

Swine Production and Challenges in Vietnam after African Swine Fever: A Case Study in Peri-Urban Hanoi, Vietnam

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Abstract

The goal of this paper was to identify major challenges in rebuilding the swine industry in Vietnam, using the Chuong My district, Hanoi as a case study. Primary data was gathered in 2020 mainly through a survey of 97 swine producers in the district. Analysis tools were descriptive and comparative statistics. Results show that after the African swine fever (ASF) outbreak, the recovery of the swine industry in Vietnam faced several challenges, including the issues of piglet quantity and quality, changing consumer preferences which were worsened by the current Covid-19 pandemic, relatively cost disadvantage of domestic production under the context of new free trade agreements, disease risk (ASF under the condition of no effective and safe vaccine), insufficient resources of farms to restock, and environmental issues caused by swine production in rural areas. The paper proposed several recommendations to rebuilding the swine herd in order to address the issues and overcome the challenges, mainly focus on improving sow quality, market information and linkages, good practices in production, training for labor, and address environmental issues.

Keywords

African swine fever, challenges, smallholders

Introduction

The swine industry contributes over 60% of the total meat production in Vietnam (GSO, 2020). The industry also provided livelihood to about 3 million producers in rural areas in 2019, among which more than 90% were smallholders with less than 100 pigs (Vietnam Livestock, 2020). These pigs were more susceptible to swine-related diseases than those in large and modern farms due to a lack of disease-prevention resources and capacity. In February 2019, the first case of African swine fever (ASF) was detected in Vietnam. The disease spread to all 63 provinces in Vietnam. The World Organization for Animal Health (OIE) confirmed that ASF affected

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pigs and wild boars up to 100% fatality rate. From February to October 2019, ASF in Vietnam caused the death and culling of approximately 5.7 million pigs, corresponding to more than 20% of the total swine population of the country. Such heavy loss amounted to approximately 330 thousand tons less pork produced (MARD, 2019), which impacted the swine industry production. As pork remains dominant in the meat consumption basket in Vietnam (Nga *et al.*, 2014), the production recovery is very important and the identification of challenges in pig production after ASF outbreak could provide information for the government and line agencies to pursue appropriate strategies. This paper provided an overview of the swine production in Vietnam amidst the ASF outbreak, government responses to the disease outbreak, identified the challenges for the swine industry, and proposed key recommendations for complete recovery in the swine sector in the future. The study analyzed swine production in Chuong My district, which ranked second in swine population among the districts of Hanoi. The study was limited to farm household level and did not cover other production by companies or cooperatives.

Methodology

Secondary data on swine production, pork meat market, and ASF situation in Vietnam and Chuong My district, as well as various relevant reports were collected from the General Statistics Office (GSO) and the Ministry of Agriculture and Rural Development (MARD). Primary data were collected through survey among 97 swine producers in 8 communes, covering 3 sub-regions in Chuong My district (Day River Bank region, Semi-mountainous region, and Delta region). The sample size was determined using Slovin's formula (Guilford & Frucher, 1973) with a margin error of 10%, given the total number of swine producers in Chuong My at the time of survey recorded at 3,411 and allocated proportionally to each commune. Swine producers were randomly selected from the list provided by the commune veterinary staff and were replaced if the farm had stopped rearing pigs (after AFS) or/and were not willing to be

interviewed. Key informant interviews with the staff working in the District Board of Veterinary and Livestock Production (DBVLP) and farmers were also conducted. Data were grouped by production scale (including small, medium, and large scales), defined by the number of pigs per liter (under 20, from 20 to 40, and above 40, respectively). The analysis tools employed in the study consisted of descriptive and comparative statistics, and ANOVA to compare means among the different groups.

Results and Discussion

Overview of swine production amidst ASF outbreak in Vietnam and government responses

Pig sector and ASF

Vietnam is one of the top swine producers in the world, with a sustained pig population of around 27-29 million in 2010-2019 (GSO, 2020). Total pork production was estimated at 3.9 million tons in 2018, accounting for 71.5% of the total meat production of the country. The production was mainly composed of numerous farm households and companies/big groups such as C.P. Vietnam Corporation and DABACO Group. These big groups adopted the 3F process (Feed – Farm – Food) while having more advantages than farm households in terms of resources, technology, and control over their own meat value chain due to integrated activities within the organizations. Small producers, on the other hand, supplied more than 80% of the total pork production in Vietnam (Nguyen – Viet Hung *et al.*, 2019), with a total number of approximately 2.5 million pig population from smallholders with less than 10 pigs (GSO, 2020). Most smallholder pig farms in Vietnam operated independently (Nga *et al.*, 2014). The studies of Nga *et al.* (2017) and Nguyen Thi Thuy *et al.* (2020) showed that there were almost no official contracts between producers to the downstream actors in the chains. Even though smallholders played an important role in agricultural value chains (Poole, 2017), they were less of an advantage in participating in more stable and higher value chain due to a lack of agreed

standards (Swinnen *et al.*, 2013), as well as the ability to provide a regular and consistent supply of the required volume.

MARD confirmed the country’s first ASF outbreak on February 19, 2019. All 63 provinces of the country reported outbreaks that influenced the culling of about 6 million pigs in March 2020. According to the latest report of MARD in July 2020 (MARD, 2020), ASF was basically under control with about 99% of the communes confirming no outbreak. There were only 188 communes in 18 provinces affected by ASF (MARD, 2020). Swine production from both farm households and companies started to recover, but complete recovery of production only happened in companies and large farms. However, the resurgence of ASF in several provinces had raised the issue of production risks for farmers. Pig population was estimated to have decreased by 7.5% in June 2020, as compared to the same period in 2019. The Livestock Production Department (LDP, 2020) reported the number of sows in April 2020 at 2.86 million, significantly falling behind the average of 4 million during 2017-2018 and creating a large shortage supply of piglets. This situation, coupled with the rising demand for production restocking, pushed the price of piglets as high as three to four times of the pre-ASF level,

amounting to about 3.0-3.6 million VND (Thu Ha, 2020). Higher production cost-plus and the supply shortage pushed up the pork prices; hence, live pig market price peaked at 100,000 VND kg⁻¹ in May 2020 or doubled the value in May 2019 (Figure 1).

Government responses

In production, the Vietnam Government took various measures to help the industry recover. The government encouraged research institutes and universities to develop a vaccine against ASF and called for relevant line ministries and local governments to take respective actions. The National Steering Committee on ASF prevention and control was formed in March 2019. This committee initiated the issuance of guidelines on the implementation of ASF prevention measures as well as guidance on the restocking of pig heard to all stakeholders and producers. Among these guidelines were Resolution No. 42/NQ-CP that proposed the urgent solutions for the prevention and control of ASF and the Decision No. 793/QD-TTg that discussed the specific mechanisms and policies to support funding for disease prevention, particularly providing compensation to producers who had to depopulate pigs due to ASF. For example, an amount of 25,000 VND kg⁻¹ (equivalent to USD 1.09 kg⁻¹) of live

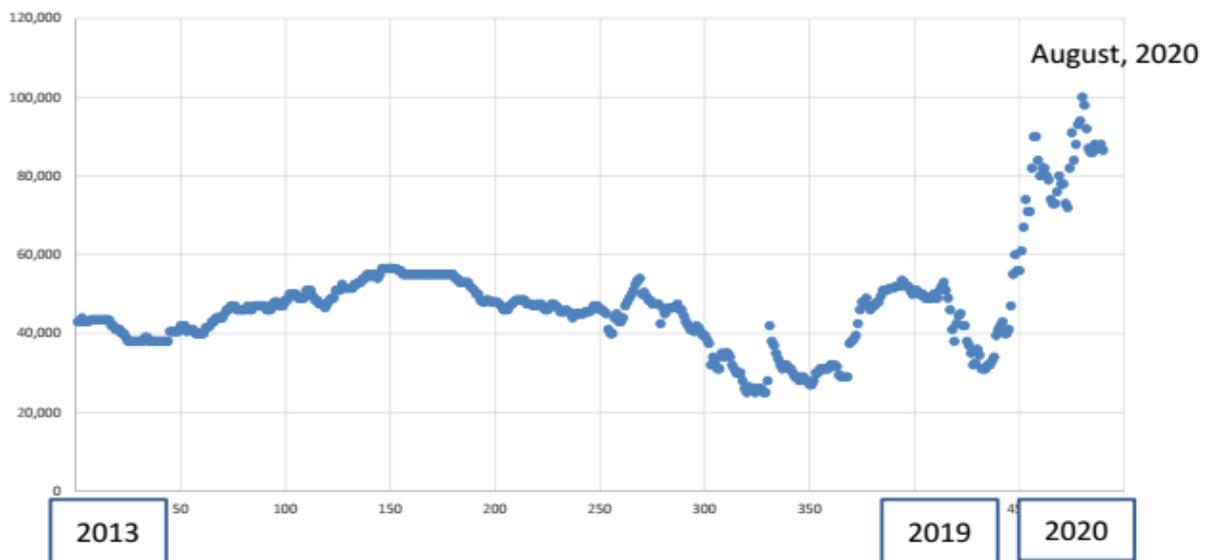


Figure 1. Trend in live pig prices in Vietnam from 2013 to 2020

Source: GSO (2020)

fattening pig and/or 30,000 VND/kg (USD 1.30 kg⁻¹) of live piglet was proposed. The banks also implemented measures of charged-off debts or rescheduled debt payments from producers who were heavily affected by ASF. Other measures to prevent smuggling and illegal transportation of animals and animal products, especially pigs and pork products, into Vietnam were also instituted (Official Letter No. 10/BCDTLCP). MARD also supported private companies to import more than 5,000 great-grandparent and grandparent pigs in 2019 and 10,000 great-grandparent and grandparent pigs in 2020 to ensure wean supplies in 2021-2024 (MARD, 2020). In July 2020, the Government approved the national plan on ASF prevention for the period 2020-2025, focusing on early detection, warning, and timely implementation of measures to prevent ASF, including bio-security and disease safety practices and other good practices along the pork value chain.

The government has encouraged companies to import both live pigs from Thailand and pork meat from other countries to meet domestic demand and stabilize live pig prices. According to statistics from the Department of Animal Health (MARD, 2020), the total volume of imported pork in 2019 surged to about 67 thousand tons, an increase of about 63% from 2018. During the first six months of 2020, the total volume of imported pork was recorded to be

over 70 thousand tons, almost tripled the volume during the same period in 2019 (MARD, 2020). About 97,300 live pigs were also imported to Vietnam from June to August 2020 for slaughtering and processing. The recovery of domestic production (even at a slow pace) with a large volume of imported pork had an immediate impact on the pork market, with the price of live hog falling under 80,000 VND kg⁻¹ (USD 3.48 kg⁻¹).

Pig production in Chuong My after ASF

Chuong My was, reportedly, one of the leading livestock producers among the districts of Hanoi, especially in pigs and poultry. Pigs were reared by (independent) farm households and contract farms and private companies. In 2017, Chuong My had 8,887 pig farm households, keeping about 188 thousand pig heads (Figure 2). There were more than 80 farms and private companies engaged in swine production in the district, with farms as contract producers of the C.P. Group. Yet, contract farms and companies produced about 38% of the total live pigs of the district in 2017.

The first ASF case in Chuong My district was detected in March 2019 and then ASF quickly spread to 32 communes/towns of the district. The total pig population had decreased steadily from nearly 415 thousand heads in 2018 to 242 thousand heads in 2019.

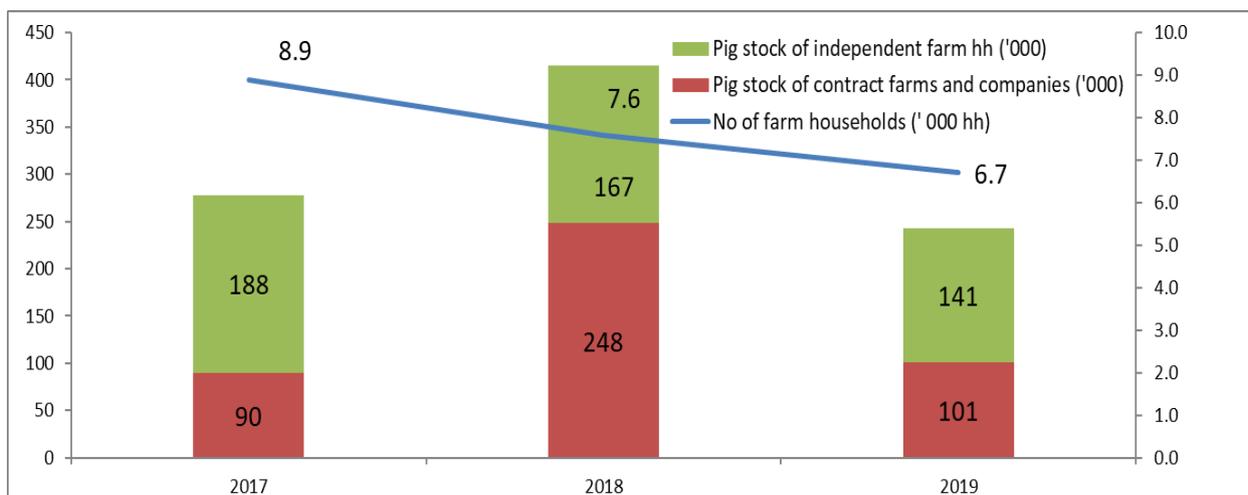


Figure 2. Total number of pig farm households and pig population in Chuong My district, 2017-2019

Low hog prices in 2017 had discouraged farmers to raise pigs. Additionally, the ASF outbreak caused losses for 2,846 farm households (Chuong My People Committee, 2020), accounting for nearly 40% of the total farm households. The total number of culled pigs was recorded at 42,113, weighted at about 3,000 tons, equivalent to about 8% of the total live weight pig produced in 2018 in Vietnam.

General information on farm households

Men shared more than 85% of main labor in pig production by farm households (Table 1). More men were employed in larger-scale pig production because the work demanded more physically strenuous work. This was also highlighted by Hung (2011), Thinh *et al.* (2018), and Ninh *et al.* (2019). Higher education of men labor plus more advanced use of pig breeds were also documented on a larger scale as shown in Table 1 with more than 50% of them using imported genetics. Pig production was quite important in households with about two-thirds of respondents saying that the activity contributed

to more than 50% of the total household income. This proportion was higher on a larger scale (Table 1).

Pig disease management at farm households

The farm households strictly applied vaccines for common diseases in pigs, such as foot and mouth disease (FMD) and pasteurellosis (more than 80% of respondents). Among the surveyed farmers, less than one-fourth were affected by ASF and experienced pig mortality due to ASF. Interestingly, medium-scale farmers seemed to better implement disease prevention management with a lower ASF infection pig mortality (Table 2). Despite many neighboring pig farms with AFS cases around, there were farm households that were free from ASF and continued to gain profit in the time of high price.

Households that were producing pigs benefited from high market prices after ASF since they could sell pigs at a price higher than 94,000 VND kg⁻¹ (USD 4.09 kg⁻¹) at the time of the survey. This was much higher than before ASF with live pig priced at 50,000 VND kg⁻¹

Table 1. General information of farm households in 2020

Indicator	Small (n = 41)	Medium (n = 35)	Large (n = 21)	All	F-Test
1. % of households with main male labor	75.61	91.43	100.00	86.60	-
2. Age of the interviewee	48.80	50.49	51.62	50.02	0.819 ^{ns}
3. Education of the interviewee (% hh)					
- No schooling	2.44	0.00	0.00	1.03	-
- Primary and Secondary education	53.66	62.85	23.81	50.52	-
- High school	43.90	37.14	76.19	48.45	-
4. Labor in pig production (persons)	1.39	1.51	1.95	1.56	5.631 ^{***}
5. Contribution of pig production to the total household income (%)					
- Below 50%	63.64	27.18	9.68	35.95	-
- Above 50%	36.36	72.83	90.32	64.05	-
6. Number of pigs in the current litter (heads)	14.15	31.46	79.33	34.5	63.4 ^{***}
7. Pig barn area (m ²)	120.63	172.43	619.52	247.3	16.93 ^{***}
8. Breeds (% hh applying)					
- Imported genetics	2.44	5.71	52.38	14.43	-
- Cross bred	95.12	94.29	47.62	84.54	-
- Indigenous	2.44	0.00	0.00	1.03	-

Note:***: Significant at 1%; ns is non-significant.

Table 2. African swine fever at pig farm households in 2020

Indicator	Small (n = 41)	Medium (n = 35)	Large (n = 21)	All
1. Households with infected cases				
- % hh affected by ASF	24.39	14.29	33.33	22.68
- % hh affected by other diseases	24.39	28.57	42.86	29.90
2. Households with pig mortality				
- % hh with pig mortality due to ASF	24.39	14.29	33.33	22.68
- % hh with pig mortality due to other disease	12.20	5.71	23.81	12.37
3. Number of pigs dead				
- Number of dead pigs due to ASF per hh	6.56	5.09	27.43	10.55
- Pigs dead due to ASF as % of hh's pig population in a year	19.08	7.03	17.29	13.34

(USD 2.17 kg⁻¹) in January-February 2019. With a total cost estimated at 5.8 million VND, farmers could gain 3.6 million VND per 100 kg (USD 156.52 per 100 kg) pig live weight. For farm households who could keep pigs and were not affected by ASF (**Table 3**), a significant amount of profit was realized. A higher cost efficiency with a lower feed cost and ratio of income/total cost of 0.71 was attained at medium production scale. The reasons behinds that were (i) medium scale was manageable by family labors, who also did several other farming works; and (ii) at this production scale, farmers could still mix feeds by themselves, i.e., concentrated feed with rice/corn bran, which could help to reduce cost. Meanwhile, in large scale production, farmers mostly used pellet feed because of a lack of labor. However, overall economic performance was not significantly different among production scales.

Challenges in swine production recovery

Quality and price of piglets

Quality of piglets. At the time of the survey, large farms have tended to source piglets from breeding companies/centers or breeding farms (**Table 4**). The small farm households preferred either producing piglets by themselves or

sourcing them from other reputable farmers who guaranteed the origin of piglets. During the ASF outbreak, farmers produced the piglets to minimize risks, save cost, and ensure quality (**Table 4**). However, the sows were mainly kept for their own household production. Hence, the quality of sows in many farm households deteriorated over time, affecting the productivity of swine production in the long term. In the coming years, sow quality should be improved through upgrading of the quality of grandparents and great grand parents. More than 50% of farm households reported that they either could not buy piglets or bought poor quality piglets (**Table 4**).

High cost of piglets. Due to the major loss of sows during the ASF outbreak in the country as indicated earlier, farmers in Chuong My district also faced difficulties in buying piglets to recover their production. About 26% of farmers reported that they could not buy piglets. If they could buy, 59% of respondents claimed that the price was very high. Most pig farmers produced piglets by themselves to ensure lower cost which was estimated at 2.1 million VND per piglet (USD 91.30) (**Table 3**) but this limited their capacity to expand their production. The prevailing average market price of a piglet (7-10

Table 3. Issues in sourcing piglets by farmers (% hh)

Indicator	Small (n = 41)	Medium (n = 35)	Large (n = 21)	All
1. Sources of piglets				
- Breeding companies	7.32	11.43	66.67	21.65
- Breeding centers	14.63	17.14	28.57	18.56
- Breeding farms	31.71	42.86	23.81	34.02
- Other farmers	53.66	40.00	33.33	44.33
- Produced by themselves	0.00	8.57	4.76	4.12
- Others	0.00	5.71	0.00	2.06
2. Difficulties in obtaining piglets				
- Could not buy	19.51	40.00	14.29	25.77
- Poor quality	21.95	42.86	9.52	26.80
- High prices	51.22	74.29	47.62	58.76
- Others	2.44	2.86	0.00	2.06
3. The most trustful source of breeds				
- Breeding companies	21.95	14.29	47.62	24.74
- Breeding centers	2.44	0.00	0.00	1.03
- Breeding farms	14.63	14.29	23.81	16.49
- Other farmers	2.44	0.00	0.00	1.03
- Produced by themselves	58.54	68.57	28.57	55.67
- Others	0.00	2.86	0.00	1.03

kg) was 3.2 million VND (USD 139.13) at the time of the survey. The price was about four times higher than before the ASF outbreak (according to the interviews with farmers). Expensive piglets contributed to much higher production costs and accounted for about one-third of the total production cost (**Table 3**). With limited financial capacity (i.e., more than half of the respondents reporting lack of capital – **Table 7**), the smallholders faced difficulties in restocking swine herd.

Consumer preferences and Covid-19

According to GSO, pork prices in Vietnam increased by 68.2% in the first six months of 2020 compared with the same period in 2019 (To Ha, 2020). However, with the large volume of pork and live pigs imported, the domestic pork market became more balanced since June 2020. Live pig price in early September 2020 was recorded at about 74,000 VND to 78,000 VND kg⁻¹ (USD 3.22-3.39 kg⁻¹) in the North. It

decreased by 30% as compared to its peak in May 2020. Retail pork prices at traditional markets in Hanoi also decreased by 20-30%. Meanwhile, Big C, a major supermarket chain in Vietnam, imported pork priced 20-40% cheaper than domestic pork (Anh Tu, 2020). Like Chinese consumers (Standaert, 2020), Vietnamese traditionally preferred freshly slaughtered ‘warm meat’ (Nga *et al.*, 2015). This demand could likely play as a natural barrier over imported meat products (ACIAR, 2011). However, changes in consumption trends have been observed with an increasing quantity of imported meat (chilled, frozen). According to MARD (2020), the total volume of imported pork increased from 9,022 tons in 2015 to more than 67,000 tons in 2019, and continued to increase in 2020. Changing behavior in meat consumption could probably be amplified by Covid-19 in Vietnam with the first case being confirmed in March 2020. This greatly affected the economy when 56,000 companies left the market. The

International Labour Organization's initial prediction (ILO, 2020) was that Covid-19 could affect the livelihood of 4.6 to 10.3 million workers by mid-2020, whether through a decline in working hours, in wages or, ultimately, loss of jobs. Reduction in income could be a reason for consumers, particularly the low-income population, to switch to less expensive foods such as imported pork.

Competitiveness and threats from import products

According to the Ministry of Industry and Trade, the average price of imported pork at the Vietnam gate was USD 2.55 kg⁻¹, equivalent to 60,000 VND kg⁻¹ in April 2020 (Nguyen Hanh, 2020). Imported pork was characterized by clear origin and product information that complied with European criteria. Meanwhile, domestic production cost was calculated at approximately 5.8 million VND per 100 kg (USD 252.17 per 100 kg) of live pigs at the farm gate (**Table 3**), equivalent to about 68,000 VND kg⁻¹ (USD 2.96 kg⁻¹) or carcass. Live pigs were collected and slaughtered (**Table 5**). Most retailers at the wet market had no product information (Nga *et al.*, 2015) or lacked the adequate facility to ensure hygiene and safety of the food (World Bank, 2017). Furthermore, main exporters of pork to Vietnam were Canada and EU countries such as Denmark, the Netherlands, Germany, and Spain. With the CT-TPP and EVFTA, imported meat (pork) would be cheaper. For example, the duty rate for pork would initially drop from 15% to

11.2% under CPTPP, then decline to zero over the next seven years. Frozen pork meat would be duty-free after seven years from the effective date of EVFTA (the maximum tax reduction for pork in the agreement was 40%) (EU Commissioner for Trade, 2020). Therefore, imported pork prices would decrease relatively as compared to domestic products. This would raise an issue on how domestic pork production could be cost-competitive in the upcoming years.

Farmers sold pigs mainly to collectors, especially larger farmers, due to the limited local market demand (**Table 5**). With the absence of official contracts with buyers, farmers faced difficulties in selling pigs, especially when collectors set lower prices. This happened generally in the smallholder pork value chain in Vietnam (Nga *et al.*, 2014).

Disease risks, insufficient resources, and environmental issues

Swine-related diseases such as diarrhea, pneumonia, fever, blue ear, or head edema could cause a reduction of up to 16.6% of the total income from pig production of smallholders annually (Nga *et al.*, 2017). In Chuong My district, farmers vaccinated pigs; hence, pig mortality due to the mentioned disease was quite low, estimated at less than two dead pigs per household (surveyed data). Pig mortality was 100% with ASF (**Table 2**), but there was no effective and safe vaccine for ASF in the world to date. This is also a major challenge for many

Table 4. Issues in selling pigs (as % of total)

Indicator	Small (n = 41)	Medium (n = 35)	Large (n = 21)	All
1. Main buyers				
- Collectors	68.29	80.00	90.48	77.32
- Local slaughterhouses	31.71	20.00	9.52	22.68
2. Farmers selling pigs to collectors	36.59	31.43	42.86	36.08
3. Difficulties in selling pigs				
- Lower prices set by collectors	46.67	54.55	44.44	48.57
- Unstable prices	33.33	45.45	22.22	34.29
- Others	13.33	0	33.33	14.29

countries in controlling ASF such as China (Wang *et al.*, 2018). Huldah *et al.* (2020) confirmed that while the process of developing effective and safe African swine fever vaccines evolved, the mechanisms of virus entry, replication within the host cells, and other methods were gradually identified. In Vietnam, there were efforts to develop a vaccine for ASF but there was no available vaccine for ASF as of this reporting. According to MARD (2020), the number of provinces and communes in Vietnam affected by ASF decreased. However, the end of the ASF outbreak can not be predicted, although the rate of reported cases appeared to be slowing recently. Due to the lack of treatment and a safe vaccine, it had been extremely difficult to control this devastating disease. The disease risk was amplified under inadequate facilities such as pig shelter conditions. More than 60% of pig producers reported that either their pig shelters were not constructed following technical standards or producers were not aware of such standards (Table 6). The fact that farmers mostly sold pigs to collectors/traders who might come

from other places also is a factor for increasing the spread of ASF, hence inter-district and inter-province management for ASF is important, which is quite similar to the management of ASF among Asian countries (Le *et al.*, 2019).

Lack of capital was perceived as the main issue in restocking pig production of farm households (Table 7) under the context of high production cost (breeding) as well as damages and losses due to ASF, particularly among other producers who had stopped raising pigs at the time of survey. Labor was not an issue for small-scale farmers but was considered a problem for larger farmers who required quality labor for managing the herds. Observations from larger farms revealed that most of them were farrow – to – finish producers, with a relatively large number of sows. During and after ASF, labor requirements were much higher, i.e., better skills in taking care of the herds (especially disease management and biosecurity conditions), and following strict rules such as more frequent disinfection pig shelters, bathing, wearing

Table 5. Types and locations of pig shelters

Indicator	Small (n = 41)	Medium (n = 35)	Large (n = 21)	All
1. Locations of pig shelter				
- In residential area	90.24	48.57	38.10	63.92
- Outside residential area	9.76	51.43	61.90	36.08
2. Criteria of hh's pig shelters				
- Did not comply with technical requirements	53.66	51.43	38.10	49.48
- Complied with technical requirements	19.51	40.00	61.90	36.08
- Did not know	26.83	8.57	0.00	14.43

Table 6. Difficulties in swine production (% of respondents)

Issues	Small (n = 41)	Medium (n = 35)	Large (n = 21)	All
Lack of land	43.90	22.86	33.33	34.02
Lack of capital	63.41	42.86	66.67	56.70
Lack of labor	0.00	5.71	14.29	5.15
Insufficient techniques	58.54	60.00	47.62	56.70
Others	2.44	8.57	9.52	6.19

protective clothes, and not allowed to go out of the farm during a cycle. This made the quality labor sources to be in scarcity, as one labor could not work for several farms as before ASF. Lack of quality labor, coupled with a higher number of pigs, could be a reason for a higher percentage of large-scale farmers affected by ASF. Aside from farmer's capacity, the limited number of veterinary staff working with numerous small farmers also challenged animal disease control, including ASF (according to the interview with staff from DBVLP), this was also the case in Russia, as mentioned by Wang *et al.* (2018).

Apart from capital and labor constraints, more than 50% of pig producers reported that they did not have an adequate understanding of technical know-how in rearing pigs (Table 7). Staff from the DBVLP revealed that the DBVLP

and feed/veterinary companies offered frequent trainings on pig rearing. More than 80% of the respondents attended training on disease management (Table 8). More than 60% of pig producers treated sick animals by themselves, but approximately only one-fourth of them felt confident in doing this. Large farmers seemed to be more confident than others in terms of their capacity to treat sick animals (Table 8), most of them hired technically qualified veterinarians for farm management. While swill-feeding might increase the risk of ASF as in China (Wang *et al.*, 2018), this issue seemed not critical in Chuong My where most farmers used the manufactured feed.

Two-thirds of pig shelters were located in residential areas. This was common among small-scale farmers (Table 6) but likely to relate with the ASF outbreak, with other animals living

Table 7. Training and self- evaluation of treating sick animals (% of respondents)

Indicators	Small (n = 41)	Medium (n = 35)	Large (n = 21)	All
1. Farm household heads attended training on	73.17	94.26	85.71	83.51
- Feeding	43.33	63.64	61.11	55.56
- Disease management	93.33	90.91	100.00	93.83
- Others	13.33	9.09	0.00	8.64
2. Self-evaluation of capacity to treat sick animals				
- Good	14.63	17.14	61.90	25.77
- Fair	65.85	65.71	33.33	58.76
- Weak	19.51	17.14	4.76	15.46

Table 8. Treatment of waste from pig production

Waste and methods of treatment	Small (n = 41)	Medium (n = 35)	Large (n = 21)	All
Pig manure				
- Biogas	85.37	82.86	100	87.63
- Compost	9.76	14.29	0	9.28
- Feeding fish	9.76	14.29	14.29	12.37
- Others	0	8.58	9.52	5.15
Waste water				
- Biogas	78.05	77.14	90.48	80.41
- Dispose to drains	24.39	11.43	4.76	15.46
- Dispose to fish ponds	4.88	20	19.05	13.4

in the same area (Dione *et al.*, 2015). Backyard swine raising was one of the pressing issues in the rural environment, despite that most of the communes in the district had set areas isolated from the residential area for livestock production. Compost of manure (**Table 9**) within residential areas (among 10% of pig households) and direct disposal of waste water from pig production to common drainage systems could cause environmental pollution and would pose more difficulties in animal disease management for farm households. There was only one farm household that applied a manure pressing machine and claimed that it was quite efficient in addressing the problem of odor within the area.

Conclusions and Recommendations

The swine industry continues to be a key player in livestock production of Vietnam in creating livelihoods as well as pork dominance in the consumers' meat basket. The ASF outbreak has caused devastating losses in the country's production and food market. MARD and line agencies have taken various measures to control the epidemic. The government has also encouraged meat imports to address the shortfall in the pork supply in the domestic market. Despite the fact that the rate of reported ASF cases seemed to decline, the end of the ASF outbreak could not be predicted. Recovery of the swine industry is urgently called for, which requires a lot of effort to prevent and control ASF and address market-related issues. This study took the case in Chuong My district, Hanoi and show that ASF had a significantly adverse impact on the pig herd of the district, and main challenges in swine production recovery after ASF were identified, such as issues of quantity and quality of piglets and changing consumer preferences which could have been amplified by Covid-19 (ongoing), relatively cost disadvantage of domestic production under the context of new free trade agreements (such as EVFTA and CT-TPP), disease risk (ASF under the condition of no effective and safe vaccine), and insufficient resources of farms to restock, and environmental issues caused by pig production in rural areas.

To speed up the recovery of the swine industry in the future, the government and line agencies should focus on improving sow quality through breeding programs to improve the quality of grandparents and great grandparents in breeding units. Cost competitiveness in pig production requires lower production and marketing costs through reduced feed cost as well as breeding cost and building efficient marketing channels with strong linkages along the value chain. The promotion of good agricultural practices in pig production should be intensified, such as VietGAHP or biosecurity, or establishing the disease-free livestock production zone, and discouraging farmers to expand production in residential areas. Training programs to improve farmer's production capacity and rural laborers in swine production must be offered free or at minimal cost, where rural occupational training programs could also be targeted. This also should be aligned with the National plan on ASF prevention. Government line ministries with partner banks or lending institutions may revisit their credit policies and offer easy and practical solutions to ease credit availability to small farm holders. Market information systems should be efficient to serve numerous small farmers to avoid excess supply (as experienced in the past). Pig waste management, as well as environmental management in the rural areas, should be strengthened.

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