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COMMERCIAL POULTRY AND PIG FARMING IN YANGON'S PERI-URBAN ZONE

By

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Food Security Policy *Research Papers*

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EXECUTIVE SUMMARY

This report presents results from a comprehensive structured survey of medium and large-scale pig and poultry farms conducted in the peri-urban zone surrounding Yangon. The survey represented pig farms raising five or more breeding sows or 20 or more swine, and all broiler, semi-broiler, and layer farms raising 500 or more birds, in randomly selected villages from 83 village tracts with high concentrations of pig and chicken farms, in Ayeyarwady, Bago (East) and Yangon regions. Owners of 90 pig farms, and 423 poultry farms (290 broiler, 38 semi-broiler, 95 layer) were interviewed.

The survey was supported by analysis of nationally representative data on poultry, meat, egg and dairy consumption for 2010 and 2015, poultry, meat, and egg retail prices from 2008 to 2017, and satellite images of peri-urban Yangon for 2014 and 2018. Together, these data sources allow us to characterize the economic and technical dimensions of medium and large-scale pig and poultry farming in Myanmar and recent trends in sectoral growth, to identify implications for policy and development programming. We summarize key findings and discuss their implications below.

Consumption of meat, eggs, and dairy grew from 2010 to 2015. Combined consumption per capita of meat, eggs, and dairy increased 13% at the union level. Almost all this increase occurred in urban areas, where consumption jumped 41%, to 28 kg/capita. Consumption in rural areas remained almost unchanged, at 18.7kg/capita. The total quantity of meat, eggs, and dairy consumed by the poorest 20% of households fell by 1.8 kg over this period, while the quantity consumed by the wealthiest 20% increased by 9.8 kg.

Increases in animal source food consumption were driven by chicken and eggs. Chicken consumption increased 72% from 2010-2015, to become the number one meat consumed (average 6.8 kg/capita). Consumption of chicken eggs increased 40%, to 4.0 kg/capita. These increases were partially offset by reduced consumption of pork, beef and mutton. Pork was the number one meat consumed in 2010, but consumption fell 22% to 4.3 kg in 2015. Beef consumption halved and mutton consumption fell by one-third over this period.

The real price of chicken meat and eggs has fallen, as the price of other meats as risen. The inflation adjusted price of chicken meat and eggs fell 29% and 36%, respectively, between 2008 and 2017. The real price of pork, beef, and mutton increased 10%, 34%, and 34%, respectively over the same period. In 2008, chicken meat was 15% more expensive than beef. By the end of 2017, it was 35% cheaper.

The number of integrated chicken-fish farms around Yangon doubled between 2014 and 2018. Integrated farms have animal houses built above or beside ponds to enable utilization of waste nutrients as inputs for fish culture. Analysis of satellite images shows the number of chicken houses integrated with fishponds in peri-urban Yangon grew from 1898 to 3868 from 2014-2018. The number of village tracts with integrated farms doubled from 121 to 230.

Two-thirds of poultry farms surveyed are integrated with fishponds. Integrating livestock and fish production has several advantages. (1) Much of the nutrients consumed by fish in integrated farms are obtained from algal blooms, fertilized by manure from animal houses above or beside the pond. This allows production of fish using limited or no feed, substantially reducing

costs compared to non-integrated fish farms. (2) Integration means that manure does not accumulate on site, so farms are free of unpleasant odors and flies, and there is no need organize manure disposal. (3) Land use productivity is maximized as farms simultaneously produce two high value crops from a single parcel of land. (4) Producing fish at low cost helps farms to reduce the risks of poultry production, for which margins are often slim and prices volatile.

More than half of farms in our sample were established within the past five years. Average broiler and layer flock sizes per farm remained fairly constant since 2016, suggesting that increases in chicken and egg production among the strata of farms surveyed have been driven more by proliferation of new farms than by scale expansion.

Most land use in pig and poultry farming contravenes Myanmar's agricultural land use classification system. Most parcels of land used for livestock production (91%) have some form of land use document associated with them, of which 69% are formal land use rights certificates. However, among parcels with formal land use rights, only 17% have a document (La Ya 30/La Na 39) that allows the land to be utilized for livestock production. Obstacles to obtaining the correct land use classification documents prevent farms from using land as collateral for formal loans, can necessitate payment of bribes, and may make tenure security vulnerable to changes in the enforcement of land use regulations.

Few farmers have received any formal training on pig or poultry farming. Only 11% of farms have received any formal training. Private companies are the main providers of extension services. Most information on farming is obtained from informal sources, with fellow farmers (mentioned by 63% of respondents) and relatives (30%) are most common. Social media plays an important role in the distribution of farming information (28%), as do staff of feed companies (32%). Formal government information sources were mentioned by 12% of respondents, and NGOs not at all. Knowledge about animal diseases is limited. An outbreak of African swine fever (ASF) - a severe viral disease – was occurring in Southeast Asia at the time of the survey. Half of pig farmers had no knowledge of the cause of ASF infections. Around 40% were not familiar with any ASF symptoms or means of prevention. Less than half of farms maintain records.

Pig farming is undergoing rapid technological change. Improved breeds of boar and sow are much more common than local breeds. Improved 'CP' breed pigs account for half of the swine, with 'local' breeds accounting for about one-quarter. Local breeds have a longer production cycle and attract a lower price than improved breeds, but can be raised wholly or partly on a diet containing items such as kitchen scraps, whereas improved pig breeds must be raised using formulated feeds (commercially manufactured feeds that are formulated to meet the complete nutritional requirements of the animal farmed) for optimum performance. Until 2010, most farms used non-formulated feeds. The share of farms using formulated feeds overtook the share using non-formulated feeds around 2015, indicating a recent shift toward intensification and commoditization of production. Eighty-nine percent of pig farms use formulated feeds.

The market for animal feed is diversifying and becoming more competitive. Thailand's CP company dominates pig feed supply, with 48% of farms using their products. South Korea's Sunjin company (16%) and China's New Hope company (11%) are the two next largest suppliers. All broiler and semi-broiler farms use formulated feeds. The poultry feed market is more diverse than the pig feed market. One quarter of broiler farms use CP feed, with the same share using feed

from Dutch company De Heus. Twenty percent of broiler farms use feed from Maykha (a Myanmar company that produces in partnership with Indonesian firm Japfa). A mix of Myanmar and foreign owned companies account for the remainder of the poultry feed market, with Myanmar companies among the top three suppliers of layer feed and semi-broiler feed. Five feed companies supply pelleted fish feeds, taking between 11% and 27% of market share each. A major change has occurred in Myanmar's fish feed market structure since 2016, when a single Myanmar company dominated supply.

Implications for policy and programming

Chicken meat and eggs play an important role in Myanmar's food and nutrition security, given the critical importance of animal source foods for combating undernutrition. Increasing production of chicken meat and eggs from 2010 to 2015 has made them much more affordable than in the recent past. This trend has helped to reduce, but not prevent, overall declines in animal source food consumption among poorer households. As of 2015, increases in pig production had not occurred on a sufficiently large scale make pork more affordable and avert declines in consumption, but pork prices have trended somewhat downward since then, and the steady growth and technological intensification of pig farms documented here suggests that this trend is likely to continue. From a nutrition perspective this dynamic represents a double-edged sword, as overconsumption of saturated fats from animal products is also associated with obesity and related negative health outcomes. Thus, there is a need for consumer education to promote adequate (but not excessive) levels of consumption, while encouraging healthier alternatives.

Integrated livestock-fish production should be recognized as a beneficial form of food production. Integrated farming reduces economic risks to livestock producers, utilizes land efficiently, produces fish at low cost, facilitates reuse of excess nutrients from livestock production, and eliminates unpleasant odors and flies. There is no export market for the fish produced in integrated systems, so there is little risk of antibiotic residues in fish from these farms damaging Myanmar's aquaculture export prospects. As such, policy should seek to regulate this economically and environmentally efficient practice (e.g. by managing discharge of eutrophic water from ponds and mandating antibiotic withdrawals prior to harvest) rather than to ban it, as advocated in some quarters.

Land used for animal husbandry or aquaculture activities should be designated as agricultural land in the formal land classification system. This would strengthen the tenure security of the occupants, lessen opportunities for corruption, and reduce farmer vulnerability to changes in the enforcement of land use regulations.

Private actors in upstream segments of the value chain and targeted social media campaigns provide entry points for training and information dissemination. These could be coordinated with carefully selected influential farmers with large networks to maximize the reach of key messages. The limited extent of government and NGO training activities suggests scope for their expansion, perhaps in coordination with, or support of, private extension agents.

There are many opportunities to improve farm management and biosecurity. These include digital services such as dedicated record keeping apps, encouraging and promoting the expansion of artificial insemination services for pigs, improvements to the design of farm buildings, and instituting quarantine services for imported animals.

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1 Introduction

Commercially oriented production of poultry, eggs and swine is growing rapidly in Myanmar. Large numbers of commercial poultry and swine farms are located in a broad arc around the city of Yangon, close to high concentrations of input supply business, transport routes and sources demand for meat and eggs. Yangon, Ayeyarwady and Bago (East) regions are among the top producers of pigs, broilers and eggs nationwide, home collectively to 29% of the nation's pigs, 48% of its broilers, 31% of its layers (Table 1A).

Despite the growing importance of Myanmar's commercial pig and poultry sector, relatively little is known about the characteristics of farming technologies or the farmers involved. The pig and poultry sector also faces important challenges, including animal diseases (Ebata et al, 2019; Burgos et al, 2009), high use of antibiotics (Larive International, 2015; Henning and Gibson, 2018), political pressure to ban the integration of chicken houses with fishponds (Twe, 2020; GNLM, 2020), and a system of land use classifications that weakens land tenure security for some farms (Obendorf, 2012).

With these factors in mind, this study was designed to elicit information on the farm segment of the poultry and pig value chain in townships falling within a 100 km radius of central Yangon. A total of 513 farms – of which 423 chicken farms and 90 pig farms – were interviewed in 13 townships in Yangon, Ayeyarwady and Bago regions[1]. This sample covered all farms identified in selected villages with at least 5 breeding sows, 20 swine, or 500 chickens.

Poultry farms can be subdivided further into layer farms (housing egg laying birds), broiler farms (housing chickens reared to produce meat), and 'semi-broiler farms' (housing male layer chickens raised for meat). Pig farms can be subdivided into farms specializing in rearing piglets for sale for on-growing by other farmers, farms specializing in raising swine for meat, and farms rearing both piglets and swine. Poultry and pig farms can also be categorized as 'integrated' and 'non-integrated', where integrated farms have animal houses constructed above or beside a fishpond, allowing for the utilization of manure and uneaten feed as an input into fish cultivation. The breakdown of the sample by type of farm interviewed is presented in Table 1

Survey findings presented in this report are organized as follows: Section 2 presents analysis of national level data on trends in consumption of animal-source foods from 2010 to 2015 and retail prices for meat and eggs from 2008 to 2017. Section 3 outlines the farm survey sampling strategy and methodology. Section 4 maps the spatial distribution of poultry and pig farms around peri-urban Yangon. Section 5 presents results the characteristics of farm owners and their landholdings. Section 6 presents findings on the technologies deployed by each type of farm. Section 7 provides details of access to marketing, services and information by surveyed farms. Section 8 concludes by summarizing key findings, and implications for policy and programming.

[1] Bago, Danubyu, Hlegu, Hmawbi, Kawa, Kayan, Maubin, Nyaungdon, Pantanaw, Taikkyi, Thanatpin, Thanlyin, Twantay.

Table 1 Breakdown of sample by type of animal raised

	All poultry	Broiler	Semi-broiler	Layer	Integrated with fish
N	423	290	38	95	283
%	100	69	9	22	67
	All pigs	**Piglets**	**Swine**	**Piglets & swine**	**Integrated with fish**
N	90	15	31	44	11
%	100	17	34	49	12
	Total				**Integrated with fish**
N	513	-	-	-	294
%	100	-	-	-	57

Note: Each respondent was interviewed about a single type of animal. If a respondent raised more than one type of animal, selection of the type of animal was randomized. The number of interviews conducted for each type of animal is reported in the table.

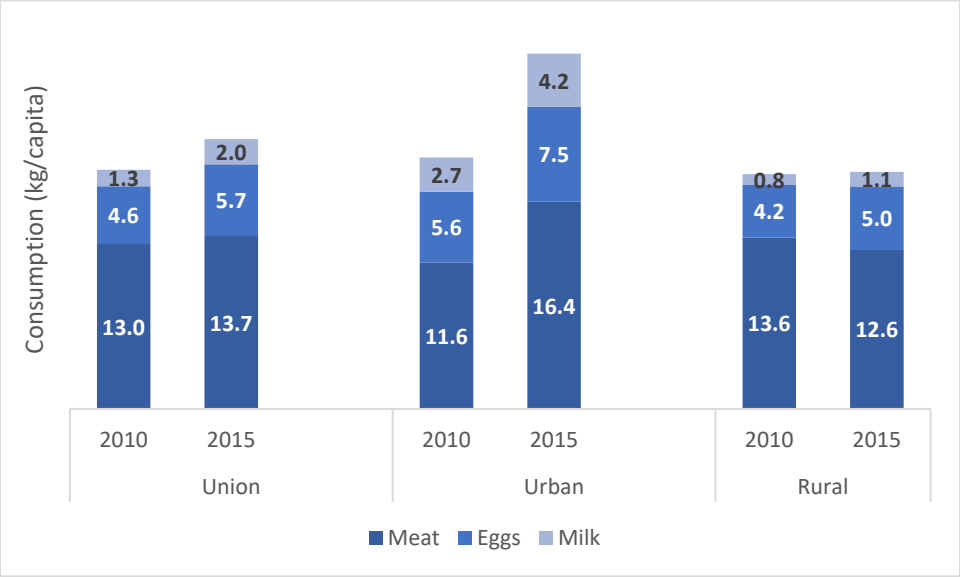
For ease of presentation, some figures and tables are included in an annex at the end of the document. References to figures and tables included in the annex are identified by the suffix "A" (e.g. Table 1A).

2 Consumption & retail prices of meat, eggs, and dairy

To gain a sense of changing patterns of supply of meat and eggs at the national scale, we analyzed data from two nationally representative household surveys, the Integrated Household Living Conditions Survey (IHLCA), conducted in 2010, and the Myanmar Poverty and Living Conditions Survey (MPLCS), conducted in 2015 to identify temporal trends in consumption of meat, eggs and dairy. We also analyzed data on retail prices collected on a weekly basis by the Central Statistical Office to evaluate trends in the price of meats and eggs from 2008 to 2017. Results are presented below, as follows.

Consumption of meat, eggs, and dairy increased from 2010 to 2015, but mainly in urban areas. Combined consumption of animal source foods per capita increased 13% at the union level, but almost all of this increase occurred in urban areas, where consumption jumped 41%, from 19.9 kg/capita to 28 kg/capita. Consumption in rural areas remained almost unchanged, at 18.7kg/capita. Consumption of dairy and eggs jumped by 52% and 24% respectively at the union level over this period, increasing in both rural and urban areas, though faster in the latter. Meat consumption increased by 5% at the union level. This increase was concentrated in urban areas, where meat consumption jumped 42%. Meat consumption in rural areas fell but 7%. Some caution must be exercised in interpreting these figures because the two surveys from which they are taken collected household food consumption data in slightly different ways. However, the trend is sufficiently strong to suggest real change occurring (Figure 1).

Figure 1 Annual consumption per capita of meat, eggs, and dairy, by location, 2010 and 2015 (Source: IHLCA 2010 and MPLCS 2015 datasets)



Consumption of chicken and eggs increased substantially from 2010 to 2015. Chicken was the number one meat consumed in 2015, with average per capita consumption of 6.8 kg. This represents a 72% increase on average consumption in 2010 (3.9 kg/capita). Consumption of chicken eggs also increased sharply during this five-year period, up 40% from 2.8 kg/capita to 4.0 kg/capita. Consumption of fresh milk also increased sharply, though from a lower base (up 73%, from 0.8 kg to 1.4 kg) (Figure 2).

Consumption of most other meats fell. Increases in chicken and egg consumption were nearly offset by reductions in consumption of pork, beef and mutton. Pork was the number one meat consumed in 2010, but consumption declined 22% from 5.5 kg, to 4.3 kg in 2015. Beef consumption recorded the largest decline, halving from 3 kg to 1.5kg/capita. Mutton consumption of also fell 33%, but from a low level (Figure 2).

Figure 2 Annual consumption per capita of meats, eggs, and dairy, 2010 and 2015, by product (Source: IHLCA 2010 and MPLCS 2015 datasets)

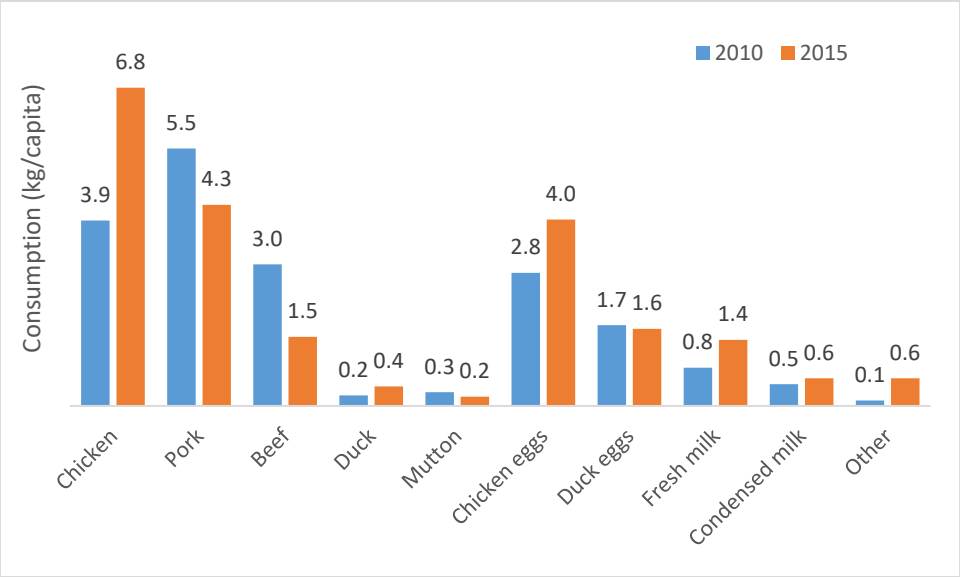
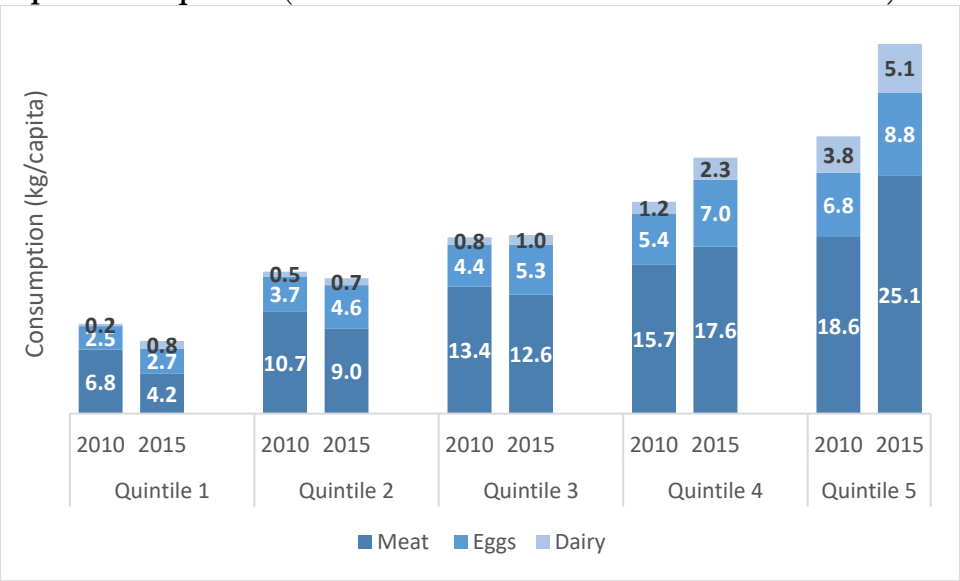
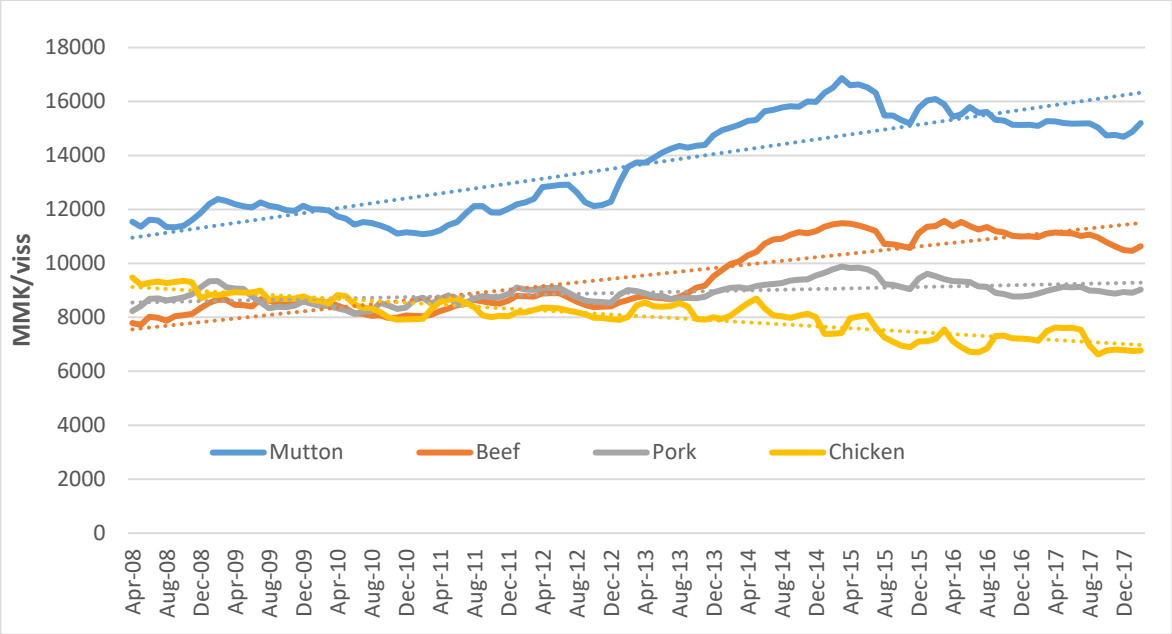


Figure 3 Annual consumption per capita of meats, eggs, and dairy, 2010 and 2015, by expenditure quintile (Source: IHLCA 2010 and MPLCS 2015 datasets)



The gap in animal source food consumption between the poorest and wealthiest households widened between 2010 and 2015. Disaggregating consumption of meat, eggs and milk by expenditure quintile (with quintile 1 approximating the poorest 20% of households, and quintile 5 the wealthiest) indicates that in 2015, members of wealthiest 20% of households ate five times more meat, eggs and milk combined per capita than the poorest 20% (39.0 kg, versus 7.7 kg). In 2010, quintile 5 households consumed three times more of these foods combined than those in quintile 1 (29.2 kg, vs 9.5 kg). Thus, the quantity of terrestrial animal source food consumed by the poorest 20% of households actually fell by 1.8 kg in five years, while the quantity consumed by the wealthiest 20% increased 9.8 kg. The average per capita consumption of meat fell for all households in quintiles 1-3 (the poorest 60% of the population), with potentially serious negative implications for nutrition. However, average consumption of chicken eggs and fresh milk rose for households in all expenditure quintiles. In fact, chicken, chicken eggs, and fresh milk were the only animal source foods for which consumption by households in expenditure quintile 1 increased substantially. These results point to the growing importance of the contribution of chicken and egg production for human nutrition in Myanmar (Figure 3).

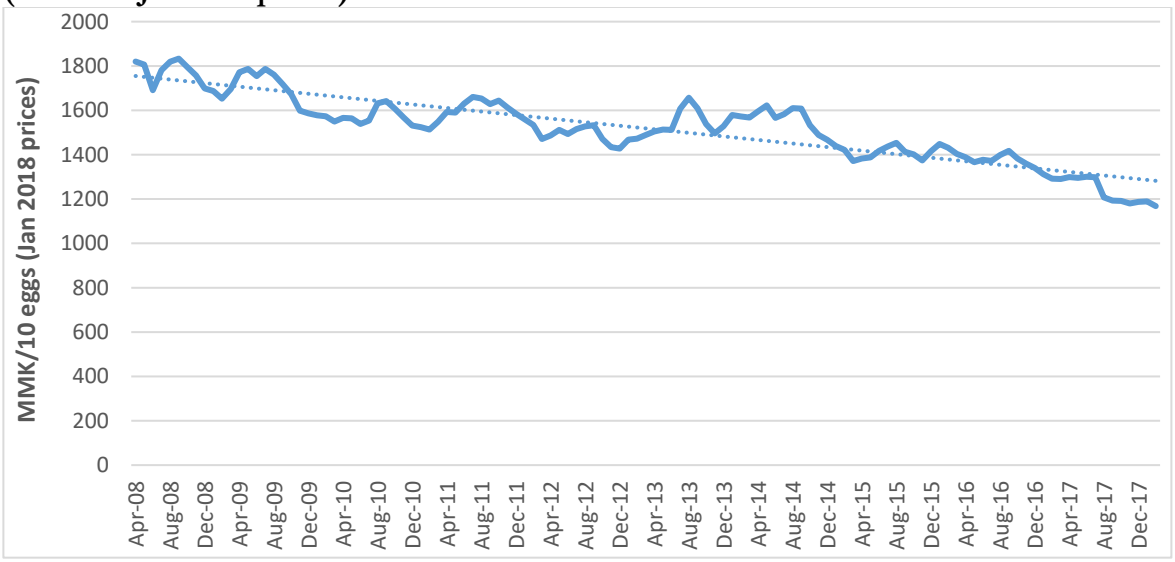
Figure 4 Real retail prices of meat, April 2008-January 2018 (constant Jan 2018 prices)



The real price of chicken and eggs has fallen over the past decade, while the price of other meats as risen. The real price of chicken meat and chicken eggs, adjusted for inflation at constant January 2018 prices, fell 29% and 36%, respectively, between April 2008 and January 2018 (Figures 4 and 5). The real price of pork, beef, and mutton increased 10%, 34%, and 34%, respectively over the same period. In 2008, chicken meat was 15% more expensive beef and 18% more expensive than pork. By 2018, chicken was 25% cheaper than pork and 35% cheaper than beef. These price trends very likely account for the pattern of consumption described above, in which consumption of chicken meat and eggs increased for households in all expenditure quintiles, while overall meat consumption fell for households in lower income quintiles. These figures suggest that the supply of chicken and eggs expanded rapidly over the past decade, resulting driving falling prices. The supply of pork appears to have grown at a

much slower rate, while that of beef and mutton may have contracted. The underlying reasons for these changes are not known, but it seems possible that a widespread shift away from use of draft animal traction and a rapidly growing export market for cattle as contributed to a shrinking supply of beef.

Figure 5 Real retail prices of chicken eggs (per 10 pieces), April 2008-January 2018 (constant Jan 2018 prices)

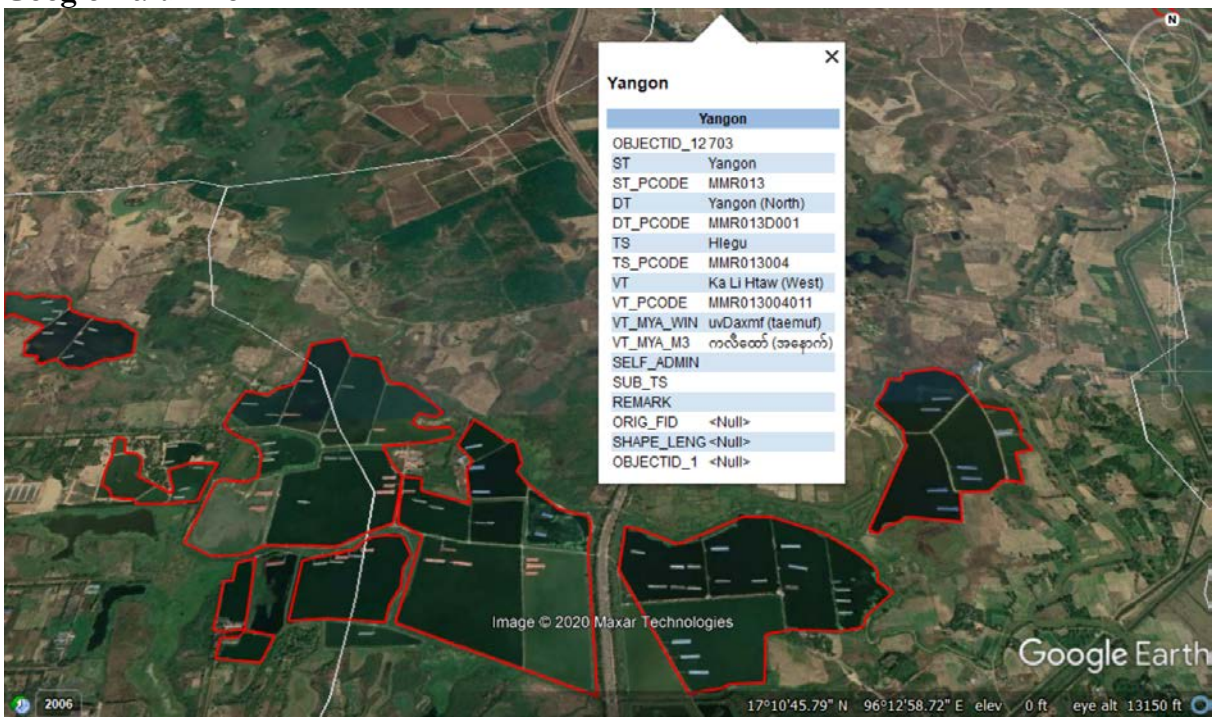


3 Sample and survey methodology

It was not possible to gain access to disaggregated information on numbers of pig and poultry farms from the recently completed National Livestock Baseline Survey (LBVD, 2019) while developing the sampling strategy for this survey. As a result, we deployed a variety of strategies to obtain information on locations and numbers of pig and poultry farms in the Yangon peri-urban zone, from which to develop a sample frame.

First, we identified locations with integrated poultry-fish farms by analyzing satellite images, by the following steps. (1) We delimited the geographical scope of the survey to the area within a 100 km radius of the center of Yangon city, and determined the extent of this zone using ArcGIS software. (2) We integrated shape files of township and village tract boundaries with Google Earth Pro software, allowing us to identify the all the administrative units falling within 100 km of Yangon. (3) We conducted a systematic visual search of satellite images of this zone, village tract by village tract, in Google Earth Pro, to identify integrated chicken-fish farms.

Figure 6 Example of identification and logging of integrated poultry-fish farms with Google Earth Pro



Integrated chicken-fish farms have a distinctive visual signature. Ponds are easily identified from their straight borders, visible earthen dikes, and their distinctive smooth water surface and olive to blue-green coloration. Chicken houses constructed over ponds are also clearly visible and easily identified as small rectangular white or brown objects, usually located close to the pond bank (See Figure 6). In contrast, chicken houses that are not integrated with fishponds are very difficult to identify as they are hard to spot and differentiate from to other types of commercial

building when viewed from above. Pig houses are rarely constructed directly over ponds and are also very difficult to identify positively from satellite images.

Wherever integrated chicken-fish ponds were identified, the location was recorded in a geo-coded database and the number of chicken houses was counted and logged. Results from the initial sweep of satellite images were rechecked and validated visually. This information allowed us to count the number and calculate the density (per km^2) of integrated chicken-fish houses per village tract within the zone of interest. Ranking village tracts by number and density of farms made it possible to identify village tracts with high concentrations of integrated farms for inclusion in the sample frame.

Pig houses and non-integrated chicken houses could not be identified. To ensure inclusion of village tracts where these types of farm were present in the sample frame, we conducted expert elicitation with key informants to identify key townships for each type of farming, and key village tracts per township. Key informants consulted included members of the Myanmar Livestock Federation, township level officers of LBVD, slaughterhouses, pig and poultry traders, and feed suppliers. Combining this information with our analysis of satellite images, we selected a pool of 83 village tracts thought to contain high concentrations of pig and chicken farms. Villages were selected for survey from each village tract randomly, by probability proportional to size.

A complete listing of pig and poultry farms was conducted in all selected villages. The listing included information on type of animal raised and flock or herd size. The survey was designed to capture information on strongly commercially oriented farming operations, so the minimum size threshold for inclusion in the survey was set at five or more breeder sows, 20 or more swine, or 500 or more broilers, semi-broilers, or layers. All farms in selected villages that met these size criteria were selected for inclusion in the survey with 100% probability. This process generated a total dataset of 513 farms, including 423 chicken farms and 90 pig farms.

This sample design does not allow for extrapolation from the population of farms surveyed to the total population of farms in the surveyed area, as we lack the information required to generate survey weights. The sample should therefore be considered representative only of the farms selected. Nevertheless, the fairly uniform nature of production practices reported among most types of farm in our sample means it is likely that the results are comparable to those for other farms in the same size range within the zone surveyed.

4 Spatial distribution of farms

Figures 7-10 map the spatial distribution of the farms surveyed. As described in the introduction, the survey included a variety of types of pig and poultry farm. Figure 7 presents this data at a high level of aggregation, differentiating only between pig and chicken farms. The map reveals that chicken and pig farms are located in a highly clustered manner, in a pattern that closely tracks the main roads to the west, north, and east of Yangon. Chicken farms are particularly heavily concentrated to the west of Yangon in Nyaungdon and Maubin (the townships where most of Myanmar's fish farms are concentrated) (Belton et al. 2018), and to the northeast, between Yangon and the city of Bago. High concentrations of poultry farms are also found on the northern edge of urban Yangon, in the townships of Hmawbi and Hlegu. Pig farms are less numerous, and somewhat more less densely clustered, with the highest concentrations found on the outer edge of northern Yangon city (Hmawbi, Hlegu) and further north in Taikkyi township.

Figure 8 illustrates the distribution of poultry farms, disaggregated into the three main categories – broilers, semi-broilers, and layers. There is some overlap in the location of different types of farm, but the figure indicates a degree of specialization within clusters. Farms the east of Yangon specialize primarily in broiler production, whereas the highest concentrations of layer farms lie due north and due west of the city. The largest cluster of semi-broiler farms is found to the northwest. The patterns suggest that clusters form not only due to physical geography (e.g. roads, proximity to urban areas), but due to the spatiality of social networks that facilitate localized spillovers of specialized information. Figure 9 shows the distribution of pig farm raising swine, piglets, and a mix of both. These are less numerous and less densely clustered than poultry farms. Most farms producing piglets are located close to areas with swine farms, which likely serve as their customers.

Figure 10 illustrates the distribution of poultry farms integrated with fishponds. Approximately two-thirds of all poultry farms in the area surrounding Yangon are integrated with fish. These are clustered particularly densely due west of the city and Maubin and Nyaungdon, and to the east in Kayan, Kawa, and Thanatpin. Non-integrated farms are concentrated primarily the north of Yangon, where they overlap to with the highest concentrations of layer farms.

Figure 7 Location of surveyed chicken and pig farms

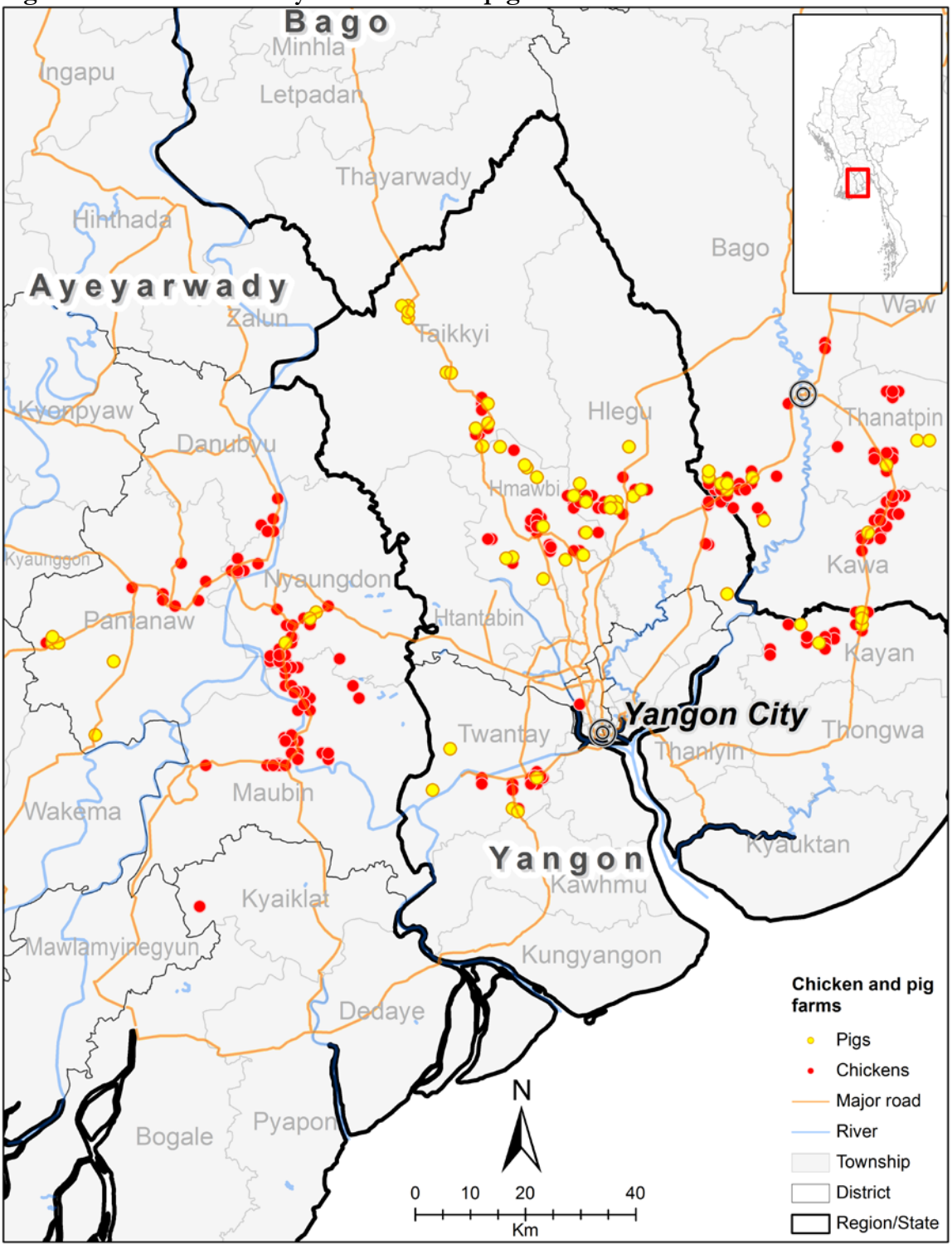


Figure 8 Surveyed broiler, semi-broiler and layer farms

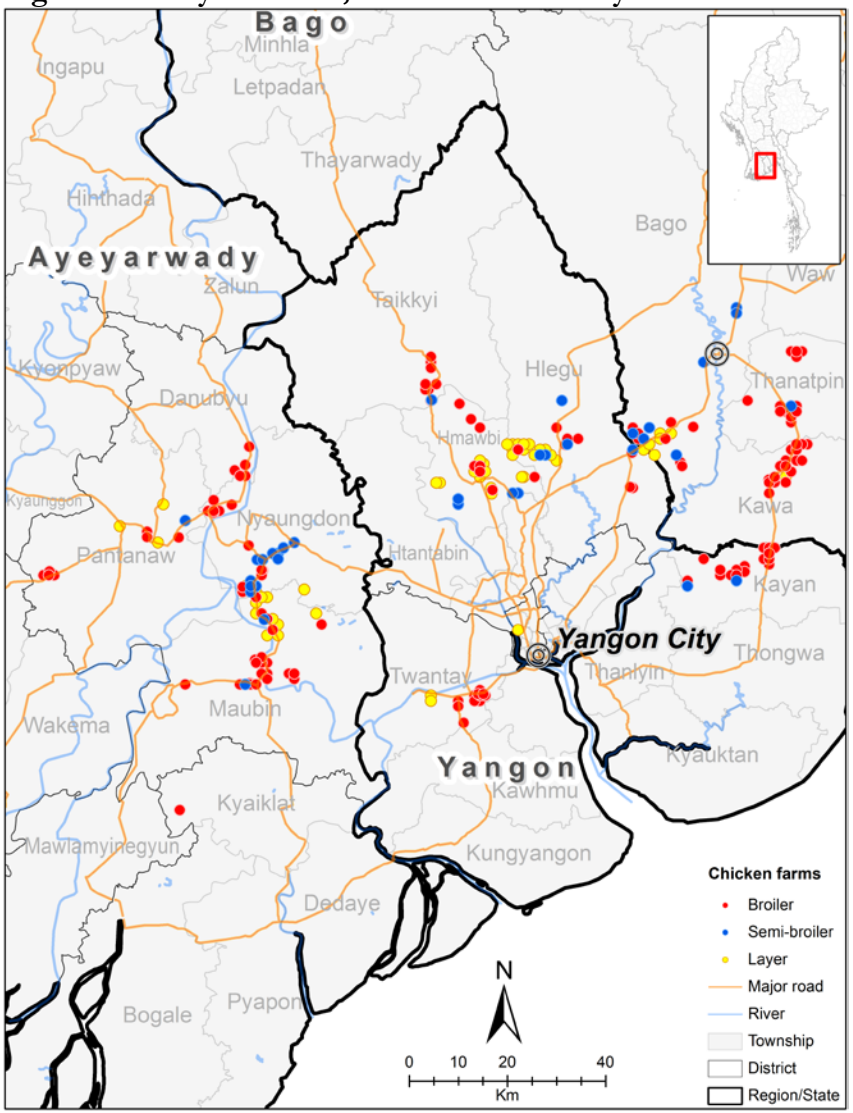


Figure 9 Surveyed piglet, swine, and mixed pig farms

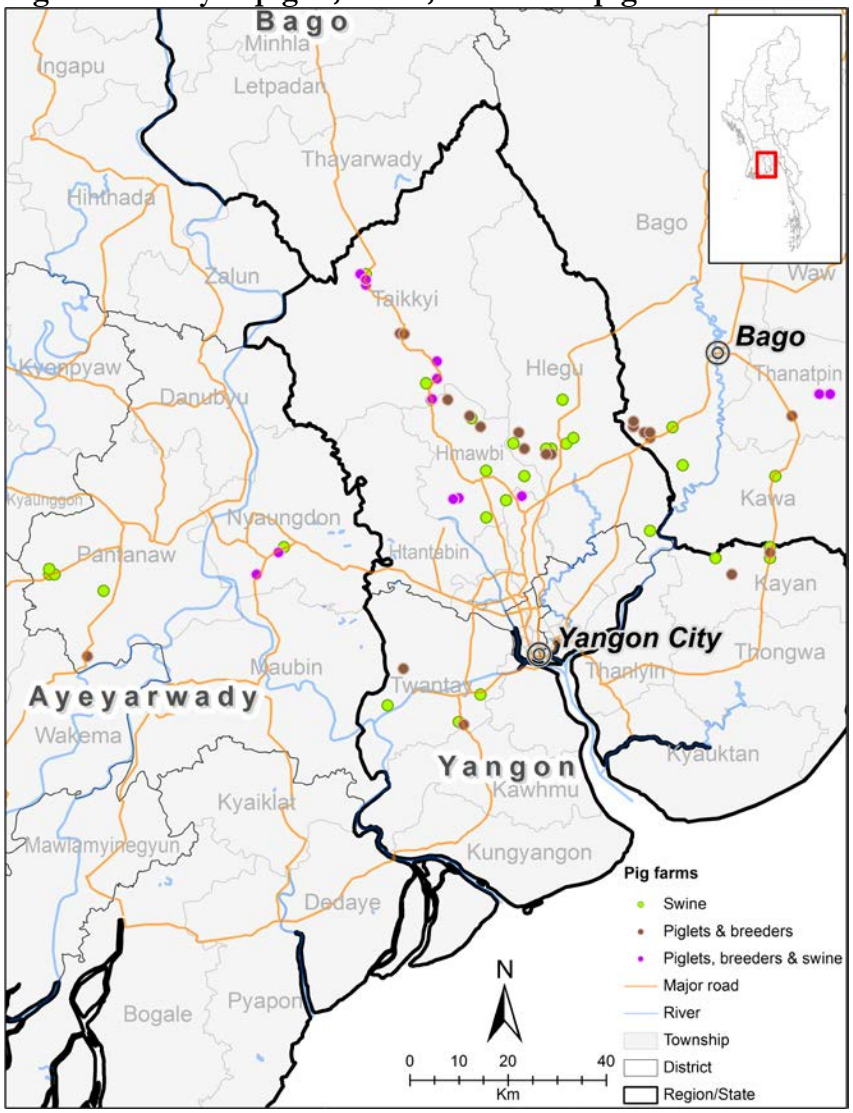
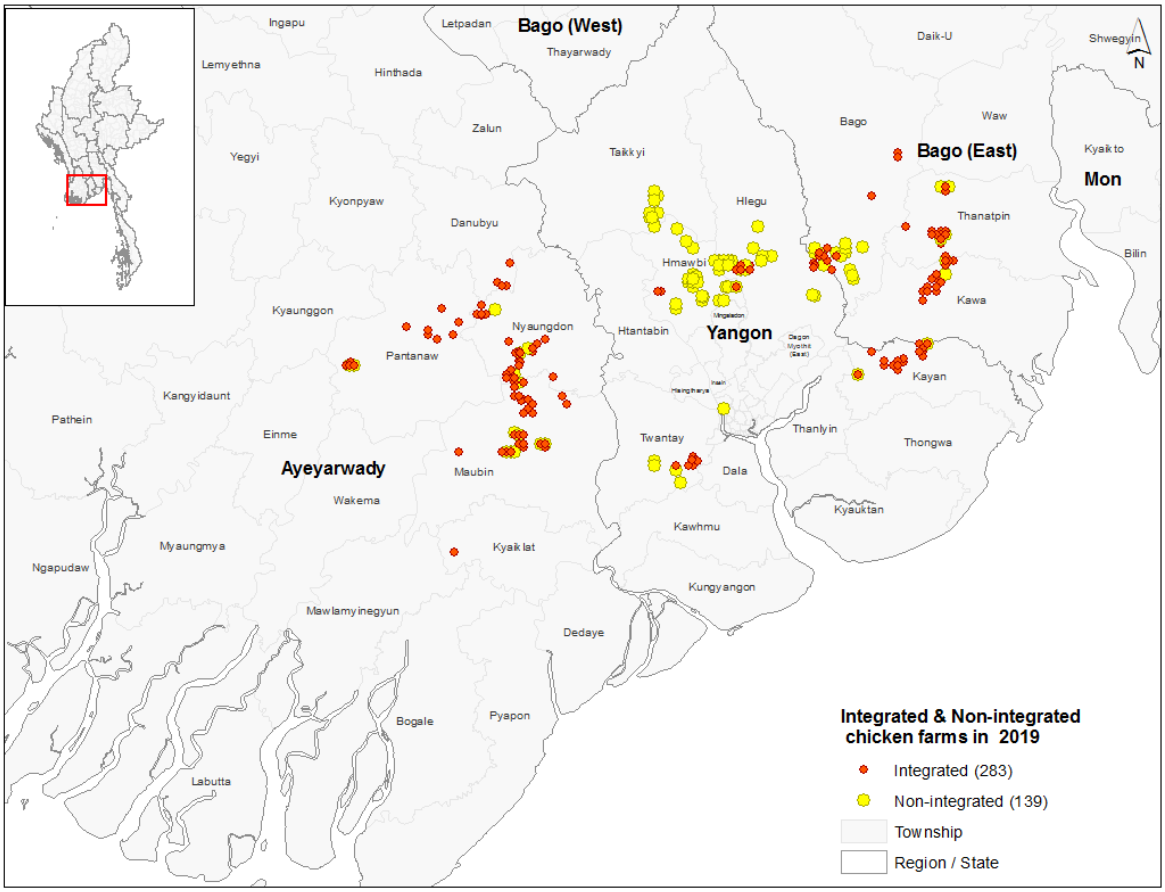


Figure 10 Location of integrated and non-integrated chicken farms



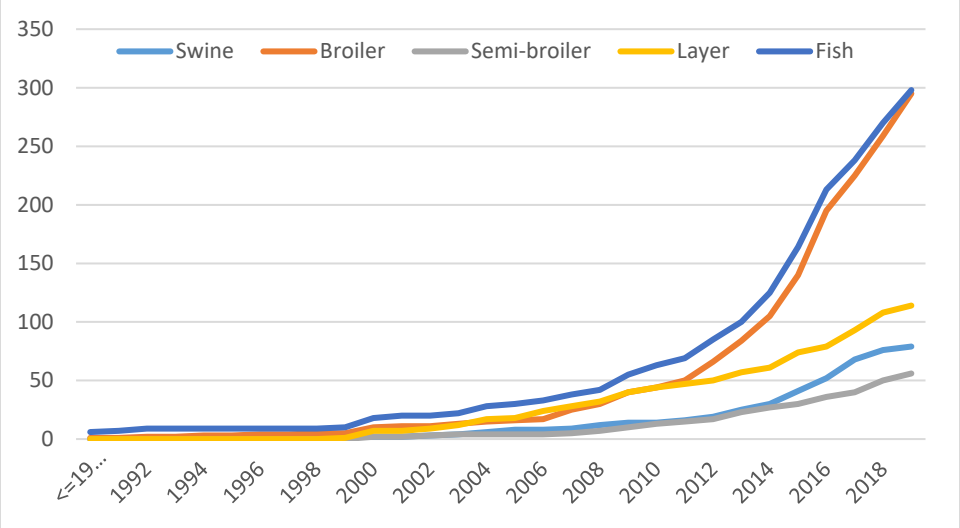
5 Farm characteristics

This section presents details of characteristics common to all farms surveyed. These include the history of farm establishment, demographic characteristics of farm owners, farm size, ownership and tenure, animal house construction, farm assets, and labor utilization,

5.1 Farm establishment

More than half the farms in our sample were established within the past five years. This result must be interpreted with caution, as our scoping research and sample selection activities suggested that the failure rate for poultry farms is high[2]. We were unable to collect information on farms that had ceased operation prior to the time of the survey. Nevertheless, these results suggest rapid growth in numbers of farms operating over the past half-decade. The cumulative number of surveyed farms established by year since 1990 is illustrated in Figure 11. Fish farms illustrated in Figure 11 are integrated with poultry (96%) or pigs (4%).

Figure 11: Cumulative number farms established by year



The number of integrated chicken-fish farms around Yangon doubled between 2014 and 2018. We conducted a systematic search of satellite images to identify the location of integrated chicken-fish farms within a 100 km radius of Yangon. The distinctive appearance of these farms, with chicken houses constructed above fishponds, makes them easy to identify with satellite images. Satellite images from Google Earth were overlaid with administrative boundaries and researchers conducted a systematic visual search. At the same time, a machine learning algorithm was trained for the same task. Both approaches yielded similar results. The number of chicken houses in every village tract within the 100 km radius of Yangon was recorded in a database, and the density of chicken houses was mapped using ArcGIS (Figure 12 and 13). This analysis reveals that the number of chicken houses on integrated chicken-fish farms around Yangon doubled from 2014 to 2018, growing 104% from 1898 to 3868, while the number of village tracts with integrated chicken-fish farms increased from 121 to 230 (see also Figure 1A)

[2] During preparations for the survey we attempted to contact farms listed in an industry publication, the Myanmar Livestock Directory. When contacted, many of these farms reported no longer being operational. Reasons for the high apparent rate of business failure are not know, but it can be surmised that fluctuating market prices and disease are among the most important factors.

Figure 12 Density of integrated chicken-fish farms by village tract, within a 100km radius of Yangon, 2014

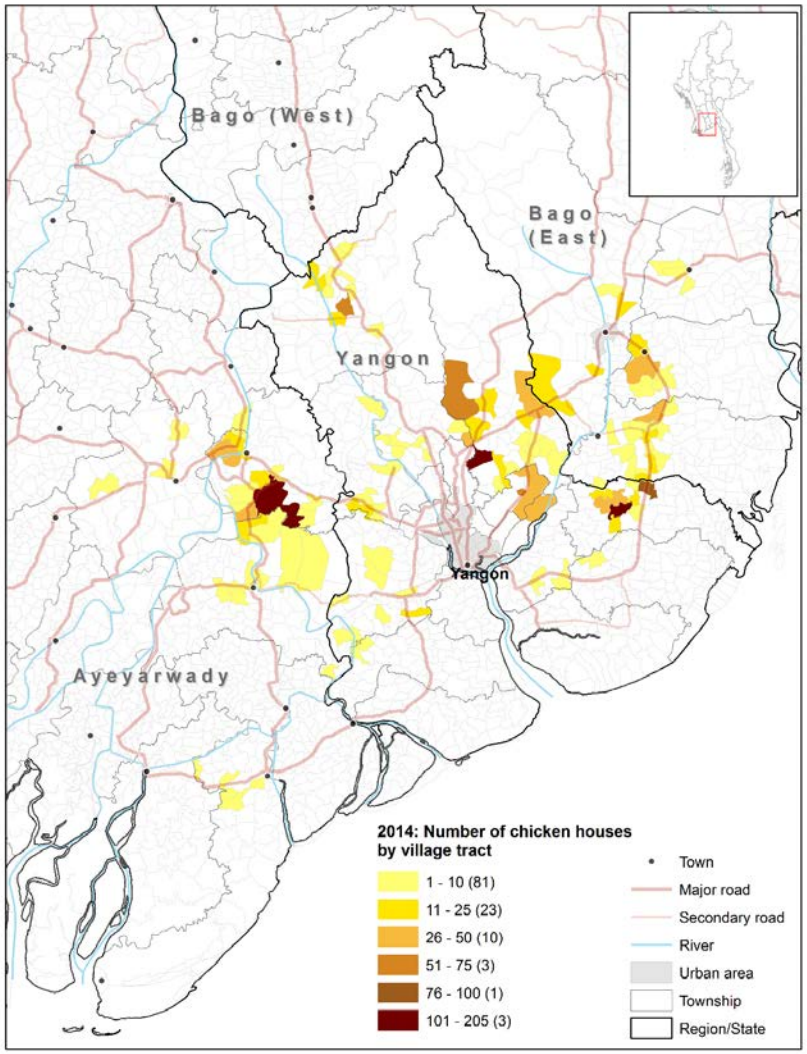
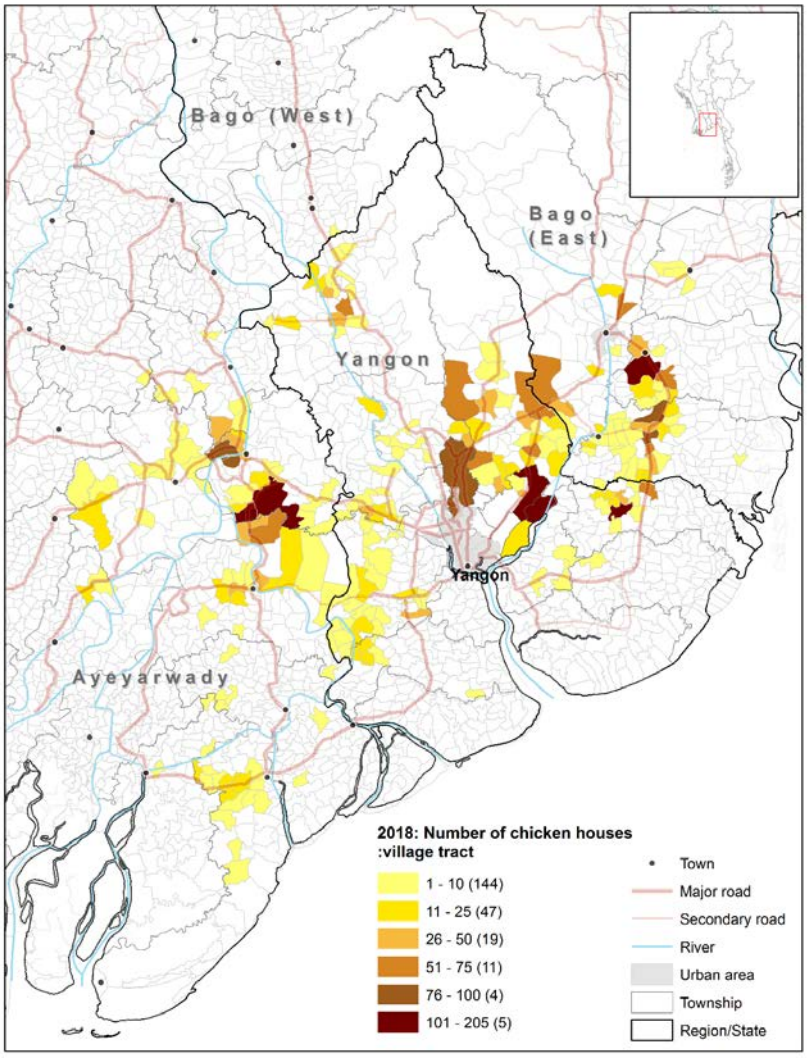


Figure 13 Density of integrated chicken-fish farms by village tract, within a 100km radius of Yangon, 2018



5.2 Farmer characteristics

Most farms in our sample are operated by households. Ninety four percent of surveyed farms are operated by households or individuals, and 4% are operated in partnership between individuals or households, with only the remaining 2% operated by companies. These figures are similar for farms raising pigs and chickens, though layer farms are slightly more likely than other types of farm to be operated by a company (8%). It is important to note that Thai company Charoen Pokphand (CP), which introduced intensive poultry farming to Myanmar in the late 1990s, operates very large vertically integrated broiler farming operations that were not covered by this survey. Our scoping interviews suggested that CPs own farms account for as much as 50-60% of Myanmar's total broiler production, and 20-25% of egg production.

Only half of farms surveyed are registered with government. Two-thirds of layer farms and just over half (51%) of broiler/semi-broiler farms are registered with the Livestock Breeding and Veterinary Department (LBVD). Only 29% of farms producing pigs reported being registered with LBVD. These figures underline the informal nature of the livestock sector and have possible implications for farmers' ability to access to information, training and veterinary services (e.g. in the event of a disease outbreak).

Most pig and poultry farm owners are relatively well-educated, middle-aged, men. Three quarters (73%) of farms were reported to be owned by men, with an average age of 44. These figures vary little by type of animal farmed. Thirty-nine percent of farm owners are educated to upper-secondary level or above (22% upper secondary, 17% university). Layer farm operators are the most highly educated on average (65% educated at upper secondary level or above), followed by broiler farms (36%) and pig farms (30%).

A variety of ethnic groups are involved in livestock farming. Two-thirds (67%) of farm owners are of Bamar ethnicity, followed by Chinese (including mixed-Chinese) ethnicity (13%), and Shan, South Asian, and Kayin ethnicity (7% each). Farm owners of Chinese and Shan origin operate a high percentage of layer farms (35% and 23%, respectively) (Table 2). Ninety-eight percent of farm owners were reported to speak Myanmar as their first language.

Table 2. Ethnicity of farm owners, by type of animal farmed

Ethnicity	Pigs	Broiler/ Semi-broiler	Layer	All
Burmese	80	71	38	67
Chinese	7	8	35	13
Shan	3	3	23	7
South Asian	3	9	2	7
Kayin	8	8	0	7
Other (specify)	0	0	2	0

One third of farm owners were born outside of the township where their farm is located. Fifty-eight percent of farmers originate from the same village where the farm was located, and eight percent originated from the same township. Fourteen percent of farm owners originate from Shan, and 9% originate from Yangon. Pig farmers are most likely to originate from the village where they farm (73%), followed by broiler farmers (65%). Layer farmers are least likely to originate from the village where they farm (14%), and most likely to originate from Shan (49%) or Yangon (17%) (Table 3). Among people who originated from somewhere other than

the location of their farm, a large majority (68%) reported having moved specifically for the purpose of establishing the farm, rising to 87% for people of Shan ethnicity.

Table 3 Place of origin of farm owners, by type of animal farmed

Place of origin	Pigs	Broiler/ Semi-broiler	Layer	All
This village	73	65	14	58
This Township	5	10	4	8
Ayeyarwady	2	5	0	4
Bago	12	2	3	2
Yangon	4	6	17	9
Shan	0	9	49	14
Other State/Region	3	4	12	5
Other country	1	0	2	0

Social networks facilitate the flow of information required to establish farms. Family, relatives, and friends living within in the area local to the farm are the most common source of information used to established pig farms and broiler farms (Table 4). Information from more spatially distant nodes in social networks (relatives and friends from the farm operator's home town) are the next most important sources of information used to establish pig and broiler farms and – in combination – are the most important source of information used to establish layer farms. This indicates that connections to friends and relatives from their place of origin facilitate the transfer of technical knowledge and other information needed to establish farm operations to migrant farmers. In contrast, the role of formal or organized sources of knowledge transmission (e.g. government, media, feed companies) is very limited, with the partial exception of layer farms, management of which is more complex and technically demanding than broiler or pig production.

Table 4 Share of farm owners reporting source of information used to establish farm

Source of information	Pigs	Broiler/ semi-broiler	Layers	All
Family/relatives/friends in local area	58	61	31	56
Relatives in hometown	16	24	26	23
Friends in hometown	19	21	36	23
LBVD	5	3	9	4
Internet	3	0	6	2
Former classmates	2	0	3	1
Books	2	0	2	1
Feed company/supplier	0	1	1	1
Other	5	2	4	3

Pig/chicken farming is a fulltime occupation for most farm owners. The average number of months worked per year by farm owners is 11 (median 12), and only 34% of owners report engaging in any other kind of work. Pig farmers are more likely to engage in other work (50%) than broiler or layer farmers (both around 30%). For those who do other work, agriculture is the main occupation (51%), followed by non-farm business (25%) and trading (16%). Layer farmers are least likely to engage in other forms of agriculture, and most likely to engage in trading or operate other non-farm businesses.

5.3 Land use, land tenure

Most land used for livestock farming is owner-operated and was acquired by purchase. Eighty-two percent of all parcels used for poultry or pig farming are owner operated. Eleven percent are leased in (9% from private owners, 2% from state institutions such as the army) (Table 5). This land rental rate is higher than is typical for crop agriculture in the Delta. About two-thirds of owner-operated parcels used for poultry/pig farming were purchased, and around one third are inherited. Rates of purchase are especially high for layer farms. This suggests that many poultry/pig farms are established on land acquired specifically for this purpose, rather than by opportunistically using land handed down from family members.

Table 5 Tenure status, acquisition and value of sample parcel

Item	Pigs	Broiler/ semi-broiler	Layer	All
Mean year of purchase	2006	2008	2009	2008
Tenure status	**%**	**%**	**%**	**%**
Owned and operated	91	79	84	82
Leased in from Private Owner	3	12	8	9
Leased in from State Institution	0	2	4	2
Borrowed in	5	4	5	4
Leased/borrowed out	2	2	0	2
Mode of acquisition	**%**	**%**	**%**	**%**
Purchased	65	58	87	65
Inherited	32	39	9	32
Allocated by State	2	1	1	1
Occupied by Self	1	2	2	2
Use rights document[±]	**%**	**%**	**%**	**%**
Any document	88	92	92	91
Form 7	25	65	24	50
Form 105	2	18	2	12
La Na 39/La Ya 30	1	20	26	17
Contract	48	16	57	30
Tax receipt	17	11	10	13
AIN grant	13	3	3	5
Median purchase price (MMK million/acre)*				
	0.39	0.71	0.59	0.53
Median value in 2019 (MMK million/acre)[≠]				
	20	10	12	10

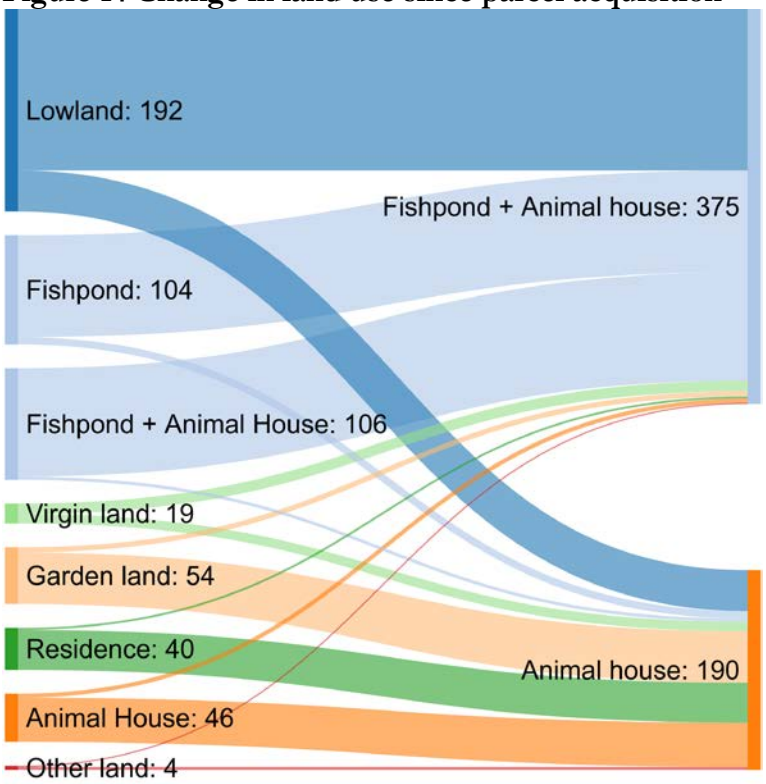
*Real price, at 2018 prices; [≠]estimated by respondent: $1 = MMK 1500 in 2019; [±]Totals equal >100% as one parcel may have multiple documents associated with it

Most parcels used for pig/poultry farming are not formally permitted to be used for livestock production. A large majority of parcels (91%) have some form of land use document associated with them. 69% of these are formal land use rights certificates issued by government (e.g. Form 7, Form 105), and 31% are other forms of documentation (e.g. purchase or rental contracts, tax receipts). Among parcels with formal land use rights, only 17% have a document that changes the designation of agricultural land to allow it to be utilized for non-agricultural uses, including livestock production (La Ya 30 or its predecessor La Na 39). Very few (1%) parcels used for pig farming possess La Ya 30/La Na 39, though this share rises to 20% for broilers, and 26% for layers. More than half of parcels have land use rights certificate that only

permit agricultural use (Form 7 or its predecessor Form 105). This share is particularly high for broiler farms (Table 5). These figures indicate that although a majority of parcels used for pig/poultry production have some form of formal tenure status, most are operated in contravention of Myanmar's agricultural land use classification system, potentially leaving them vulnerable to fines, or even land confiscation if rules are enforced. During scoping interviews, respondents reported being unable to obtain the correct land use classification documents for land utilized in livestock production, preventing them from using is as collateral for formal loans. Others reported having to pay substantial bribes in order to obtain land use certificates, and expressed concern at that future changes in land policy could threaten their tenure security.

Land values have increased dramatically. The mean year of acquisition of purchased parcels of land was 2008. The average real value (adjusted to 2018 prices) of parcels of land purchased jumped almost 20 times between year of acquisition and time of survey, up from MMK 2,700,000/acre to MMK 537,000,000/acre (worth approximately $1800 and $36,000, respectively, at 2019 exchange rates). Median values are considerably lower but follow a similar trend in terms of the magnitude of increase (Table 5). This reflects the rapid land price inflation that has occurred in Myanmar over the past decade, particularly in locations in proximity to the major roads entering Yangon. This pattern also points to land speculation as part of the motivation for some farm owners acquiring land for livestock cultivation. Applications to convert land use from agricultural to non-agricultural designations (by applying for La Ya 30) may help prepare the way for eventual construction of commercial or residential premises, contributing to even higher land values.

Figure 14 Change in land use since parcel acquisition



Most land converted to pig/poultry production was originally 'le' agricultural land. Two thirds of all parcels are used for integrated fish-livestock production, with standalone animal houses accounting for only one third of parcels used to grow pigs/poultry. Nineteen percent of

all parcels were already used for integrated livestock-fish production at time of acquisition, and 18% were used for fish cultivation at time of acquisition, with animal houses added after acquisition. One third of all current pig/poultry parcels were *le* land (low lying irrigable land officially designated for use in paddy cultivation) at the time of acquisition, indicating significant levels of conversion of agricultural land to integrated livestock-fish farming, and to a lesser extent, standalone pig or poultry farming. At time of acquisition, 10% of parcels were 'garden land' - another category of agricultural land – and 7% were residential land. Garden and residential lands were mainly converted to standalone animal houses, whereas le land was mainly converted to integrated livestock-fish production, reflecting the respective hydrologies of these categories of land (Figure 14).

5.4 Farm size

Most farms are medium sized. Most farms are comprised of a single parcel of land (Table 6). The average area of land operated per farm is 16.3 acres (median 6.3). This is larger than the average area of agricultural land farmed by households in the Delta (10.2 acres) (Cho et al. 2017). Pig farms are smallest on average (mean 8.7 acres, median 1.1 acres), followed by broiler farms (mean 14.4 acres, median 6.1 acres), and layer farms (mean 31 acres, median 10 acres). Some very large farms exist (up to a maximum 520 acres for broilers, and 700 acres for layers).

Most farms operate in a single location. Fourteen percent of farms report renting or owning land for livestock farming in another location besides the surveyed farm, operating an average of 15 acres of land in the second location.

Two-thirds of animal houses are integrated with fishponds (i.e. the animal houses are built above or beside ponds to enable utilization of waste nutrients as inputs for fish culture). Levels of integration are lowest for animal houses used to rear pigs (24% of parcels), and highest for broilers (78%), with layer houses intermediate (43%). Pig farms have slightly fewer animal houses per farm on average than broiler or layer farms (Table 6).

Table 6 Farm characteristics

Farm type	Number of parcels per farm	Number of animal houses per farm	Farm size (acres)			Animal houses integrated with fish ponds (%)
			Mean	Median	Max	
Pig	1.3	2.4	8.7	1.1	80	24
Broiler/Semi-broiler	1.2	2.6	14.4	6.1	520	78
Layer	1.2	3.6	31.0	10.0	700	43
All	1.2	2.8	16.4	6.3	700	62

There is more variation in the number of animals on pig farms than poultry farms. The median herd size on surveyed pig farms is moderate (30 swine, 22 piglets and breeders), but a small number of very large farms have herds of 4000 animals, bringing the average herd size for swine to 229 and for piglets and breeders to 817 (Table 7)[3]. Average flock size on broiler farms is about half that on semi-broiler or layer farms. The largest broiler and layer farms both house close to 80,000 birds, but average broiler farm size is just over 6000 birds (3000 median), as compared close to an average of 14,000 layers (just over 6000 median). Layer farms tend to have

[3] The minimum cutoff for inclusion of pig farms in the sample was a herd of 10 or more animals.

larger flocks than broiler farms in part because broiler farms raise pullets (young birds that have not yet begin to lay eggs) for part of the production cycle. Semi-broiler farms tend to have larger flocks than broiler farms because the individual birds are smaller than broilers.

Table 7 Number of animals per farm

Animal	Mean	Median	Max
Piglets	817	22	4323
Swine	229	30	4130
Broilers	6089	3000	78,000
Semi-broilers	11,910	6000	116,013
Layers	13,791	6235	79,700

Average stocking densities for broiler chickens are low. Table 8 displays the average size and number of animals per house, and the mean density of animals per square meter. In Thailand, the stocking density for broilers recommended by the Department of Livestock Development is 8 birds/m^2, but farms often stock at higher densities (Huo and Na-Lampang, 2016). The average density reported in the present survey is 5 birds/m^2. This suggests that Myanmar farms likely perform favorably in terms of animal welfare. Although broiler productivity in Myanmar appears lower than it could be, low stocking densities in chicken houses that that are semi-open to the surrounding environment and thus experience high levels of ambient heat and humidity at may reduce mortality levels, and thus may not necessarily result in lower production.

Table 8 Mean number of animals per unit, unit size, and stocking density

Animal	Mean size of house (m^2)	Animals per house	Mean density (heads/m^2)
Piglets	488	545	1.1
Swine	285	144	0.5
Breeder pigs	289	62	0.2
Broiler chicken	547	2809	5.1
Semi-broiler	480	4922	10.3
Layer chicken	575	5380	9.4

5.5 Farm assets

Construction costs for farm buildings are substantial. Farms producing pigs have the lowest median construction costs, (MMK 2,500,000, or approximately $1670), but the highest construction costs per m^2, ranging from MMK 46,000-63,000 ($30-42), as compared to MMK 17,000- 36,000/m^2 ($11-24/$m^2$) for broilers and layers. Layer farms have the highest construction costs on a per farm basis (median MMK 24,000,000, or $16,000). Farms raising broilers/semi-broilers have intermediate construction costs (median MMK 7,500,000 or $5000 per farm) (Table 2A).

Most farm buildings are built with basic materials and that offer low biosecurity. Variations in construction costs by farm type reflect the materials chosen. Most buildings housing animals are roofed in zinc or thatch, with thatch being most common in broiler farms. Broiler farm floors are most commonly constructed with bamboo and netting. Pig sties commonly have concrete floors, whereas layer houses use a mix of bamboo, concrete and wood. Broiler farm walls are constructed primarily of tarpaulin and bamboo, whereas brick is the most

common material used for wall on buildings housing pigs and layer houses utilize a variety of materials (Table 3A). The simple construction of most farm buildings is indicative of generally low levels of biosecurity and environmental control on farms. Buildings with semi-open construction make it difficult to exclude possible vectors of disease such as insects, birds and rodents, or to closely control environmental parameters such as temperature or light.

Farms own a wide variety of assets for transport, energy supply, environmental control and hygiene. The share of farms owning each type of asset changed relatively little between 2014 and 2019, with slight increases in rates of ownership for some types of asset. Ownership of boats is most common for broiler farms, in part due to the location of integrated chicken-fish farms in areas accessible primarily by waterways rather than by road. Ownership of 4- and 6-wheel truck is most common among layer farms, but only about one fifth of layer farms own either type of truck, suggesting a high degree of reliance on traders or hired transport services to collect and deliver products to market. Well over 70% of broiler and layer farms own a generator, as compared to 31% of pig farms, reflecting the importance of electricity for providing lighting and heat to raise chickens. Layer farms are most likely to own a transformer (12%) – an expensive item needed to gain access to the national grid in areas without public electricity connections. Heaters for providing warmth to chicks are common on broiler and layer farms, but fans, sprinklers, and air conditioners for reducing heat stress are less widely used. Ownership of cleaning equipment for washing and disinfecting farm buildings is also common (Table 4A).

The median value of semi-fixed assets owned per farm (i.e. excluding land and buildings) is substantial, at MMK 24.7 million ($1650). Pig farms have the lowest median asset value (MMK 0.95 million or $630). This is less than half the median value of assets owned by broiler farms (MMK 2.5 million or $1740), and about one quarter of the median asset value of layer farms (MMK 3.8 million or $2500). This pattern underlines differences in capital intensity and specialization among the three types of farming,

5.6 Capital and credit

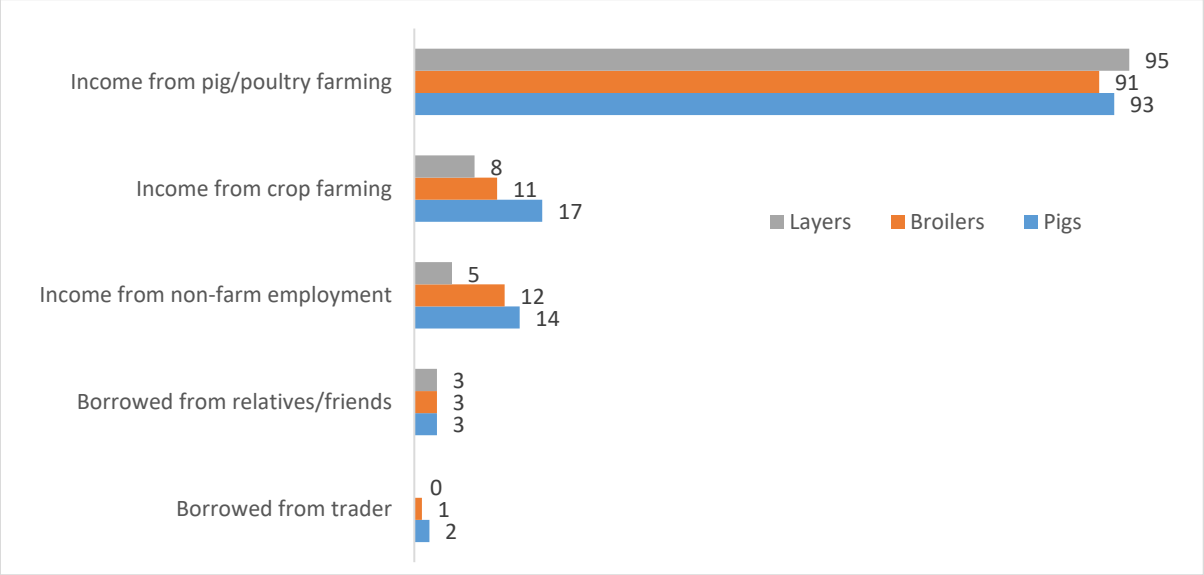
Savings are the main source of farm startup capital. Income from crop farming is the single most common source of investment capital (used by 29% of farms) followed income from non-farm businesses (23%) and sale of assets (17%). Loans from relatives and friends are also frequently used. However, loans from other sources both informal (e.g. moneylenders) and formal (banks, contract farming, etc.) are rarely used to finance the establishment of pig and poultry farms. This likely reflects both limited access to such loans, and their terms (e.g. regular repayment schedules, high rates of interest). Remittances or earnings from migration are rarely used as startup capital, perhaps because their value is not adequate to finance large investments. A similar pattern is apparent of acquisition of farm assets. Here, the main source of capital used to buy productive assets for the farm is savings from livestock farming, but crop farming, non-farm business and savings are used frequently, and credit and remittances are used rarely (Table 5A)

Earnings from livestock production are the most common source of capital used to buy farm assets. Overall, 80% of farms reported reinvesting income from livestock production in purchasing farm assets. This share varies little by type of farm. The second most important source of income used to fund asset purchases is crop farming. Crop farming is a more important source of funds for pig and broiler farmers than for layer farmers. Income from non-farm businesses and work, and savings from other sources, are also important sources of capital

for asset acquisition, especially for layer farmers. Credit (both formal and informal) and remittances are rarely used for fund investments in farm assets (Table 5A).

Borrowing to procure inputs for pig or poultry farming is rare. Working capital overwhelmingly comes in the form of income from livestock farming. Income from crop farming and non-farm employment are the next most commonly used source of working capital, especially for pig farms. Only 3% of farms report borrowing from relatives or friends, and from 0-2% report borrowing from traders (Figure 15). However, it is quite common for feed sellers to supply feed on credit, particularly broiler feed. (see Section 6.5)

Figure 15 Source of funds used for purchasing inputs for pig and poultry farming, by share of farms reporting (%)



Farm owners rely on own resources and social networks to make up shortfalls in working capital. Most farms (42%) draw on their own savings to do so, and a significant share (16%) draw on funds from other businesses they operate. Borrowing from family (38%) or friends or other farmers (19%) is also a common response. Borrowing from other sources (traders, formal or informal lenders, feed companies) is relatively rare, again underlining the importance of informal networks (Table 6A).

5.7 Social capital, collaboration, conflict, and challenges

We asked respondents about the business environment they operate in, including indicators of cooperation, conflict, provision of supporting infrastructure and services, and the nature of challenges faced. These results are summarized below.

The level of participation in community activities by farm owners is high. This is particularly the case for pig and broiler farmers, approximately three-quarters and two-thirds of whom originate from the same villages where their farms are located, but even among layer farmers who are less likely to originate locally, participation in the social life of the community through activities such as attending weddings or ordination ceremonies and making donations is commonplace (Table 7A).

Level of reported conflict is low. The most common problem reported as theft of stock (around 15% of poultry farms, and 4% of pig farms), followed by theft of equipment (around 5% of all farms), and trespassing (about 5% of poultry farms). Violent acts such as vandalism, poisoning stock, or threats to self or staff are rare, suggesting good relations between farms and community members (Table 7A).

Infrastructure provision has improved markedly in past 5 years. Approximately 30-40% of farms of all types reported having benefitted from improvements to public infrastructure including electricity and water connections and road construction, within the past 5 years. This appears suggestive of general improvements in infrastructure taking place across the board in the areas surveyed (Table 7A). However, during scoping interviews it was common for respondents to report poor road condition and lack of access to electricity among the main challenges faced in operating their businesses, indicating room for further improvements.

It is very common for farmers to share information, but less common to share equipment or costs. We asked respondents about the types of cooperation they engaged in with fellow farmers. Thirteen percent of broiler farmer share transport or tools with fellow farmers, but this type of behavior is uncommon for pig and layer farms. Few farms share hired labor, but half of poultry farms and 38% of pig farms share family labor on a regular basis – about 8 times in the past 12 months, on average. Sharing information on farm management and animal health with fellow farmers is very common, reported by three-quarters of pig and broiler farms, and two-thirds of layer farmers, who share each type of information about once a month on average. Sharing information on suppliers and buyers is also common, especially among broiler farms, more than 60% of which do so. This findings underline how important informal social relationships are for facilitating the flow of technical and business information, and point to some of the advantages of the dense geographical clustering of farms, where co-location facilities these types of interaction (Table 8A).

Table 9 Three biggest challenges faced in operating farm

Challenge	Pigs	Broiler/ Semi-broiler	Layers
Fluctuating market prices	73	87	74
High input costs	64	71	60
Accessing credit	23	28	26
Difficulty finding/keeping workers	7	14	23
Accessing electricity	10	14	16
Disease	21	10	9
Access to market information	6	12	5
Access to veterinary services	11	3	9
Illegal trade from other countries	7	5	1
High labor costs	0	8	3
Access to information on farm management or disease	6	1	1
Poor road condition or transportation	3	2	3
Lack of buyers	3	3	0
Predation of stock	1	0	3
Land related problems	0	1	1
Other challenge	3	5	8
Not applicable	6	2	2

Producers face a variety of challenges. Respondents were asked to name the three largest challenges faced in operating their business. The most commonly cited problem was fluctuating market prices, mentioned by 87% of broiler producers, and just under three quarters of layer and pig farmers. Similar information was reported during our scoping interviews, with broiler prices said to be particularly unstable. High input costs was the second most common challenge, cited by roughly 60-70% of farms. Around one-quarter of respondents noted that accessing credit was a challenge, across all types of farm, corresponding with the low levels of credit utilization reported above and suggesting potential opportunities for development of suitable credit instruments. Close to one-quarter of layer farms reported difficulties in finding or keeping workers, reflecting perhaps both labor scarcity and the rather undesirable nature of the work involved. Ten to fifteen percent of farms found accessing electricity a challenge. The share of pig farms reporting disease as a challenge was about double that of poultry farms (21% vs around 10%), and 11% of pig farms cited accessing veterinary services to be a problem. Other challenges were mentioned relatively infrequently (Table 9).

5.8 Training and access to information

Few farmers have received any formal training on pig or poultry farming. Only 11% of all farms surveyed had received any formal training. This is striking, given that poultry and pig rearing on the scale practiced by farms in the sample can be a complex and technical operation. Broiler farmers had the lowest levels of formal training (8%) (Table 10).

Table 10 Share of farms having received formal training

Type of training received	Pig	Broiler	Layer	All
Any training	14	8	15	11
Poultry production	1	7	15	8
Pig production	14	0	0	3
Fish production	0	3	1	2

Private companies are the main providers of extension services. Sixty-one percent of training recipients had been trained by a feed company. One-quarter of training recipients had been trained by a LBVD. Few farms (2%) reported having received training from NGOs, suggesting scope for expansion of both government and NGO training activities, and support to private sector extension providers to strengthen their activities (Table 9A)

Most farms actively seek out information on to help them operate their businesses effectively. Almost all farms reported seeking multiple types of information. The most common type of information sought was market prices (89% of farms), reflecting the importance of this variable for farm profitability. Information on feeding practices (75%), animal health problems (66%), and farm management were among the most common types of information sought, indicating the importance placed by farmers on maintaining good husbandry and animal health. Around half of farms sought reputational information on traders and input providers, indicating the importance placed on interactions with actors upstream and downstream in the value chain (Table 10A).

Most information is obtained from fellow farmers and other informal sources. Fellow farmers are by far the most commonly cited source of information (mentioned by 63% of farms), with relatives (30%), and friends (20%) also common providers of information, underling again the importance of network effects and social capital in mobilizing the

information needed to operate farms businesses. Social media also plays an important role in the distribution of farming information (cited by 28% of respondents), and is more widely used to source information than internet searches (11%), again underlining the importance of personalized social networks as conduits for information. Staff of feed company staff are the most frequently mentioned formal or semi-formal information providers (32%), and private vets (20%), medicine shops (17%), and feed traders (15%) appear to play a similar role as private information providers. Formal government sources (officers of LBVD or Department of Fisheries) were mentioned by 12% of respondents, and NGOs not at all. These results seem to indicate that private actors already embedded in the upstream segments of the value chain offer an entry point for providing trainings and disseminating information, as do targeted social media campaigns, perhaps coordinated in cooperation with carefully selected influential farmers with large networks (Table 10A).

5.9 Record keeping, knowledge and experience of disease

Less than half of farms maintain records. Record keeping is an important activity to enable farmers to measure and improve performance. Slightly less than half of farms (44%) keep any records. Layer farms, which involve the highest degree of technical complexity in their operation among the three farm types have the highest levels of record keeping (59%), and pig farms have the lowest (34%). Among farms which keep records, most track stocking rate (80%), feed use (78%), mortalities, (83%), laying rate (layer farms only – 84%), and profit and loss (82%). About one-third of farms track the growth rate of their animals, and only 13% calculate feed conversion ratio (FCR) - an important indicator of performance[4] (Table 11A). Among those farms that maintain records, around 80% do so using a record book of their own making, with most of the remainder using a record book provided by a feed company. Very few farms maintain electronic records. This suggests opportunities to increase record keeping to improve farm management, possibly with the use of digital services such as dedicated apps.

Levels of knowledge about African swine fever are low. At the time the survey was being conducted, an outbreak of African swine fever (ASF) - a severe viral disease - was occurring in China and other parts of Southeast Asia, with cases reported in Myanmar in August 2019. Pig farmers were asked questions about their knowledge of sources of infection, symptoms, and means of prevention of the disease. Levels of knowledge were low. Forty-six percent of farmers had no knowledge of the cause of infection, 40% were not familiar with any symptoms, and 37% could not name a means of prevention, while 40% believed erroneously that the disease could be prevented by vaccination (there is no commercially available vaccine as of the time of writing). Only a small number of farmers were able to correctly identify certain causes of infection (e.g. insect bites, consuming contaminated pork products), symptoms (e.g. respiratory problems), or means of prevention (e.g. biosecurity measures). Interestingly, social media was the most Traditional broadcast media (38%) and government sources (29%) were also among the most cited (Figure 16). These findings suggest a need for greater preparedness to establish mixed-media public information campaigns in response to veterinary emergencies, to ensure that accurate information can be disseminated as widely as possible in a timely manner.

[4] FCR is an indicator of the efficiency with which feed is converted into harvested animal output

Reported experience of mass mortalities was low. Our sample did not include farms no longer in operation, so is likely biased toward farms with no experienced mass mortalities that could put a farm out of business. Never-the-less, the share of farms never having experienced any disease that caused mass mortality is high (89% overall, and over 90% for broiler and layer farms). Pig farms were slightly less likely to report never having experienced mass mortality due to disease (77%). Porcine reproductive and respiratory syndrome virus was the cause of mass mortality by pig farmers reported most often, encountered by 16% of respondents. Only 6% of layer farmers and 1% of broiler farmers reported having experienced mass mortalities due to H5N1 (Avian Influenza) (Table 11).

Figure 16 Sources of information and knowledge about African Swine Fever among pig farmers

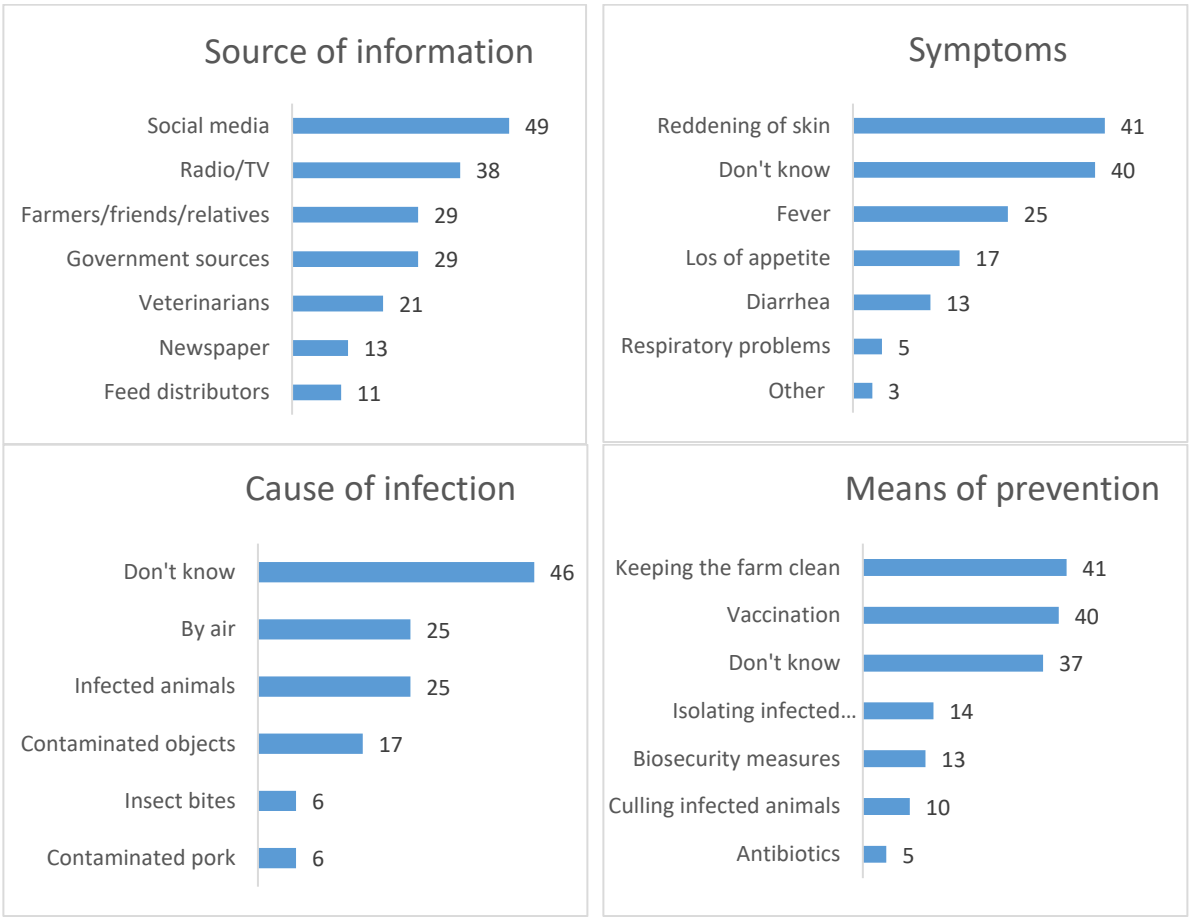


Table 11 Share of farms experiencing diseases or other causes of mass mortality

	Pig	Broiler/ Semi-broiler	Layer	All
No disease experienced	77	91	92	89
Mass mortality due to high temperature	2	6	0	4
Porcine reproductive & respiratory syndrome virus	16	n/a	n/a	3
Other mass mortality	2	2	0	2
H5N1	n/a	1	6	2
Hog cholera	3	n/a	n/a	1
Mass mortality of fish due to lack of oxygen	0	1	1	1

5.10 Labor

Most farm employ a mix of family and longterm hired labor. Family members of the farm owner work on one-third of farms. This figure is close to half, for pig farms, but only 20% on layer farms. This pattern reflects the tendency for some pig farms to be operated as household enterprises, and layer farms as specialized businesses, with broiler farms falling somewhere between the two. One average 1.5 family members work in addition to the farm owner on farms employing family members. Women family members are slightly more likely than men to provide labor on pig farms (56% women), but less likely on poultry farms (where women account for a little over one-third of family workers). Seventy-one percent of farms employ one or more longterm workers, ranging from 30% of pig farms to 88% of layer farms, underlining the tendency described above. It is most common for farms to employ individual men (45% of farms), or husband and wife couples (38%) as longterm workers. Entire families including children are employed occasionally (Table 12). The vast majority of longterm workers are 'live-in' workers who stay are the farm site. About a third of farms hire causal laborers, mainly for repairs to farm buildings or harvesting birds. Additional details relating to long term and casual hired labor are found in Tables 12A-16A.

Table 12 Employment of family labor, and longterm labor, by type of worker

Item	Pig	Broiler/ Semi-broiler	Layer	All
Family labor (% of farms employing)				
Any family labor	49	32	20	33
Women	56	38	36	42
Men	44	63	64	58
Family members working in addition to owner (n)	1.7	1.4	1.6	1.5
Longterm labor (% of farms employing)				
Any longterm labor	30	77	88	71
Husband and wife	7	40	59	38
Women	7	8	24	11
Men	23	49	53	45
Whole family	3	5	5	5

Note: Table excludes labor allocated to fish cultivation activities on integrated farms

6 Farming pigs and poultry

6.1 Farming pigs

34% of pig farms in the sample raise only swine (for producing meat), 17% raise piglets for sale to other farms (often also keeping breeder pigs), and 49% raise a mix of piglets/breeders and swine, with piglets produced for own swine rearing needs and – in case of surplus – sale to other farms. No households in our sample reported contract farming pigs or piglets.

6.1.1 Raising piglets

More than half of households raising piglets kept breeding boars or sows. Fifty-five and 86% percent of piglet raising households reared boars and sows, respectively. Farms keep an average of 4.2 (median 2) boars and 85 (median 6) sows (Table 13).

Improved breeds of boar and sow are much more common than local breeds. Farms rearing piglets reported raising a total of six improved breeds of boar and sow, along with local and mixed breeds. 79% and 73% of households keep improved breeds of boar and sow, respectively, with local breeds of boar and sow kept by 11% and 27% of households (Table 13). Well over half of breeder pigs were sourced from own or other farms, but around one-third of boars and one-quarter of sows were sourced from specialized breeder stock suppliers. A small number of farms import pigs directly from Thailand. According to our scoping interviews, pigs exported from Thailand, receive a health certificate from the Thai Department of Livestock Development, but do not undergo quarantine upon import to Myanmar.

Table 13 Details of breeder pig numbers, breeds, and sources

Item	Boars	Sows
Farms keeping (%)	55	86
Mean number kept	4.2	85
Median number kept	2	6
Breed		
Local (%)	11	27
CP (%)	16	36
Thai (%)	32	9
Yorkshire (%)	5	-
Pietrain (%)	16	9
Duroc (%)	11	6
German landrace (%)	-	3
Mixed breed (%)	11	9
Source		
Own stock (%)	18	17
Neighboring farms (%)	18	20
Non-local farms (%)	18	20
Swine trader (%)	6	14
Imported by self (%)	6	3
Breeder stock company (%)	35	23
Feed company (%)	-	3

Pigs bred mainly by direct insemination. Only two farms in the sample (6%) purchased artificial insemination services, and 10% artificially inseminated by themselves. Reliance on direct insemination can increase costs to the farmer where a stock of boars is maintained for this purpose and can also increase the risk of spreading of diseases within or between herds. This suggests possibilities for supporting the expanded provision of artificial insemination services.

Most piglets are vaccinated. Table 14 displays details of piglet rearing. There is wide variation among farms in numbers of piglets produced and raised. For example, the mean number of piglets currently raised is 281, while the median is 12. Eighty seven percent of piglets have been vaccinated, mainly by private vets (59% of cases) or the farm owner (26%). Provision of vaccinations by LBVD and feed companies is rare. Most piglets are sold at 6-7 weeks of age, for around MMK 75,000 ($50 at the time of the survey), with farms selling an average of 62 piglets (median 50) in the past 12 months, generating a median annual gross revenue from piglet sales of MMK 3,400,000 ($2270). The average number of pigs sold per farm changed little between 2016 and 2019.

Table 14 Details of piglet rearing

Piglets	Mean	Median
Number born in past 12 months	189	90
Number currently in stock	281	12
Received vaccination (%)	87	-
Vaccination provider		
Independent private vet (%)	59	-
Self (%)	26	-
Vet from LBVD (%)	7	-
Vet from feed company (%)	4	-
Other private vet & Self (%)	4	-
Age at sale (weeks)	7	6
Price at sale (MMK)	77,433	70,000
Weight at sale (kg)	17	10
Number of occasions sold in past 12 months	7	4
Gross income from sales ('00,000 MMK)	48	34
Number sold (2019)	62	50
Number sold (2016)	53	60
Number of buyers (2019)	8	4
Number of buyers (2016)	12	3

6.1.2 Raising swine

Most farms raise improved breeds of swine. Pigs referred to by farmers as 'CP' breed are the most common of these, accounting for 51%, though many of these are likely not supplied by the company itself. 'Local' breeds account for about one-quarter of the total. According to our scoping interviews, improved pig breeds must be raised using formulated feeds for optimum performance, whereas local breeds can be raised wholly or partly in a diet of non-formulated feeds such as kitchen scraps. Local breeds have a longer production cycle and attract a lower price than improved breeds. More than half of farms (54%) raising swine obtain piglets from their own breeder stock, and 20% obtain from nearby farms (Table 17A). Only 17% of farms

obtained piglets from feed companies. Among these 80% purchased piglets from CP, 13% from Chinese company New Hope, and 7% from Korean company Sunjin.

Herd size varies widely across farms. The average number of swine raised at the time of the survey was 149, while the median was 22, underlining the existence of a small number of large farms that bias mean averages upwards. Most pigs (85%) had been vaccinated, with most vaccinations provided by the farmer (39%) or an independent veterinarian. A little under half of farms reported having experienced no swine mortalities within the past 12 months, with a median mortality rate of 7% for farms experiencing mortality. Farms sold an average of 238 swine (median 45) within the past 12 months, at an average size of just under 90 kg/animal. The sales price per animal averages about MMK 250,000 ($160 at the time of the survey), or MMK 2811 ($1.90) per kg. Gross revenues from annual swine sales are substantial, with a median of MMK 11.4 million ($7600) and mean of MMK 70 million ($46,700). The average scale of farm operations has increased since 2016, particularly for farms at the upper end of the size distribution (Table 15).

Table 15 Swine production details

Item	Mean	Median
Number of swine raised, at time of survey	149	22
Number of piglets raised as swine, any source (past 12 months)	268	61
Number of own piglets raised as swine (past 12 months)	70	22
Number of piglets purchased (past 12 months)	198	0
Purchase price per piglet	87,446	82,500
Pigs receiving vaccination in past 12 months (%)	85	-
Vaccination provider		
Self (%)	39	-
Independent private vet (%)	37	-
Vet from feed company (%)	18	-
Vet from LBVD (%)	9	-
Seller (%)	1	-
Farms with zero mortality in past 12 months (%)	45	-
Mortality rate (farms experiencing mortality) (%)	9.4	6.8
Mortality rate (all farms) (%)	5.2	0.6
Number sold in past 12 months	238	45
Number sold in 2016	158	40
Age at time of sale (months)	4.9	4.5
Sales price per animal (MMK)	251,547	254,250
Sales price per kg (MMK)	2811	2838
Weight at sale (kg)	89.5	89.6
Number of occasions sold in past 12 months	2.8	2.0
Gross income from sales (MMK million)	70.0	11.4
Number of buyers in past 12 months	2.5	2
Number of buyers in 2016	2.8	3

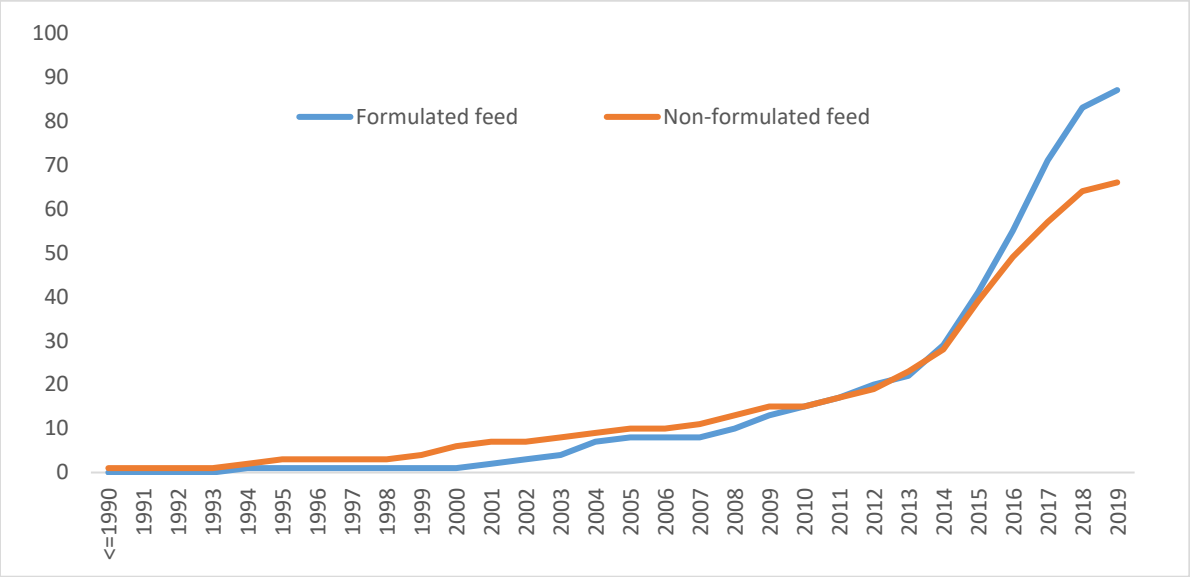
Most pig farms use formulated feeds. Eighty-nine percent of pig farms use formulated feeds (commercially manufactured feeds that are formulated to meet the complete nutritional requirements of the animal farmed) (Table 16). CP dominates the supply of pig feed, with 48%

of respondents using. Sunjin (16%) and New Hope (11%) and are the two next largest suppliers of pig feed (Figure 2A). Until 2010, more farms used non-formulated feeds than formulated feeds. The share of farms using formulated feeds overtook the share using non-formulated feeds around 2015, indicating a recent pattern of intensification and commoditization of production taking place (Figure 17).

Table 16 Broad input use characteristics

Item	% of farms using	Mean cost (MMK million)	Median cost (MMK million)	All farms	Swine only	Piglets & breeders	Mixed farms
				Share of non-labor input costs			
Formulated feeds	89	44.2	4.4	95.1	98.5	86.3	83.6
Non-formulated feeds	67	1.1	0.3	2.3	0.5	2.3	11.6
Therapeutants	70	0.6	0.1	1.2	0.4	7.5	1.7
Fuel/energy	67	0.3	0	0.7	0.4	0.9	2.0
Transport	-	0.1	0	0.2	0.2	0.6	0.4
All inputs	-	46.4	6.7	100	100	100	100

Figure 17 Cumulative number of pig farms using formulated and non-formulated feeds for first time, by year.



Large numbers of farms continue to use non-formulated feeds. Two-thirds of farms survey reported doing so. The most common of these are rice bran and broken rice, indicating that many farms use a combination of feeds – either to reduce expenditure on feed (substituting non-formulated feed for formulated), or accelerate growth rates (substituting formulated for non-formulated). Use of formulated feeds is lowest (and conversely use of non-formulated feeds is highest) on farms that raise a mix of swine and piglets. Feed is by far the greatest non-labor input cost into pig farming, accounting for 97%. Therapeutants (antibiotics, vaccines, probiotics, disinfectants, etc) account for only 1% of non-labor operating costs (though 7.5% on farms specializing in rearing piglets) (Table 16). A more detailed breakdown of input use and source of inputs is presented in Table 18A and 19A.

Most pig farming inputs are purchased without credit. Only fifteen percent of farms report buying formulated feeds exclusively in the form of in-kind credit, and 14% report purchasing these feeds with a mix of in-kind credit and cash. Most formulated feeds (71%) are purchased outright using cash, and shares of other inputs purchased in this way are larger yet, rising to 94% for medicines (Table 17)

Table 17 Form of payment for pig inputs, by type of input

Payment method	Formulated feeds	Non-formulated feeds	Medicines	Energy	Other
Cash	71	85	94	100	100
In-kind	15	7	6	0	0
Cash & kind	14	7	0	0	0

6.2 Poultry farming

Among the farms surveyed, 78% produced chickens for meat (broilers and semi-broilers), and 22% for primarily eggs (layers). Broilers are the most common animal raised, accounting for 69% of all farms surveyed. Semi-broilers are male layer chickens. In many other countries these are destroyed upon hatching, but in Myanmar they are raised for meat, particularly for use in the restaurant trade, where their meat is preferred to that of broiler chickens in preparation of biryani dishes. Two-thirds of chicken farms are integrated with fishponds.

Only 2% of respondents surveyed participate in poultry contract farming arrangements. Of these, all were broiler farmers. Ninety percent had contracts with CP. All farms contracted to CP received day old chicks (DOC), feed, and medicine under contract. Our scoping interviews indicated that CP and at least one Myanmar company organize contract farming of eggs, but most of these farms are located in Shan State.

6.2.1 Broiler and semi-broiler farming

This subsection presents data on the characteristics of broiler and semi-broiler farms, taking a view of the entire farm over the past 12 months, and a single randomly selected 'sample house', over its most recent complete production cycle.

Integrated farms are approximately twice as large as non-integrated farms on average. Integrated broiler farms produced an average of 21,000 birds each within the past 12 months, as compared to 13,000 for non-integrated farms. The gap between the two types of farm is even larger for semi-broiler farms; integrated semi-broiler farms produced an average of nearly 25,000 birds in the past 12 months, compared to just over 10,000 birds on non-integrated farms. The mean number of broilers raised per farm at any given time is 5800 (median 3000). Average flock size per farm for both types of bird has remained stable since 2016 (Table 18).

The average size of semi-broilers at harvest is less than half that of broilers. Broilers weigh about 2.5 kg on average when harvested, whereas semi-broilers, which have not been selectively bred to produce meat, weigh about over 1.1 kg per bird. Broiler farms sell birds more frequently than semi-broiler farms (about five times per year, versus about three times per year), reflecting the shorter production cycle of the former. The average gross revenue from both types of farm is substantial: MMK 91 million ($61,000) for broilers, and MMK 58 million ($38,500) for semi-broilers, underlining such farms are best thought of a small and medium enterprises (SMEs) (Table 18).

Table 18 Broiler and semi-broiler farm production details (whole farm)

Item	All farms (mean)	All farms (median)	Integrated (mean)	Non-integrated (mean)
Broilers				
Number of birds being reared at present	5816	3000	6584	4439
Weight per bird (kg)	2.52	2.61	2.52	2.50
Total sales, past 12 months (MMK million)	91.3	45.0	104.8	55.7
Number of occasions sold in past 12 months	4.8	5.0	-	-
Number of birds sold in past 12 months	18,953	9250	21,122	12,942
Number sold in 2016	23,512	8000	29,180	10,531
Number of buyers in past 12 months	3	2	-	-
Number of buyers in 2016	3	2	-	-
Semi-broilers				
Number of birds being reared at present	10,864	5000	12,884	4338
Weight per bird (kg)	1.09	1.06	1.09	1.09
Total sales, past 12 months (MMK million)	57.9	31.1	66.7	33.1
Number of occasions sold in past 12 months	3.5	3.0	3.6	3.0
Number of birds sold in past 12 months	21,169	14,000	24,812	10,241
Number sold in 2016	25,300	13,500	28,224	15,265
Number of buyers in past 12 months	3.7	1	-	-
Number of buyers in 2016	2.3	2	-	-

Broiler production cycles are shorter than semi-broiler production cycles. Broiler cycles last an average of 45 days, whether or not the farm is integrated, with an average fallow of 17 days between cycles to allow for cleaning and repairs to take place. This equates to a total 62 days per cycle, or 5.8 cycles per year if continuous stocking and fallowing takes place. Semi-broiler cycles last 71 days on average with a 31-day fallow, allowing for 3.6 cycles per year. Broiler farms stock fewer day-old-chicks per chicken house than semi-broilers farms (median 2000 and 3500, respectively), but have a higher average mortality rate (7.7% vs 4%).

The average broiler FCR of 1.6 reported by respondents is similar to the average FCR of broilers in Thailand (USDA, 2018). However, only a small number of respondents were able to state the FRC. As FCR is an important performance indicator, these are likely among the better performing farms so the all population average FCR might be higher. Semi-broilers have a higher average FCR than broilers (2.0), reflecting the fact that they have not been bred for optimized growth. A little over half of farms made use of veterinary services during the most recent cycle, but with farm owners reporting themselves to be the main source of veterinary care on around 60% of farms. Private vets, or vet from feed companies (in the case of broilers) are the next most common source of veterinary services. The gross revenue generated by a single poultry house per cycle is considerable – median MMK 8.6 million ($5700) for broilers, or MMK 9.4 million ($6250) for semi-broilers (Table 19).

Table 19 Details of the most recent completed cycle in the sample house

Item	Broilers			Semi-broilers		
	All farms	Integrated	Non-integrated	All farms	Integrated	Non-integrated
Number of fallow days between cycles	17	15	21	32	25	45
Duration of cycle (days)	45	45	45	71	72	68
Day-old chicks stocked (mean)	2447	2579	2871	4135	4353	3663
Day-old chicks stocked (median)	2000	2000	1500	3500	3500	3500
Mortality rate (%)	7.7	7.5	8	4	4	2.8
Reported feed conversion ratio	1.6	1.6	1.5	2.0	2.0	-
Mean number of birds sold	2472	2661	1938	3618	3729	3376
Median number of birds sold	1860	1938	1465	3213	3375	3913
Mean value of birds sold (MMK million)	11.93	12.88	9.12	14.56	16.11	8.74
Median value of birds sold (MMK million)	8.57	9.12	7.26	9.38	8.74	11.75
Farms using veterinary services (%)	56	53	64	53	42	75

6.2.2 Layer farming

Table 21 presents details of layer farms operation and egg production for the whole farm and for the sample house, over the past 12 months and during the month prior to the survey.

Table 21 Layer farm details (whole farm and sample house)

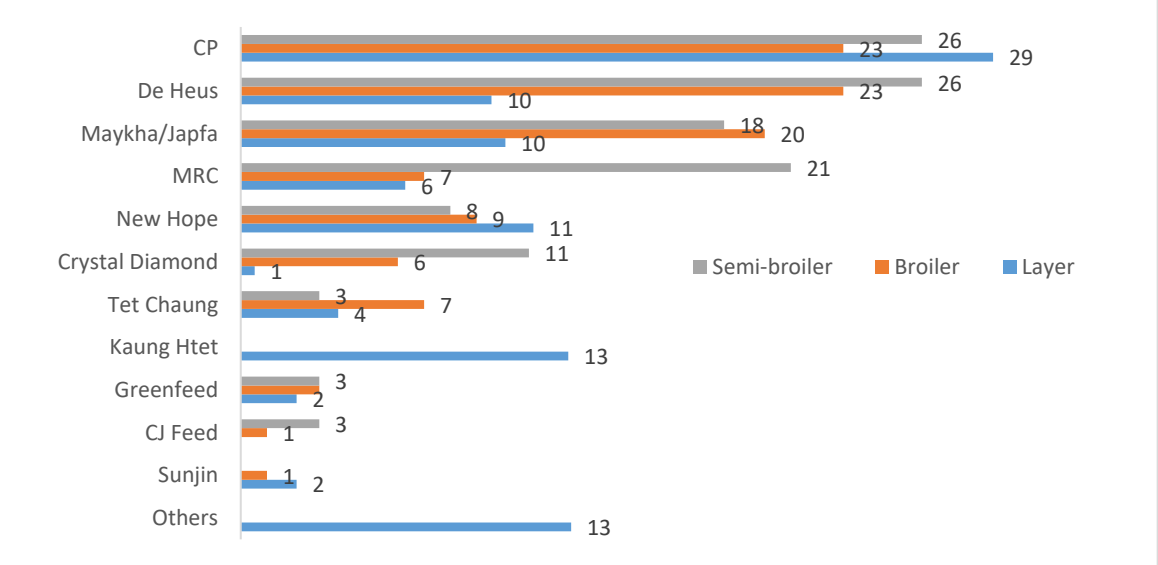
	Mean	Median
Whole farm		
Share of farms raising pullets (%)	85	-
Number of pullets per farm	4709	0
Number of layers being raised at present	13,748	6070
Share of farms selling eggs in past 12 months (%)	91	-
Number of months in past 12 with egg sales	9.6	12
Value of eggs sold in past 12 months (MMK million)	273.62	116.4
Number of eggs sold in past month	303,189	121,500
Number of eggs sold in past 12 months	2,489,587	966,000
Number of eggs sold in in 2016	2,465,485	1,260,000
Number of buyers in past 12 months	2.8	1
Number of buyers in 2016	2.8	1
Share of farms selling spent layers in past 12 months	41	-
Number of spent layers sold in past 12 months	8440	4725
Average weight of spent layers sold (kg/bird)	2.1	2
Value of spent layers sold in past 12 months (MMK million)	43.1	25.7
Value of spent layers (MMK/kg)	2159	2147
Sample house		
Number of weeks since beginning of cycle	45	39
Number of weeks remaining until end of cycle	36	35
Expected duration of current cycle (weeks)	79	74
Number of layers being raised at present	5487	3000
Mortality rate in cycle to date (%)	6	4
Number of eggs sold in past month	101,970	60,000
Quantity of eggs sold in past month (kg)	6059	3565
Value of eggs sold in the past month (MMK million)	11.08	6.57
Share of farms with vaccinated layers (%)	73	-

Layer farms produce 2.5 million eggs per year on average. The average layer flock size is 13,748 birds. Eighty-five percent of layer farms also raise pullets (female chickens that have not yet begun to lay eggs), in preparation for restocking, averaging 4709 birds per farm. Most layer farms sell eggs year-round, and the total annual value of egg sales revenues is substantial, averaging MMK 273 million ($182,000). Average farm size has been stable since 2016, when mean and median annual egg production was similar to that in the 12 months preceding the survey. The number of egg buyers per farm has also remained constant. Forty-one percent of layer farms sold spent layers within the past 12 months, with an average value of MMK 41 million ($27,300). The average duration per layer cycle is 79 week (18 months). Individual layer houses have an average flock size of 5487. The average output of each layer house is about 100,000 eggs per month (approximately 20 eggs per bird, per month), with a value of MMK 11 million ($7386), weighing about 5 tonnes.

6.2.3 Poultry feed and credit

All broiler and semi-broiler farms use formulated feeds. Only 1% of broiler farms report using any type of non-formulated feed. The poultry feed market is more diverse than the pig feed market. Around one quarter of broiler farms use CP feed, with the same share using feed from Dutch company De Heus. Twenty percent of broiler farms use feed from Maykha (a Myanmar owned company that produces feed in partnership with Indonesian firm Japfa). A mix of several homegrown Myanmar companies and several foreign owned companies, including China's New Hope, and Vietnam's Greenfeed account for the remainder of the broiler feed market. Two Myanmar companies, Kaung Htet and MRC, are among the top three suppliers of layer feed and semi-broiler feed, respectively (Figure 18). The majority of broiler farms (56%) and layer farms (64%) buy feed direct from the company that produces it. About one-third of farms source feed through feed distributors. Feed distributors serve as 'one stop shops', also supplying medicines and other poultry farming inputs, especially for semi-broiler farms, about half of which obtain feed and medicine, from feed distributors (Table 20A).

Figure 18 Share of broiler and semi-broiler farms using formulated feed, by brand (%)



More than half of poultry feed is obtained in the form of in-kind credit. Half of broiler feed and one-quarter (23%) of layer feed is obtained as credit in kind. Some feed is obtained using a mix of cash and in-kind credit (16% broiler, 12% layer) (Table 20). The high prevalence

of in-kind credit provision for feed in poultry farming, as compared to pig farming reflects two factors. First, the duration and nature of the production cycle. The production cycle is approximately three times longer for swine than broilers meaning that poultry feed suppliers can recoup their working capital much more quickly than those supplying pig farmers, while layer farms produce a regular stream of income through egg sales, making regular repayment possible. Second, the competitive nature of the poultry feed market means that numerous companies are actively seeking to attract customers, driving the use of in-kind credit to gain market share.

Table 20 Form of payment for broiler & semi-broiler inputs, by type of input (%)

	Broilers			Semi-broilers			Layers
Payment method	**Feed**	**Medicine**	**Other**	**Feed**	**Medicine**	**Other**	**Feed**
Cash	43	79	92	38	64	85	65
In-kind	50	16	3	56	36	-	23
Cash & kind	7	6	5	6	-	15	12

6.3 Integrated fish farming

Fifty seven percent of surveyed farms are integrated with fish. Broiler farms are most likely to be integrated (73%), followed by layer farms (46%), and pig farms (12%). None of the farms surveyed produced fish on a contract farming basis. The average integrated farm operates 1.8 ponds, with a total area of 27 acres (median 11 acres) (Table 22A). This is a similar size to the average for farms in in Myanmar, of around 30 acres (Belton et al. 2017). Integrated farms are 3.3 times larger on average than non-integrated farms (total area 28.5 acres, versus 8.7 acres). The median size of non-integrate farms is just 2 acres, compared 11 acres for integrated farms).

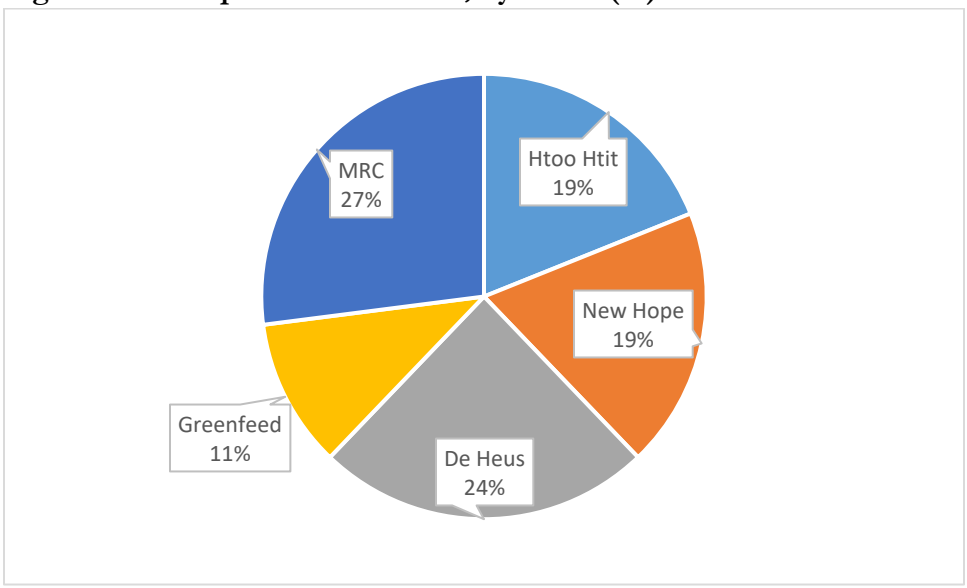
Fish production on integrated farms is dominated by a polyculture of three fish species. Rohu is the dominant species, stocked by 88% of farms and accounting for 60% of the quantity and 62% of the value of fish produced. Pangasius catfish and pacu are the next most common species, stocked by around three quarters and two-thirds of farms, respectively, and both accounting for about 15% of the total quantity of fish produced. Other carp species account for most of the remainder of production. Only 4% of farms nurse their own seed. Most fish seed is obtained from private nurseries (59%) or private hatcheries (34%).

Yields of fish from integrated ponds are moderate. Average productivity is 956 viss/acre (3.8 t/ha) (Table 21), reflecting the semi-intensive nature of integrated fish production, in which the majority of nutrients consumed by fish are obtained from algal blooms fertilized by chicken manure that falls into the pond from the houses above it. One-third (35%) of farms use no external fish feed at all, relying entirely on nutrients from animal production. This enables them to obtain a crop of fish that is effectively 'free' apart from the cost of labor and fish seed. Another advantage of integration with fish is that there is no need for farms to organize the disposal of manure (Table 23A), and manure does not accumulate on site, meaning that farms are free of unpleasant odors and flies. Half of farms (51%) provide supplementary non-formulated feeds (mainly rice bran) to boost pond productivity. Eight percent of farms use formulated (nutritionally complete, pelleted) fish feeds, and 6% use both formulated and non-formulated feed. Among all integrated fish farms, 8.5% use floating pelleted feeds, and 8% use sinking pellets.

The pelleted fish feed market is undergoing rapid diversification. Five feed companies supply pelleted fish feeds, making up between 11% and 27% of market share each (Figure 19).

Two are Myanmar companies (Htoo Htit, and MRC), and three are foreign owned (New Hope, De Heus, Greenfeed). These figures indicate that a major change has taken place in Myanmar's fish feed market since 2016. In 2016, twice as many fish farmers in Myanmar used sinking feeds as floating feeds. Floating feeds cost more than sinking feeds, but are more efficient to use. A single Myanmar company accounted for 65% of sinking feed and 51% of floating feed, and there were no foreign owned fish feed producers (Belton et al., 2017). Around 40% of fish feed used in 2016 was purchased direct from a feed factory (Belton et al., 2017). In contrast, only 3% integrated farms interviewed in 2019 bought fish feed direct from a feed factory, while well over half (58%) buying from a feed distributor, indicating that substantial developments in fish feed supply and marketing networks during this period. Most fish feed (80%) is purchased directly, and 16% as advanced as credit in kind.

Figure 19 Share pelleted fish feeds, by brand (%)



Gross revenues from fish are similar to gross revenues from pigs, broilers and semi-broilers. The average annual gross revenue per farm from sales of fish is MMK 69.4 million ($46,500) (Table 21). This is of a similar magnitude to the gross revenue from average annual sales of swine, and about three-quarters of the average gross annual sales of broilers. Farms sold 52 t of fish on average per year (median 16 t).

Table 21 Fish production and sales, whole farm, past 12 months

Item	Mean	Median
Quantity of fish sold in past 12 months (t)	52.2	16.3
Sales value of fish in past 12 months (MMK million)	69.4	25
Number of occasions sold fish in past 12 months	1.37	1
Number of fish buyers in past 12 months	1.7	1
Quantity of fish sold in 2016 (t)	87.8	19.6
Number of fish buyers in 2016	1.7	1
Yield (t/ha)	3.84	1.93

7 Marketing

This section presents details on the marketing of pigs, poultry, eggs, and fish.

Swine account for most pigs sold. Eighty five percent of pigs sold by farms in our sample during their most recent sale were swine. Average sales of swine are larger than those of piglets (mean 168 swine, versus 22 piglets). The median number of pigs sold during the most recent sale was considerably smaller than the mean (20 swine and 10 piglets), indicating that most farms sell relatively small quantities of animals (Table 22).

Brokers play an important role in mediating sales of piglets and swine. Almost half (49%) of farms had sold pigs during the preceding two months. More than one-third of piglets are sold direct to other farmers, but 27% are sold through township level brokers, 18% through village level brokers and 18% through other types of trader. In the case of swine, 10% are sold direct to slaughterhouses in Yangon, and 33% are purchased by traders in Yangon wholesale markets, indicating the primary destination for most swine produced in the area covered by the survey. Fifteen percent of swine are sold to traders in local wholesale markets and 1% to local slaughterhouses, indicating the existence of local markets for pork products. Brokers at township level and village level account for 15% and 4% of sales, respectively. It is common for farms to make repeat sales to the same buyer. Almost all buyers (98%) assume responsibility for organizing transport from farm to market. None of the farms reported taking credit from the buyer in their most recent transaction (Table 22).

Table 22 Details of most recent sale of pigs

Item	Swine	Piglets
Composition of most recent sale (%)	85	13
Mean number sold	168	22
Median number sold	20	10
Mean price per animal (MMK '00,000)	2.5	0.7
Type of buyer (%)		
Trader in Yangon wholesale market	33	0
Township level broker	22	27
Trader in local wholesale market	15	9
Yangon slaughterhouse	10	0
Village level broker	4	18
Trader from other township	4	9
Retailer	4	0
Swine farmer	3	36
CP	3	0
Local slaughterhouse	1	0
Times sold to most recent buyer in past 12 months	2.6	-
Farms receiving credit from most recent buyer (%)	0	-
Buyers providing transport to point of sale (%)	98	-

The quantity and value of most recent sale of poultry, eggs and fish reflect the frequency of harvesting. Eggs are harvested on a daily basis and sold at frequent intervals, with a median quantity of 594 kg (9115 eggs, worth MMK 1.1 million) sold per transaction. Broiler and semi-broiler sales have a median weight of 1885 kg and 1554 kg, respectively and a value of

approximately MMK 9 million ($6000). Median sales of fish, which take place just over one time per year on average, are 16.3 t, with a value of MMK 20.4 million ($13,600) (Table 23).

Table 23 Details of most recent sale (poultry, eggs and fish)

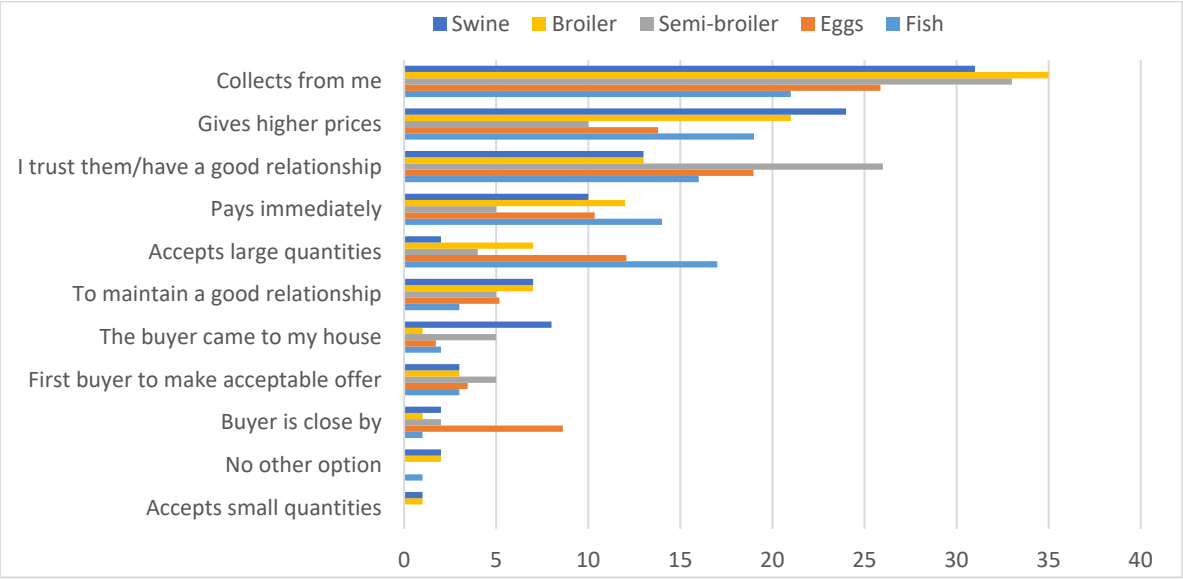
Item	Broilers	Semi-broilers	Eggs	Fish
Mean number sold	2878	4779	53,525	-
Median number sold	1900	3900	9115	-
Mean value of most recent sale (MMK million)	13.47	13.75	6.43	53.63
Median value of most recent sale (MMK million)	8.58	9.85	1.1	20.4
Mean weight of most recent sale (kg)	7328	5344	3473	45,769
Median weight of most recent sale (kg)	1840	1554	594	16,300
Mean price per bird (MMK)	4829	2874	n/a	n/a
Mean sales price per kg (MMK)	1886	2682	1852	1171
Type of buyer (%)				
Trader in Yangon wholesale market	61	62	46	71
Township level broker	12	14	8	11
Trader in local wholesale market	11	7	18	10
Retailer	7	2	13	3
Contract farming	4	0	0	0
Trader from other township	3	7	5	3
Yangon slaughterhouse	1	3	n/a	n/a
Village level broker	1	0	5	0
Other chicken farm	0	2	0	0
Consumers	0	0	2	0
Times sold to most recent buyer in past 12 months	4	3.4	-	1.5
Farms receiving credit from most recent buyer (%)	2	5	3	1
Buyers providing transport to point of sale (%)	92	95	87	47

Fish are the cheapest animal source food produced by the farms surveyed. The average value per kg of fish produced in integrated farms is MMK 1171/kg ($0.80). The average value per kg of broilers and eggs is MMK 1886/kg and MMK 1852/kg ($1.25), respectively; approximately 60% higher than the price of fish. The farmgate price per kg for swine is MMK 2811/kg ($1.90); 49% higher than the price of broilers and more than double the price of fish (Table 23). This makes fish produced in integrated farms more accessible to consumers on a cost basis than other animal source foods, while eggs and broilers are equally accessible. The price of semi-broilers (used mainly in the restaurant trade) is similar to that of swine.

Most chicken and fish is sold direct to Yangon. Around 70% of farms selling fish and more than 60% of those selling poultry sell to traders based in Yangon, as do 46% of farms selling eggs. Traders in local wholesale markets are among the next most important buyers, account from 7% (semi-broiler) to 18% (egg) sales. This is indicative of fairly low levels of intermediation in the supply chain, with most farmers interacting directly with wholesale markets, rather than smaller local collectors. The level of transactions with traders in local wholesale markets also indicates the existence of a significant market for poultry, eggs and fish in the peri-urban zone around Yangon. Sales to township level brokers who sell on to wholesalers in other locations account for between 8% (eggs) and 14% (semi-broilers) of sales. Sales to smaller village level

brokers are extremely limited, again underlining relatively direct supply chains. Thirteen percent of layer farms sell direct to retailers, but very few farms sell direct to consumers. Most farms sell to the same buyer on multiple occasions, indicating the importance of relationships between buyers and sellers, but very few (5% or fewer) farms receive credit from the buyer. Many buyers provide transport services to the farmer, particularly in the case of poultry sales (Table 23).

Figure 20 Reasons for selling to buyer during most recent sale (% of responses)



Farmers choose buyers on the basis of convenience, prices offered, and quality of interpersonal relationships. Figure 20 presents reasons reported by farmers for choosing to sell to the most recent buyer of swine, broilers, semi-broilers, eggs, or fish, that they transacted with. For all products, the most frequently reported reason for selling to the most recent buyer is that they collected the product from the farm (cited by roughly one quarter to one third of respondents). The next most common reason overall is that the buyer gives higher prices than others, indicating that farms have a range of options to choose from when selecting a buyer. Trusting the buyer or having a good relationship with them is the third most common response. The buyer pays immediately is another common response, cited by approximately 10% of respondents. Other responses are less common. Very few respondents reported selling to buyers because they had no other option, or simply because the buyer was close by. This underlines the ability of farmers to 'shop around' for buyers, and to take into account a variety of factors including services provided by the buyer (most importantly transporting product to market) and terms of sale (price, speed of payment). However, the frequency of repeat sales to a single buyer (Table 23) also indicates that factors such as a buyer's perceived trustworthiness, personal affinity between buyer and seller, and search costs involved in seeking alternative buyers encourage the formation of longer-term partnerships.

8 Conclusions

This report presents results from a comprehensive structured survey of medium and large-scale pig and poultry farms conducted in the peri-urban zone surrounding Yangon. The survey represented pig farms raising five or more breeding sows or 20 or more swine, and all broiler, semi-broiler, and layer farms raising 500 or more birds, in randomly selected villages from 83 village tracts with high concentrations of pig and chicken farms, in Ayeyarwady, Bago (East) and Yangon regions. Owners of 90 pig farms, and 423 poultry farms (290 broiler, 38 semi-broiler, 95 layer) were interviewed.

The survey was supported by analysis of nationally representative data on poultry, meat, egg and dairy consumption for 2010 and 2015, poultry, meat, and egg retail prices from 2008 to 2017, and satellite images of peri-urban Yangon for 2014 and 2018. Together, these data sources allow us to characterize the economic and technical dimensions of medium and large-scale pig and poultry farming in Myanmar and recent trends in sectoral growth, to identify implications for policy and development programming. We summarize key findings and discuss their implications below.

Consumption of meat, eggs, and dairy grew from 2010 to 2015. Combined consumption per capita of meat, eggs, and dairy increased 13% at the union level. Almost all this increase occurred in urban areas, where consumption jumped 41%, to 28 kg/capita. Consumption in rural areas remained almost unchanged, at 18.7kg/capita. The total quantity of meat, eggs, and dairy consumed by the poorest 20% of households fell by 1.8 kg over this period, while the quantity consumed by the wealthiest 20% increased by 9.8 kg.

Increases in animal source food consumption were driven by chicken and eggs. Chicken consumption increased 72% from 2010-2015, to become the number one meat consumed (average 6.8 kg/capita). Consumption of chicken eggs increased 40%, to 4.0 kg/capita. These increases were partially offset by reduced consumption of pork, beef and mutton. Pork was the number one meat consumed in 2010, but consumption fell 22% to 4.3 kg in 2015. Beef consumption halved and mutton consumption fell by one-third over this period.

The real price of chicken meat and eggs has fallen, as the price of other meats as risen. The inflation adjusted price of chicken meat and eggs fell 29% and 36%, respectively, between 2008 and 2017. The real price of pork, beef, and mutton increased 10%, 34%, and 34%, respectively over the same period. In 2008, chicken meat was 15% more expensive than beef. By the end of 2017, it was 35% cheaper.

The number of integrated chicken-fish farms around Yangon doubled between 2014 and 2018. Integrated farms have animal houses built above or beside ponds to enable utilization of waste nutrients as inputs for fish culture. Analysis of satellite images shows the number of chicken houses integrated with fishponds in peri-urban Yangon grew from 1898 to 3868 from 2014-2018. The number of village tracts with integrated farms doubled from 121 to 230.

Two-thirds of poultry farms surveyed are integrated with fishponds. Integrating livestock and fish production has several advantages. (1) Much of the nutrients consumed by fish in integrated farms are obtained from algal blooms, fertilized by manure from animal houses above or beside the pond. This allows production of fish using limited or no feed, substantially reducing costs compared to non-integrated fish farms. (2) Integration means that manure does not accumulate on site, so farms are free of unpleasant odors and flies, and there is no need

organize manure disposal. (3) Land use productivity is maximized as farms simultaneously produce two high value crops from a single parcel of land. (4) Producing fish at low cost helps farms to reduce the risks of poultry production, for which margins are often slim and prices volatile.

More than half of farms in our sample were established within the past five years. Average broiler and layer flock sizes per farm remained fairly constant since 2016, suggesting that increases in chicken and egg production among the strata of farms surveyed have been driven more by proliferation of new farms than by scale expansion.

Most land use in pig and poultry farming contravenes Myanmar's agricultural land use classification system. Most parcels of land used for livestock production (91%) have some form of land use document associated with them, of which 69% are formal land use rights certificates. However, among parcels with formal land use rights, only 17% have a document (La Ya 30/La Na 39) that allows the land to be utilized for livestock production. Obstacles to obtaining the correct land use classification documents prevent farms from using land as collateral for formal loans, can necessitate payment of bribes, and may make tenure security vulnerable to changes in the enforcement of land use regulations.

Few farmers have received any formal training on pig or poultry farming. Only 11% of farms have received any formal training. Private companies are the main providers of extension services. Most information on farming is obtained from informal sources, with fellow farmers (mentioned by 63% of respondents) and relatives (30%) are most common. Social media plays an important role in the distribution of farming information (28%), as do staff of feed companies (32%). Formal government information sources were mentioned by 12% of respondents, and NGOs not at all. Knowledge about animal diseases is limited. An outbreak of African swine fever (ASF) - a severe viral disease – was occurring in Southeast Asia at the time of the survey. Half of pig farmers had no knowledge of the cause of ASF infections. Around 40% were not familiar with any ASF symptoms or means of prevention. Less than half of farms maintain records.

Pig farming is undergoing rapid technological change. Improved breeds of boar and sow are much more common than local breeds. Improved 'CP' breed pigs account for half of the swine, with 'local' breeds accounting for about one-quarter. Local breeds have a longer production cycle and attract a lower price than improved breeds, but can be raised wholly or partly on a diet containing items such as kitchen scraps, whereas improved pig breeds must be raised using formulated feeds (commercially manufactured feeds that are formulated to meet the complete nutritional requirements of the animal farmed) for optimum performance. Until 2010, most farms used non-formulated feeds. The share of farms using formulated feeds overtook the share using non-formulated feeds around 2015, indicating a recent shift toward intensification and commoditization of production. Eighty-nine percent of pig farms use formulated feeds.

The market for animal feed is diversifying and becoming more competitive. Thailand's CP company dominates pig feed supply, with 48% of farms using their products. South Korea's Sunjin company (16%) and China's New Hope company (11%) are the two next largest suppliers. All broiler and semi-broiler farms use formulated feeds. The poultry feed market is more diverse than the pig feed market. One quarter of broiler farms use CP feed, with the same share using feed from Dutch company De Heus. Twenty percent of broiler farms use feed from Maykha (a Myanmar company that produces in partnership with Indonesian firm Japfa). A mix of Myanmar and foreign owned companies account for the remainder of the poultry feed

market, with Myanmar companies among the top three suppliers of layer feed and semi-broiler feed. Five feed companies supply pelleted fish feeds, taking between 11% and 27% of market share each. A major change has occurred in Myanmar's fish feed market structure since 2016, when a single Myanmar company dominated supply.

Implications for policy and programming

Chicken meat and eggs play an important role in Myanmar's food and nutrition security, given the critical importance of animal source foods for combating undernutrition. Increasing production of chicken meat and eggs from 2010 to 2015 has made them much more affordable than in the recent past. This trend has helped to reduce, but not prevent, overall declines in animal source food consumption among poorer households. As of 2015, increases in pig production had not occurred on a sufficiently large scale make pork more affordable and avert declines in consumption, but pork prices have trended somewhat downward since then, and the steady growth and technological intensification of pig farms documented here suggests that this trend is likely to continue. From a nutrition perspective this dynamic represents a double-edged sword, as overconsumption of saturated fats from animal products is also associated with obesity and related negative health outcomes. Thus, there is a need for consumer education to promote adequate (but not excessive) levels of consumption, while encouraging healthier alternatives.

Integrated livestock-fish production should be recognized as a beneficial form of food production. Integrated farming reduces economic risks to livestock producers, utilizes land efficiently, produces fish at low cost, facilitates reuse of excess nutrients from livestock production, and eliminates unpleasant odors and flies. There is no export market for the fish produced in integrated systems, so there is little risk of antibiotic residues in fish from these farms damaging Myanmar's aquaculture export prospects. As such, policy should seek to regulate this economically and environmentally efficient practice (e.g. by managing discharge of eutrophic water from ponds and mandating antibiotic withdrawals prior to harvest) rather than to ban it, as advocated in some quarters.

Land used for animal husbandry or aquaculture activities should be designated as agricultural land in the formal land classification system. This would strengthen the tenure security of the occupants, lessen opportunities for corruption, and reduce farmer vulnerability to changes in the enforcement of land use regulations.

Private actors in upstream segments of the value chain and targeted social media campaigns provide entry points for training and information dissemination. These could be coordinated with carefully selected influential farmers with large networks to maximize the reach of key messages. The limited extent of government and NGO training activities suggests scope for their expansion, perhaps in coordination with, or support of, private extension agents.

There are many opportunities to improve farm management and biosecurity. These include digital services such as dedicated record keeping apps, encouraging and promoting the expansion of artificial insemination services for pigs, improvements to the design of farm buildings, and instituting quarantine services for imported animals.

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Annex

Figure 1A Cumulative number of integrated and non-integrated broiler farms established by year

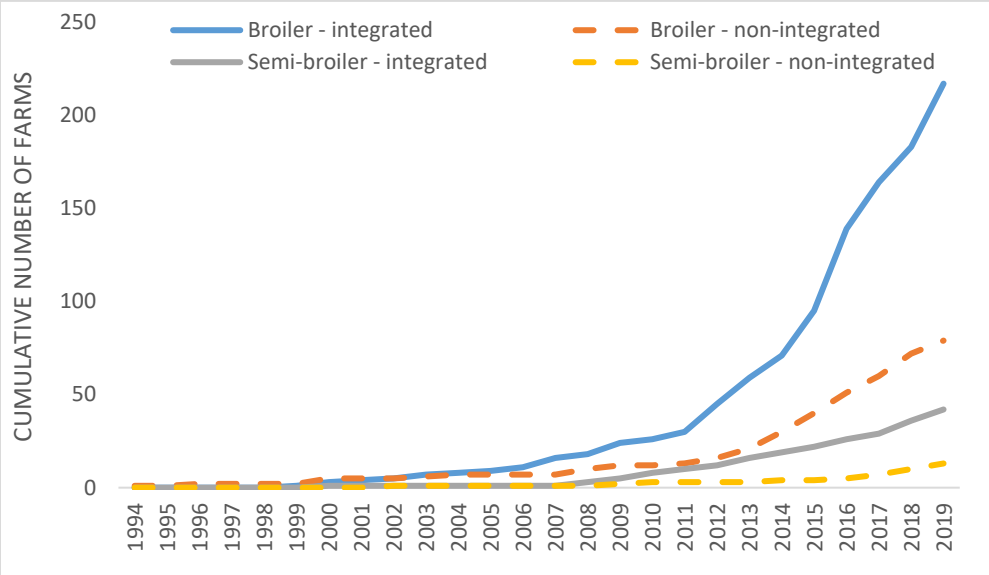

Figure 2A Share of pig farms using formulated feed, by brand (%)

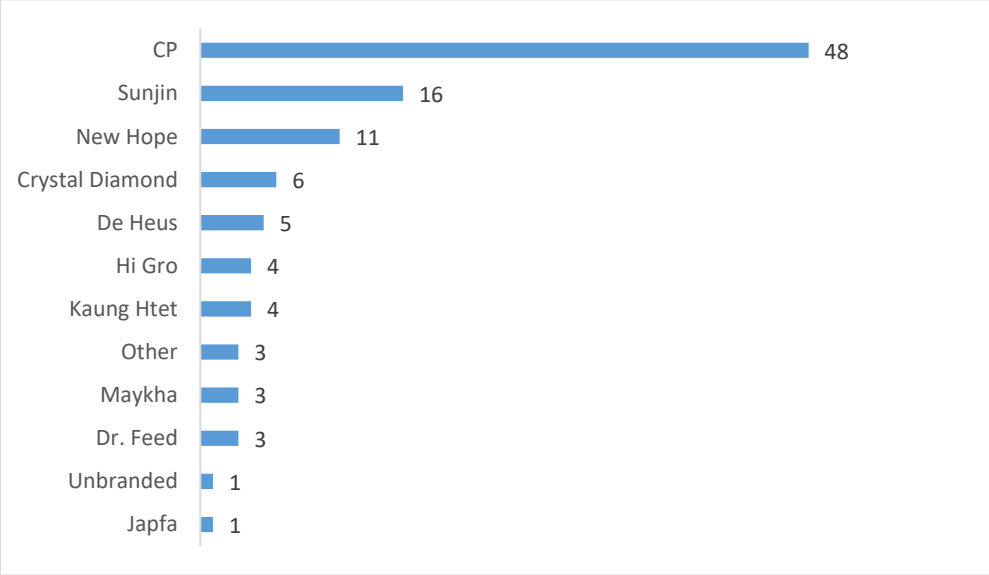

Table 1A Population of pigs, broilers and layers in Ayeyarwady, Bago (East) and Yangon) (Source: LBVD, 2019)

	Population	Rank (among states/regions)	Share of national total (%)
Pigs			
Ayeyarwady	986,586	1	17
Bago (East)	409,931	4	7
Yangon	291,672	10	5
Myanmar	5,800,000	-	-
Broilers			
Ayeyarwady	1,587,981	4	10
Bago (East)	2,342,862	3	14
Yangon	3,867,870	1	24
Myanmar	16,200,000	-	-
Layers			
Ayeyarwady	1,098,805	5	11
Bago (East)	346,111	9	3
Yangon	1,616,061	3	16
Myanmar	10,000,000	-	-

Table 2A Farm building construction costs

Cost (MMK '00,000)*	Piglets	Swine	Broiler	Semi-broiler	Layer
Mean cost per unit	56	91	80	78	193
Median cost per unit	10	28	50	50	100
Mean cost per m^2	0.63	0.46	0.17	0.23	0.36
	Piglets/swine		**Broiler/semi-broiler**		**Layer**
Mean cost per farm	248		228		521
Median cost per farm	25		75		240

* Real cost of construction at 2018 prices

Table 3A Farm building construction materials

Materials	Pigs	Broiler/ semi-broiler	Layers	All
Roof				
Zinc	73	25	80	45
Thatch	24	74	20	53
Zinc & Thatch	1	2	1	1
Thatch & Plastic	1	0	0	0
Floor				
Bamboo	18	90	34	66
Netting	13	75	24	54
Concrete	77	4	27	20
Wood	1	3	24	8
Iron	0	2	8	3
Earth	4	1	7	3
Earth plus other	0	0	3	1
Walls				
Plastic/Tarpaulin	28	82	37	63
Bamboo	11	35	11	26
Netting	8	14	28	17
Brick	65	1	9	13
Wood	5	0	15	4
No wall	0	1	13	3
Iron netting/sheet	1	3	4	3
Insulator wall	0	0	2	0

Table 4A Share of households owning productive assets, by type of farm

	Share of farms owning (%)					Number per farm		
Asset	**All (2014)**	**All (2019)**	**Pig**	**Broiler**	**Layer**	**Pig**	**Broiler**	**Layer**
Vehicle								
Motorbike	40	46	49	47	42	1.0	1.4	1.4
Boat (motorized)	21	31	7	41	22	1.3	1.5	2.4
Boat (unmotorized)	18	21	6	27	14	4.2	1.8	1.5
4-wheel truck	9	8	4	7	20	1.3	1.2	1.2
6-wheel truck	7	7	6	5	18	1.4	1.3	1.5
Trawlarjee	0	1	0	1	3	0	1.0	1.7
14-wheel truck	0	0.2	1	0	0	1	0	0
Energy source								
Generator	62	67	31	73	79	1.4	1.4	1.5
Battery	13	29	19	38	9	2.6	2.2	4.0
Solar Panel	14	26	13	33	11	1.5	1.7	3.4
Transformer	2	4	4	2	12	1.4	1.0	1.2
Environmental control								
Light bulbs	20	18	11	17	25	14.7	55.6	39.1
Charcoal heater	42	55	3	75	35	8.0	8.2	9.7
Electric/gas heater	11	13	4	11	29	89.5	5.8	7.3
Fans	9	9	12	5	17	11.4	15.4	14.9
Sprinkler	4	5	6	5	5	1.1	36.6	13.8
Air conditioner	1	1	3	1	3	6.3	3.0	11.3
Water pump	51	55	54	57	46	1.3	1.6	2.5
Aerator (for pond)	0.4	0.4	0.0	0.3	1.1	2.0	12.0	8.0
Hygiene								
Manual sprayer	52	60	43	62	67	1.0	1.5	2.9
Spraying machine	18	26	18	27	32	2.0	1.4	2.7
Cleaning machine	18	22	8	29	16	1.6	1.5	2.2
Other								
Weighing scale	61	72	40	77	85	2.6	1.3	1.9

Table 5A Sources of capital for farm startup and asset acquisition (% of farms)

Source of capital	Pigs	Broiler/ Semi-broiler	Layer	All
Startup capital				
Crop farming income	33	32	14	29
Non-farm business income	33	20	25	23
Income from sale of land or asset	11	17	22	17
Loan from relative/friend	13	19	12	17
Livestock farming income	11	18	16	16
Trading business income	7	10	15	10
Non-farm work	9	5	2	5
Investment from family member/relative	1	4	5	4
Loan from informal money lender	2	3	3	3
Loan from trader	1	1	3	2
Loan from contract farming	0	1	0	1
Migration/remittances	1	0	0	0.4
Loan from private bank	0	0	1	0.4
Mya Sein Yaung/MFI	1	0	0	0.4
Asset acquisition				
Livestock farming	70	84	76	80
Crop farming	30	30	9	26
Savings from other source	11	20	29	20
Non-farm business	22	15	31	19
Non-farm work	14	11	20	13
Sale of assets	3	10	11	9
Relatives	1	2	1	2
Credit from moneylender	1	3	0	2
Credit from private bank	0	0.3	1	0.4
Credit from feed supplier	0	0	1	0.4
Credit from trader	0	1	0	0.4
Remittances	0	0.3	0	0.2

Table 6A Responses to question "If have problem with working capital, how do you cope?"

	Pigs	Broiler/ Semi-broiler	Layers	All
Money from savings	49	38	51	42
Borrow from family	37	40	33	38
Borrow from friends/farmers	16	21	12	19
Use money from other business	20	14	15	16
Borrow from informal lenders	6	5	1	4
Borrow from trader	3	4	5	4
Borrow from formal lenders	1	1	4	1
Borrow from feed company	3	1	0	1
Renegotiation of payments	1	1	0	1
Not applicable	8	6	10	7

Table 7A Share of respondents participating in community, benefiting from state action, experiencing social conflict, or experiencing business challenges (% of farms).

	Pigs	Broiler/ Semi-broiler	Layers
Participation in community activities in past 5 years			
Attended wedding in local community	91	93	74
Attended ordination ceremony	88	84	57
Participated in sports activity	22	26	15
Made donation to local religious institution	82	81	70
Made donation for development of local infrastructure	60	46	60
Made donation to disaster relief effort	46	46	18
Played a mediating role in a dispute	20	18	10
Conflicts experienced in past 5 years			
Theft of stock	4	14	15
Theft of equipment/materials	6	4	5
Trespassing	1	6	4
Vandalism	0	1	2
Poisoning of stock	1	1	1
Threats against self or workers	1	1	1
Violence against self or workers	0	1	1
Benefits experienced in past 5 years			
Electricity connection	36	40	42
Water connection	29	38	30
Road construction	41	33	46
Irrigation infrastructure	4	4	6
Dispute mediation by local officials/elders	9	13	11
Receipt of land concession	2	3	10
Tax breaks	0	4	1

Table 8A Incidence and frequency of collaboration with fellow farmers

Type and frequency of cooperation	Pigs	Broiler/ Semi-broiler	Layers
Share tools with fellow farmers (%)	6	13	3
Number of occasions in past 12 months	4	5	12
Share vehicles (%)	8	13	2
Number of occasions in past 12 months	6	9	6
Share hired labor (%)	4	5	1
Number of occasions in past 12 months	10	6	4
Share family labor (%)	38	50	49
Number of occasions in past 12 months	9	8	8
Discuss farm management (%)	75	75	67
Number of occasions in past 12 months	11	8	9
Discussed animal health (%)	74	74	66
Number of occasions in past 12 months	11	9	11
Share information about suppliers (%)	57	69	56
Number of occasions in past 12 months	9	12	12
Share information about buyers (%)	42	63	49
Number of occasions in past 12 months	10	8	14
Ever outsourced an extra order (%)	3	14	6

Table 9A Training providers, by type of training

	Training subject			
Training provider	Any	Pig production	Poultry production	Fish production
Feed company	61	64	69	27
LBVD	25	29	26	18
DOF	11	0	3	55
NGO	2	0	3	0
Vet	2	0	0	0
Other	0	7	0	0

Table 10A Share of farms ever having sought information, by type of information and source

	Pigs	Broiler/ Semi-broiler	Layers	All
Type of information				
Market prices	82	92	88	89
Feeding practices	74	73	80	75
Animal health problems	69	66	66	66
Trader's reputation	37	59	65	56
Feed supplier's reputation	41	56	49	52
Farm management	37	42	41	41
Business ideas	30	38	38	37
Farm licensing requirements	4	14	15	12
Finding land for farm	4	12	16	11
Livestock insurance	0	2	5	2
Source of information				
Neighboring farmers	58	70	45	63
Feed company staff	26	32	42	32
Relatives	23	34	22	30
Social media	36	24	34	28
Friends	26	20	15	20
Private vet	34	17	19	20
Vet medicine shop	19	16	18	17
Feed traders	15	16	11	15
LBVD/DOF officer	7	11	18	12
Internet	13	9	16	11
People from hometown	7	4	8	5
Wholesalers	6	3	1	3
Classmates	2	1	0	1

Table 11A Share of farms keeping records, by type of record

Type of record	Pigs	Broilers/ Semi-broilers	Layers	All
Farms keeping any record (%)	34	42	59	44
Among record-keeping farms (%)				
Mortality	61	87	86	83
Profit and loss	81	84	77	82
Stocking rate	61	80	91	80
Quantity of feed used	84	76	80	78
Quantity harvested	52	66	41	58
Growth rate	42	39	30	37
Laying rate	-	-	84	84
Feed conversion ratio	6	14	13	13

Table 12A Longterm labor arrangements

Item	Pig	Broiler/ Semi-broiler	Layer	All
Number of workers hired*				
Husband and wife	11.3	2.9	3.9	3.5
Women	10.3	3.2	8.4	6.1
Men	3.8	3.2	7.0	4.0
Whole family	3.7	3.4	6.3	3.9
Average monthly salary (Lakh MMK)				
Husband and wife	1.9	1.9	1.9	1.9
Women	1.8	1.1	1.3	1.2
Men	1.4	1.4	1.3	1.4
Whole family	2.7	1.8	2.9	2.1
Share of workers receiving in-kind payments (%)				
Husband and wife	83	41	65	49
Women	50	56	57	55
Men	62	63	69	64
Whole family	67	39	75	48
Value of in-kind payments in past 12 months (Lakh MMK)				
Husband and wife	7.5	11.2	10.6	10.7
Women	6.0	7.8	6.5	7.2
Men	6.5	8.5	23.1	11.6
Whole family	16.2	9.2	23.7	14.4
Share of workers receiving lodging (%)				
Husband and wife	100	96	98	97
Women	100	74	83	80
Men	100	93	88	93
Whole family	100	89	100	92
Share of workers receiving bonus (%)				
Husband and wife	67	45	45	46
Women	17	30	26	27
Men	38	40	22	36
Whole family	67	39	0	36

Note: *among farms hiring each type of worker

Table 13A Total value of monthly income received by long term workers, and share of workers receiving loans from employers

Type of worker	Total value monthly of income in past 12 months (MMK '00,000)*	Share of workers receiving loans from employers
Husband and wife	2.15	9
Women	1.36	5
Men	1.62	6
Whole family	2.31	16

*Salary + in-kind payments + bonuses

Table 14A Form of bonus received, by type of farm

Item	Broilers	Layers	Pigs	All farms
Farms giving any bonus (%) (among which, form of bonus)	41	35	44	40
FCR	4	0	0	3
Survival rate	10	7	8	9
Values of sales	19	10	17	17
Total quantity harvest	1	3	0	1
Amount of profit earned	65	62	50	63
Extra work	5	17	33	10
Growth rate	3	0	0	2
Other	2	3	0	2

Table 15A Details of casual labor on pig and broiler farms

Item	Pig	Broiler
Hiring casual labor (%)	31	31
Average number of male casual laborers hired per farm*	3.7	7.2
Average number of male causal labor days worked during last cycle		
Average number of female casual laborer hired per farm*	2.6	1.7
Average number of female causal labor days worked during last cycle		
Share of households paid a daily wage (%)	80	86
Average male daily wage (MMK)	7500	6643
Average female daily wage (MMK)	4500	4667
Total cost of casual hired labor (whole farm, past 12 months)	447,000	-
Total cost of casual hired labor (sample house, last complete cycle)	-	304,000

* Among farms hiring male/female casual labor

Table 16A Details of work performed by casual workers on pig and broiler farms

Activity	Share farms with casual workers using for this purpose (%)
Pig farms	
Repairing pig house	80
Buying piglets	17
Birthing piglets	13
Buying/transporting/hauling feed	13
Washing pigs	3
Guarding	3
Transporting pigs to market	7
Cleaning pig sites	3
Broiler farms	
Repairing poultry house	63
Harvesting birds/transporting to market	46
Cleaning poultry house	12
Buying/transporting/hauling feed	9
Buying/stocking day old chicks	5
Disinfecting poultry house	4
Giving medicine	3
Feeding	2
Guarding	2
Other	3

Table 17A Breed and source of swine raised

	Share of farms
Breed	
CP (%)	51
Local (%)	27
Mixed breed (%)	16
Thai (%)	11
"Billion" (%)	1
Source	
Own stock (%)	54
Neighboring farms (%)	20
Feed company (%)	17
Swine trader (%)	3
Non-local farms (%)	2
Imported by self (%)	2
Breeder stock company (%)	1

Table 18A Detailed pig farming input use characteristics

Input	All farms	Swine only	Piglets & breeders only	Mixed farms
Formulated feeds				
Breeder feed	54	21	68	73
Starter feed	80	85	63	82
Grower feed	61	79	26	62
Finisher feed	65	76	53	62
Concentrate	9	6	5	13
Non-formulated feeds				
Broken rice	46	26	21	71
Rice bran	40	24	16	62
Rice	1	0	5	0
Mixed rice bran & broken rice	12	9	32	7
Wheat bran	12	9	21	11
Maize	4	0	0	9
Dry fish/prawn powder	1	0	5	0
Kitchen waste (commercial)	1	0	5	0
Kitchen waste (domestic)	11	9	16	11
Vegetables	6	0	21	4
Therapeutants				
Vaccines	34	32	21	40
Vitamins	19	18	5	27
Antibiotics	9	3	0	18
Probiotics	5	6	0	7
Disinfectants	29	26	26	31
Lime	59	62	47	62
Salt	1	0	0	2
Fuel/energy				
Electricity	56	59	53	56
Diesel	30	44	21	22
Petrol	9	3	0	18

Table 19A Share of pig farms obtaining inputs, by source

Source	Formulated feeds	Non-formulated feeds	Medicines	Other inputs
Feed factory	6	0	4	3
Feed company	37	0	20	8
Feed distributor	59	26	25	12
Vet Store/clinic	5	3	49	29
General store	1	6	9	37
Friends/relatives	1	12	0	0
Own production	2	17	0	0
Market	1	17	0	32
Other farmers	0	2	0	0
Rice mill	0	59	0	0
Vet from LBVD	0	0	1	0

Table 20A Share of broiler and semi-broiler farms obtaining inputs, by source

	Broilers			Semi-broilers			Layers	
Source	Feeds	Medicine	Other inputs	Feeds	Medicine	Other inputs	Feeds	Medicine
Feed company	56	32	9	45	21	10	64	51
Feed distributor	37	35	11	55	44	28	21	19
Vet Store/clinic	0	30	16	3	44	24	0	17
Market	0	0	46	0	0	38	0	0
General store	0	1	31	0	0	38	0	0
Feed factory	7	2	0	3	3	3	10	3
Contract farming	2	2	1	0	0	0	0	0
Importer	0	1	4	0	1	3	0	1
Friends/relatives	0	1	1	0	3	0	1	2

Table 21A Details of fishponds on integrated farms

Item	Pigs	Broilers/ Semi-broilers	Layers	All
% of farms integrated with fish	12	73	46	57
Mean number of ponds per integrated farm	3.2	1.6	2.8	1.8
Mean area of ponds operated per integrated farm	59.9	19.3	65.5	27.7
Median area of ponds operated per integrated farm	12	10	25	11

Table 22A Fish production details

Species	Farms stocking (%)	Share of sales value (%)	Share of quantity produced (%)	Yield (kg/ha)	Yield (viss/acre)
Rohu	88	62	60	5218	1296
Pangasius	73	17	16	3231	803
Pacu	63	11	15	3845	955
Mrigal	23	5	3	1505	374
Catla	28	4	3	3820	949
Mixed carps	5	1	1	723	180
Tilapia	5	0	1	2013	500
All	-	100	100	3850	956

Table 23A Means of manure disposal

Use	% of responses
Input for own fishpond	61
Throw away	17
Sold to other farmers as fertilizer	11
Used as fertilizer on own farm	8
Given as fertilizer to other farms	6
Other	1