | 12 |
| Pig | 2 | 2 | 2 | 2 | 8 |
| Total | 44 | 41 | 39 | 41 | 165 |

Before the start of data collection, the objective of the discussion was explained to all participants and oral consent was obtained to record discussions and use them for research purposes.

Data collected were analysed using thematic analysis in combination with simple descriptive statistics, aided by tables, figures and charts. Cost and margin analysis was conducted to assess the economic viability of pig production from data collected during the in-depth interviews with farmers. The cost of family labour was not captured in this study despite often appearing as a key cost in margins analysis. This is due to the focus of the study on smallholder households, in which family labour cannot easily be assigned to pig rearing as members of the family engage in many other activities at the same time. Besides, the opportunity cost of family labour, especially women who are mainly responsible for housework and children caring, is almost zero in the local context of limited employment opportunities. Finally, it should be noted that because of the small sample size, results should be interpreted with care and should not be generalized.

Stakeholders' workshop

A stakeholders' workshop was organized on 30 May 2017 attended by 40 participants from research institutes and the government, including provincial and local representatives and leaders from the two study sites of Son La and Hoa Binh provinces, researchers from Vietnam National University of Agriculture (VNUA) and ILRI, as well as donor representatives. The participants provided feedback on research findings from the scoping study and shared ideas on proposed research questions and objectives of a new research project on smallholder pig farming in maize-based systems in Northwest Vietnam. Discussions revolved around these three topics:

- I. Demand for different breed types of pigs (indigenous, cross-bred and exotic); a topic that was broadened to pig meat attributes
- II. Pig production and feeding systems
- III. Potential business models for small-holder pig producers

Achievement against activities and outputs/ milestones

As per the small research activity (SRA), three main activities were planned corresponding to the following specific objectives:

- i. Assess the current level of competitiveness and profitability of pig farming (commercial, cross-bred or indigenous breeds) and other major agricultural activities—especially maize—in the northwest region of Vietnam
- ii. Conduct a market study to assess likely changes in the next 10 years based on past trends and stakeholders' perceptions of future scenarios (risks and opportunities) and analyse implications on growth potential, viability and sustainability of smallholder pig systems in the northwest region
- iii. Identify market-based incentives and explore institutional/organizational arrangements that will harness these to boost the competitiveness of smallholder pig producers

Regarding the first objective, and as detailed in the next section, a qualitative pig and maize value chain assessment was conducted in four selected communes focusing on the producers' node of the value chain. Data were also collected for a gross margins analysis to assess the level of competitiveness. However, the planned analysis of market access through a price decay function could not be conducted due to the characteristics of the available dataset (ILRI humid tropics household survey data, 2015). Because the data did not include month of sale, we were unable to control for within-year seasonality. A price decay function looks at the effect of market access (using distance or travel time as proxy) on price (Baltenweck and Staal 2007). For this report, the objective was to assess the effect of distance to the next major market on the farm gate price of pigs. Results of the econometric analysis are available upon request. However, the evidence collated from secondary sources, the qualitative value chain assessment and the gross margins data allowed us to draw some conclusions on the level of competitiveness.

Regarding the second objective, data required for the market study were collected at the field level (at the same time as the value chain assessment) by interviewing input suppliers, producers, traders, butchers/abattoir owners, retailers, extension workers, veterinary staff and farmer organization leaders. Secondary data were also used, particularly to look at consumers' demand for pork (level and attributes). The assessment of possible evolution of the pig sector was conducted both at field level and with stakeholders. These activities are presented in detail in the next section, including visioning exercises conducted in each of the surveyed communes. A similar exercise was also done during the May stakeholders' workshop.

Finally, for the third activity, results were consolidated and entry points were shared and discussed at the May 2017 stakeholders' workshop. The results were then synthesised into this document, where they can be found in the next section.

Key results and discussions

The presentation of this research is organised into three topics. Topic 1 looks at the demand side of the pig sector in Northwest Vietnam, corresponding to the second objective of the SRA to investigate the regional pig market and consumer demand for pork now and in the future. The analysis therefore starts with the consumer end of the value chain and the policy environment, as it is increasingly recognized that the demand shapes the evolution of farming systems. After analysing the ‘market pull’, the analysis continues with Topic 2, looking at farm level productivity aspects, identifying potential mechanisms to better meet the identified demand while remaining competitive. Topic 2, therefore, addresses the first objective of the SRA. Based on the first two analyses, Topic 3 looks at business approaches, or institutional/organizational arrangements, to improve smallholder pig producers’ links with markets, corresponding to the third objective of the SRA.

Topic I–Demand for different pig meat attributes: available evidence and research gaps

Background on pig demand and policy environment

Importance of pig meat in household consumptions, trends and drivers

Household consumption and trends

Meat of all types in general and pork in particular play an important role in daily diets of Vietnamese households. According to general statistics office (GSO) statistical data, meat consumption in Vietnam increased significantly during the period 2002–2014. On average, a Vietnamese consumed 15.6 kg of meat in 2002. This increased to 22.4 kg in 2014 (GSO 2016a). Despite having a high poverty rate, meat consumption in the northwest is interestingly higher in comparison with some other better-off regions. For instance, per capita meat consumption in the northwest was estimated at approximately 19.9kg in 2014, higher than that in the Mekong river delta (18.6kg), or in the north central coast (19.0 kg) (GSO 2015). Urban residents tended to consume more meat than their rural counterparts. However, growth of urban pork consumption was slower than growth of rural pork consumption during the last decade. If this trend continues, the meat consumption gap between the two areas will likely narrow and possibly converge over time.

Of all meat types, pork was the most consumed accounting for 57% of total volume consumed annually (GSO, 2015). Note that this figure might actually be considerably higher because out of home consumption of pork and processed pork products are not captured in the estimates. The northern uplands region, to which the northwest region considered for this study belongs, has always ranked amongst the top three regarding per capita pork consumption among the economic regions of Vietnam, second only to the Red River Delta, with average per capita pork consumption of 13.4, 11.1 and 11.7 kg in 2010, 2012 and 2014 (est.), respectively (VHLSS data from various years). The northwest region also exhibited one of the highest growth rates in per capita pork consumption during the period 2002–2010, with pork consumption increasing by 50% during this period. This is similar to growth rates observed in the north central coast and the central highlands

(Nga et al. 2013). Pork and meat in general, is an important animal source food for the northwest people for at least two reasons—fewer choices of animal source foods as less favourable conditions for fish aquaculture and extremely high rate of children malnutrition (39.2% of communes having noteworthy diseases) (GSO 2015).

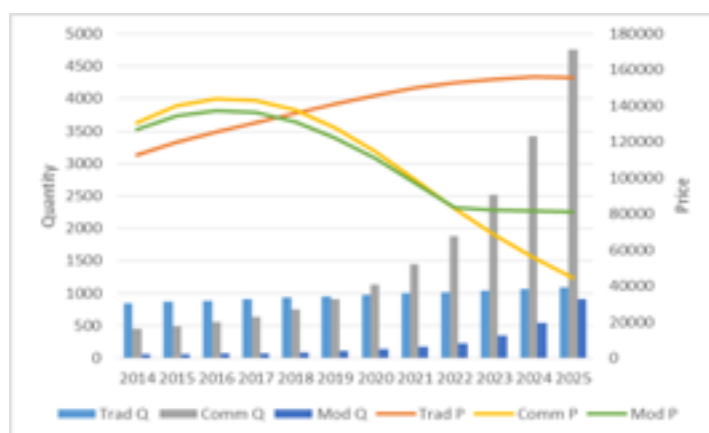
Vietnamese consumers spend the largest share of their meat budget for pork. In 2010, 34% of total meat budget for urban dwellers and 38% for rural dwellers were devoted for pork. Consumers in both rural and urban areas also ranked pork as the most important meat in the meat basket (ILRI 2011).

There is an apparent inconsistency of estimates and projections of pork consumption reported by official sources, likely due to different measurement methods applied for generating the estimates. For example, The U.S. Department of Agriculture (USDA 2011) indicated a relatively stable trend of pork consumption for the period 2007–2011 at 21 kg/capita/year based on total supply data. The International Food Policy Research Institute (IFPRI) estimates using the IMPACT model showed 19 kg of pork consumed per capita for 2010 and 22 kg for 2020 (Rosegrant et al 2008). Meanwhile, using monthly consumption data from VHLSS which cover 46,000 households nationwide and are conducted every two years, GSO (2015) gave a much lower estimate of approximately 12 kg/capita/year. Although the estimate increased to just under 13kg in 2014, this is lower compared to USDA and IFPRI figures cited above.

With increasing pig numbers (26.7 million in 2014, 27.8 million in 2015 (est.)), total pork production of Vietnam has increased significantly from 1.4 million tons in 2000 to 3.5 million tons in 2015 and was projected to continue increasing in the next coming years (GSO 2016a; Food and Agricultural Policy Research Institute (FAPRI) 2014). Approximately three-fourths of the total pork production is consumed domestically. Vietnam also imports frozen pork from Hong Kong, Spain, Italy, Denmark, United States and Canada to meet the demand of a growing food processing industry. In the period between 2014 and 2015, more than two million tons of pork were imported annually and the import was forecast to increase in the future. Ipsos Business Consulting reports a fourfold increase in pig imports (in value) between 2010 and 2014, from USD1.9 million to USD8.2 million.

Projections of market trends of the Vietnam pig sector have been simulated by a Vietnam pig sector model (Que et al. 2015) which solves simultaneously the consumer and producer equilibrium prices in related urban and rural markets of all seven regions in Vietnam, using varying assumptions about productivity growth and income. The results suggest that, under the worst-case scenario of zero productivity growth in the traditional pig sector versus 10% in the modern pig sector, demand for modern and commercial pig will increase rapidly (19 and 24% respectively); but still at a slower rate than the increase in supply. As a result, modern and commercial pigs were projected to account for 6 and 77%, respectively of total pork demand in 2025, while traditional pigs' share will drop to 18% from 62% in the base scenario. Modern and commercial pig prices will subsequently drop while traditional pig prices will slightly increase (Figure 2).

Figure 2: Projected market trends of the Vietnam pig sector



Source:VPM 2014

Drivers of pork consumption

Increasing consumption of pork is attributed to the following drivers:

Population

Accounting for more than half of the total meat volume consumed by Vietnamese consumers, pork consumption is expected to rise with growing population. During the period 2000–2016, total volume of pork production in live weight has more than doubled from about 1.5 million tons in 2000 to 3.7 million tons in 2016. Growing per capita consumption of pork as explained below, coupled with growing population, will remain strong drivers of the demand for pork in Vietnam in the future. Similar trend was observed in the northwest region. Huyen et al. (2016b) found that in almost all villages in the region, farmers keep raising pigs, including indigenous pigs, to meet high and stable pork demand throughout the year. Discussions with farmers in the four studied communes in the northwest also indicated a considerable increase of pork consumption of local people over the last five years, driven by increasing cash income.

Economic development and urbanization

Income is identified as one of the factors affecting pork consumption, yet the direction of its impact is mixed in the literature. While USDA (2005) found a negative relationship between pork consumption and household income in the USA, the other studies conducted in developing countries found the opposite relationship, meaning that households tend to spend more on pork as their income increases (Do et al. 2013; Cosmos et al. 2013; ILRI 2011; Renuka et al. 2009; Mukesh 2012). In developing country settings such as Vietnam, the positive relationship between income and pork consumption also reflects the historically strong preference for pork over other meats by the typical Vietnamese consumer. Recent economic development in the northwest explores tourism as local advantage. As a result, Moc Chau (Son La) and Mai Chau (Hoa Binh) opened up festivals that are unique and attractive to urban or foreigner tourists, such as a fruit picking festival in Moc Chau and Ban flower festival in Dien Bien. This has in turn increased meat consumption, including pork, at both provincial and regional levels. Some special pork products have been developed and marketed in the northwest such as smoked pork and dried pork, especially products processed from indigenous pigs. For example, a Google search for “dried pork” (in Vietnamese) created about 221,000 hits, more than 70% of which is directed to the northwest. According to the Voice of Vietnam (VOV) (2015), GDP growth rate of this region was estimated at 8.1% in 2014, higher than the national average of 5.98%.

In addition to income, urbanization contributes to the growth of pork consumption (Liu and Deblitz 2007). In 2014, urbanization rate in the northern upland regions (covering the northwest) was estimated at about 16.6%, very low as compared to the national average of 32.8% (GSO 2016b), which might not be a key accelerator for pork consumption for the locals. But the urbanization rate in Vietnam is projected to be nearly 40% in 2020 and between 40 and 45% in 2030 (GSO 2011; United Nations 2014), which might open up more market for pork from production regions including the northwest. In Vietnam, per capita pork consumption of urban residents is significantly higher than that of rural residents (Nga et al. 2013).

Changes in lifestyle and consumer concerns on food safety

The combination of emerging supermarkets, food stores and fast food chains, coupled with changes in lifestyle of consumers, especially the youth, were hypothesized to have effects on pork consumption in Vietnam. Luu and Vu (2014) indicated that reputation, customer services and shopping space affected the choice of consumers between traditional markets and supermarkets. International Trade Administration (ITA, 2015) highlighted that the rapid development of restaurant chains in big cities such as Hanoi and Ho Chi Minh City, featuring barbecue menus, led to huge demand for imported meat including pork and beef.

Increasing consumer awareness and concerns on food safety, as well as health education, might have implications for pork/meat demand. ILRI says, “there is a growing demand for quality and safety attributes among higher income consumers, particularly in urban areas; these include attributes such as leanness, free from harmful residues and from animal diseases and guarantee of hygienic slaughtering and processing” (ILRI 2011).

Importance of pig meat in household consumptions, trends and drivers

Domestic supply of pork has by far exceeded the domestic market demand in Vietnam (Ministry of Agriculture and Rural Development (MARD), Global Trade Atlas (GTA) 2015). China is the biggest importer of Vietnam's pigs. According to UN Comtrade statistics (2017), official pig exports from Vietnam to China reached USD38.3 million in 2014 and USD54.5 million in 2015 (accounting for 82% and 84.8% of total pig export value, respectively). The average growth of pig exports to China between 2000 and 2015 was 8.66% annually. However, the figures only reflect formal exports, specifically suckling pigs. In reality, Vietnam's pigs are mainly exported to China informally through the Vietnam-China borders in the north. A rough estimation by the animal husbandry department of MARD indicated that Vietnam exported approximately 50,000 tons of pigs through the Vietnam-China borders in 2014 and 60,000 tons in 2016. These figures have exceeded those of formal exports to all markets in the same period (21,000 tons in 2014 and 65,000 tons in 2016).

China has high demand for imported pigs to serve its big population given scarcity in domestic supply. In 2015, the total volume of pork production in China was about 54.9 million tons while consumption was about 55.7 million tons, meaning that China had to import around one million tons of additional pork (USDA 2016). This created a great opportunity for Vietnam's pigs because Vietnam has a significant comparative advantage in pig production compared to China (revealed comparative advantage index (RCA) of Vietnam in 2015 was 0.23 compared to 0.16 of China). As a result, China is forecasted to remain the main market of Vietnam's pigs in the future.

Despite being an important import market, informal cross-border trade with China poses high market and price risk to the Vietnam pig sector given the instability of this market, not only in terms of demand but also in terms of product standards and collection prices (Figure 3). The instability and negative impacts of this market on the Vietnam pig sector were clearly shown in 2016. During the period between March and May 2016, prices of live pigs in Vietnam skyrocketed due to the increasing demand from China. Chinese traders were willing to buy Vietnamese pigs of any quality at high prices relative to prevailing domestic pig prices. They even preferred pigs weighing above 90 kg, even up to 150 kg. These types of pigs are rarely consumed in Vietnam because of the high fat content. Farmers received an average profit of up to VND1.5 million (USD67) per pig. Thus, many of them rushed to enlarge farms and expand herds in response to the market pull. However, from July–August 2016, pig prices in Vietnam decreased by 23% compared to the March–May period because the Chinese traders suddenly stopped buying pigs. According to the Animal Husbandry Association of Dong Nai province, the biggest pig producing province in Vietnam with 50% of its total pig production being exported to China, the drop was driven by the oversupply of pig stocks in China. The closure of the Chinese market for Vietnam pigs resulted in remarkable losses to the pig sector in Dong Nai and elsewhere in other provinces that had previously been selling live pigs to China.

Figure 3: Price of live pigs in domestic market ('000VND/kg) and its relative correlation with China demand



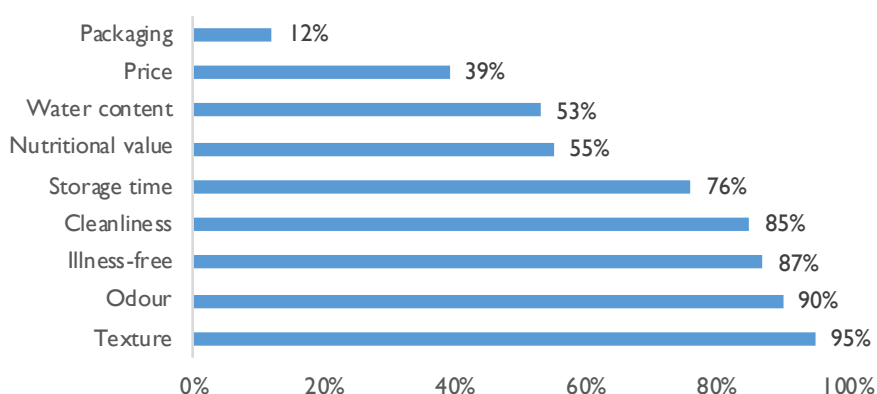
Source: Ministry of Finance (2017)

Meat attributes (including breeds)

Consumer preferences for pork attributes

The Vietnamese population prefer fresh over chilled/frozen meat (Lapar et al. 2009, Lapar and Toan 2010). As a result, wet markets where fresh pork is supplied every day remain the main outlets of choice by most Vietnamese consumers in both rural and urban areas (Lapar et al. 2009, Nga et al. 2015). A survey of 32 urban households under the PigRisk project indicated that 68.4% of urban respondents bought fresh pork from central wet markets, 29.2% bought from village markets, 0.2% from supermarkets and 0.4% from street vendors (ILRI 2017). Meat texture, characterized by firmness, viscosity and colour, odour, cleanliness and no illness are the most important attributes preferred by most consumers when buying fresh pork (Figure 4).

Figure 4: Important pork attributes considered by consumers (% consumers citing attributes, multiple responses possible)



Source: Baseline consumer survey in Hung Yen and Nghe An 2013

Along with improved living standards, growing concerns about food safety recently have induced consumers to seek for safe pork products. Pedregal et al. (2010) found that Vietnamese consumers would be willing to pay more for fresh pork if improved hygiene were guaranteed. More than 90% of consumers in the PigRisk survey were willing to pay a premium price of approximately 20% higher than the normal price for pork that is “safe” (Nga et al. 2015). Food safety, from the viewpoint of most customers, is usually linked to traditional raising methods. These methods use raw feed solely or little industrial feed. With this concern, indigenous pigs that are usually raised by ethnic minority groups are perceived to embody these preferred attributes more than cross-bred and exotic pigs. Ban pigs, for example, are perceived to be tastier, more tender and healthier than cross-bred and exotic pigs and therefore, achieve considerable higher prices at all nodes of the value chain (Nguyen et al. 2009; Nguyen et al. 2014).

Findings from KIs with slaughter men and pig traders in Hoa Binh and Son La also acknowledged increasing demand for indigenous pigs, especially from specialty restaurants in big cities such as Hanoi, Ninh Binh etc. The highest demand was observed during the Lunar New Year festival when households prepare special dishes to serve at various events/parties held to celebrate this special occasion. However, it should be noted that only a small proportion of better-off consumers can afford indigenous pigs because of their higher prices compared to the pork usually purchased by the majority of rural consumers for their daily consumption. Thus, indigenous pork is rarely found in wet markets and is usually sold in specialty shops or by traders known to supply these types of pigs. Participants of the final workshop also raised concerns over the upscaling of indigenous pig production (from small to commercial scale) given the limited number of customers. It is suggested that more research on potential market demand for this product would be able to identify opportunities and possibilities of scaling in the local context.

“I’m not sure how the production of indigenous pigs will develop in the future if we increase the production scale because number of consumers for indigenous pigs are not many. As far as I know, indigenous pigs in northwest are mainly transported to Hanoi and nearby cities but the maximum volume is just 400 kg per day,” said Hoa Binh’s representative in the stakeholders’ workshop.

Perspective of producers on consumer preferences

In the studied sites, most pig farmers have gradually shifted from subsistence to commercial production. Therefore, perceptions on consumer preferences are crucial to identifying production strategies. Even though local pigs in general, or indigenous pigs in particular, have higher selling price and lower cost of production due to lower use of external inputs, some farmers are reluctant to engage in these types of production systems as their sole enterprise because of low growth performance and long production cycles. Hence, there is low turnover rate that translates to relatively lower total profits in one production cycle, compared to cross-bred and exotic pigs. Hoa Binh's representative in the stakeholders' workshop said, "after one year of raising, local Ban pigs could reach an average live weight of 45 kg and bring a profit of only VND three million (about USD 130) per head to farmers, which was much lower compared to cross-bred and exotic pigs".

Consequently, smallholder households are currently raising local and indigenous pigs, more as a side activity rather than a core activity in their farms and are using household residues and agricultural by-products as feed. Of the four communes, farmers in the three communes of Tan My, Phu Luong and Muong Coi articulated their plans to produce more cross-bred and exotic pigs to serve increasing market demand (see Table 3). Only in Bac Phong, where market access is limited and ethnic minority groups are dominant, farmers opted to invest more on indigenous pigs and their crosses.

Table 3: Changes in pig/pork demand, inferred from producers and meat retailers in Hoa Binh and Son La

| Commune | Demand (producer's perspectives) | Demand (inferred from retailer) |
|-----------|--|---|
| Tan My | Moving to cross-bred and exotic | Consumers prefer fresh, lean meat; red color meat |
| Phu Luong | Moving to cross-bred and exotic | Higher price of indigenous pig compared to cross and exotic |
| Muong Coi | Moving to cross-bred and exotic | |
| Bac Phong | Moving to cross-bred Wild cross-bred, Ban pig | No information |

Sources: FGD 2017

Expected changes over the next 15 years and the drivers

Convergence of rapid economic growth in recent years (6–7% per year), increased income and urbanization are expected to drive consumption of more protein (meat, milk and dairy products and eggs) in Vietnam. The demand for fresh pork as the dominant meat in the Vietnamese diet is forecast to increase across all income-level classes. Minot et al. (2010) using the Vietnam pig sector model (VPM) estimated that in a scenario of high income elasticity for pork and a 10% productivity growth in the modern pig sector, consumption of traditional pork products (fresh, unprocessed pork) will grow at about 6% per year and consumption of modern pork products (chilled, frozen and processed pork) will increase at 18% per year. In the recently updated VPM using the same scenario, demand for commercial pig is projected to grow at 21% (Que et al. 2015). Hoang and Meyers (2015) took into consideration the effects of urbanization and shifting of income groups to predict per capita pork consumption of 22.1 kg and 27.8 kg for 2020 and 2030 respectively.

There is also a growing demand for quality and safety attributes among higher income consumers, particularly in urban areas (Lapar et al. 2011 and 2012). These include attributes such as leanness, free from harmful residues, animal diseases and guarantee of hygienic slaughtering and processing standards. Lemke and Valle (2008) stated that in the future, further diversification of the domestic market is expected, in which niche markets for specialty products from local breeds in traditional production systems will go along with imported products to meet high quality and food safety requirements. Phuong et al. (2014) found that Ban pigs from the northwest are mainly sold to restaurants in the region and in Hanoi and some lowland provinces to be processed and served to customers. This niche market sometimes experienced a supply shortage of "pure" Ban pigs; the gap was filled with cross-bred Ban pigs (often crossed with Mong Cai pigs). The latter, however, had lower price probably due to higher slaughter weight and fat content, as well as inferior meat quality in terms of flavour. Taking the margin for all value chain actors (especially producers) into account, the optimal slaughter weight of Ban pigs should increase to slightly above 20 kg (Muth et al. 2017).

Feedback from participants of the final workshop indicated that consumers are likely to pay more attention to feeding methods rather than pig breed. Most participants insisted that pure indigenous pigs are becoming scarce and slowly disappearing and that mainly cross-breeds of indigenous pigs and exotic pigs are the predominant types being raised by most pig raising households in the northwest region. The meat quality of these pigs is still highly valued by consumers when raised with traditional feed. Hoa Binh's representative in the stakeholders' workshop said, "determinants of demand for pigs (no matter what types of pig breeds) are traditional raising methods. Currently many households are raising cross-bred and exotic pigs using traditional methods using raw feed rather than industrial feed. Their products are still preferred by customers".

Summary of key points and research gaps

Pork remains an important animal source food in the Vietnamese diet. Demand for pork has increased over time, largely attributed to population growth and rising income. Demand for pork is not only about quantity but also quality, where the former, to some extent, has been satisfied by quick expansion of domestic production as well as meat importation while the latter must receive more consideration.

Vietnam's pig production has rapidly increased in recent years, including periods of oversupply, particularly when anticipated demand from regular markets did not materialize. An example could be the recent closure (mid-2016) of the Chinese market for Vietnamese pig exports. Domestic pig supply seems to respond only slowly to market demand developments, particularly regarding the quality aspects of demand. Impressive growth in pig production and dependence on the China export market have recently contributed to drastically falling pig prices. This market shock could propel the pig sector and pig farmers to reconsider production strategies and reorient them to meet emerging consumer demand for quality attributes rather than just quantity. Given rising income, changes in lifestyle and increasing consumer awareness about health and nutrition, the pig value chain in Vietnam should grasp this opportunity and upgrade in such a way to satisfy consumers' stringent requirements for quality and food safety, while still harnessing their local competitive advantage to produce pigs and pork products vis-a-vis imported pork.

Several studies on pigs in Vietnam covering both technical and economic aspects are available in the existing literature. Among these, pig value chain analysis is the most comprehensive topic that has been studied covering production, marketing, performance and other economic aspects. However, some gaps in research and information on pig and maize-pig system might be further explored. Some areas that can be explored are as follows:

- Make available reliable data on pork consumption (per capita/per household) for both home consumption and away from home consumption. At present, different estimates of per capita pork consumption are observed, having been generated using different methodologies and it is difficult to estimate country level total pork demand, as well as pork demand specific to the northwest region.
- Study behaviour in pork purchase and pork consumption and its dynamics such as location of purchase (modern or traditional), products (fresh/chilled; breeds; food safety labelling; 'traditional' raising methods etc.) and other factors affecting pork demand in the northwest region.
- Analyse emerging business models that respond to these market opportunities and their implications for pig value chain development in the northwest region and support promising ones through market system approaches.
- Understand outlook for China's demand for imported pig/pork and implications of other cross-border pig trading on pig production in the northwest.

Topic 2—Sustainable productivity improvement mechanisms focusing on feeding

Pig production in the northwest of Vietnam and livelihoods

Pig population: by province, over time, by breed, by system

Pig production in the northwest

The national pig population has continuously increased over the years from about 16 million heads in 1995 to approximately 28 million heads in 2015, with the highest growth observed in the period between 1995 and 2005. The northwest contributed about 8.5% of total pigs and this figure was almost stable over time (see Table 21 in section 10).

Among the six provinces in the northwest, Son La is the leading province in pig population, accounting for around one-fourth of the total number of pigs in the whole region.

The national pig density, as measured by the number of pig heads per person, was estimated at about 0.3 and has remained relatively stable through the years during the period between 2011 and 2015. This figure was relatively lower than the pig density in the northwest. Among six provinces in this region, Lao Cai had the highest pig density, estimated at about 0.68 in 2015 (see Table 22 in section 10).

Pig production in the research sites

Levels of market access was found not only to have a relationship with pig value chain development, but also to be positively associated with pig production scale. For instance, in Hoa Binh province, pig population in the better market access commune (Tan My) was nearly 7500 heads, almost triple that in the poorer market access commune of Phu Luong. Similarly, in Son La province, pig population in Muong Coi commune with the better market access was estimated at about 5100 heads, more than double that in Bac Phong commune with the poorer market access conditions. Commercial pig farmers in Muong Coi are mainly Kinh people who have moved from the Red river delta, while pig farmers in Bac Phong are mainly minority ethnic people such as Muong and Dao. An increasing trend in pig production was observed in all communes (Table 4).

Table 4: Pig population in the research communes and its past trend

| Commune | Levels of market access | Pig population (head) | Past trend |
|-----------|---|-----------------------|------------|
| Tan My | Close to the town, good road | 7,467 | Increase |
| Phu Luong | Difficult conditions, remote area | 2,700 | Increase |
| Muong Coi | Located along the national road | 5,050 | Increase |
| Bac Phong | Located far from the district centre, difficult conditions. | 1,800 | Increase |

Source: Report of communes 2016

The growth in pig population is based on increases in either production scale or number of pig holders or both. Larger production scale was found in the better market access communes of Muong Coi and Tan My. Some households raise up to 200 pigs/cycle in Muong Coi and the existence of some medium size pig farms was reported in Tan My. The average production scale of exotic and cross-bred pigs was 10–20 heads/cycle and 30–40 heads/cycle, respectively. This was much larger than that of local pigs, which was less than 10 heads/cycle in all communes (Table 5).

Table 5: Pig production scale in the research communes by breed type [pigs/cycle]

| Commune | Exotic | Cross-bred | Mong Cai | Ban pig | Loi pig |
|--------------|--------|-------------------------|----------|---------|---------|
| 40 (average) | | | | | |
| Tan My | 10–20 | 10–50 (80% households) | NA | 4–5 | NA |
| | | 50–100 (20% households) | | | |
| | | 5–10 (20% households) | | | |
| Phu Luong | 10–20 | 10–30 (70% households) | NA | 7–8 | NA |
| | | >30 (10% households) | | | |
| | | | | | |
| Muong Coi | NA | 30 | NA | 1–2 | NA |
| Bac Phong | NA | NA | 1–2 | 5–10 | < 10 |

Source: FGD 2017

Meat production for family consumption and use of left-over food were the two major purposes of pig keeping by smallholder pig keepers in the past. However, over the last five years, pig production has gradually become a major economic activity for cash income and for employment generation, attracting more and more farmers. The proportion of pig farmers amongst farming households has increased in all communes and many farmers have started to upgrade their pig production to produce pigs at a commercial scale. At a value chain meeting in Muong Coi commune of Son La province, a participant said, “I settled down here seven years ago. At that time, there were only 20% of households having pigs compared to 50% currently”.

The decision by farmers to commercialise pig production is driven by market demand, in this case, mainly demand from China. As mentioned earlier, pig prices decreased suddenly in 2016 because China stopped buying pigs from Vietnam, causing a big challenge to pig producers. Many farmers, especially in Tan My commune where a large proportion of pig population was being exported to China, abandoned their pig production or decreased their production scale. Even though some opportunities from the niche market of supplying high-quality local pork production to urban consumers has recently emerged, this cannot offset the loss from decreasing demand from China due to the limited number of consumers.

Trend of pig production in the next 15 years

Pig production continuously expanded in the past, largely driven by demand from domestic and Chinese markets. At the time the FGDs were conducted in March 2017, live pig prices had been continuously decreasing since the fourth quarter of 2016 due to the strict import policies imposed by China. It was reported that live pig prices dropped to about VND25,000/kg, which was much lower than production costs. As such, majority of farmers interviewed in the research sites were quite cautious when speaking about the future and most of them felt unsure about pig production in the next 15 years. In the short term, farmers confirmed that they would continue keeping pigs but might consider reducing or maintaining the current production scale while waiting for market prices to return to the previous levels prior to Chinese import restrictions. They mentioned two main reasons for these decisions:

- Very limited alternative employment opportunities for rural family labour in the study locations, other than raising pigs because of constraints of resources, skills, markets and very few locally available non-farm jobs
- Some farm households had invested in basic infrastructure for pig production and therefore could not abandon these (sunk costs). Instead, they found ways to maintain their production at minimal variable costs while waiting for signs of market recovery.

Next to the uncertainty about future pig production presented above, some farmers, particularly in Bac Phong commune, expressed a more optimistic belief in the future of pig production, given their specific local conditions. Accordingly, their pig production was forecast to develop strongly in the future, especially if a local permanent market opens and operates regularly as planned. Currently, the whole commune has only one temporary market that operates every 10 days at a small waterway port nearby the commune office to serve the local demand for meat. The commune has proposed a plan to construct a permanent meat market, replacing the current wet/temporary markets within the next few years. This market is anticipated to lead to increasing daily meat consumption by local consumers, due to increased supply and therefore enhance the pig production in the commune. While farmers in this commune projected a decrease in the production of Mong Cai pigs, they expect positive trends for Ban and cross-bred pigs, given strong consumer preferences for their premium quality: “Ban pigs taste good and get higher prices”, “Ban pigs taste better even though they have more fat”.

Farmers in Muong Coi commune raised concerns on food safety and forecast the increasing demand has to meet hygiene and safety requirements in the future.

Pig breeds and production systems

The term “local breeds” is generally used for pig breeds that are not related to exotic breeds and have been bred and raised in local communities. This term therefore excludes exotic breeds and their crosses. “Local breeds” therefore includes indigenous pigs (such as Ban or Loi), Mong Cai² pigs and crosses of Mong Cai and indigenous pigs. According to participants of the final stakeholders’ workshop, pure indigenous pigs are not being kept in Hoa Binh and Son La anymore; in this report therefore, the term “indigenous” actually refers to cross-breeds of indigenous pigs. These animals, however, still require traditional feeding methods, such as free-range scavenging and the availability of non-industrial feeds, to maintain their perceived “good” quality. While meat quality can be divided into technological, nutritional, hygienic and sensory qualities (Hofmann 1994), consumers are usually more concerned with sensory meat quality, characterized by attributes such as juiciness, flavours, stringiness and fat content. Reduced levels of concentrate feeding and increased intake of natural feedstuff (as currently being practiced under traditional feeding methods) are proven to reduce daily gains in growing pigs which in turn leads to significantly increased lean meat content, reduced intramuscular fat and increased tenderness (Danielson et al. 1999; Hansen et al. 2001). These attributes are considered good and much preferred by Vietnamese consumers (Lapar 2010).

Traditionally, farm-households in Vietnam have predominantly been raising local pig breeds. However, the introduction of exotic breeds and cross-breeds with higher productivity and shorter production cycles, initiated by breeding programs of both government and non-government organizations over the last two decades, has gradually changed the breed composition. As of 2010, exotic and cross-bred pigs account for 93% of the total pig population nationwide; with local pig breeds accounting for only 7% (Department of Livestock Production–MARD 2015). Exotic breeds and cross-bred pigs are mainly raised in the lowlands, while local breeds are more common in the uplands.

Farm households often raise sows to produce piglets. There are four types of sow breeds reared in the northwest, namely, indigenous breeds, Mong Cai breeds, cross-breeds and exotic breeds, of which the first two (referred as local breeds) are predominant. For example, in Lao Cai province, local sows account for about 60% of total sows (Lao Cai government 2016). Conversely, almost all boars are crosses or exotic breeds such as Yorkshire, Landrace, Pietrain and Duroc. About 65% of fattener pigs are cross-bred or exotic breeds and 35% are local breeds. In the studied communes, farmers are currently raising all types of pig breeds mentioned above, but there is a trend of gradual replacement of local pigs with exotic and cross-bred pigs. However, the poorest commune (Bac Phong) is likely to follow a different path than the other communes. Although farmers in this commune have also started shifting to exotic breeds and cross-breeds, they are still keeping a considerable number of Mong Cai pigs, for breeding, and of indigenous pigs (Ban and Loi pigs) for home consumption and for sale in local markets (Table 6). This is attributed both to economic factors (i.e. production of cross-bred and exotic pigs requires more investment while market opportunities are more limited in this location) and to socio-cultural factors, i.e. raising of local pigs is closely linked with the culture and tradition of ethnic minorities, such as the celebration of New Year and special occasions.

² Mong Cai breed, which has much higher reproductive capacity compared to indigenous breed, was introduced to support farmers in upland areas under Program 135

Table 6: Composition of pig breeds in the studied communes and forecasted trend

| Commune | Share in total pig population (%) | | | | | Trend in future |
|-----------|-----------------------------------|------------|----------|-----|-----|---|
| | Exotic | Cross-bred | Mong Cai | Ban | Loi | |
| Tan My | 35 | 60 | 0 | 5 | 0 | Not clear |
| Phu Luong | 20 | 80 | 0 | <1 | 0 | Not clear |
| Muong Coi | 20 | 70 | 0 | 10 | 0 | Cross: Decrease Exotic: Increase |
| Bac Phong | 0 | 7 | 20 | 70 | 3 | Ban and Cross: Increase Mong Cai: Decrease |

Source: FGD 2017

Despite acknowledging comparative advantages of exotic pig vis-a-vis local pigs in terms of growth performance and profit, not all farmers were successful in the transition process. This process requires investment in physical infrastructure, access to input market (piglets and feed), as well as farmer's know-how. During an FGD, a farmer described how he tried to raise exotic pigs, but all pigs died after a short time. Raising exotic pig breeds, thus appears to be more challenging as compared to other breeds especially in poor market access communes. No households in Bac Phong commune were found to be keeping exotic pigs, while in the three remaining communes, some 20 to 35% of pigs were exotic breeds. Exotic pigs are usually raised in confined systems.

Cross breeds have become more common in the studied communes, with about 80% of pig farmers raising these breeds. The average production scale of these breeds varied significantly across the studied communes, ranging from 5–10 heads/cycle to more than 50 heads/cycle. Like exotic pigs, cross-bred pigs are usually raised in confined systems.

Mong Cai pigs are widely used as sows for breeding due to their high fertility rate, and in fact, are preferred over indigenous sows. Mong Cai fatteners normally have high fat content, hence are valued lower than the other breeds.

Indigenous pigs are largely raised in free-range systems, as observed in Bac Phong commune and in some upland villages in the other communes. Indigenous pigs, Mong Cai pigs and chicken are usually reared all together in home backyards/gardens. When pigs are reared in open areas, cross-breeding of different pig breeds and inbreeding are unavoidable, which result in variable quality of indigenous pigs.

Loi pigs, a cross of wild pigs and Mong Cai, are newly adopted by farmers in Bac Phong commune; piglets are mainly sourced from Muong Coi commune. The production scale of Loi pigs is still small with less than 10 heads per household. However, farmers who are raising Loi pigs expressed their strong belief in the future potential of this new breed given its good productivity and high value.

Regarding the development and future potential of indigenous breeds in comparison with the other breeds, representatives from Hoa Binh and Son La during the stakeholders' workshop emphasized that indigenous pig production is one of the traditional activities of ethnic minority groups in the northwest. These pigs are easier to rear using locally available resources (maize, agricultural by-products). Maize grains could be used to feed pigs directly without the need of milling. Thus, despite prevailing advantages of cross-bred and exotic pigs such as high growth rate and stable demand from consumers, indigenous pigs will continue to be raised in these communities given people's preferences that are strongly rooted to socio-cultural values. Along with programs promoting commercial production of high-productivity cross-bred and exotic pigs, Hoa Binh province has some programs that support the preservation and development of indigenous pig breeds (e.g. JICA-funded project to maintain the indigenous pigs).

As for pig production systems, Lemke et al. (2002) categorized two typical systems in the northwest, namely resource-driven production system (i.e. driven by the availability of farm resources) and demand-driven production system (i.e. driven by the market-demand for pork). Improved Vietnamese Mong Cai, exotic breeds and their cross-breeds have been replacing local breeds. The advantage of these pig breeds is their high productivity while their disadvantages are low adaptability to local husbandry conditions and high input costs. Local breeds, in contrast, are mainly raised in remote, steep hillside areas. They are well adapted to the low input management, able to cope with low nutritional value of feed, seasonal variations and poor hygienic conditions; they also have a reputation for good disease resistance. Less favourable characteristics of local/indigenous breeds are high fat content, low lean meat ratio, low growth rate and low fertility rate. Given these conditions, the demand-driven system is likely to be more applicable in the lowland/ better market access communes (Muong Coi, Tan My and Phu Luong) and for cross-bred and exotic pigs. The resource-driven system is more applicable in Bac Phong, where local pigs (Ban, Loi Mong Cai) are predominant.

Gautier et al. (2009) categorized five pig production systems as shown in Table 7. All of these systems, except the large-scale category, could be found in the four communes. The application of a certain production system depends both on the type of pig breed and the prevailing production practices applied by local people. For example, backyard fattening is still practiced when raising cross-bred pigs in Bac Phong and Muong Coi communes.

Table 7: Pig production systems in the studied communes

| | Scavenging | Backyard fattening | Small-scale | Medium – scale | Large-scale |
|------------------------|---|---------------------------|---------------------------|-------------------------|------------------------|
| Herd | 1 sow + piglets + 1–2 fatteners | 1<>10 fatteners | 1<>10 sows >10 fatteners | 10<>50 sows + fatteners | > 500 sows + fatteners |
| Level of intensiveness | Scavenging | Semi – intensive | Semi – intensive | intensive | intensive |
| Location | Remote districts/ communes especially in northern uplands, central, highlands | Lowland and midland areas | Lowland and midland areas | Lowland areas | Lowland areas |
| Tan My | Still exist, applied to Ban pig <5%> | Existing | Existing | Very few | No |
| Phu Luong | Still exist, applied to Ban pig <3%> | Existing | Existing | Very few | No |
| Muong Coi | Still exist, applied to Ban pig <10%> | Existing | Existing | Very few | No |
| Bac Phong | Widely practiced for Ban pig | Existing | Not popular | No | No |

Source: Literature review and fieldwork in Hoa Binh and Son La 2017.

Traditional roles of pig production among various communities

According to Nguyen (2005), a typical family meal for Vietnamese consumers (lunch or dinner) includes steamed rice, fish soup to eat with rice, a meat or fish dish and a vegetable dish (either stir fried or boiled/steamed). Among animal-sourced food, pork is the most important in terms of quantity and frequency of use for human nutrition provision (Nga et al. 2013).

Pig production supplies pork for not only daily human consumption, but for also spiritual events, such as local festivals, weddings, funerals, etc. In the areas where labour-exchange is practiced (as in Phu Luong and Bac Phong), the host family might buy a whole pig to serve to friends/neighbours for helping them (i.e. in crop cultivation/harvesting, house building). Indigenous pigs are also used as gifts (for urban consumers), especially during Tet Holidays. In smallholder farming systems in lowland provinces, pig production can absorb crop by-products and left-over food and release manure for crop production and into fish ponds in the VAC (gardening-fishing-livestock) system, as well as provide gas for cooking from biogas systems. In the studied communes, however, no VAC system was found. From the farmers' perspectives, since pigs

are fed by industrial feed, their manure has a high-water content and contains a lot of germs that might cause crop diseases. In the studied communes, pig manure is therefore rarely used for crop production, but instead directly disposed into open environments or canal systems. This practice poses a high risk of pollution, especially in the communes with commercial production scales (Tan My and Muong Coi).

Pig production is regarded as a crucial livelihood and income source for farmers (Huyen et al. 2016b; Nga et al. 2013). It serves as a supplementary source of funds for children's education, for investment and as a "living insurance" against shocks (accidents, illness, natural disasters, etc.) This allows farm households to smoothen their consumption stream and also enables them to be more resilient against systemic shocks and is particularly important for poor households that usually don't have access to formal financial institutions. Farmers in Muong Coi and Bac Phong considered pigs as a "source of savings" when asked to evaluate the importance of pig farming.

Pig production plays an important role as a means of livelihood in the daily activity of farm households.

"I do not know what to do if not raising pigs" (FGD in Phu Luong commune)

"I feel bored if not hearing pigs' noise" (FGD in Bac Phong commune)

Even though the FGDs were carried out during the time of continuous pig price decreases, farmers (especially smallholders) insisted that they would never stop raising pigs, as feed from home-produced waste and leftover food were always available and there were no better options for income generation. The other reason relates to the strong cultural affiliation with pig production.

Contribution of pigs to farm income: in northwest and comparison with other provinces

According to the ACIAR-ILRI-CAP survey (2008), pig production generates about 14% of total household income and one-fourth of agriculture income, based on a survey of 700 pig producing households in the lowland production systems in six provinces representing six ecological regions and selected purposively to represent pig production systems in North, Central and South Vietnam. These provinces were Phu Tho for the Northern Uplands, Ha Tay for the Red River Delta, Nghe An for the North Central Coast, Dak Lak for the South-Central Coast, Dong Nai for the South East and Tien Giang for the Mekong River Delta (Lapar and Staal 2010). In the studied communes in the northwest, pig production may contribute up to 80% of household income, as the participants of the FGDs conducted in Muong Coi commune indicated for exotic breeds and cross-breeds (Table 8). The production of exotic and cross-bred pigs contributed far more to household income compared to local pig production. In Bac Phong, where local pigs are predominant, Ban pig production was reported to contribute only up to 20% towards total household income. Ban pigs are mostly raised for home consumption while Mong Cai pigs are only raised for breeding purposes.

Table 8: Contribution of pig production to household income in Lac Son and Phu Yen districts

| Commune | Exotic breed | White cross-breeds | Ban pig | Mong Cai |
|-----------|--------------------------------|--------------------|---------------|------------|
| Tan My | 7–40% | | NA | NA |
| Phu Luong | 10–60% and increase with scale | | NA | NA |
| Muong Coi | 50–80% | 30–50% | Insignificant | NA |
| Bac Phong | NA | 20 (for sale) | 10–20% | Sow mainly |

Source: FGD 2017

In addition to type of pig breed, the importance of pig farming in farm households' income depends on production scale and market access level. For instance, in a commune with better market access (Tan My), income from pig production

contributed 40% to total income of households producing pigs at large scale, 15–20% in case of medium-scale and 7% in case of small-scale production. The contribution was much larger in the poorer commune (Phu Luong) with the corresponding figures for different production scales at 60%, 50% and 10–60%, respectively.

Gender and youth considerations

During the FGDs, it was revealed that both men and women are involved in various nodes of the pig value chain, although with different roles. Regarding input suppliers, whoever is available at a shop would act as seller, whether man or woman. However, only men transport feed to farmers' homes, because "this task links to business transactions, relationship building and transports, more suitable for men and women are better at doing housework and taking care of children" (FGDs in Muong Coi commune).

Both men and women participate in pig production itself, but with different roles. These vary by production scale. Women tend to be dominant in managing pig farms at small and medium scales (i.e. less than 30 pigs), but larger scale production is mostly managed by men. Men mostly handle vaccination, insemination and treatment of sick animals, while women mostly do the feeding, cleaning and collecting feed. In Bac Phong, when husband and wife go to work in the fields (upland in forest), the wife usually brings along a basket to collect natural feed on the way back. Older people and children are also involved in pig production, by sharing simple and light tasks, such as feed mixing, or cleaning the pig barn.

All pig traders participating in the FGDs were male, a situation also observed in PigRisk. It is reported that the nature of this job requires dealing with many farmers and long-distance downstream actors (i.e. bigger traders, slaughterhouses), which was stated to be more suitable for males rather than females.

All interviewed slaughter entities are household-based, operated often by husband and wife. The man kills the pigs and processes the carcass, while the woman assists in preparation, cleaning and processing.

Meat retailing is mostly handled by females, both at home and in wet markets. Retail locations include village corners and meat stalls right in front of their homes, where other food items, such as tofu, vegetables and eggs, also are sold.

In the pig-maize system, women are even more involved. Here, women also take care of maize farming, harvesting, drying, storage and selling. It was observed that the smaller the production scale, the greater the likelihood of female participation both in pig and maize production, which raises important issues on choice of technologies and market outlets to promote, to minimise drudgery and improve livelihoods.

With the trend of male and young females (less than 35 years old) migrating to other places to find off-farm or seasonal jobs, mid-aged and older females are also more likely to be more involved in home-based economic activities, such as small-scale pig production. It appears that formal companies are reluctant to hire women above 30, which impacts on the labour availability for agriculture.

Degraded lands and unfavourable changes to climate conditions have been reported as factors negatively affecting crop production at the farm level, leading to more livestock production being taken up as an alternative option. Hence, improving the capacity of females in agriculture production in general, pig production and maize farming would be an important opportunity to improve the livelihoods in the northwest.

Productivity, sales and market orientation

Productivity and economic performance of pig production

The pig production cycle in the northwest is much longer than in the Red River Delta (Huyen et al. 2016a). For instance, to raise a cross-bred pig to 100kg slaughter weight takes about 6–8 months in the northwest compared to just 4–6 months in the Red River Delta. Pure Ban pigs and their cross-breeds (e.g. Ban x Mong Cai) in the northwest are often raised

for about a year to reach an average weight of 30–50 kg and 60–70 kg, respectively, depending on the feeding method (completely traditional feeding or mixing traditional and industrial feed).

The same pattern was also observed in the studied communes (Table 9). The average length of a production cycle of Ban pigs was approximately one year, twice the production length for cross-bred and exotic pigs. Some farmers in Muong Coi raised cross-bred pigs in the traditional way (no use of commercial feed), which extended the production cycle up to seven months. At slaughter, Ban pigs weighed on average only 20 kg, 25% of the slaughter weight of the other two breeds. Consistent with the more resource-driven farming system in which they are raised, the production cost of Ban pigs is estimated at only about VND2.8 million, much lower than the costs incurred in producing cross-bred and exotic pigs, at VND3.26 million and VND3.25 million/100kg respectively. Despite the overall decreasing trend of pig prices, the price of Ban pigs price remained stable at about VND90,000–100,000V/kg. Thus, raising Ban pigs has still brought considerable profit to farmers, while revenues from raising cross-bred/exotic pigs were just enough to cover the production costs (excluding family labour). While these results are only illustrative, due to small sample size, they show that at current prices, cross-bred and exotic pig raising is not highly profitable and feed costs drive the profitability down.

Table 9: Economic performance of raising different pig breeds (margins analysis)

| Item | Cross-bred | Exotic | Ban |
|---|------------|--------|-------|
| 1. Length of a production cycle (day) | 135 | 145 | 300 |
| 2. Average live weight at slaughter (kg) | 77.5 | 88 | 20 |
| 3. Economic performance (estimated for 100 kg of live weight pig), VND000 | | | |
| Costs | 3,267 | 3,252 | 2,800 |
| - Piglet | 530 | 400 | 300 |
| - Feed cost | 2,554 | 2,700 | 2,500 |
| - Vet cost | 110 | 120 | 0 |
| - Other cost | 72 | 32 | 0 |
| Revenues | 3,250 | 3,350 | 9,000 |
| Gross income for family labour | -17 | 98 | 6,200 |

Source: Computed from information provided by farmers in 2017, based on data from three pig farmers per commune

Constraints faced by pig farmers

Pig farmers face various constraints to maintain and develop their production. In the four studied communes, seven types of constraints were reported: diseases, lack of capital, lack of land, technical issues, waste treatment, fluctuation of output prices and feed availability. The ranking of these constraints differed across the communes. For instance, in Tan My and Muong Coi (villages with better market access), farmers ranked fluctuation of output prices as the top constraint, while in Phu Luong commune, animal health risks were placed first in the list (Table 10). Unsurprisingly for an extensive animal production system, diseases were ranked as most important in Bac Phong.

Table 10: Farmers' rankings of constraints in pig production

| Constraint | Tan My | Phu Luong | Muong Coi | Bac Phong |
|------------------|--------|-----------|-----------|-----------|
| Lack of capital | 2 | 3 | 4 | 3 |
| Lack of land | 2 | 5 | - | - |
| Technical issues | 4 | 4 | 3 | 4 |
| Waste treatment | - | 6 | - | - |
| | 1 | 2 | 1 | - |
| Feed | - | - | - | 2 |
| Marketing | - | - | - | 5 |

Source: FGD 2017

Diseases: Diseases regularly affect pig production in all studied communes. Pig diseases occur either due to unfavourable weather conditions or insufficient vaccinations. The diseases most commonly reported by respondents included swine enzootic pneumonia (SEP), caused by mycoplasma and leptospirosis (although the latter is usually only detected at slaughter houses, so caution needs to be exercised with this result). Sick pigs grow slowly or even die, causing considerable losses to farmers. When piglets are affected at a very young age (4–7 days), it is quite common to observe the diarrhoea (and sometime death) with white faeces, which might be mainly due to *E. coli* infections.

“After being born until reaching a weight of 5–6kg, piglets easily contract white faeces and asthma disease. Last year, all piglets in the villages died because of these diseases” (Value chain mapping meeting in Bac Phong commune)

Capital: Expanding production or switching to other breeds requires investment, especially for cross-bred and exotic pigs. Farmers in the studied sites reported that they did not have enough money to upgrade their pig production with advanced technologies such as tap water, cooling and warming systems or biogas to increase the scale of production, or to use veterinary services. This partly explains why the current pig production has remained small and underdeveloped. Besides, financial limitations also affect farmers’ ability to afford animal feed. Approximately 90% of pig households have to buy animal feed using delayed payment or on credit.

“After selling pigs, households will have money to pay feed suppliers. In these cases, they will be charged an interest rate of VND10,000 per a bag of feed” (Value chain mapping meeting in Phu Luong commune).

Land: Lack of land was only listed as a constraint in Phu Luong commune. This adversely affected pig production in two aspects. Firstly, for some households living near main transport roads, land limitations did not allow them to expand pig housing. Secondly, raising indigenous pigs (Muong pigs) requires access to considerable land area, to allow for free-ranging or extensive production practices – a precondition for Muong pig keeping.

Technological know-how: Similar to other provinces, technical issues were one of the barriers impeding pig production in the study sites. These are the four major issues related to technical know-how:

- Firstly, pigs are mainly raised using farmers’ own experiences in pig feeding practices. Due to low education levels and the absence of related technical trainings (especially in Bac Phong), farmers lack knowledge on feed values, optimal feed composition and appropriate feeding methods to ensure growth and quality of pigs, especially for sows and piglets.

“I do not understand why pigs eat a lot but do not gain weight. I do not think it is relevant to pig breeding because this happens for both Ban pigs and white pigs” (Value chain mapping meeting in Bac Phong commune).

- Secondly, farmers do not have the skills to recognize early disease symptoms and rely on para-vets who are usually far away. As a result, it is often costlier and sometimes too late for treating sick pigs. In their opinion, if they can recognize pig diseases from early stage, disease treatment effectiveness would be higher and treatment cost would be lower.

“I and my husband both have low education. We mainly raise pigs based on our own experiences. When diseases happen, we do not have any ideas of vet drugs which could be used for treating sick pigs” (Value chain mapping meeting in Tan My commune).

- Thirdly, farmers experience difficulties in selecting good breeding pigs (criteria attributed to good piglets) and in correctly identifying the best breeding time, especially for households that produce piglets.

“I do not have experience in identifying the suitable time for mating sows. The number of piglets born per one cycle will increase if mating is conducted at the right time” (Value chain mapping meeting in Muong Coi commune).

- Finally, pig producers reported a lack of knowledge about vaccination (types of vaccine and when to use), especially for sows.

Waste treatment: Waste treatment was considered as a constraint by some households. Households in the research site raise different animal species, mainly pigs, buffaloes, cattle and poultry. Manure of buffaloes and cattle is usually used for crop production while pig manure is rarely used. According to the farmers' opinion, pigs fed with industrial feed produce manure with a high-water content which may contain germs that can cause crop diseases (FGDs in Tan My commune). Having limited space for composting of waste and in the absence of biogas systems on expanding farms may also create serious environmental pollution. In Tan My, some pig farmers located along main roads are observed to directly discharge liquid pig waste onto the road.

Prices: Price movements of both inputs and outputs are a big hindrance to pig production. Input prices are high, especially for industrial feed, while output prices fluctuate over time. Hence, the economic efficiency of pig production is low and unstable. In certain periods, e.g. early 2017, pig selling prices were VND24,000/kg live weight compared to more than VND40,000/kg live weight in 2016; subsequently, revenues from selling pigs were not enough to cover feed costs. Moreover, due to lack of knowledge about market demand, farmers tended to spontaneously expand pig production when selling prices increased. Thus, supply increases significantly within a short period, while demand remains unchanged, leading to a dramatic drop-in output prices and consequently, losses to pig farmers. Besides, traders and farmers reported that selling prices were strongly influenced by the volume of pig exports to the Chinese markets across the Vietnam-China border. The Chinese market is well-known for not being stable for many agricultural products including pigs. From the farmers' perspectives, low output prices are a crucial constraint that cannot easily be addressed because prices are determined by market forces, in the absence of a price-control regime.

"We can somehow handle other constraints but there is no way to handle prices which are determined by market" (Value chain mapping meeting in Muong Coi commune).

"Diseases only cause losses in one cycle but selling prices will affect many cycles of pig productions" (Value chain mapping meeting in Tan My commune).

Price fluctuations are more likely to affect women because they are the main providers of labour in pig production. This constraint was also found to affect rich households more, due to their larger scale and higher investments (FGD in Bac Phong).

Pig feeding, including trends for the next 15 years

Type of feeds and sources, including maize

Commercial feeds are increasingly the basis of livestock production in Vietnam. According to MARD (2015), total commercial feed production has increased five-fold in the period 2000–2015 (from about 2.7 million tons in 2000 to 16 million tons in 2015) while total pig population only increased 1.4 times during the same period. Most feed millers are located in the Red River Delta and the South East regions. In 2015, only 14 feed millers were found in the northwest and no feed millers were operating in the Central Highlands.

In the studied communes, maize and rice bran were the main starch components for feeding pigs of all breeds (Table 11). Commercial feeds were largely used for exotic and cross-bred pigs in Tan My, Phu Luong and Muong Coi, but were rarely used in Bac Phong due to high costs. Agricultural by-products such as vegetables, wild tree leaves and food leftovers were mainly used for local pigs. Ban pigs were raised in free-range systems using raw feed; while Loi, Mong Cai and cross-bred pigs could be fed by either raw or cooked feed. The use of cooked feed is considered better for the pigs' stomach and digestion; however, it is very labour consuming, according to farmers' opinion. Exotic pigs are exclusively fed with raw feed.

Feeds for Ban pigs were mostly self-produced or collected from forests (Duong leaves), while commercial feeds were bought from outside. Maize for pig feeding was either self-produced (in small scale pig production and high surplus maize farms) or purchased from outside (in large scale pig production). Some farmers reported that they preferred buying industrial feed to maize because only commercial feed could be bought on credit.

Table 11: Feed components, sources and preparation for feeding pigs by breed

| | Ban pig | Mong Cai | Loi pig | Cross-bred | Exotic |
|----------------|--|---|--|---|---------------------------------------|
| Feed component | Cassava Rice bran Maize Duong leaves* Banana tube Other vegetables Food leftover | Cassava Rice bran Maize Duong leaves* Banana tube Other vegetables | Cassava Rice bran Maize Duong leaves* Banana tube Other vegetables Food leftover | Rice bran Maize Commercial feed Duong leaves* Banana tube Other vegetables | Rice bran Maize Commercial feed |
| Preparation | Almost raw | Cook/raw | Raw/cook | Raw/cook | Raw |
| Sources | Home produce | Home produce | Home produce | Home produce and buy | Home produce and buy |

Source: FGD 2017

Note: * In Bac Phong commune only

The percentage of maize in starch components varied significantly, ranging from less than 10% up to 80%, depending on breed and commune (Table 12). Maize was used less for indigenous, Mong Cai and Loi pigs (less than 20%), largely due to the lower price of its substitute (i.e. cassava), as per farmers' description. However, the use of maize for these breeds is forecast to increase in the future, driven by its higher productivity compared to natural traditional feeds (i.e. banana tube, leaves) and increasing demand for high quality local pork in big cities like Hanoi. This trend, however, was not clear for exotic and cross breeds, depending on the relative prices of commercial feed vis-a-vis maize and of pig prices.

Table 12: Role of maize in starch component and future trend

| | Indigenous | Mong Cai | Loi Pig | Cross | Exotic |
|------------------------------|--------------------------|--------------------------|--------------------------|---|---|
| % maize in starch component* | <10% | 10% | 15–20% | 10–80% | About 80% |
| Trends (future)** | Probably slight increase | Probably slight increase | Probably slight increase | Depending on: Scale and relative price of maize and commercial feed | Depending on: Scale and relative price of maize and commercial feed |

Sources: FGD 2017

Note: * Percentages were different among communes (low land/highland) and provinces (Hoa Binh/Son La);

** different between provinces (Hoa Binh/Son La) depending on output price

Feed as a share of total production costs

Feed made up about 75–89% of total production costs in the communes with better market access (Tan My and Muong Coi) as well as in Phu Luong, where farmers included a large proportion of commercial feed in pigs' feed ration. In contrast, farmers in Bac Phong mainly utilized self-produced feed and wild leaves collected from forests, so feed accounted for half of total production costs. Maize was considered as a main component in the feed ration, especially for Ban Pigs in Bac Phong and Tan My. In the four studied communes, maize accounted for about 20–65% of the total production costs, which includes fixed and variables costs (feed, piglets, veterinary, electricity, water, labour, etc.) (Table 13).

Table 13: Percentage of feed and maize in total pig production cost (%)

| Commune | Share of feed cost/ total cost | | | Share of maize cost/ total cost | | |
|-----------|--------------------------------|--------|-----|---------------------------------|--------|---------|
| | Cross-bred | Exotic | Ban | Cross-bred | Exotic | Ban pig |
| Tan My | 75 | - | 89 | 20 | - | 65 |
| Phu Luong | 78 | - | - | 15 | - | - |
| Muong Coi | 80 | 83 | - | 20 | 41 | - |
| Bac Phong | 50 | - | 50 | 40 | - | 40 |

Source: Computed from information provided by farmers 2017

Maize millers³

Prior to 2007, maize millers were mostly located in the northwest provinces bordering Hanoi (e.g. Hoa Binh province) due to the moderate volume of production. The maize millers did preliminary processing (husking, shelling and drying) and then supplied maize materials to feed factories in other provinces. Maize farmers sold maize (with cob) or dried corn grains to private traders who then sold to maize millers or sell back to livestock farmers.

Since 2007, maize production in the northwest has grown significantly, evidenced by accelerated expansion of maize area, production volume, number of maize farmers and production scale (Keil et al. 2009). Private traders and feed factories started settling nearer to the northwest (i.e. Son La, Hoa Binh, Xuan Mai, etc.). To ensure the stable supply of maize materials, feed factories are often based on a network of private traders. These traders forge agreements with a group of farmers to fully or partly invest towards support of maize production inputs (i.e. seeds, fertilizer, credit, etc) and then buy the maize produced by these farmers. The private traders are also equipped with simple machines for husking, shelling and drying maize before delivery to feed factories.

Along with increasing production scale, many farmers choose not to sell maize (with cob) to traders immediately after the harvest. Instead, they do preliminary processing of maize by themselves, or/and using milling services at local maize millers for feeding animals. Maize millers are more concentrated in commercial maize production area (not present in any of the studied communes).

Knowledge and support systems

The extension system in Vietnam is organized and operates at all levels: Central (National Center of Extension), Provincial (Extension Centre), District (Extension Station) and commune (commune-based extension staff). In some places, the extension staff even operate at village level. Trainings on crop and livestock production are provided not only through the extension system (as assigned), but also by private companies. Private feed and veterinary drug companies often organize trainings for livestock farmers, mostly on how to use their products, to serve their own purposes of sale promotion.

All studied communes have communal extension and veterinary staff. However, the capacity of these staff is limited due to inappropriate background. Consequently, farmers do not receive much support from this network. During the FGDs, farmers complained that they faced difficulties in receiving pig production knowledge related to the selection of good breeds, appropriate feed ration formulation, diagnosis and treatment of pig diseases, as well as for accessing markets. Feedback from Hoa Binh's representatives in the stakeholders' workshop revealed that several marketing groups of farmers have been established through development projects funded by NGOs such as World Vision, with the aim of helping pig farmers overcome these difficulties. These groups are working well in terms of providing high quality inputs and services, but still face constraints in finding output markets.

At a higher level, researchers and NGOs forecast that with the growth in pig demand all over the world, especially in China, pig production systems need to change. However, the existing extension systems are insufficiently prepared to support pig farmers in this transition.

Constraints

Farmers did not report major difficulties in ensuring sufficient feed quantity for pig production in the studied communes, except in Bac Phong. In that commune, there are no feed suppliers located inside the commune and pig production is heavily dependent on the availability of Duong leaves, which are gradually being exhausted due to abnormal weather conditions (e.g. droughts) and excessive use of weeding chemicals. In terms of feed quality, farmers in Tan My and Phu Luong raised concerns about the uncertainty of commercial feed quality, given the presence of various feed brands in the market. The high price of both maize and commercial feeds and the refusal to sell maize on credit by feed suppliers were listed as other constraints during the FGDs in all communes. Besides, labour shortages also appeared as a constraint restricting the use of maize as pig feed by farmers (Table 14).

³ Most of the information in this section is based on a key informant interview with staff from the Maize Research Institute.

Table 14: Constraints in pig feeding and feed sources

| | Quantity | Quality | Price | Other |
|-----------|---|-----------------------------------|---|--|
| Tan My | No | Unsure quality of commercial feed | High (both commercial + maize) Not able to buy maize on credit | Labor consuming in feed preparation, using maize |
| Phu Luong | No | Unsure quality of commercial feed | High (both commercial + maize) Not able to buy maize on credit | Labor consuming in feed preparation, using maize |
| Muong Coi | No | No idea | High (both commercial + maize). | |
| Bac Phong | No feed suppliers in this commune Exhausted natural leaves (Duong) for pig | | | Price of maize seed is high |

Sources: FGD 2017

The availability of local feed resources has decreased considerably in recent years due to the adverse impacts of climate change. According to Huong et al. (2018), the high mountains in the northwest are especially affected, due to the increasing frequency of natural hazards such as drought, heavy rains causing erosion and landslides and other extreme weather phenomena such as snow. Winter frosts and hot summer weather is seriously restricting the growth of natural vegetation.

Findings from the fieldwork showed that many pig farmers in the studied communes sell maize grain to traders at a low price instead of using it to feed their pigs while buying industrial pig feed. This results in low profits from their pig and maize farming. Reasons for this practice include (i) poor storage technologies reducing maize quality, which might cause digestion problems (ii) drying maize for storing is time and labour consuming (iii) in some cases, maize farmers agreed to sell all maize to traders at harvesting time to receive cash advances at the beginning of a season (iv) maize farmers are able to buy industrial feed on credit. Some farmers forecast that in future maize will be used more, replacing cassava and other raw feeds because it has a higher nutrient density which helps pigs grow faster with better meat quality. Participants in the stakeholders' workshop also identified maize, not cassava despite its competitive price, as the key substitute to industrial feed that can reduce feeding costs. Moreover, the provinces have policies to restructure rice production, making more land available for maize farming. The anticipated increase in maize production can provide cost-effective feed for pigs in lieu of purchased industrial feed. The use of maize as pig feed, however, will require a change in pig production and management practices such as in ensuring appropriate feed ration balancing to achieve optimal growth of the animals. New technologies to process maize for use as animal feed will also be required.

Past and future trends

The trend of gradually replacing raw feed with commercial feed was acknowledged in all studied communes (Table 15). This process, however, depends largely on pig breeds and production scale (which is ultimately affected by not only conventional production practices but also by level of market access). Among the four communes, Bac Phong, the commune with the poorest market access, experienced the slowest pace in this process, with only few pig producers presently using commercial feed.

Table 15: Past and future trend of pig feeding in the four studied communes

| Communes | Past | Present | Future |
|-----------|---|------------------------------------|--|
| Tan My | Vegetables, maize, cassava | Vegetable, maize, commercial feeds | Vegetable, maize, commercial feeds |
| Phu Luong | Vegetables, maize, cassava | Vegetable, maize, commercial feeds | Vegetable, maize, commercial feeds |
| Muong Coi | Vegetables, maize, cassava | Vegetable, maize, commercial feeds | Vegetable, maize, commercial feeds (minimized for safety meat) |
| Bac Phong | Vegetables, maize, cassava | | |
| | Vegetable, maize, commercial feeds (very limited application) | | |
| | Vegetable, maize, commercial feeds (limited application) | | |

Sources: FGD 2017

The participants in the stakeholders' workshop also emphasized the prevalence of industrial feed use in pig production among pig farmers in the region. The larger the production scale, the more industrial feed farmers use. Once the scale exceeds 10 pigs per cycle, farmers tend to shift to mixing industrial feed with raw feed, rather than solely using traditional feed.

The same trend in evolving feeding patterns is expected to continue in the future. The main drivers include changes in pig breed composition (expansion of exotic and cross-bred pig production demanding more commercial feed use) and larger production scale. Only the farmers in Muong Coi forecast that their target market of pigs and pork in the future would no longer be China, due to its uncertainty in terms of demand and prices, but the domestic market with a strong consumer preference for natural and tasty products. Therefore, they would keep using a large percentage of agricultural products (mainly maize) ensuring meat safety, an attribute much preferred by Vietnamese consumers.

Maize production and environmental degradation

Generally, pig production has few positive impacts on the environment, as articulated by participants in the FGDs. However, various negative impacts could be listed:

- Waste water: urine, organic compounds
- Solid waste: manure and food excess
- Odour and hygiene, affecting people

According to Nguyen (2016), a single pig may release about 1.5–3.5 kg /day of solid waste (manure + food excess) and 10–50 litres of waste water per day. The solid waste released by pig production affects the wind circulation in enclosed farms, as well as the waste water. It is constituted of more than 75 compounds, containing N and S, such as NH₃, amin, mercaptan, H₂S and vapourable organic acids. Six million tons of CO₂ are estimated to be released annually by medium-sized pig farms as a result of an estimated 73 million tons of pig waste disposed improperly into ponds, channels and sewerage or merely left to decay in the fields each year.

In the four studied communes, as shared by farmers and observations during the study, pollution from pig production did not appear to be ?? serious, probably due to the relatively low pig density and the small scale of production. Only in some cases, where pig households are located near main roads was waste directly released to canals or roads. However, the research did not collect specific data on this aspect, either through focused observations or sampling.

Maize production and marketing in the northwest

The maize production area in the northwest has increased gradually over time and accounted for nearly one-third of total maize area in Vietnam in 2015 (Table 23 in section 10, Appendix 1), yet the province is only about 15% of the total country in terms of land area. The adoption of hybrid maize was considered the most important agricultural innovation of the 20th century for the highlands, which contributed to increases in the maize production area and farm income (Friederichsen and Neef 2010). Son La province has the largest maize area in the region and also has the highest level of maize production in the country because of its favourable conditions, rapid application of advanced production techniques, high-yielding varieties and accessibility to markets (Friederichsen and Neef 2010; Tran 1998).

Total maize volume produced in the northwest rose sharply from 847.2 thousand tons in 2010 to 1,149.4 thousand tons in 2014, contributing approximately 21% of total maize production. The total production, however, declined to 1,117.6 thousand tons in 2015 (Table 24 in section 10, Appendix 1), due to the decrease in output from Son La province.

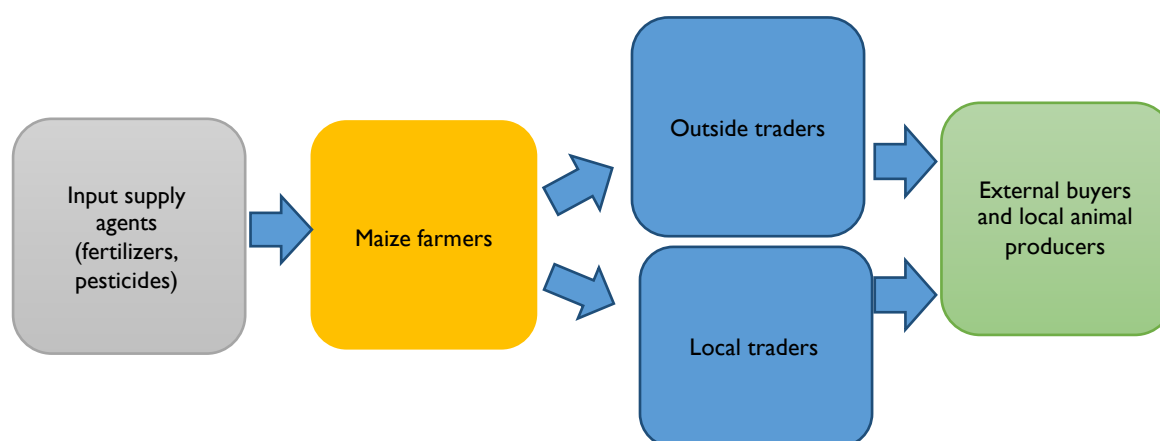
Maize production and marketing patterns in the northwest varies among provinces in the region. In Son La province, maize is mainly grown for commercial purposes and sold to collectors and wholesalers. The province has advantageous natural conditions for growing maize and has experienced a rapid improvement in transportation systems (Karimov et al. 2016). See Figure 7 in section 10, Appendix 1. In contrast, maize production in Yen Bai province is mainly for household consumption and animal raising (Hauswirth et al. 2012). According to Do and Tran (2014), there are three channels of commercial maize marketing in the northwest of Vietnam. The largest volume of maize produced in the region (84%) is sold through the first channel in which collectors and traders buy maize directly from farmers and then sell them to wholesalers or agents. These actors then sell maize to animal feed or food processing companies. Approximately 15% of total maize produced is sold through channel 2 in which maize is sold directly to wholesalers, not through collectors and traders. Only a small proportion of maize (0.7%) goes directly from farmers to consumers through channel 3.

Fluctuation in maize prices in the region is acknowledged, not only during different periods, but also among different provinces. Because of a lack of market information and post-harvest processing and storing facilities, farmers often sell maize during harvest seasons, with farmers being price takers, having almost no power in price setting (Do and Tran 2014; Karimov et al. 2016). For example, maize in Hoa Binh province usually sells at the lowest price during the period from June to May when maize is harvested and more than 71% of farmers would sell maize right after harvesting, with up to 68% of total production sold during this period. The rest of the produced maize is usually sold from October to December at a higher price. In Son La, only 25% of farmers sold their maize right after harvest because they have better maize preservation systems.

The variation in maize prices was validated in the studied communes. Findings from interviews with small scale farmers in Muong Coi and Bac Phong in Hoa Binh province showed that maize was sold at the lowest price during harvest and at the highest price during off-season periods. Specifically, the price of dried maize in Muong Coi during harvesting time was only VND4.5 million per ton. Then two months later, the price was up to VND5.6 million per ton. In Bac Phong, the maize price was highest in December and January (almost VND four million per ton of whole fresh maize) and lowest in late October and November (around VND3.5 million per ton of whole fresh maize) due to more maize surplus available during this period.

The relative price of maize compared to its substitutes affects the farmers' decision on its use as pig feed. For instance, feedback from local stakeholders in Bac Phong revealed that a surprisingly low volume of maize was kept at home for animal raising. This is mainly driven by the higher price of maize compared to its substitute, cassava. Because pig production in Bac Phong is mainly for home consumption rather than for sale, using cheaper but less productive feed (i.e. cassava) than maize was preferred by farmers.

Figure 5: General value chain of maize in the northwest Highlands



Findings from value chain mapping meetings in the four studied communes listed the key actors involved in the maize value chains: input suppliers, farmers, traders, maize processors and users (Figure 5). Input suppliers are often located inside the communes and provide maize seeds, fertilizers, pesticides, etc. Maize farmers include those who specialize in producing maize only and those combining both maize and livestock production. Maize traders may be local people or come from outside the communes. These traders often buy maize directly from farmers, dry it and then sell it to maize processors (millers or animal feed companies) in neighbouring provinces or even to other regions such as the Red River delta. Source: VC mapping meetings in Hoa Binh and Son La province, March 2017.

Some differences in maize value chains among the four studied communes were highlighted.

- In Tan My commune (Figure 7, Appendix 1), local maize collectors offered inputs on credit to farmers at the beginning of a new season. In return, farmers paid back when harvesting with the added interest rate of about 1.5–2% per month. No formal maize trading contracts between farmers and local collectors or external traders were found in Tan My. Of the total maize volume harvested, farmers kept only 7–8% for animal raising, mainly for pigs.
- In Phu Luong commune (Figure 8, Appendix 1), local collectors also provided inputs on credit to farmers but charged a higher interest rate, 3% per month. The scale of maize production in this commune was very small (less than 4000m² per household), thus most of the maize produced (80%) was kept at home for pig raising.
- In Muong Coi commune (Figure 9, Appendix 1), provision of inputs on credit by local collectors was also found, at an average interest rate of about 2% per month. In this commune, “Co moi” or local brokers operate during harvest seasons with the specific function of introducing external maize collectors/buyers to farmers and receiving a commission for each introduction. Because of their larger production scale, farmers in this commune kept approximately 20% of total maize produced at home for animal raising, mainly for pigs. Interestingly, maize traders in this commune were mainly women.
- In Bac Phong commune (Figure 10, Appendix 1), the value chain was very different compared to the other three communes. As the poorest commune and being rather isolated from markets (the commune centre is about 60km from Phu Yen, the district centre), maize production and marketing in this commune was least developed. Nevertheless, maize is considered to be an important source of income. However, maize productivity is very low due to reduced soil fertility. Aside from local and external traders (mainly from district centres), the Farmers’ Association in this commune also sells inputs on credit to farmers with an interest rate of about 2.5 to 3% per month.

The maize-pig system in the northwest

As described above, the integration of maize and pig systems is quite common in the studied communes. Most farmers produce maize for cash income and/or for feeding animals. About 80% of farmers in Muong Coi combined both activities (maize and pig farming) in their farms, while this figure was only 40% in Bac Phong. Bac Phong has hillier and less advantageous conditions for both maize and pig production compared to Muong Coi. Generally, the practice of integrated pig-maize production system has decreased over time in the studied communes due to land degradation and the

replacement of locally available feeds with commercial feed, especially when the scale of pig production increases as already described above (Table 16).

Table 16: Extent of maize-pig system in the studied communes

| Communes | % farmers applying | Past trend | Reason |
|-----------|--------------------|--|---|
| Tan My | NA | Decrease | Decreasing maize land (degradation and erosion). Commercial feed is an alternative to maize |
| Phu Luong | NA | Decreasing | Decreasing maize land (degradation and erosion). Commercial feed is an alternative to maize |
| Muong Coi | 80 % | Significant increase | Maize is mixed with commercial feed, Convenient for expanding scale. More self-sufficiency in feeds; Saves costs and is more economical. |
| Bac Phong | 30–40% | No significant change / might decrease | Decreasing maize land (degradation and erosion) Maize production requires family labour; less labour is devoted to pig production Trend of specializing in pig production (for commercial purposes) |

Sources: FGD 2017

Roles, advantages and disadvantages of the maize-pig system

Maize and pig production play a crucial role in household livelihoods in all studied communes. Both contribute to family income and generate jobs for family labour. The integrated pig-maize system has several main advantages, including:

- Maize production provides feed for pig raising so farmers can save a certain amount of their income that otherwise would be used for buying animal feed.
- Feeding pigs with maize rather than commercial feed, as reported by farmers, helps increase pigs' resistance to diseases.
- Farmers are able to adjust their feed rations, responding to changes in market conditions (i.e. at time of high commercial feed price and/or low pig price, own-produced maize replaces purchased commercial feed hence reducing production cost).

Table 17 provides more details on the advantages and disadvantages of the integration.

In addition to the advantages above, farmers also listed some key disadvantages attached to this integrated system, including:

- Farmers do not have enough labour to cover both activities at the same time, especially where maize is planted in the uplands far away from home.
- Using maize for feeding pigs requires more investment of time and labour for feed processing and preparation. This is more difficult where production is expanding and seasonal labour migration increases.
- Degradation of maize quality during home storage (e.g. accumulation of aflatoxins) may reduce feed quality and thus adversely affect pigs' growth performance.

Table 17: Roles, advantages and disadvantages of integration maize and pigs

| Commune | General roles | Advantages | Disadvantages |
|-----------|------------------------------------|--|--|
| Tan My | Contribution to income, employment | <ul style="list-style-type: none"> • Self-produced feed, don't have to spend cash • Higher price for pig fed with non-commercial feeds • Save cost • High yielding varieties (maize) are more available | <ul style="list-style-type: none"> • Limited land for maize production; • Increasing disease incidence in maize production. |
| Phu Luong | Contribution to income, employment | <ul style="list-style-type: none"> • Save cost and don't have to spend cash; • High yielding varieties (maize) are more available • Increasing maize production in winter season; and areas lacking water for rice is shifting to maize production | <ul style="list-style-type: none"> • Difficult to store and preserve in long time; • Labour consuming in preparation of feed; • Decreasing maize land |
| Muong Coi | Main sources of income | <ul style="list-style-type: none"> • Self-produced feed, don't have to spend cash • Save cost • High yield varieties (maize) are more available • Pigs fed with maize have better appearance (skin) than those fed with commercial feeds. • No antibiotic substances in maize (unlike in commercial feeds) • More sustainable system | <ul style="list-style-type: none"> • Not much relation between maize production and pig production because maize could be sourced outside; • Higher fat content in pigs if fed with more maize; also, lower growth rate; • Labour and time consuming • Degraded land is difficult for maize production; income from maize production is lower than from other crops, such as soybean, fruit trees. |

| Commune | General roles | Advantages | Disadvantages |
|-------------------|---|---|---|
| Bac Phong | Main sources of income | <ul style="list-style-type: none"> • Self-produced feed • Higher income as compared to single activity | <ul style="list-style-type: none"> • Difficult to store and preserve in long time; • Labour consuming in preparation of feed; • Maize is more costly than other feeds (cassava, banana, Duong leaves). • Degraded land and adverse weather changes for maize production; • Off-farm income (from hired labour employment) is higher than maize-pig system; • Pig breeds (cross-bred) is more suitable to commercial feed. |
| Commune Tan My | General roles Contribution to income, employment | <ul style="list-style-type: none"> • Advantages • Self-produced feed, don't have to spend cash • Higher price for pig fed with non-commercial feeds • Save cost • High yielding varieties (maize) are more available | <ul style="list-style-type: none"> • Disadvantages • Limited land for maize production; • Increasing disease incidence in maize production. |
| Phu Luong | Contribution to income, employment | <ul style="list-style-type: none"> • Save cost and don't have to spend cash; • High yielding varieties (maize) are more available • Increasing maize production in winter season; and areas lacking water for rice is shifting to maize production | <ul style="list-style-type: none"> • Difficult to store and preserve in long time; • Labour consuming in preparation of feed; • Decreasing maize land |

| Commune | General roles | Advantages | Disadvantages |
|-----------|------------------------|--|--|
| Muong Coi | Main sources of income | <ul style="list-style-type: none"> • Self-produced feed, don't have to spend cash • Save cost • High yield varieties (maize) are more available • Pigs fed with maize have better appearance (skin) than those fed with commercial feeds. • No antibiotic substances in maize (unlike in commercial feeds) • More sustainable system | <ul style="list-style-type: none"> • Not much relation between maize production and pig production because maize could be sourced outside; • Higher fat content in pigs if fed with more maize; also, lower growth rate; • Labor and time consuming • Degraded land is difficult for maize production; income from maize production is lower than from other crops, such as soybean, fruit trees. |
| Bac Phong | Main sources of income | <ul style="list-style-type: none"> • Self-produced feed • Higher income as compared to single activity | <ul style="list-style-type: none"> • Difficult to store and preserve in long time; • Labour consuming in preparation of feed; • Maize is more costly than other feeds (cassava, banana, Duong leaves). • Degraded land and adverse weather changes for maize production; • Off-farm income (from hired labor employment) is higher than maize-pig system; • Pig breeds (cross-bred) is more suitable to commercial feed. |

Source: FGD 2017

Another issue is the shortage of labour available needed in the pig-maize systems, mostly due to the increasing trend of out-migration of local rural labour. Farmers in Bac Phong commune reported that because of decreasing income from maize production over the years, many young rural women in this commune have moved to low land areas (e.g. Hung Yen and Hanoi) seeking employment in the garment and shoe industries. These labour trends may have significant implications on the sustainability and viability of local maize production in the near future.

Future trend of the maize-pig system

Farmers in all four communes forecast that the upland maize area will decrease in the future due to land degradation and decreasing maize prices. The pig-maize system would remain in practice in the communes, but the number of adopters might decrease or remain unchanged (Table 18).

Table 18: Trend of maize-pig system in the studied communes

| Commune | Future trends |
|-----------|--|
| Tan My | <ul style="list-style-type: none"> • Decrease in number of pig farmers but maintain the pig-maize system • Decrease maize area |
| Phu Luong | <ul style="list-style-type: none"> • Maize demand for feeding increases • No expansion in maize area • Use of maize as feed depends on commercial feed price; maize is used more if commercial feed price increase |
| Muong Coi | <ul style="list-style-type: none"> • Maize for pig feeding increase as demand for safe meat increases in the future • Maize-pig system might remain unchanged or decline in practice • Semi- industrial pig production will increase; but maize will remain as main feed component |
| Bac Phong | <ul style="list-style-type: none"> • Number of maize farmers will decrease • Maize for pig feeding will decrease due to decrease in maize land and degraded maize land • Number of maize farmers will decrease • Trend of increasing use of cross-bred pigs use of more commercial feed other than maize |

Source: FGDs 2017

Constraints and challenges in maize production: Environmental degradation

Despite improvements in productivity and increases in cultivated area in comparison with a decade ago, most farmers interviewed indicated that the maize farming systems in the northwest are still considered unsustainable. Maize is mainly grown in one season, except in Hoa Binh province where it is grown in two seasons in some areas. Also, maize is primarily grown on the hills and sloping lands, causing soil erosion during the rainy season that erodes organic nutrients, resulting in unfertile top-soil. Soil erosion and degradation due to unsustainable practices in cultivation of sloping lands and the rapid growth in maize production area have been reported as emerging issues in the region. Both cultivated upland area and productivity of maize were reported to have been recently decreasing over the years.

During harvest periods local markets have difficulties absorbing all the maize being supplied. Local farmers have almost no strategies in dealing with this market saturation situation, due to their lack of market information and limited facilities for processing and storage. In addition, findings from both the literature review and the fieldwork indicated that maize preservation facilities among farmers is poor. Farmers in most communes cannot store maize over long periods.

Other constraints for maize production identified by farmers include increasing input costs, shortage of capital and poor roads to access mountainous farms (Table 19).

Table 19: Constraints in maize production in the northwest

| | Tan My | Phu Luong | Muong Coi | Bac Phong |
|--|--------|-----------|-----------|-----------|
| Mono maize cropping for spring and summer-autumn maize, depending on rain water | X | X | X | X |
| High input cost (seeds and fertilizers) | X | X | X | X |
| No sustainable farming techniques applied for maize production leading to land degradation | X | X | X | X |
| Shortage of capital for production and high interest rate charges for credit | X | X | X | X |
| Difficult roads for maize transportation from the mountain fields | X | - | X | X |
| Natural calamities (unexpected storm in spring) | - | X | X | - |
| Lack of post-harvest facilities | - | X | - | X |
| Migration of labour to other lowland areas | - | - | - | X |

Sources: FGD 2017

Results of key informant interviews with the local commune's extension staff revealed the main challenges facing maize farmers being the low maize price, a lack of capital for production and conventional and inefficient farming methods. Even though some trainings on maize production techniques have been provided by the extension systems at different levels, their impacts are still questioned.

Regarding the future of maize production, local participants in the stakeholders' workshop provided very different viewpoints compared to the farmers in the studied sites, which implies a significant disconnect between policy makers or implementers and farmers. The workshop participants forecast that rice and maize would still remain key crops in the uplands in the next 15 years. The maize area would increase while rice area would probably decrease due to climate change. Presently, parts of the rice growing areas have been switched to growing maize annually, due to low rice productivity and impacts of climate change. However, growing maize on a large scale might lead to negative impacts on the ecosystem due to the excessive use of pesticides and chemical fertilizers, leading to soil and water pollution.

Summary of key points and research gaps

Pig and maize production is a traditional farm activity in Vietnam and particularly in the northwest region where both pigs and maize present a huge potential for growth and livelihood opportunities. In the region, it is hard for farmers to move to other farming enterprises. Apart from migration, there are few other opportunities for rural labour and clear difficulties in transferring labour from farm to non-farm employment and even from farm to farm. Pig production apparently continues to be an important economic activity in the uplands for family nutrition, employment, income and for absorbing home agricultural produce. Maize-pig integration could be a promising farming system that makes use of self-produced feed (maize) to gain cost competitiveness as well as to supply market demand for indigenous pigs (tastier than conventional pork, though more expensive), or pork from pigs fed with limited commercial feed (considered to be safe and have better taste by consumers).

Results from the field survey in the four studied communes in Hoa Binh and Son La provinces show that there is a clear trend of expansion of pig production, both in pig population and production scale over the past years, despite the recent difficulties due to the Chinese restrictions of pig exports from Vietnam. Pig production in the northwest has been changing in terms of production system scale, feeding as well as regarding the breeds adopted. Among the factors driving this change, market accessibility greatly influences the speed of change. Also, local breeds have been replaced by cross-bred and exotic breeds and the feeding practice has changed accordingly, with more commercial feed being used. Communes with better access to market have experienced faster changes. Changes in breed and feed use in Muong Coi and Tan My have

been faster, while in Bac Phong, pig production has only slowly been changing from indigenous to cross-breeds. However, while higher productivity breeds (cross-bred and exotic) are increasingly being adopted overall, some farmers have switched back to indigenous breeds, for example to Ban pigs in Hoa Binh, or Loi Pigs in Bac Phong, in response to higher demand for good quality meat. It was observed that conventional pig prices vary considerably but indigenous pig prices have remained quite stable.

The maize – pig system has been widely practised by farmers in the four communes. This integrated system is considered more advantageous over a single farm activity for (i) consuming home agricultural produce that otherwise farmers have to sell somewhere else; (ii) convenience, as maize feed is available at home and farmers don't have to spend cash; (iii) saving on feed cost; and (iv) potentially producing a product for supplying a niche meat market for high quality (indigenous) pigs and meeting the demand for “clean” pork. Yet, several disadvantages were identified during the survey, including: (i) maize production being labour consuming, especially on a larger production scale; (ii) difficulties in preservation of maize and prevalence of aflatoxins in maize; (iii) higher fat content of pork from pigs fed with excessive amounts of maize in their diets; (iv) longer production cycle of pigs fed with unbalanced feed rations and (v) inability to buy maize on credit unlike commercial feeds.

It remains to be seen whether and how the interactions between maize and pigs will effectively evolve in a desirable manner in the future, given these advantages and disadvantages, including the fact that the maize area in the northwest has been decreasing due to land degradation and the high maize production cost, in the context of recently falling maize prices. Identification of alternative farm-produced feeds, for example forage legumes, which may replace or complement maize, while making these systems more environmentally sustainable is an important research opportunity. Also, the appropriate role of self-produced maize in these systems, compared to purchased maize and commercial mixed feeds should be determined. Finally, feed quality issues affecting pig production, including aflatoxins in maize, remain seriously under-researched.

Topic 3: Business approaches to link Northwest Vietnam pig farmers to inclusive and sustainable markets

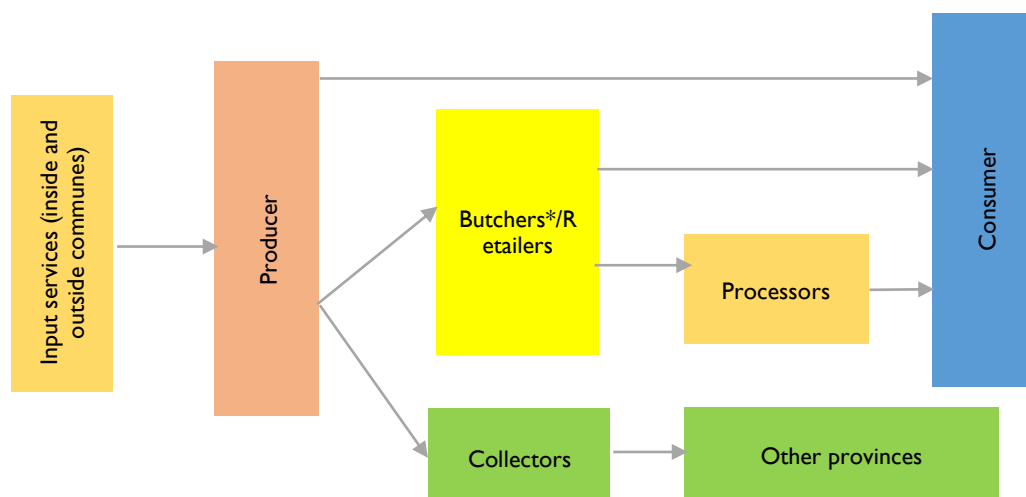
Current business model in the study sites

Description of the value chains

There are important market related constraints that prevent small-holder pig farmers from effectively getting involved in high-value added chains. These constraints include output price volatility, input price increases, localized demand, sporadic demand from external markets (e.g., unofficial Chinese exports), etc. As in other countries and livestock value chains, the existence of these constraints is mainly driven by inefficient business arrangements in pig value chains in specific local contexts. Figure 5 displays the general pig value chain in the four studied communes. The value chain consisted of the following main actors: input and service suppliers, pig producers, pig collectors/traders, pig butchers/slaughters, meat processors, meat retailers and consumers. One actor can perform multiple functions such as being butcher/slaughter cum retailer or feed and veterinary products supplier cum producer, etc. Depending on geographical locations and market access, some actors may not be present in some communes. For example, while in the best market access commune, Muong Coi, all value chain actors cited above are present, there was no meat processor found in Tan My and Phu Luong – the two communes with poorer market access. In the poorest commune, Bac Phong, outside actors played an important role in production and marketing since there were no input suppliers, butchers/slaughters and meat retailers within the commune.

This section provides details of all major value chain stakeholders, except for producers, which have been covered in the previous section.

Figure 5: General pig value chain in the studied communes



Source: FGD 2017

Input supply: There are no input or service providers in Bac Phong, the commune with poor access to market and fewer pigs compared to the other study sites; thus, pig farmers need to source pigs from outside. In the other communes, with better access to market and more pigs, the market is sufficiently large for the establishment of feed and veterinary medicine service providers. Each commune has between 1 to 10 input suppliers. These suppliers specialize in selling feed or veterinary medicine or provide a combination of both. Piglets are mostly sourced within the communes as most farmers have sows producing their own piglets. In cases where their own sows cannot produce sufficient piglets for a production cycle, farmers buy additional piglets from neighbouring farmers or from traders. However, this is not commonly observed in the studied communes. Only one piglet trader was found in Tan My and Phu Luong and there are no professional breeding farms in these communes. In Bac Phong, breeding stocks are mainly purchased from breeding farms in the nearby communes (Gia Phu, Van Yen and Muong Coi). At least three breeding farms were found, usually providing good-quality piglets for pig farmers in Bac Phong commune.

Marketing of pigs: Among the four communes, Bac Phong is less concerned by the general trend of shifting from subsistence to commercial production, as the breed composition described in Topic 2 has already shown. Due to its small production scale, the number of pigs produced annually is only sufficient to serve local consumers within the commune, mostly for special events such as parties, weddings or funerals. There are no existing channels to bring its pigs to outside markets. On the other hand, several commercial pig farms are found in better market access communes. 60% of pigs produced in Tan My, 70% in Phu Luong and 50% in Muong Coi are consumed outside the district/province, or even exported to China. Most small-scale farmers sell pigs to local butchers while medium and large-scale farmers tend to sell pigs to traders.

Viewing the value chain as a whole, there seem to be only limited linkages among the actors. No formal relationships were reported. Transactions are mostly done in spot markets without advanced agreements or contracts. Some inputs such as commercial feed can be bought on credit but with a price premium of about 5–10% compared to in cash purchases. Although information on prices and market demand is sometimes exchanged between pig farmers and buyers, advanced agreements for pig trading hardly exist. No pig farmer groups in the communes were established to support pig farmers in pig production and marketing. Recently, a plan to establish a pig production cooperative in Bac Phong commune to help farmers with promoting and marketing of indigenous pigs has been developed; however, it is not clear when this plan will be implemented.

Analysis of value chain actors apart from farmers

Feed suppliers

As explained above, various value chain actors are operating within three out of the four studied communes; none were found in Bac Phong. Input suppliers were interviewed in the three communes where they were present. Input suppliers often operate their businesses next to their houses. To establish the business, business registration is required and owners have to obey business rules as defined by law and government.

Input suppliers do not specialize in any specific product but rather sell various products including feed, veterinary medicine, maize seed, fertilizers, pesticide, especially during crop seasons and household groceries. Feed often constitutes the most important product as this item is traded all year round. A shop usually sells several brands of pig feed with an average storage quantity of approximately 2–4 tons. All feed suppliers have a separate place to store feed, where feed bags are placed not touching the ground directly and protected from rats. Feed bags are also categorized by brand and stage of animal growth, type of animal, or expiry date.

Because input suppliers are usually also experienced pig producers, they have knowledge of good quality feed as well as efficient feeding methods and therefore provide advice to their customers when requested. They also provide other types of advice, like the use of crop fertilizers.

Two feed suppliers in Tan My and Phu Luong communes buy feed from the first level feed agent, located in the district town, while the feed supplier in Muong Coi buys feed from feed millers in Hung Yen and Hai Duong province and acts therefore as the first level feed agent himself. The cost of raw material accounts for 90–95% of total costs in the feed business. Therefore, the selling price is based on the cost of feed sourcing. At the time of the interviews, feed prices for weaners/piglets was highest, followed by feed for growing pigs and then the feed for sows.

Smallholder pig producers constitute the majority of customers. Input suppliers provide feed on credit when customers cannot afford to pay at the time of purchase, at a set interest rate. However, one of them had to stop selling on credit because the amount of debt accumulated became too high to sustain, putting his business viability at risk. Trading volumes are relatively stable year-round. The average monthly quantity of feed sold ranges from 4–20 tons/shop. Sales are usually lower during January–March as many festivals and village activities take place during this time. Volumes have recently decreased (since December 2016) due to the reduction in pig population. In Phu Luong commune, the feed supplier reported higher demand for feed during May and June, as farmers start a new cycle for the Tet holiday. Meanwhile, in Tan My commune, the feed business depends on pig prices, with farmers using more commercial feed when the pig price is high and vice versa. In Muong Coi, the amount of feed sold is stable throughout the year.

The most important features of feed products being sought by farmers, as reported by input suppliers, are feed brand and feed quality (using feed brand as criteria), usually evaluated by smell (Tan My commune). During the time of high pig prices, farmers often buy high quality feed to achieve higher weight growth and vice versa. Farmers do not pay much attention to the size of packaging; the current standard is 25kg/bag appears to be convenient. The expiry date of the package is also considered by farmers in Tan My commune.

The number of shops in the study sites has increased, triggered by increasing pig production (despite the recent decrease from December 2016) and a shift in the use of feed from traditional feed to industrial feed. Besides, new feed brands have entered the market, illustrating the dynamics of the sector. New feed companies have introduced new products. However, all the feed suppliers reported that they are not concerned about new feed products appearing in the market, as farmers are used to specific brands and continue using those, seeing no need to change to new types. Farmers indicated that using natural feeds can help with producing higher quality meat but pigs' growth is slow leading to low profits.

Competition, interestingly, is not found to be stiff among feed suppliers, even when there are about 10–20 feed suppliers within and around a commune. The main reason is that feed brands are quite differentiated. Input suppliers however revealed that they did not know much about the competitors' performance.

The major constraint faced by feed suppliers is lack of capital (see Table 20). To engage in this business, input suppliers are required to make a large initial investment to purchase animal feed from feed companies, yet they are not always able to get direct payment from their customers at purchase (mostly payments are delayed).

Table 20: Summary of main constraints faced by other VC actors in the pig value chain

| Actor | Main constraints |
|------------------|--|
| Input supplier | Lack of capital Farmers delay in paying |
| Butcher-Retailer | Down in trading quantity, more difficult to sell meat, especially from January–March Lack of labour for slaughtering Hardness of slaughtering activity Delay in payment of buyers |

Sources: In depth interviews with actors

Butchers and retailers

Slaughter units were found in all communes, except in Bac Phong. There is no central slaughterhouse in the studied communes. Slaughtering and retailing are usually done by the same entity, with pigs being slaughtered at home and the pork transported to wet markets. No business registration is required, but various regulations and inspections by local government, especially veterinary staff, have to be considered, especially relating to veterinary hygiene and quarantine issues. The inspection is usually done at marketplaces. For all the interviewed butchers-cum-retailer units, both husband and wife are involved in the work, with the husband responsible for killing animals and processing these into carcasses, while the wife is responsible for assisting him and retailing meat and other products. Meat is sold directly to final consumers at the house, in front of the house, or at local wet markets. Income from slaughtering and retailing activities account for 50–70 % of total household income. In practice, people do not only specialize in pork retail; they also sell other products such as household goods and vegetables. Pig barns are used to keep pigs before slaughtering. The butchers cum retailers purchase pigs from farmers in the commune at market price. About 90 percent of their total production cost is the live pig cost.

All pigs are sourced from small farmers in the communes. A butcher from Muong Coi reported that he purchases all the pigs from a farmer at once, does the slaughtering and only pays the farmer when all the pigs have been slaughtered. Pig barns can normally hold about 3–10 heads. Small vans and motorbikes are the most common means of transport.

On average, each entity slaughters about 10–35 head per month. In peak times, such as during Tet holidays, up to 50 pigs are slaughtered per month. The production scale of the retail butchers is very stable. The slaughtering unit in Phu Luong operates at the lowest scale, with only one pig slaughtered every three days. There is no seasonality in selling pork, except during Tet holiday and some specific months (January, April and September (lunar calendar)) in Phu Luong commune, because of local festivals; and also during summer (Tan My commune).

The selling price largely depends on the live pig market. For the last two years, the difference between the highest and lowest prices is about VND 10,000. In general, the selling price is about VND 40,000–50,000/kg higher than the buying price. There is little difference between prices of different retailers, as retailers exchange price information. Besides, they also obtain information about prices through other sources, including television and internet. Pork price at retail does not vary much throughout the year, being only a bit lower during the summer time (May and June) due to the hot weather leading to lower demand (in Tan My commune), or higher during Tet holidays. The butchers report that pork prices did

not change very much over the last two years. They recently decreased by about VND10,000/kg due to the lower live pig price.

According to the butchers-cum-retailers, consumers prefer lean meat, high viscosity, safe meat and firmness. The consumers also ask whether the slaughtered pig was in good health and whether the pig was fed with traditional feed or commercial feed. They also enquire about the source of the pig (local production or from other places). Consumers are also concerned about the pork price. The price of indigenous pigs is higher than that of cross or exotic pigs. Consumers have their trusted meat retailers. Butchers-cum- retailers are only interested in information from within the commune and are not seeking information on market and price trends outside their market, suggesting that the markets are quite segmented.

Retail butchers also report that there is no clear trend in meat consumption in their communes, because the quantity of pigs slaughtered has been almost constant. However, there are more retailers operating at village level (including meat vendors- such as in Bac Phong commune). Also, interviews with farmers suggest that pork demand has increased locally, especially in upland areas where income has improved.

Pork is found quite accessible in the studied communes (except in Bac Phong and in upland villages). On average, there are about 6–15 retail butchers competing within a locality. They also reported that there was no hard competition among them, as the number of meat suppliers is adequate relative to the consumption capacity of the local market. Also, each retailer has his or her own regular customers, most of them being neighbours.

Several issues in slaughtering and retailing activities were reported (see also Table 20). First, the slaughtering activity itself is hard work; it requires butchers to wake up very early in the morning. Second, the debts from consumers (delayed payment) sometime cause cash-flow problems. Third, when pig prices are low and farmers are more likely to use home-grown instead of industrial feeds, there is a tendency by some consumers to by-pass pork retailers and purchase a pig directly from the producer. They then hire someone to slaughter it or they slaughter it themselves. Also, one person in Phu Luong reported that it is hard nowadays to find good quality pigs, although their criteria for a good quality pig were not defined.

Veterinary staff

Regarding the provision of animal health services, all communes have a veterinarian. Only the veterinarian in Tan My was available for interviews. The veterinarian is responsible for (1) updating the situation of pig diseases in the commune twice a month and reporting to the district veterinarian, (2) updating the population of pig herd in the commune once a month and (3) vaccinating buffalos, cows and pigs in the commune if farmers require. No trainings related to pig production have been delivered in the commune in the recent past. According to the veterinarian interviewed, large-scale farmers often buy veterinary drugs and treat pig diseases by themselves while small-scale farmers mainly rely on the veterinarian. In both cases, farmers obey the treatment regimens strictly and often stop treating as soon as pigs have recovered. The veterinary staff in Tan My reported that there has been no training class for pig production at the commune so far. Pig disease outbreak was not observed in the commune for several years. Common pig diseases are diarrhoea, Edema, leptospirosis although these did not have serious impact on pig production. According to the respondents, the major constraint is pig marketing (finding customers, good price). At the time of interview (March 2017), pig price at farm gate had dropped to about VND30,000/kg, much lower compared to the previous year (peak was VND46,000/kg), and production cost was about VND34,000/kg, therefore validating the data collected at farmer level reported Table 9.

Other associations

Also, as in the rest of the country, there are formal farmer associations, established and operating under the management of the Vietnam Farmers' Union (VFU) in all studied communes. These are socio-political and non-profit organizations with two main activities. First, they communicate and implement plans with farmers as per the orientation of the Communist party, encouraging farmers to participate actively in the socio- economic development of the commune, including encouraging farmers to improve their education and vocational training. Secondly, these associations assist farmers in developing their own economic activities. This entails providing services to farmers in terms of training in farm production

and assisting the development of cooperatives. The assignment of membership is different depending on the communes. In Tan My and Bac Phong, membership is assigned to farming families: each family is a member of the farmer association. But in the other two communes, membership is by individual farmer, not at family level. The applicant to the Farmers' Union must complete some procedures such as the submission of required documents and payment of a membership fee of twelve thousand VND per year. Total membership varies considerably by commune, (see Table 25 in section 10, Appendix 2), depending on population as well as agricultural production in the communes.

Prevailing business approaches: what has been tried and implemented so far?

Three overall business approaches within the pig value chain have been identified and documented in the literature: the first one is the 'preferred trader'; the second one is through linking producer groups to specialized outlets, while the third one is the contract farming approach.

The 'preferred trader' approach is documented by Huong et al. (2009). The authors compare Ban and Mong Cai (MC) value chain structures and performance, as well as the impact of institutional arrangements (e.g. having a preferred trader or not) on margins and household income. While the small sample size limits the generalisation of the results, the authors show that on average 'preferred traders' give a higher price compared with the price paid by non-preferred traders. Between the two pig types, Ban pigs in general fetch higher farm gate prices than MC pigs. The highest margins were thus achieved by Ban producers with preferred traders, although the effect on overall household income remains unclear.

Moving to the second approach, linking farmers to markets via the establishment of farmer groups or cooperatives is increasingly seen as an efficient approach pursued by intervention projects to improve the livelihoods of small-scale producers in developing countries in general and in Vietnam in particular (Asia-Pacific Association of Agricultural Research Institute 2008). This approach helps improve market access of farmers and their bargaining power in selling their products. With strong support from the government and international organizations, the number of established marketing farmer groups has quickly increased over the past decades (Wolz and Duong 2010). While other agricultural commodities such as coffee, rice, vegetables, aquaculture, etc. have gradually found appropriate business models that are effectively linking farmers to markets, this is still a big challenge for livestock and for pigs in particular. In recent years, several projects have introduced some initiatives to overcome this challenge including piloting some models with mixed results.

A study in Hai Duong province in Northern Vietnam carried out by Lapar et al. (2006) illustrated the effectiveness of producer cooperatives in enabling smallholder pig farmers to better access high-value product markets. The case study documented the growth of specialized pig raising as facilitated by membership in a pig cooperative, from 11 households at the start of the project in 2000 to 250 households in 2005. Based on information collected from a sample of 20 coop-members and 20 non-members, pig production performance and outcome from coop participation were evaluated. Key findings from the study show that collective action (in terms of membership in a pig cooperative) helped farmer members to effectively adopt new technologies, to reduce transaction costs for accessing markets for inputs and services and for outputs, and therefore to increase their returns from pig production. Specifically, farmers' production costs declined by 25–30% since diseases were more effectively controlled and feed costs were lower while the selling price of pigs increased by 15–20% due to better quality pork (i.e., uniform and stable), resulting in a net increase of about 16% in profit margin per kg of live weight meat. Pig buyers or collectors also reduced their costs of collecting and grading pigs by about 20%. Scholl et al. (2015) carried out a comprehensive study on 286 members of 18 pig marketing groups initiated by seven projects and 479 non-members in three provinces and the capital of Vietnam to compare the effectiveness of different models and comparing them with individual farmers without joint marketing, using propensity score matching techniques. Groups were classified into 3 categories, from the simplest to the most complicated, including Common Interest Groups, Cooperative Groups and Cooperatives. The findings show that formation of groups (in all forms) were successful in linking farmers to more profitable markets and therefore helped increase their household incomes. In particular, the average size of the pig herd was much larger for members than for non-members (26.8 versus 6.8); and between 2009 and 2012, the income of the farmer group members increased by 827USD compared to non-members.

Similar models were applied successfully in developing marketing channels for specialty pig breeds that have recently shown significant increase in demand due to their superior meat characteristics and growing concerns of consumers over food safety issues. Le et al. (2016) analysed the potential for developing a marketing channel for specialty local Ban pork as an alternative to supplying the local markets under the 12-year development program in the uplands of Vietnam. Information on marketing activities were investigated for 180 members of cooperative groups in 10 villages in Son La province; and at the same time, market demand information was collected from 57 traders who regularly transport local Ban pigs from Son La to specialty restaurants in Hanoi. The results showed that the cooperative groups were effectively operating as an entity and facilitating increased awareness of farmers about the competitiveness of the local pig products. Members of the cooperative groups had better access to market information through regular meetings of the groups and were therefore able to make timely adjustments to their production. The number of local Ban pigs sold to food stores in Hanoi with high prices thus increased. Farmers received an average of VND9000 more compared to the local market price for each kg of live weight. The added value accruing to each cooperative group member amounted to VND11,300/kg live weight.

Despite showing encouraging results, the sustainability of these farmer groups after the intervention projects withdraw from the ground is still untested. Scholl et al. (2015) showed that farmers identified external project interventions, not internal factors, as reasons for group success. In other words, subsidies of the projects in any form, either technical trainings or in-kind payments (pigs or monetary value of a pig, pig feed, financial incentives, etc.), were key reasons for the successful operation of the farmer groups. That explains why many business models were acknowledged to be successful at the time of project implementation but failed to maintain their operation once support from the project is withdrawn at the end of project implementation. Thus, to ensure the long-term development of these models, different factors such as member set-up, management, trademark registration, strict quality control and written contracts with regular customers should be given more attention.

The third approach described in Lapar et al. (2007) is contract farming. The approach has many benefits, such as access to quality inputs and services, including credit, assured markets for the pigs, access to information, reduced exposure to production and market risks and reduced transaction costs, both in terms of input procurement and output marketing as well as those arising from asymmetric information in product quality certification; i.e., farmers are able to get higher price for quality pigs. Empirical evidence shows, however, that smallholders could not easily participate in such contracts, given the inherent limitations they face by being small. Contractors that implement this contract growing schemes generally find it more costly to monitor and supervise numerous small scale farms, compared to a few large scale ones; hence, their preference to engage relatively larger-scale pig raisers. The conclusion is that smallholder participation in such contracts may be limited in the long term, unless alternative forms of contracts can be developed that will provide the right incentives for the private sector to engage with smallholder producers.

Summary of key points and research gaps

There is a large heterogeneity in the structure of the pig value chains in Northwest Vietnam. Remote villages tend to have fewer input and services providers and have less organized and structured channels to output markets. Various mechanisms have been suggested, tested and evaluated to improve smallholder pig producers' access to stable and profitable output markets. The 'preferred' trader model is well suited for small scale pig producers but may not be amenable to scale up in its current form. Contract farming is a promising approach to increase overall supply, but this arrangement is not within easy reach of small-scale farmers, as it favours larger producers due to economies of scale. Identifying and testing alternative forms of contracts that could mitigate the scale barrier and provide the right incentives for the private sector to engage with smallholders is a rich area for future enquiry. Collective action, through producer groups or cooperatives, has shown promising results in addressing market barriers arising from information asymmetry and transaction costs, when external support is provided, but the economic sustainability of these organizations remains to be validated under varying contexts.

Conclusions and recommendations

The following sections provides some concluding remarks as well as recommendations.

Conclusions

There is a large body of evidence regarding the opportunities offered by pig farming to improve livelihoods for many small scale and resource poor households in the northwest region of Vietnam. The systems are still traditional, with livestock, crop farming and agro forestry being strongly integrated: maize and wild tree leaves are fed to indigenous pigs. As in other areas in developing countries, the systems are changing, for example with the rapid expansion of the growing of maize as a cash crop, driven by the increasing demand for commercial livestock feed. Such change has resulted in environmental degradation due to maize being cultivated on steep slopes and in monoculture. This study has looked at mechanisms to support the integration of the pig and maize activities to improve smallholders' income while making the system more environmentally sustainable, also looking at arrangements to improve market systems. The study has been organized along three complementary topics. The first one aimed at understanding the demand for different pig meat attributes and the evolution of demand. Literature review and stakeholder discussions have shown that pork is and will remain an important animal-sourced food in the Vietnamese diet, driven by growth in population and income. Increasing concerns for food safety and quality provide another dimension of emerging demand for pork attributes that will shape markets and value chain development and the appropriate supply response. While the supply of pigs has increased quantitatively, in response to domestic and export demand, the northwest pig systems have not been sufficiently able to adapt to the changing demand for pork and to find a 'niche' for their products. Yet, these systems still being traditional, pig producers in Northwest Vietnam can take advantage of their relatively 'natural' production practices that have been increasingly valued by specific types of consumers in specific markets. For example, indigenous and cross-bred pigs raised the 'traditional' way using locally grown, 'natural' feeds, can fetch high price premiums in specialist shops in provincial and regional towns and in big cities in other regions. To be able to support such evolution, the second topic has looked at sustainable productivity enhancement mechanisms, focusing on maize and its role in improving pig productivity via improved feeding practices. Results from the field survey in the four studied communes in Hoa Binh and Son La provinces show that there is a clear expansion trend in pig production in the recent past, both in pig population and in scale of production. There has also been changing patterns in pig production in terms of type of production system and feeding practices and breeds adopted in the northwest. The maize–pig system is being widely practised by farmers in the four communes. This integrated system has both advantages (cost, convenience) but also drawbacks (labour requirements, higher fat content of pork fed with more maize, longer production cycle in raising pigs mainly on maize compared to commercial feed). Although it remains to be seen whether and how the interactions between maize and pigs will effectively evolve in the future, more research is needed on alternative farm–produced feeds, for example forage legumes, which may replace or complement maize, while making these systems more environmentally sustainable. For these systems to impact household income through better market integration, the third and last topic looked at institutional arrangements to link pig farmers to markets, presenting various models tested and documented in the literature. Collective action allows smallholders to access lucrative markets, but these organizations tend to deteriorate once external support is withdrawn. On the other hand, contract farming has by design a strong private sector component and tends to be economically sustainable, but this arrangement is not within

easy reach by small scale farmers, as it favours larger producers due to economies of scale. Finally, the 'preferred trader' approach has not been sufficiently documented but may not be amenable to scale up in its current form.

Recommendations

For this project, the recommendations relate to research gaps that were detailed at the end of each of the three topics. For the topic on 'demand for different pig meat attributes', additional research efforts are needed on the following topics:

- Better evidence on pork consumption, differentiated by main meat attributes; behaviour in pork purchase and pork consumption as well as factors affecting pork demand in the northwest region;
- Evidence on market demand for specific pork attributes (including breed, feeding practices), their sources and drivers of growth and outlook for the future, including the outlook for the China market and implications of other cross-border pig trading on pig production in the northwest.
- Regarding the second topic on 'sustainable productivity improvement mechanisms', there is a need to better articulate whether and how the interactions between maize and pig will effectively evolve in a desirable manner in the future, given the aforementioned advantages and disadvantages, including the fact that the maize area in the northwest has been decreasing due to land degradation and the high maize production cost. Therefore, research gaps relate to:
 - Identification of alternative farm-produced feeds, for example forage legumes, which may replace or complement maize, while making these systems more environmentally sustainable.
 - Evidence on the role of self-produced maize in these systems, compared to purchased maize and commercial mixed feeds.

Finally, regarding the third topic on 'business approaches to link northwest pig farmers to inclusive and sustainable markets', it remains unclear which one of the three documented approaches, or which combination of these, may have the greatest beneficial impact on livelihoods. A possible combination of some of these approaches, working with private sector entrepreneurs - for example a preferred trader system (providing direct linkages with producers), linked to specialty outlets in provincial and regional towns (playing the role of a contractor), organized around producer groups (to allow for economies of scale), may be worth investigating.

References

- Asia-Pacific Association of Agricultural Research Institutions (APAARI). 2008. *Linking farmers to market: Some success stories from Asia-Pacific Region*. Bangkok, Thailand: APAARI.
- Baltenweck, I. and Staal, S. 2007. Beyond one-size-fits-all: differentiating market access measures for commodity systems in the Kenyan highlands. *Journal of Agricultural Economics* 58(3):536–548.
- Cosmos, A. B., Vida, O. P. and Samuel, Y. A. 2013. Assessment of factors influencing the consumption of pork and poultry meat in Ghana: a comparative study. *International journal of Innovative Research in Management* 4(2): ISSN 2319–6912. Available at <http://www.vnmpublication.com/IJIRM/2013/4%20April/2.pdf>
- Danielson, V., Hansen, L. L., Moller, F., Bejerholm, C. and Nielsen, S. 1999. *Production results and sensory meat quality of pigs fed different amounts of concentrate and ad lib clover grass or clover grass silage*. In: Hermansen, J.E., Lund, V., Thuen, E. (Eds.), *Ecological animal husbandry in the Nordic countries*, proceedings from NJF-seminar No. 303, Horsens, Denmark, pp. 79–86.
- Department of Livestock Production. 2015. *Livestock production in year 2015 and planning to 2020*. Unpublished report. MARD. Hanoi, Vietnam.
- Do, T. L., Tran, T. C., Nguyen, T. T. H., Vu, K. X. and Nguyen, A. D. 2013. Analysis of factors affecting demand of pork consumption in Vinh city, Nghe An province. *Journal of Science and Development* 11(3): 429–438.
- Do, V. N. and Tran, D. T. 2014. Research and suggest some solutions to develop maize production at the Northwest Region. *Journal of Science and Development* 12(6), 862–868.
- Food and Agricultural Research Institute (FAPRI). 2014. World Agricultural Outlook Database. Available at <http://www.fapri.iastate.edu/tools/outlook.aspx>
- Friederichsen, R., and Neef, A. 2010. Variations of Late Socialist Development: Integration and Marginalization in the Northern Uplands of Vietnam and Laos. *The European Journal of Development Research* 22(4): 575–564. doi: 10.1057/ejdr.2010.23
- Gautier, P., Phuong, T. T. and Ninh, N. V. 2009. *Pig genotypes in Vietnam: Demand versus supply*. Technical Report. International Livestock Research Institute. Hanoi, Vietnam.
- Government of Vietnam. 2017. Annual social economic development planning reports of Tan My, Phu Luong, Muong Coi and Bac Phong communes.
- GSO. 2011. Population projection for Vietnam: 2009–2049. Hanoi: General Statistics Office of Vietnam.
- GSO. 2015. Vietnam Household Living standard survey report.
- GSO. 2016a. Statistical Year Book of Vietnam 2015. Hanoi, Vietnam: Statistical Publishing House.
- GSO. 2016b. Điều tra dân số và nhà ở giữa kỳ 2014, di cư và đô thị hóa ở Việt Nam.
- Global Trade Atlas (GTA). 2015. International import and export commodity trade data. Available at <https://ihsmarkit.com/products/maritime-global-trade-atlas.html>
- Hansen, L. L., Claudi, M. C. and Andersen, H. J. 2001. *Meat and eating quality from organically produced pigs* (in Danish). In: Jakobsen, K, Hermansen, J.E. (Eds.), Intern report no. 145. Danmarks JordbrugsForskning, Forskningscenter Foulum (DIAS): *Okologisk og udendørs svineproduktion–Hvor starvi?*, 39–47.
- Hauswirth, D., Hoang, X. T., Nguyen, Q. T., Dam, Q. M., Nguyen, V. S. et al. 2012. *Potential of conservation agriculture as an alternative to maize monocropping in mountainous areas of Vietnam*. Proceedings of the 3rd international conference on conservation agriculture in Southeast Asia. Hanoi, Vietnam. 10-15 December 2012.

- Hoang, H. K. and Meyers, W. H. 2015. Food demand in Vietnam: structural changes and projections to 2030. Selected poster prepared for presentation at the International Association of Agricultural Economists Conference. Milan, Italy, August 9–14, 2015. <http://ageconsearch.umn.edu/record/212456/files/Meyers-Food%20demand%20in%20Vietnam-393.pdf>
- Hofman, K. 1994. What is quality? Definition, measurement and evaluation of meat quality. *Meat Focus International* 3: 73–82
- Huyen, L. T. T., Muth, P. C., Markemann, A., Schöll, K. and Zárate, A. V. 2016a. Potential for the development of a marketing option for the specialty local Ban pork of a Thai ethnic smallholder cooperative group in Northwest Vietnam. *Trop Anim Health Prod* 48: 263–271.
- Huyen, L. T. T., Thuy, D. K. and Sautier, D. 2016b. Study with Value chain stakeholders in the Black Pig value chain in Mai Son, Son La province. The sustainability of Black Pig value chain in Mai Son District, Son La province (Vietnam): Assessment with value chain stakeholders.
- Huyen, N. T. T. 2017. Risk in smallholder pig production in Hung Yen province, Vietnam. Unpublished PhD thesis.
- Huong, P. T. M., Hau, N. V., Kaufmann, B., Zarate, A. V. and Mergenthaler, M. 2009. Emerging supply chains of indigenous pork and their impacts on small-scale farmers in upland areas of Vietnam. Contributed paper prepared and presented at the International Association of Agricultural Economists Conference. Beijing, China, August 16–22, 2009.
- International Livestock Research Institute (ILRI). 2011. *Pigmeat value chain in Vietnam: Background proposals for the CGIAR Research Program on Livestock and Fish*. Nairobi, Kenya: ILRI. Available at <https://hdl.handle.net/10568/16888>
- International Livestock Research Institute (ILRI). 2015. *Humid tropics household survey data in Vietnam*. Available at <https://africapendata.org/dataset/htsas-hs-vietnam>
- International Livestock Research Institute (ILRI). 2017. *Reducing disease risks and improving food safety in smallholder pig value chains in Vietnam (PigRISK)*. ILRI Project Update. Nairobi, Kenya: ILRI. Available at <https://hdl.handle.net/10568/89007>
- Ipsos Business Consulting. 2015. Vietnam Meat Market. www.ipsosconsulting.com
- International Trade Administration (ITA). 2015. Vietnam agribusiness report. Available at <https://www.export.gov/article?id=Vietnam-Agribusiness>
- Karimov, A. A., Nguyen, T. T., Cadilhon, J. J., Hoang, T. T., Dang, T. H. et al. 2016. *Value chain assessment report for maize, pig, plum and tea in Son La*. <https://books.google.com.vn/books?i>
- Keil, A., Saint-Macary, C. and Zeller, M. 2009. *Maize boom in the uplands of northern Vietnam: economic importance and environmental implications. In proceeding of Tropentag 2009*. Conference on international research on food security, natural resource management and rural development.
- Lac Son district People Committee' website. 2017. <http://lacson.hoabinh.gov.vn/>
- Lao Cai government. 2016. Report on livestock production in Lao Cai province. Unpublished document.
- Lapar, M. L., Vu, T. B., Nguyen, T. S., Tiongco, M., Jabbar, M. and Staal, S. 2006. *The role of collective action in overcoming barriers to market access by smallholder producers: some empirical evidence from northern Vietnam*. Research Workshop on Collective Action and Market Access for Smallholders, 2–5 October 2006. Cali, Colombia.
- Lapar, M.L., Nguyen, T. S., Costales, A. and Delgado, C. 2007. *Contract farming for equitable market-oriented swine production in Northern Vietnam*. Final project report submitted to FAO. Hanoi, Vietnam: ILRI, HAU and IFPRI.
- Lapar, M. L. Toan, A., Que, N. N., Jabbar, M., Tisdell, C. and Staal, S. 2009. *Market outlet choices in the context of changing demand for fresh meat: implications for smallholder inclusion in pork supply chain in Vietnam*. Selected paper presented at the International Association of Agricultural Economists Conference. Beijing: PRC, August 2009.
- Lapar, M. L. 2010. Paper at final workshop of ACIAR funded project on improving competitiveness of pig producers in an adjusting Vietnam market. October 2010. Melia, Hanoi.
- Lapar, L. and Toan, N. 2010. *Demand for pork by Vietnamese consumers: Implications for pro-poor livestock policy and development agenda in Vietnam. Improving the competitiveness of pig producers in Vietnam*. Project Brief 1. Nairobi, Kenya: ILRI. Available at <https://hdl.handle.net/10568/2465>.
- Lapar, M. L. and Staal, S. 2010. Competitiveness of smallholder pig producers in Vietnam. Project Brief. Improving the competitiveness of pig producers in Vietnam. Nairobi, Kenya: ILRI.

- Lapar, M. L. and Tiongco, M. M. 2011. Private standards in pork value chains: role, impact and potential for local innovation to improve food safety and enhance smallholder competitiveness. *Farm Policy Journal* 8(3): 39–53. A private future for food and fibre quality, Australian Farm Institute. ISSN: 1449-2210.
- Lapar, M. L., Toan, N. N., Staal, S., Que, N. N. and Tuan, N. D. A. 2011. *The pork value chain in Vietnam: emerging trends and implications for smallholder competitiveness*. Contributed paper presented at the Australian Agricultural and Resource Economics Society Conference. Melbourne, Australia. 8–11 February 2011.
- Lapar, M. L., Toan, N. N., Staal, S., Minot, N., Tisdell, C. et al. 2012. Smallholder competitiveness: Insights from pig production systems in Vietnam. Selected paper presented at the 28th triennial conference of the International Association of Agricultural Economists. Foz do Iguaçu, Brazil. 18–24 August 2012.
- Le, T. T. H., Muth, P. C., Markemann, A., Scholl, K. and Zarate, A.V. 2016. Potential for the development of a marketing option for the specialty local Ban pork of a Thai ethnic smallholder cooperative group in Northwest Vietnam. *Trop Animal Health Proc* 48: 263–271
- Lemke, U., Thuy, L., Zarate, A., Kaufmann, B. and Vang, N. 2002. Characterization of smallholder pig production systems in mountainous area of North Vietnam.
- Lemke, U., Thuy, L., Zarate, A., Kaufmann, B. and Vang, N. 2002. Characterization of smallholder pig production systems in mountainous area of North Vietnam.
- Liu, H. and Deblitz, C. 2007. Determinants of meat consumption in China. Asian Agribusiness Research Centre (AARC). Working Paper 40: 1–16.
- LLuu, T. D. H. and Vu, L. D. 2014. Analysis of buying behavior of consumers at the wet and supermarket in Can Tho city. *Journal of Science of Can Tho University* 30: 1–7 (Phân tích hành vi mua sắm của người tiêu dùng ở chợ truyền thống và siêu thị tại thành phố Cần Thơ. Tạp chí Khoa học Trường Đại học Cần Thơ. 30: 1–7).
- Minot, N., Rich, K., Nguyen, N. Q. and Nguyen, A. P. 2010. *Transformation of pig markets in Vietnam: Will small-scale pig farmers be squeezed out?* Technical report prepared for the ACIAR-funded project Improving Competitiveness of Pig Producers in an Adjusting Vietnam Market. Washington DC, USA: International Food Policy Research Institute (IFPRI).
- Ministry of Finance. 2017. Monthly reports of market prices. Available at http://www.mof.gov.vn/webcenter/portal/cqlg/r/m/htgtt/tvtgtc?centerWidth=100%25&leftWidth=0%25&rightWidth=0%25&showFooter=false&showHeader=false&_adf.ctrl-state=l3okxm1qed_4&_afLoop=21224096576766199#!%40%40%3F_afLoop%3D21224096576766199%26centerWidth%3D100%2525%26leftWidth%3D0%2525%26rightWidth%3D0%2525%26showFooter%3Dfalse%26showHeader%3Dfalse%26_adf.ctrl-state%3Dfte1xjw_4
- Muth, P. C., Huyen, L. T. T., Markemann, A. and Zárate, A. V. 2017. Tailoring slaughter weight of indigenous Vietnamese Ban pigs for the requirements of urban high-end niche markets. *Wageningen Journal of Life Sciences* 80: 27–36
- Mukesh, K. M. 2012. Modern lifestyle, Non veg food and its impact on environmental aspects. *Global Journal of Human Social Science* 12(7) Version I.0, April 2012.
- Nga, N. T. D., Ho, N. N., Pham, V. H. and Lapar, M. L. 2013. *The pig value chain in Vietnam: A situational analysis report*. ILRI Research Report. Nairobi, Kenya: ILRI.
- Nga, N. T. D., Lapar, M. L., Pham, V. H., Nguyen, T. L., Tran, V. L. et al. 2017. Performance of meat retailer in pig value chain in Vietnam. Paper presented at international conferences of food and Agriculture, UPLB. Philippines.
- Nga, N. T. D., Nguyen, T. T. H., Pham, V. H., Duong, N. H., Tran, V. L. et al. 2015. Household pork consumption behavior in Vietnam: Implications for pro-smallholder pig value chain upgrading. Tropentag.
- Nguyen, N. T. D. 2005. Văn hóa Việt Nam thường thức. Cultural and National Publishing house. Hanoi, Vietnam.
- Nguyen., V. H, Kaufmann, B. and Mergenthaler, M. 2009. Emerging supply chains of indigenous pork and their impacts on small-scale farmers in upland areas of Vietnam. Contributed paper prepared for presentation at the International Association of Agricultural Economists Conference. Beijing, China, August 16–22, 2009.
- Nguyen, T. Q. H. 2016. Pig farming waste management in Vietnam. Available at http://wepa-db.net/3rd/en/meeting/20160126/pdf/AM4_VN_ActionProgram_I_160126.pdf
- Nguyen, V. P., Do, T. M. H., Tran, H. C., Markemann, A., Valle Zarate, A. and Mergenthaler, M. 2014. Impact of quality

- attributes and marketing factors on prices of indigenous pork in Vietnam to promote sustainable utilization of local genetic resources. *Livestock Research for Rural Development* 26 (7).
- Nguyen, V. P. 2015. *Preferences for high-value agricultural products in developing countries: Demand analyses for livestock products in Vietnam*. Unpublished PhD Thesis. Rheinischen Friedrich-Wilhelms-Universität Bonn.
- Pedregal, V. D., Nguyen, N. L., Figuié, M. and Moustier, P. 2010. *Familiarity with consumer expectations to support smallholders: Demand for quality pork in Vietnam*. pp. 127–137.
- Phuong, N. V., Hanh, D. T. M., Cuong, T. H., Markemann, A., Valle, Z. A. and Mergenthaler, M. 2014. Impact of quality attributes and marketing factors on prices for indigenous pork in Vietnam to promote sustainable utilization of local genetic resources. *Livestock Research for Rural Development* 26(126). Available at <http://www.lrrd.org/lrrd26/7/phuo26126.html>. Accessed April 28, 2018
- Que, N. N., Phong, N. A., Thiep, D. H., Rich, K., Minot, N. and Lapar, M. L. 2015. Future scenarios for pig sector development in Vietnam: Results from an updated policy simulation model. Technical report. Nairobi, Kenya: ILRI.
- Renuka, N., Sathian, C. T., and Sujatha, S. 2009. Impact of family income on consumption of Livestock products at Kalpetta, Kerala. *Veterinary World* 2(8): 323–324.
- Rosegrant, M. W., Msangi, S., Ringler, C., Sulser, T. B., Zhu, T. et al. 2008. *International model for policy analysis of agricultural commodities and trade (IMPACT): Model description*. Washington DC, USA: International Food Policy Research Institute (IFPRI). 49pp
- Scholl, K., Markemann, A., Megersa, B., Birner, R., Zarate, A. V. 2016. Impacts of projects initiating group marketing of smallholder farmers – a case study of pig producer marketing groups in Vietnam. *Journal of Co-operative Organization and Management* 4: 31–41.
- Thu K, Donham K, Ziegenhorn R, Reynolds S, Thorne PS, Subramanian P, et al. 1997. A control study of the physical and mental health of residents living near a large-scale swine operation. *J Agric Saf Health* 3:13–26.
- Trading Economics. 2017. <https://tradingeconomics.com/vietnam/gdp-growth>
- Tran, D. T. 1998. *Maize production and selling in Son La*. Hanoi, Vietnam: Agricultural Publishing House.
- United Nations, Department of Economic and Social Affairs, Population Division. 2014. *World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352)*
- UN Comtrade database. 2017. <https://comtrade.un.org/>
- USDA. 2005. Factors Affecting U.S. Pork Consumption. Electronic Outlook Report from the Economic Research Service. <https://www.ers.usda.gov/>
- USDA. 2011. Trade forecast update: Pork higher; beef and broiler meat stable. www.fas.usda.gov/DLH/circular/2011/livestock_poultry.pdf
- USDA. 2016. *Livestock and Products Semi-annual: China's Pork Imports to Increase in 2016*. Available at <https://gain.fas.usda.gov/>
- VPM. 2014. *Vietnam Pig Model*. Unpublished document
- Wolz, A. and Duong, P. B. 2010. The transformation of agricultural producer cooperatives: the case of Vietnam. *Journal of Rural Cooperation* 38(2): 117–133.
- Wing, S. and Wolf, S. 2000. Intensive livestock operations, health and quality of life among eastern North Carolina residents. *Environ Health Perspect* 108(3):233–8.

List of publications produced by project

Baltenweck, I., Nguyen, T. T., Nguyen, T. D. N., Pham, V., Nguyen, H. N. et al. 2017. *Technical report on assessing competitiveness of smallholder pig farming in the changing landscape of Northwest Vietnam*. ILRI Research Report. Nairobi, Kenya: ILRI.

Baltenweck, I., Nguyen, T. T., Nguyen, T. D. N., Pham, V., Nguyen, H. N. et al. 2017. *Pig and maize interactions: lessons for strengthening pig farmers' livelihoods and improving maize farmers' land use*. Abstract submitted to the North-West Vietnam Research Symposium.

International Livestock Research Institute (ILRI). 2017. *Assessing competitiveness of smallholder pig farming in the changing landscape of northwest Vietnam*. ILRI Project Profile. Nairobi, Kenya: ILRI. Available at <https://hdl.handle.net/10568/82556>.

Appendixes

Appendix I: additional information related to ‘topic 2’

Table 21: Pig population in northwest provinces (2011–2015)

| | 2011 | 2012 | 2013 | 2014 | 2015 |
|--|----------|----------|----------|----------|----------|
| 1. Pig population (000 heads) | | | | | |
| - Country | 27,056.0 | 26,494.0 | 26,264.4 | 26,761.4 | 27,750.7 |
| - Northwest | 2,322.1 | 2,268.3 | 2,184.2 | 2,277.8 | 2,345.0 |
| As % of country total | 8.6 | 8.6 | 8.3 | 8.5 | 8.5 |
| 2. Pig population in six northwest provinces (%) | | | | | |
| Lao Cai | 18.2 | 18.2 | 19.2 | 19.0 | 19.4 |
| Yen Bai | 18.4 | 18.7 | 19.7 | 19.9 | 20.4 |
| Dien Bien | 12.5 | 12.7 | 13.5 | 13.3 | 13.8 |
| Lai Chau | 8.8 | 8.0 | 8.3 | 7.9 | 7.9 |
| Son La | 23.4 | 23.6 | 21.7 | 22.6 | 22.6 |
| Hoa Binh | 18.8 | 18.8 | 17.6 | 17.3 | 15.8 |
| All | 100 | 100 | 100 | 100 | 100 |

Source: GSO 2016a

Table 22: Pig density in six northwest provinces (2011–2015)

| | 2011 | 2012 | 2013 | 2014 | 2015 |
|-----------|------|------|------|------|------|
| Viet Nam | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Lao Cai | 0.7 | 0.6 | 0.6 | 0.7 | 0.7 |
| Yen Bai | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| Dien Bien | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| Lai Chau | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 |
| Son La | 0.5 | 0.5 | 0.4 | 0.4 | 0.5 |
| Hoa Binh | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

Source: GSO 2016a; Unit: pigs/person

Table 23: Production area of maize in the northwest provinces

| Provinces | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|----------------------|---------|---------|---------|---------|---------|---------|
| 1. The whole country | 1,125.7 | 1,121.3 | 1,156.6 | 1,170.4 | 1,179.0 | 1,179.3 |
| 2. The northwest | 270.8 | 271.7 | 313.9 | 311.6 | 319.7 | 316.6 |
| Lao Cai | 31.1 | 32.7 | 33.7 | 34.7 | 39.1 | 37.2 |
| Yen Bai | 22.6 | 24.9 | 24.7 | 26.7 | 28.5 | 28.2 |
| Dien Bien | 29.1 | 29.8 | 29.2 | 29.3 | 29.9 | 29.7 |
| Lai Chau | 19.4 | 20 | 21.4 | 21.2 | 22.1 | 22.7 |
| Son La | 132.7 | 127.5 | 168.7 | 162.8 | 162.5 | 159.9 |
| Hoa Binh | 35.9 | 36.8 | 36.2 | 36.9 | 37.6 | 38.9 |

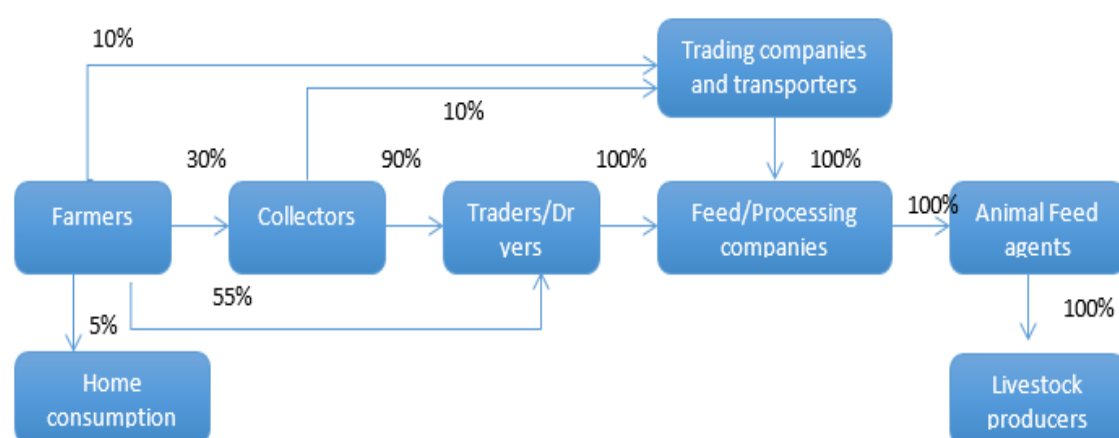
Source: GSO 2016a; Unit: thousand ha

Table 24: Production of maize in the northwest highlands (thousand tons)

| Provinces | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|----------------------|---------|---------|---------|---------|---------|---------|
| 1. The whole country | 4,625.7 | 4,835.6 | 4,973.6 | 5,191.2 | 5,202.3 | 5,281.0 |
| 2. The northwest | 847.2 | 967.5 | 1,133.2 | 1,146.3 | 1,149.4 | 1,117.6 |
| Lao Cai | 101.6 | 110 | 115.6 | 122.2 | 117.7 | 131.5 |
| Yen Bai | 64.7 | 72.8 | 75.5 | 84.5 | 83.6 | 92.9 |
| Dien Bien | 67.4 | 71 | 71.6 | 74.2 | 76.1 | 76.2 |
| Lai Chau | 50.1 | 52.7 | 59.4 | 57.3 | 62.1 | 65.7 |
| Son La | 417.4 | 506.7 | 667.3 | 654.7 | 657.7 | 588.7 |
| Hoa Binh | 146 | 154.3 | 143.8 | 153.4 | 152.2 | 162.6 |

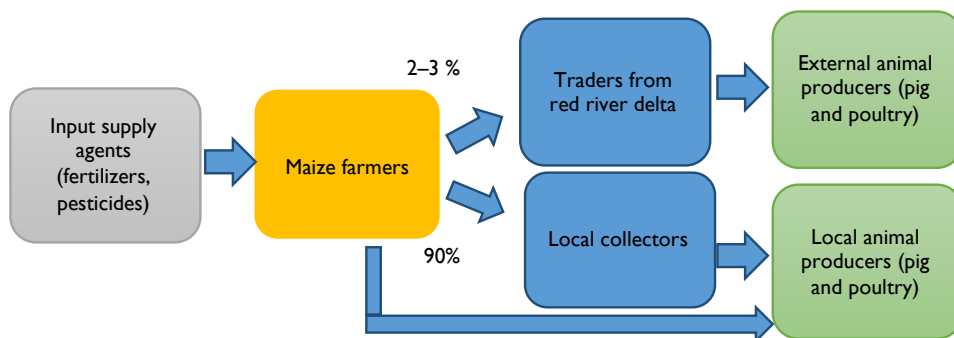
Source: Computed from VGSO 2016

Figure 6: The maize value chain in Son La



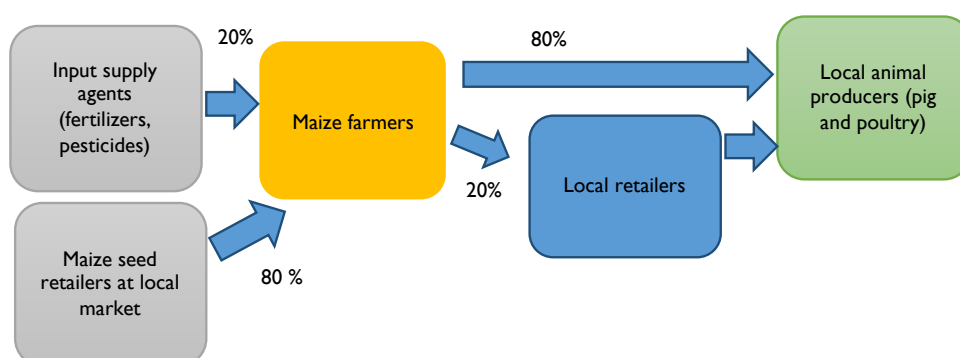
Source: Karimov et al. 2016

Figure 7: The maize value chain in Bac Phong commune, Phu Yen district, Son La



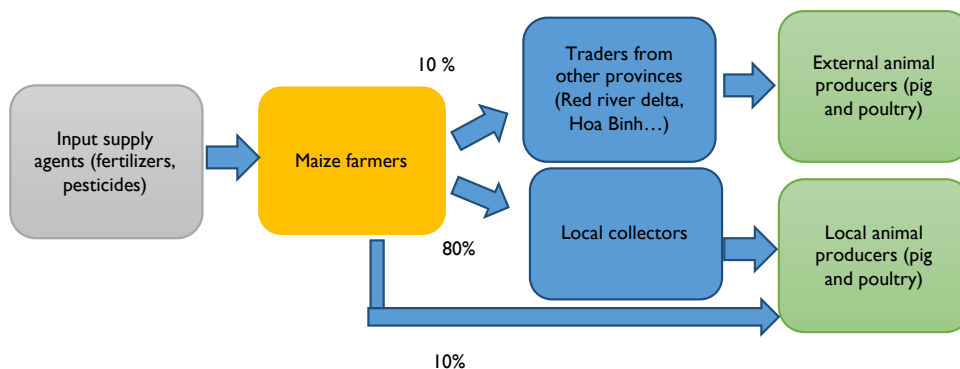
Source:VC mapping meeting at Tan My commune, March 2017

Figure 8: Value chain of maize in Phu Luong commune, Lac Son District, Hoa Binh province



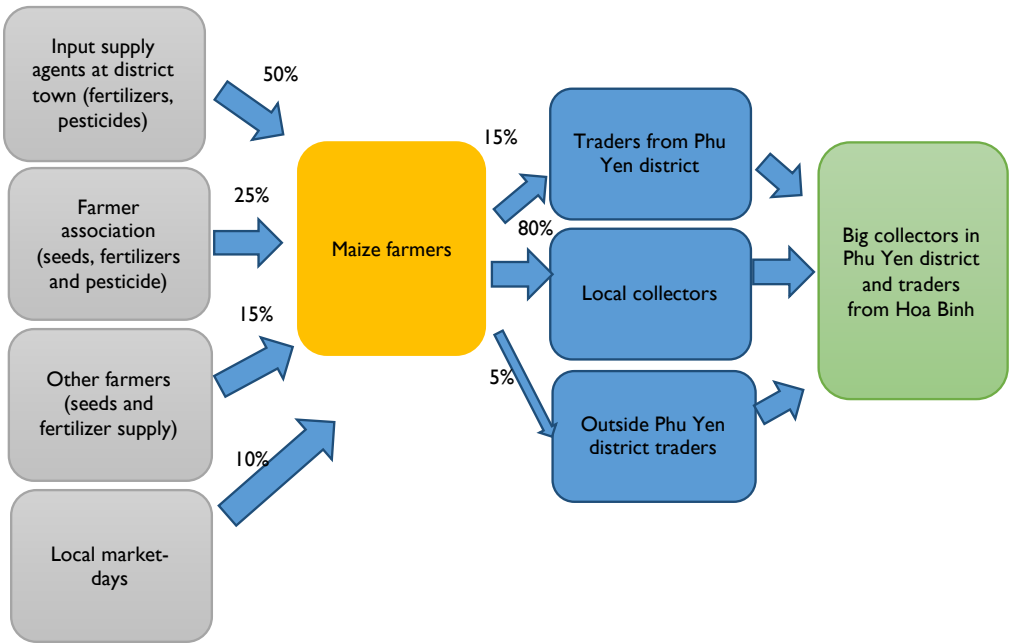
Source:VC mapping meeting at Phu Luong commune, March 2017

Figure 9: Value chain of maize in Muong Coi commune, Phu Yen district, Son La



Source:VC mapping meeting at Muong Coi commune, March 2017

Figure 10: Value chain of maize in Bac Phong commune, Phu Yen District, Son La



Source: VC mapping meeting at Bac Phong commune, March 2017

Appendix 2: additional information related to ‘topic 3’

Table 25: Key characteristics of farmer associations in the surveyed communes

| | Hoa Binh | | Son La | |
|---------------------------------|---|-----------|-----------------------------------|---|
| | Tan My | Phu Luong | Muong Coi | Bac Phong |
| Credit groups | 15 | 11 | 5 | 2 |
| Services for farmers | Trainings | Trainings | Trainings | Trainings |
| | Intermediary in fertilizer supply | | Intermediary in fertilizer supply | |
| Specific activity for maize/pig | Cooperation with Syngenta for producing GMO maize | None | None | Intermediary in supplying maize seed |
| | Collaboration with vet to train pig farmers (feed companies provide training) | | | Plan to establish Pig Production Cooperatives |

Sources: Key informant interviews 2017

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