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Impacts of COVID-19 on Myanmar's chicken and egg sector, with implications for the sustainable development goals

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ABSTRACT

CONTEXT: Chicken and eggs make important contributions to the food and nutrition security of low-income households in Myanmar, making it important to understand the impacts of COVID-19 on Myanmar's poultry sector.

OBJECTIVE: First, we evaluate the responsiveness and resilience of different chicken and egg farming systems in Myanmar to the shock of COVID-19. Second, we evaluate implications of the performance of the chicken and egg sector during COVID-19 for the Sustainable Development Goals.

METHODS: We conducted six waves of telephone interviews from June to November 2020 with 269 chicken farms close to Yangon. We compared impacts in two types of production system - broilers and layers - using a survey of the same farms conducted in 2019 as a baseline. For each type of farm, we compared 'integrated' and 'non-integrated' farms, where integration involves combining production of chickens and fish.

RESULTS AND CONCLUSIONS: First, the COVID-19 pandemic severely impacted chicken and egg production. More than 30% of broiler farms and 10% of layer farms closed before June, 42% of long-term farmworkers were laid off, and indicators of business sentiment were much more pessimistic than in 2019. Second, the sector experienced a V-shaped recovery until September 2020 when a second wave of COVID-19 hit Myanmar. Third, the impacts of COVID-19 vary by production system. Broiler farms have a much shorter production cycle than layer farms and were able rapidly adjust operational status by closing or reopening, whereas very few layer farms reopened after closing. Fourth, integrated layer-fish farms proved more resilient to the shock of COVID-19 than layer farms, with 90% of layer-fish farms and 76% of layer farms remaining operational in November, but there was no difference in the performance of broiler-fish and broiler farms. Fifth, the slow supply response of layer farms has meant higher egg prices for consumers, likely affecting nutritional intakes and making it more difficult for Myanmar to achieve the second Sustainable Development Goal of ending hunger and malnutrition by 2030.

SIGNIFICANCE: The results contribute to understanding of the challenges faced by chicken farms in Myanmar during the COVID-19 pandemic, and the effectiveness of their adaptive responses. Results have implications for other countries in Asia where integrated livestock-fish farms are common, and other developing countries where the poultry sector is expanding rapidly.

1. Introduction

The COVID-19 pandemic has hit Myanmar's economy hard. GDP was projected to fall by at least 17.4% compared with 2019 (Diao et al. 2020) even before a second wave of COVID-19 infections emerged in September 2020, accompanied by stringent containment measures. The impacts of COVID-19 on Myanmar's agricultural sector have been less severe than on industry and services, but livestock and fishery output has declined (World Bank 2020). Since the onset of the COVID-19 outbreak, livestock farmers in Myanmar have faced supply side challenges including logistical disruptions caused by movement restrictions implemented to slow COVID-19 transmission, and collapsing demand for livestock products (Diao et al. 2020; USDA 2020). Livestock sectors in many other countries have faced similar impacts from COVID-19

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(FAO 2020; Liverpool-Tasie et al. 2020; Zhang 2020).

Consumption of chicken and eggs increased substantially in Myanmar in recent years, up 72% and 40%, respectively, between 2010 and 2015. Consumption of fish remained stable and consumption of other meats fell over the same period. This shift in consumption patterns is the result of reductions in the price of chicken and eggs, which are now cheaper than they were in 2010, both in real terms and relative to the price of other meats. This trend reflects very rapid growth in Myanmar's intensive poultry farm sector over the past decade (Belton et al. 2020).

Consumption of animal sourced foods, such as fish, meat, eggs, dairy, is strongly associated with reductions in the prevalence of child stunting and other indicators of undernutrition (Headey et al., 2018). High prices of animal-sourced foods are a key constraint limiting their consumption in Myanmar (Mahrt et al. 2019). Any shock affecting the supply or the price of eggs or chicken would therefore have implications for food and nutrition security. For example, a survey conducted in June 2020 in Myanmar's Dry Zone found that around 40% of rural households consumed meat less frequently or in smaller portions than they had done before the onset of COVID-19, mainly due to pandemic related reductions in household income (Lambrecht et al. 2020). Chicken and eggs have become the second and third most important animal-sourced foods, respectively, after fish in Myanmar during the past decade (Belton et al. 2020) . Eggs are especially critical for the food and nutrition security of low-income households, making it important to understand the impacts of COVID-19 on Myanmar's poultry sector.

There are two main types of intensive chicken farm in Myanmar. Broiler farms raise broiler chickens for meat. Layer farms raise layer chickens producing eggs. The total number of farms in Myanmar raising broilers and layers was 10,700 and 6300, respectively in 2018 (LBVD 2019). Most farms are located in peri-urban areas around major cities, with the largest concentrations around Yangon. Layer farms in Myanmar, with median flock sizes of 6235 birds, are usually larger than broiler farms which have a median flock sizes of 3000. Layer farms have higher fixed and operating costs, but generate larger revenues than broiler farms (Belton et al. 2020).

Production cycles for broilers are much shorter than for layers. It takes around 1.5 months (45 days) to raise a broiler to harvest, whereas layers have an average economic lifespan of 18 months (79 weeks) (Belton et al. 2020). Beyond these time windows, broilers stop growing and the egg laying rates decline, eroding farm profitability as the birds continue to require daily feeding. The short broiler production cycle makes it possible for farms to close temporarily when facing business shocks and resume production relatively quickly when conditions improve. In contrast, the long layer production cycle may result in more lagged effects of business shocks on layer farm operations.

We hypothesize that these differences have implications for the responsiveness of broiler and layer production systems to both supply and demand side shocks resulting from COVID-19. Previous studies have compared profitability (Amos 2006; Anang et al., 2013; Saran and Mini 2010) and impacts of disease (Omer et al. 2010) between broiler and layer farms. However, to date there has been no comparative analyses of their responsiveness to economic shocks such as the COVID-19 pandemic. Such analysis can assist policymakers adopt timely and appropriate measures to help broiler and layer farms and consumers.

A second form of differentiation in Myanmar's poultry farming systems is between 'integrated' and 'non-integrated' farms. Poultry houses on integrated farms are constructed above fishponds, allowing poultry manure and uneaten feed to be utilized as inputs for fish cultivation. Manure acts as a fertilizer that stimulates growth of plankton in the pond that are eaten by filter-feeding fish. This enables production of fish with little or no feed inputs (Little and Edwards 2003). Integration of poultry with aquaculture facilitates low-cost production of fish, which may be sold strategically to smooth cash flow and incomes, offset financial losses, or pay for inputs for poultry production. The prices of fish and poultry products do not necessarily move in the same direction, thus greatly reducing the price risk. In the remainder of the paper we differentiate between four types of poultry farming system: non-integrated broiler ("broiler"), integrated broiler-fish ("broiler-fish"), non-integrated layer ("layer"), and integrated layer ("layer-fish").

Studies of other forms of integrated farming suggested a range of potential benefits relative to non-integrated farms, including increased productivity, incomes, employment, and nutritional value (e.g. Ahmed and Garnett 2011; Dubois et al. 2019; Ramanathan et al. 2020; Tipraqsa et al., 2007). Moreover, a meta-analysis by Gil et al. (2017) found that integrated agricultural systems increase climate resilience. However, most of these studies focused on crop and animal integration, with few studies on poultry and fish integration. No other study has compared the responsiveness and resilience of integrated and non-integrated chicken farms to a systemic shock such as the COVID-19 pandemic, which impacts the entire food system.

Resilience is the ability of social-ecological systems to cope with shocks (Adger 2000). It is a latent variable that cannot be observed or measured directly (Béné 2020; Farrell et al. 2020). Our data do not enable us to calculate a Resilience Capacity Index as a metric for the resilience of chicken farms (FAO 2016). However, previous studies have adopted a variety of proxy indicators of resilience, including production (Di Falco and Chavas, 2008), labor (Komarek et al., 2015), profit (Browne et al., 2013), and crop failure rate (Jones and Thornton 2009). We therefore use several outcome variables to infer chicken farm resilience. These include whether chicken farms remained operational or reopened after closing, farm operational capacity, and number of workers hired. We contend that chicken farms that remain in operation, reopen, recover operational capacity, or rehire workers, display resilience to shocks associated with COVID-19.

We hypothesized that: (1) Broiler and layer farms would respond differently to the shock of COVID-19; (2) Integrated chicken-fish farms would be more resilient to economic shocks than non-integrated farms. We test the two hypotheses using data from a six-round telephone survey of 190 broiler and 79 layer farms in Myanmar, conducted from June to November 2020. We present evidence on the following aspects of farm performance: farm operational status (the extensive growth margin); production capacity relative to 2019 (the intensive growth margin); on-farm employment levels; a purchasing managers index (PMI) of business sentiment.

Our paper makes the following contributions to the literature. First, we study evolving impacts of COVID-19 on different types of chicken farm by comparing farm performance during the crisis with that prior to the shock. Second, we explore the performance of the poultry sector in Myanmar during the COVID-19 pandemic in relation to the Sustainable Development Goals (SDG). Third, our results may have implications for other countries in the region like China, Thailand, and Vietnam, where integrated livestock-fish farms are common (Little and Edwards 2003), and for countries such as Nigeria where the poultry sector is expanding rapidly (e.g. Liverpool-Tasie et al. 2017).

The remainder of the paper is organized as follows: First, we describe the surveys. Second, we present data on the impacts of the COVID-19 pandemic on chicken farms and evaluate differences in the performance of integrated and non-integrated farms. We then examine the impacts of the pandemic on SDGs. The final section concludes by summarizing the key findings.

2. Methodology

Our results are drawn from telephone surveys with 269 chicken farms located within a 100 km radius of central Yangon city, corresponding roughly to the extent of city's peri-urban fringe. Three-

quarters of the broiler farms and half of layer farms were integrated with fishponds. We conducted six survey rounds. The first four rounds were conducted biweekly in June and July 2020, with the fifth and sixth rounds in August and November. We drew the sample from a survey of 423 chicken farms conducted by the authors in August and September 2019. We excluded 38 'semi-broiler' farms[1] and attempted to contact all the remaining farms, among which 269 (190 broiler and 79 layer) answered our calls and agreed to be interviewed. This sampling strategy enables comparison of chicken farm business performance from after the onset of COVID-19 with farm performance in the previous year.

We were unable to access disaggregated information on numbers of poultry farms from a recently fielded National Livestock Baseline Survey (LBDV, 2019) at the time we implemented our original farm survey in 2019. To generate a sample frame, we conducted a systematic visual search of satellite images using Google Earth Pro to identify integrated chicken-fish farms. These are easily recognizable from their distinctive visual appearance. We counted the number and density (per km^2) of integrated chicken-fish houses per village tract (the lowest level administrative sub-unit) and identified locations with high concentrations for inclusion in the sample frame.

Non-integrated chicken farms cannot be identified from visual assessment of satellite images. To ensure their inclusion and validate findings for integrated farms, we conducted expert elicitation with key informants including members of the Myanmar Livestock Federation, township level officers of the Livestock Breeding and Veterinary Department (LBVD), poultry traders, and feed suppliers. Combining this information with our analysis of satellite images, we selected a pool of village tracts containing high concentrations of chicken farms. Villages from each village tract were selected randomly for survey by probability proportional to size. A census of poultry farms was conducted in all villages selected. All farms with at least 500 broilers or layers were selected for inclusion in the survey with 100% probability. Although the sample was not statistically representative of all chicken farms in the surveyed area, previous research shows that production practices among surveyed farms are highly standardized, making our findings applicable to other farms in the same size range within the zone surveyed (Belton et al. 2020).

Our questionnaire on COVID-19 impacts consisted of three parts. The first module covered the self-reported operational status of the farm (operational, temporarily closed, or permanently closed). Farms considered 'temporarily closed' were closed at the time of interview but reported by their owners to be expected to reopen. The second module posed questions about business operations, including cash flow, labor, and farmers' expectations about changes in operational capacity, revenue, and costs. The format of these questions followed the Purchasing Managers' Index (PMI). The PMI is a measure of economic trends in the manufacturing and service sectors that summarizes whether market conditions, as viewed by purchasing managers, are expanding, staying the same, or contracting. An index reading of 50 means that the variable is unchanged. An index above 50 signals growth or expansion, while below 50 indicates decline or contraction. We computed a PMI for operational capacity, operating cost, and revenue to track changes in chicken farmers' expectations on these aspects of their businesses. The third questionnaire module covered input procurement and sales. Questions were designed to be simple and brief so that respondents would be willing to participate in multiple interview rounds, and generate data for descriptive analysis. Where relevant, we tested the significance of differences in means.

To gain deeper contextual insights into the impacts of COVID-19 and associated policies on the poultry sector we conducted a dozen key informant interviews with other players in the chicken and egg value chain, government agencies, and non-government organizations. These included representatives from day-old-chick breeder farms; the Livestock, Breeding and Veterinary Department of the Ministry of Agriculture, Livestock and Irrigation; and the Myanmar Livestock Federation.

[1] 'Semi-broilers' (male layer chickens) and spent layers are also sold for meat, but account for a minor share of total chicken production so we focus on broiler farms as a source of meat and layer farms as a source of eggs.

3. Results

3.1. Impacts on chicken farmers and broiler and egg supply

3.1.1. Operational status of chicken farms

Demand for broilers in Myanmar suffered a double hit in 2020 with a salmonella outbreak in January and February that was followed immediately by COVID-19. According to interviews with the Yangon Poultry Association, without COVID-19 the broiler market was expected to recover by March for Thingyan, the main national holiday. However, the COVID-19 outbreak caused many broiler farms to close temporarily or permanently. Because layer production cycles are longer than for broilers, the responses from layer farms were delayed: Closures of layer farms due to COVID-19 began later, in May 2020.

About 60% of the closed farms in the early June survey round reported both low demand and cash flow problems as the two main reasons for their closures. After July fewer farms reported low demand as reason for closure, but the share of both broiler and layer farms reporting being unable to maintain operations on current cash flow increased gradually. In August, 9% of broiler farms reported that they could not maintain operations on their current cash flow for longer than three months. This number increased to 21% in November after Myanmar experienced a second wave of COVID-19, beginning at the end of August. The share layer of farms reporting that they could not maintain operations for longer than three months with their current cash flow increased from 1% in June to 17% in November.

Broiler farms have recovered gradually since early June thanks to rising demand, and many broiler farms that closed temporarily have reopened. The share of broiler farms in our sample that were operational increased from 69% in early June to 81% in August and November. On the other hand, the share of operational layer farms in our sample decreased from 90% in early June to 83% in July and remained at this level in August and November (Table 1). Broiler farms have a faster supply response than layer farms due to their short production cycle and lower operational cost that accounts for initial divergence and subsequent convergence in the pattern of farms closing and reopening.

Layer-fish farms appear to have been more resilient to the impact of COVID-19 on their business than layer farms. Of the layer farms in our sample, 24% were closed in November. Of these, almost 80% of their owners reported that they expected the shut-down to be permanent. In contrast, 90% of layer-fish farms remained operational in November, and only half of those that closed expected to not reopen. The share of layer-fish farms operational between late June and November was significantly higher than the share of operational layer farms during this period (Fig. 1). Although the layer farm sub-samples are quite small (39 non-integrated and 40 integrated), this result suggests strongly that layer-fish farms have proven more resilient to the economic shock of COVID-19 than layer farms.

However, no difference was observed in the performance of broiler-fish and broiler farms, in terms of farm closure rates. We hypothesize that this is because demand for broilers suffered a double hit from the salmonella outbreak in January, followed immediately by COVID-19. These demand challenges for broiler farms were compounded on the supply side by shortages of day-old-chicks, explored later in the paper. Challenges in acquiring chicks impacted broiler farms much more than layer farms due to the short production cycle of the former. For broiler farms, these additional challenges may have exceed the cash flow buffer provided by income from sales of fish in determining whether broiler farms were able to remain operational.

Smaller broiler farms were more likely to close permanently during the COVID-19 pandemic, causing the broiler sector to become more

Table 1
Operational status of chicken farms by survey round, percent of farms surveyed.

	Broiler farms						Layer farms					
	early June	late June	early July	late July	Aug.	Nov.	early June	late June	early July	late July	Aug.	Nov.
Still in operation	69	72	78	82	81	81	90***	85**	83	85	83	83
Temporarily closed	25	22	11	7	8	5	4	6	8	6	6	5
Permanently closed	6	6	11	11	11	14	6	9	9	9	10	12

Source: 2020 Yangon peri-urban poultry farmer survey – first to sixth rounds.
Note: Tests for differences of means of share of operational farms between broiler and layer farms.
** Significant at 5%.
*** Significant at 1%.

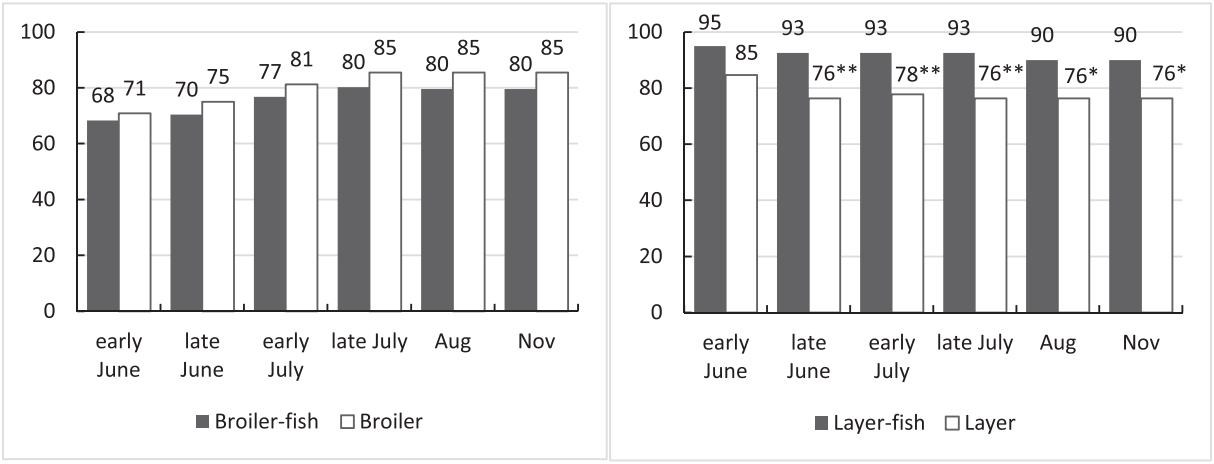

Fig. 1. Share of integrated and non-integrated broiler and layer farms remaining operational, by survey round.
Note: Tests for differences of means of share of operational farms between integrated and non-integrated for both broiler and layer farms.
*Significant at 10%; **Significant at 5%; ***Significant at 1%.
(Source: 2020 Yangon peri-urban poultry farmer survey – first to sixth rounds.)

concentrated. The mean flock size of permanently closed broiler farms was 3560, as compared to a mean flock size of 6560 for the remaining operational broiler farms. This pattern did not hold for layer farms, for which the mean size of permanently closed farms was similar to the mean flock size of the operational ones.

3.1.2. Changes in production

Besides changing their operational status, chicken farms were able to adapt by adjusting the quantity of birds in their flocks. Because the production cycle for broilers is much shorter than for layers, broiler farmers have greater flexibility than layer producers in adapting to short term changes in input costs and demand. However, the degree of flexibility is limited by the biology of the birds, which have been highly selectively bred and require adherence to a standardized feeding protocol and production cycle duration to maintain levels of productivity that are economically efficient.

The average length of broiler production cycles increased from 45 days in 2019 to 51 days around early June 2020, while the average length of the gaps between cycles increased from 17 days in 2019 to 28 days by early June 2020. The number of birds stocked by broiler farms

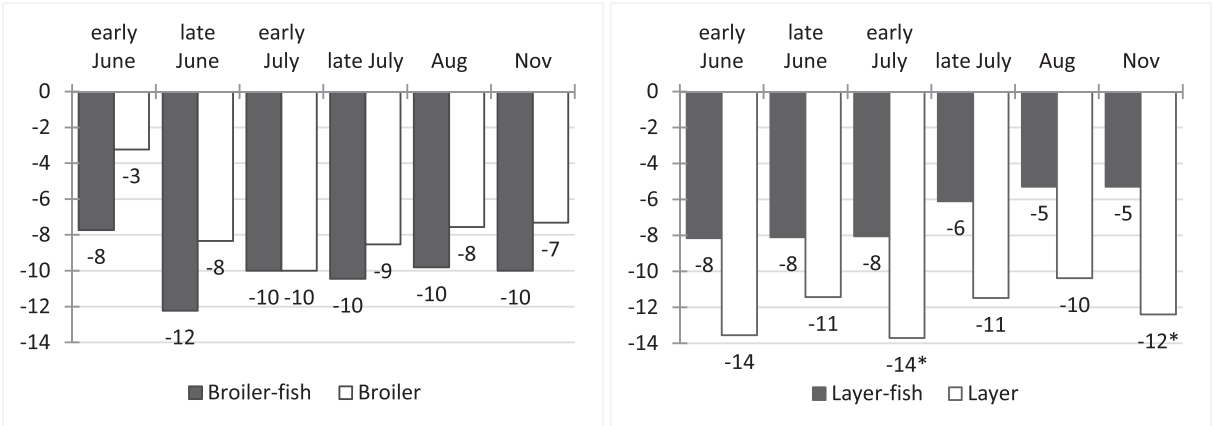

Fig. 2. Percentage change of operational capacity in chicken farms compared with 2019, monthly average level by chicken type and integrated/non-integrated system.
(Source: 2020 Yangon peri-urban poultry farmer survey – first to sixth rounds.)

also decreased by 20% in early June compared to the 2019 average. Chicken farmers continued to adjust their behavior between July and November in response to the evolving market, and operational capacity recovered slightly from late July. The operational capacity of layer farms decreased more than layer-fish farms, although the difference was only significant in early July and November (Fig. 2). This pattern is consistent with our finding that layer-fish farms are economically more resilient than layer farms thanks to sales of fish.

Breeder farms that produce day-old broiler chicks for were also impacted by COVID-19. Key informants reported that, to cope with the low demand for chicks due to the outbreaks of salmonella and the early stages of the COVID-19 pandemic, some breeder farms lowered day-old-chick production by either selling breeders as meat or producing and selling more eggs instead of incubating them. Some breeder farms closed. For the farms that kept their breeders, it would take at least 21 days to incubate a new cohort of day-old-chicks. For the farms that got rid of their breeders, it would take an additional four months to rear new breeders. Therefore, a supply shortage of day-old-chicks became the key bottleneck for broiler farms in June as demand for broilers began to pick up. This caused the price of day-old-chicks to spike in June and July (Fig. 3). The Government of Myanmar acted rapidly to allow day-old-chicks to be imported. This decision, taken in mid-May in consultation with the Myanmar Livestock Federation, greatly eased supply shortages by August. This swift policy intervention to stabilize the supply of day-old-chicks appears to have been an important factor in stabilizing the volatile broiler market in Myanmar, contributing to the sector's resilience.

3.1.3. Farmers' expectations

Chicken farmers became more optimistic about improving their operational capacity and increasing revenues between June and August, yet more worried about the higher costs they were experiencing. However, they became pessimistic again based on our November survey round, due to the second wave of COVID-19.

The PMI operational capacity indices for both broiler and layer farms increased significantly in August but remained below 50 (Fig. 4-a). This suggests that the operational capacity of both broiler and layer farms improved between July and August but remained lower than the 2019 average. The Myanmar government's policy of allowing importation of day-old-chicks since mid-May meant that fewer broiler farms have suffered from a shortage of day-old-chicks since this time, which has contributed to their improvement in operational capacity. Additionally, price increases for eggs in August (Fig. 3) helped the operations of layer farms.

The PMI revenue index for both broiler and layer farms increased considerably between July and August (Fig. 4-a). The revenue index for broiler farms in August exceeded 50, suggesting that the operational broiler farms expected their revenues to reach the 2019 average level. For layer farms, the PMI revenue index in August (62) surpassed that of broiler farms (52). Layer farms likely benefited from a 10% increase in the price of eggs in August, even though the total quantity of eggs sold by surveyed farms barely changed. The PMI revenue index for both broiler and layer farms decreased considerably in our November survey round due to the collapsing demand for chicken and eggs amid the second wave of COVID-19 (Fig. 4-a).

Layer-fish farms outperformed layer farms for all three PMI indexes in every survey round between June and November 2020 (Fig. 4-b, 4-c, 4-d). This implies that layer-fish farms were always able to maintain higher operational capacity and revenue, and lower costs than layer farms. This again demonstrates that layer-fish integrated farms were more resilient to economic shocks than pure layer farms.

3.1.4. Employment

Poultry farming is a labor-intensive activity. Most fulltime workers in the sector originate from low-income households in remote rural areas and live permanently on-farm (Belton et al. 2020). According to our survey in 2019, chicken farms hired an average of seven long term workers. According to LBVD's National Livestock Baseline Survey (LBVD 2019), the three regions covered by our survey (Ayeyarwady, Bago, Yangon) account for 51% and 24% of Myanmar's broiler and layer population, respectively. The average flock size of broiler farms in these three regions is similar to most other states and regions in Myanmar. Layer farms in the regions in our survey are also of similar size to most other states and regions, except for Shan State which has 37% of the national layer population, and average flock sizes that are several times larger than those found in the rest of the country (LBDV, 2019).

Because intensive chicken farms in Myanmar follow quite standardized production practices, we assume that chicken farms near the other major cities adopt the same labor-chicken ratio. Using the total poultry population from the Myanmar National Livestock Baseline Survey (LBDV 2019), we estimate that there were approximately 23,900 long term farmworkers in the chicken sector before the pandemic.

Particularly at the beginning of the COVID-19 outbreak in Myanmar, chicken farms reduced the number of workers employed due to reduced production. According to our telephone surveys, the number of workers hired by broiler farms surveyed fell by almost half between September 2019 and June 2020 – from 998 to 521 (Fig. 5). Although many broiler farms that closed have reopened since early June, the total number of workers hired has not increased for either broiler-fish or broiler farms. As the broiler market became more volatile due to COVID-19 (see price fluctuations in Fig. 3), broiler farmers were likely more cautious about rehiring workers.

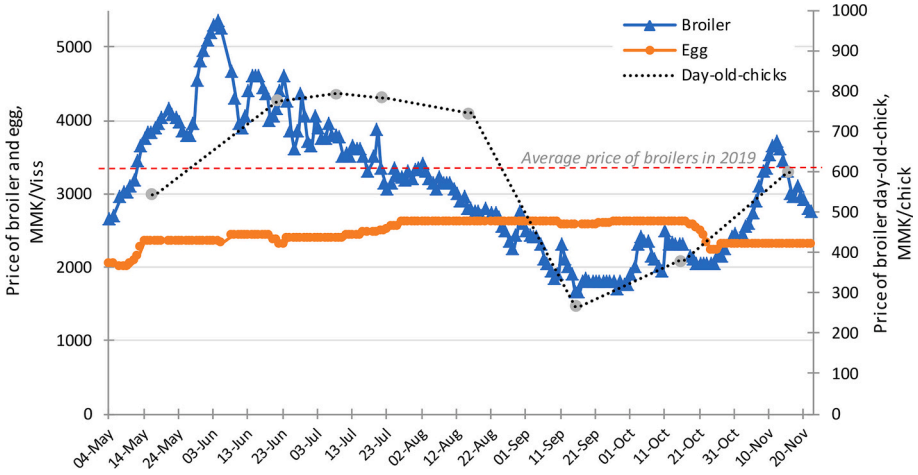

Fig. 3. Daily farmgate prices of broiler chickens and chicken eggs and price of broiler day-old-chicks, May to November 2020.
Note: Viss is a traditional unit of mass in Myanmar equivalent to 1.63 kg. In early 2020, MMK 1375 ≈ USD 1.00.
(Source: Authors' compilation based on the daily broiler and egg price posted on Facebook by Myanmar Livestock Federation. The price of day-old-chicks is based on the Yangon peri-urban poultry farmer survey (six rounds).)

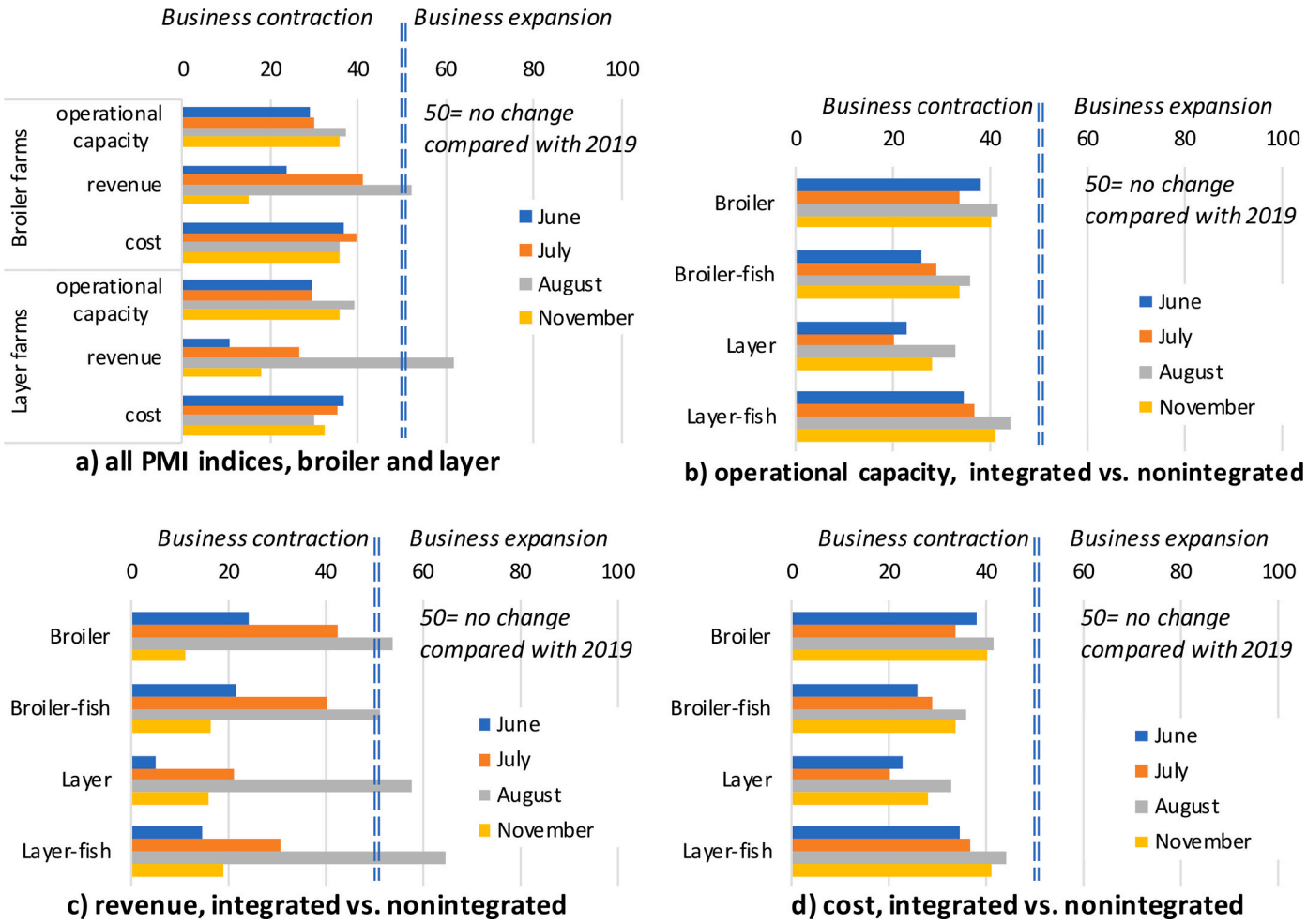

Fig. 4. Purchasing Managers' Indices (PMI) of chicken farms in 2020 compared with 2019.
Note: In order to compare with the August monthly data, we converted the four rounds of biweekly data in June and July to monthly data. If the value is above 50, it means expansion. Below 50 implies expectation of contraction.
(Source: 2020 Yangon peri-urban poultry farmer survey – first to sixth rounds.)

On the other hand, among the layer farms in our sample, layer-fish farms in particular started to rehire workers since the late July, although the number of workers decreased again due to second wave of COVID-19 in Myanmar (Fig. 4). This again suggests that layer-fish farms are more resilient to shocks than pure layer farms. Layer farms probably benefited from the relatively more stable market and rising price of eggs and increased the number of workers that they employed accordingly. Nonetheless, the total number of workers hired by layer farms remained much lower than in 2019.

Total job losses on chicken farms up to the November survey round accounted for 42% of the total 2019 labor force on the farms surveyed. Using the total broiler and layer population from the Myanmar National Livestock Survey (LBDV, 2019), and assuming the same job loss rate, labor-chicken ratio, and wage rate of the chicken farms around the other major cities are same as the surveyed farms in Yangon area, we estimate a loss of an estimated approximately 10,000 full-time chicken farm worker jobs, and a monthly wage loss USD 1,200,000 for Myanmar's chicken sector as a whole.

3.2. Implications for Myanmar's achievement of the sustainable development goals

SDG 2 ("Zero Hunger"), specifically "Target 2.1 – Universal access to safe and nutritious food", is likely to deteriorate in Myanmar due to the impacts of COVID-19 on the poultry sector. The prevalence of undernourishment, which is an indicator for Target 2.1, decreased significantly in Myanmar over the past two decades from 32% in 2004–06 to 10.6% in 2016–18 (FAO et al. 2019). Consumption per capita of animal-sourced foods has increased considerably in urban areas, although it has remained almost unchanged in rural ones (Belton et al. 2020). Among low-income households, egg is the only category of animal sourced food for which consumption has increased. All recent increases in animal-sourced food consumption have been driven by growth in the supply of chicken and eggs and their falling real prices (Belton et al. 2020). The outbreak of COVID-19 has partially reversed these trends. Such impacts have significant potential to delay the achievement of the SDG Target 2.1 in Myanmar.

Recent job losses and reductions in income on poultry farms and among other participants in the poultry value chain in Myanmar are substantial. These are expected to have adverse implications for Myanmar's achievement of SDG 8 ("Decent Work and Economic Growth") – specifically, Target 8.3 to "Promote policies to support job creation and growing enterprises".

4. Conclusions

We present evidence on the impacts of COVID-19 on broiler and layer farms in Myanmar, based on a high frequency longitudinal survey

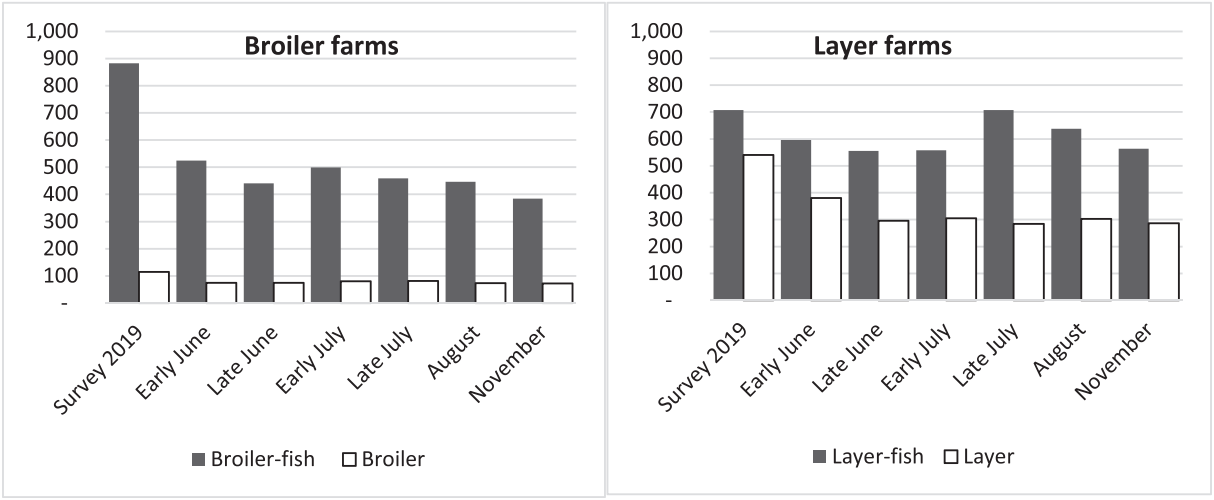

Fig. 5. Changes in total number of hired workers on operational chicken farms by type of farm.
Source: 2020 Yangon peri-urban poultry farmer survey – first to sixth rounds.

of 269 farms. We find evidence of a partial 'V' shaped recovery from March to August for broiler farms. Broiler farms responded rapidly to undersupply and rising prices following the easing of COVID-19 lockdown restrictions in May. The outlook for revenue in the August PMI surpassed 50, indicating an expectation of expansion in September. Although the operational capacity of broiler farms only decreased slightly in November as the second wave of COVID-19 infections emerged in Myanmar in September 2020, the farmers expected their revenue to decrease dramatically due to the collapsing demand.

Layer farms were slower to close than broiler farms, but once shut down, they faced difficulties in reopening in response to rising egg demand. The slow supply response of layer farms resulted in a 30% increase in the price of eggs from May to August. Integrated layer-fish farms have proven more resilient to shocks than layer farms, with a much lower failure rate. For broiler farms, large swings in the price of broiler chicken and day-old-chicks seem to have overridden the ability of integrated farms to offset risk through sales of fish, causing broiler-fish and broiler farms to suspend operations at the same rate.

More than 40% of chicken farm workers have lost permanent employment since the beginning of the crisis. Low-income consumers for whom eggs now represent a vital source of micronutrients, will also suffer from reduced intakes of this important nutritious food. These trends will negatively impact Myanmar's ability to reach SDG targets 2 on hunger and malnutrition, and 8 on employment.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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