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Livestock, capture fisheries, and aquaculture in Myanmar: Status and recent trends

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ABSTRACT

Traditional forms of livestock-rearing and fishing have been central components in rural livelihoods in Myanmar for centuries and remain important today. More capital-intensive forms of marine fishing, aquaculture, and poultry farming began to expand during the early-1990s and grew briskly thereafter. This paper summarizes the status of the supply side of livestock, capture fisheries and aquaculture sectors in Myanmar, based on analysis of nationally representative data extracted from the Myanmar Living Conditions Survey 2017 and supporting information from other recent surveys and secondary sources. We examine levels of livestock ownership, participation in capture fisheries and aquaculture, reasons for rearing livestock, ownership of fishing assets, and household earnings from all three activities. We also discuss the characteristics of more geographically clustered, capital-intensive forms of poultry and swine farming, fishing, and fish farming, and the downturn in these sectors beginning in 2020 with the twin crises of COVID-19 and the coup. We conclude with a discussion of possible future directions for livestock farming, capture fisheries and aquaculture in Myanmar, along with priorities for sectoral upgrading.

1. INTRODUCTION

Traditional livestock-rearing and fishing have been central components in rural livelihoods in Myanmar for centuries and remain so today (Khin 1948). More capital-intensive forms of marine fishing, aquaculture, and poultry farming began to expand during the early-1990s and have grown briskly since (Tezzo et al 2018; Belton et al 2020). Poultry and aquaculture commoditization accelerated from 2011-2019, stimulated by the demand side pull of rapid income growth, and foreign and domestic investment in areas such as feed milling and food retail (e.g., businesses such as Kentucky Fried Chicken, which opened in Myanmar in 2015). However, despite recent growth, both sectors both lag those in more developed countries in the region in terms of technological sophistication, scale, and regulation (e.g., World Bank 2019a).

This paper summarizes the status of the supply side of livestock, capture fisheries and aquaculture in Myanmar, based on analysis of nationally representative data extracted from the Myanmar Living Conditions Survey 2017 (MLCS), and reviews trends in these sectors using supporting information drawn from other recent surveys and secondary sources. We analyze MLCS to sketch a picture of the contributions of livestock, capture fisheries, and aquaculture to household incomes in the four agroecological zones (Delta, Dry Zone, Coasts, Hills) by which MLCS results are stratified (World Bank 2019b). The livestock and fishery modules of MLCS asked questions about each household's ownership, production, sales, and consumption of livestock and livestock byproducts, and aquaculture and capture fisheries products in the past 12 months. Respondents were asked to estimate the quantity or value of these variables, making it possible to calculate the value of livestock and fish income, expenditure, and consumption for each household.

We examine levels of livestock ownership, participation in capture fisheries and aquaculture, reasons for rearing livestock, ownership of fishing assets, and average household earnings from all three activities. We also discuss the characteristics of more geographically clustered, capital-intensive forms of poultry and swine farming, fishing, and fish farming, and the downturn in these sectors since the twin crises beginning in 2020. We conclude with a discussion of possible future directions, and priorities for sectoral upgrading.

2. CONTRIBUTIONS OF LIVESTOCK AND FISHERIES TO RURAL HOUSEHOLD INCOMES

Table 1 presents data derived from MLCS on the share of rural household income originating from different sources. We divide the country into the four agroecological zones (AEZs) on which the MLCS sample stratification is based[1]. The following points stand out.

First, the overall reported contribution of livestock to average rural household incomes (calculated as the value of livestock and any livestock byproducts sold, consumed, or received as gifts, minus any production costs incurred) is reported as slightly negative (-1 percent). The share

[1] We follow classifications from the MLCS poverty report (World Bank, 2019b) where States/Regions are mapped to approximate AEZs: Delta (Ayeyarwady, Bago, Mon, Yangon); Coastal (Rakhine, Tanintharyi); Dry Zone (Mandalay, Magway, Naypyidaw, Sagaing); Hills (Chin, Kachin, Kayah, Kayin, Shan).

of household income originating from livestock is reported as slightly negative in the Delta and Dry Zone (indicating net financial losses on average) and as contributing 2 percent and 3 percent respectively in the Coastal zone and Hills. We surmise that these figures underrepresent the contribution of livestock to rural household incomes due to difficulties with accurate measurement. Costs associated with maintaining livestock that remained unsold during the survey recall period may appear as negative income.

Second, income from fish production (capture fisheries and aquaculture) makes a low reported contribution to rural incomes in the Delta (3 percent) and Dry Zone (1 percent), and slightly negative contribution in the Hills (-2 percent). Fishing income and associated costs can also be difficult to record accurately in household surveys, because fishing activities are temporally variable and unpredictable in nature, as determined by factors including seasonality, lunar cycle, weather, and the shifting location and abundance of fish stocks, so these figures should be treated with some caution.

Table 1: Income share by activity among rural households (%)

Income source	Delta	Coastal	Dry Zone	Hills	Total
Crops	24	10	32	59	32
Livestock	-2	2	-2	3	-1
Fish	3	11	1	-2	2
Non-farm enterprise	18	25	15	13	17
Wage	41	36	39	12	34
Remittance	9	12	8	11	9
Rental	1	1	1	1	1
Social transfer	1	1	1	1	1
Others	4	3	5	2	4
Sample N	*2,304*	*1,176*	*2,160*	*2,748*	*8,388*

The Coastal zone, where fish originate primarily from marine capture fisheries, has by far the largest share of reported rural income derived from fish, at 11 percent. This figure is similar to the share of income reported from crop farming in the Coastal zone (10 percent). Similar findings have been reported in Mon State, where commercial small-scale marine fishing was found to account for 11 percent of rural income in 2015, as compared to 13 percent derived from rice cultivation (CESD, IFPRI & MSU 2016).

Table 2 partially addresses difficulties in calculating net incomes by breaking down the average value and share of gross income[2] originating from crop farming, livestock, and fish production for all households engaged in these activities. Overall, the total gross income from these three sources is highest on average in the Delta (USD 2,008/household) and lowest in the Hills (USD 1,220/household). These variations are likely driven in part by differences in average landholding sizes among zones.

[2]Gross income is calculated as the value of sales, plus the imputed value of consumption originating from own production and any production given-away.

As expected, crop farming makes the biggest contribution to gross income among the three activities, averaging 86 percent nationally. The share of livestock in gross producer income is highest in the Dry Zone (10 percent) and Hills (9 percent), underlining the importance of animal husbandry for livelihoods in these zones (c.f., Belton et al. 2021a), and lowest in the Coastal zone (6 percent). Conversely, the share of fish in gross income is by far the highest in the Coastal zone (34 percent), underlining the importance of marine fishing to the coastal rural economy. In the Delta, where most of Myanmar's freshwater fishing and aquaculture are concentrated, fish and livestock account for similar shares of producer income (6 percent and 7 percent, respectively). Fish contributes only 1 percent of gross producer income in the Dry Zone and Hills.

Fish and livestock make proportionately greater contributions to the incomes of poorer households than to the incomes of the better-off. We divide households into expenditure terciles as a proxy for income, where tercile 1 is the third of households with the lowest per capita expenditures, tercile 3 is the third of households with the highest per capita expenditures. The wealthiest third of households obtain higher average gross incomes from crops, livestock, and fish than the poorest third. However, fish contributes twice the share of producer income for households in expenditure tercile 1 (8 percent) compared to those in expenditure tercile 3 (4 percent). Similarly, livestock contributes 11 percent of gross producer income for the poorest third of households, and 7 percent for the wealthiest.

Table 2: Gross income from crops, livestock and fish for producing households, by zone and expenditure tercile (USD/household)

	Delta	Coastal	Dry Zone	Hills	All	All (T1)	All (T2)	All (T3)
Crops (USD)	1,737	762	1,561	1,101	1,450	830	1,535	2,316
Crop share (%)	*86*	*60*	*89*	*90*	*86*	*82*	*87*	*89*
Livestock (USD)	143	74	172	110	139	108	148	174
Livestock share (%)	*7*	*6*	*10*	*9*	*8*	*11*	*8*	*7*
Fish (USD)	129	425	20	9	92	80	91	113
Fish share (%)	*6*	*34*	*1*	*1*	*5*	*8*	*5*	*4*
Total (USD)	2,008	1,261	1,753	1,220	1,681	1,018	1,774	2,604
Total (%)	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

Note: Gross income is the aggregated value of sales, own consumption, and gifts given away. Agricultural households are defined here as households who engaged in crop farming, fisheries (aquaculture or fishing), or selling own livestock.

The figures presented above do not capture the full extent of the contributions of livestock and fish to Myanmar's rural economy because intensive livestock farming, commercial aquaculture, and larger-scale capture fisheries all tend to be highly spatially clustered, often in peri-urban areas. Targeted oversampling or dedicated surveys in these locations are required to ensure the representation of these enterprises. We discuss specialized highly commercial forms of livestock and fish production in more detail in later sections of the paper.

3. NATIONAL SURVEY RESULTS

3.1 Livestock

In this section we present analysis of data from the MLCS, summarizing: (1) the share of households involved in cultivation of different types of livestock; (2) the number and value of livestock owned per household; (3) the reported purpose of livestock ownership. Ownership of livestock is far more common in rural areas than urban (although 12 percent of urban households own some form of livestock), so we limit our analysis here to rural households.

Rural livestock keeping is extremely common, even among households without agricultural land. Well over half (59 percent) of rural households, and 41 percent of landless rural households raise animals. Among landed households (defined here as those owning any farmland), this share rises to 75 percent (Table 3).

Chickens are the most common animals raised (33 percent of rural households), followed by cattle (26 percent) and pigs (24 percent). Less common animals include ducks (5 percent), buffalo (4 percent) and goats[3] (2 percent) (Table 3). Cattle are the most common animals kept by landed rural households (reared by 45 percent), consistent with their use in agriculture and access to fodder from farm crop residues, followed by chickens (39 percent). Among landless households the most common animals raised are chickens (29 percent) and pigs (20 percent).

Cattle are most common in the Dry Zone, where they are widely used as draft animals; kept by 42 percent of households, rising to 69 percent among the landed. Chickens and pigs are most common in the Delta (kept by 44 percent and 29 percent of households, respectively), followed by the Hills (36 percent and 29 percent). Ducks are most common in the Delta (12 percent of households), and buffalo are most common in the Hills (11 percent) (Table 3).

Table 3: Share of rural households owning livestock, by zone (%)

Animal	Delta	Coastal	Dry Zone	Hills	Total
Buffalo	2	4	2	11	4
Cattle	17	19	42	18	26
Goats	1	1	2	2	2
Pigs	29	13	20	29	24
Chickens	44	36	22	27	33
Ducks	12	3	1	2	5
Any livestock	59	54	60	58	59

The livestock rearing activities captured by the MLCS are predominantly small-scale. Households raise an average of 4 head of cattle or buffalo, 2.5 pigs, 29 chickens, or 20 ducks. Buffalo and cattle are the most valuable of these animals, worth an estimated total of USD 1602 and USD 1345, respectively, to households that raise them. The average total value of goats and pigs owned is estimated at USD 405 and USD 196, respectively. The total value of chickens and

[3] 'Goats' also includes a small number of sheep.

ducks owned per household averages USD 36 and USD 46 respectively, reflecting small flock sizes. These numbers do not vary much by zone, with the partial exception of goats, herds of which are 3-4 times larger in the Dry Zone than the rest of the country.

Reported average gross incomes earned by rural households rearing livestock average USD 143/year. This underlines the small-scale nature of most livestock rearing reported in the survey. Average gross income from most types of livestock ranges from approximately USD 100-150, but reaches only USD 36/year for chickens. Gross income from livestock rearing is highest in the Dry Zone (USD 160) and lowest in the Coastal zone (USD 113) (Table 4).

Table 4: Gross income (USD) per rural household by type of livestock, conditional on ownership, and zone

Type of animal	Delta	Coastal	Dry Zone	Hills	Total
Buffaloes	206	115	152	142	153
Cattle	173	96	131	113	137
Goats	77	49	257	6	146
Pigs	111	68	119	66	101
Chickens	28	81	31	40	36
Ducks	61	5	10	15	54
Any livestock	146	113	160	116	143

Note: Gross income is the aggregate value of sales, own consumption, and gifts given away of livestock and their by-products.

Livestock rearing is used strategically to meet a variety of important functions within the rural household economy. Cattle and buffalo are kept mainly for draught power (as reported by around 73 percent of owning households), followed by sale of animals or their products (30 percent), and as a source of manure (around 15 percent). Informal cross-border exports of live cattle to China increased steeply before 2020, leading to moves to formalize the trade (Diao et al, 2020). Although keeping cattle is widespread, there is little dedicated dairy farming, and fresh milk consumption is low and concentrated mainly in urban areas, averaging 1.4 kg/capita/year nationally and just 0.5 kg/capita/year in rural areas in 2015 (Scott et al. forthcoming).

Table 5: Share of rural households reporting main purpose of owning livestock, by livestock type (%)

Purpose	Buffalo	Cattle	Goats	Pigs	Chickens	Ducks
Livestock or products for sale	30	29	83	87	56	60
Food for family	1	1	4	6	58	51
To cope with expenses	4	6	13	13	14	14
Draught power	72	74	0	0	0	0
Manure	14	18	2	0	0	0
Transport	8	14	0	0	0	0
Savings	7	5	14	22	4	4
Breeding	2	1	0	0	0	0

In contrast, pigs and goats are raised mainly for sale (reported by around 85 percent of households), as a form of savings (mentioned by 22 percent and 13 percent of respondents, respectively), and to cope with expenses (a similar function to savings, mentioned by 13 percent). Only 1 percent of households rearing cattle and 6 percent raising pigs do so for their own consumption. In contrast, households raising chickens and ducks report that producing food for own consumption and producing for sale are of approximately equal importance (both mentioned by >50 percent of households). Coping with expenses is the next most important reported reason (14 percent) for raising poultry (Table 5).

3.2 Capture fisheries and aquaculture

Fishing and aquaculture are far more common in rural areas than urban ones (where only 1 percent of households engage in both activities combined), so all results presented in this subsection refer to rural households. Table 6 presents the share and estimated number of rural households engaged in fishing or aquaculture by AEZ in 2017.

Aquaculture is comparatively rare, practiced by just 0.4 percent of rural households, equivalent to 34,000 households nationally. In contrast, 11 percent of the rural population, equivalent to >900,000 households engage in some form of fishing: over 26 times more than are practicing aquaculture. In the Delta and Coastal regions, 18 percent of households practice fishing, as do 13 percent of those in the Hills. About half of all fishers and fish farmers are in the Delta, which is the epicenter of most of Myanmar's commercial aquaculture, and the site of its main inland capture fishery as well as a significant marine fishery. Participation in fishing and fish farming are lowest in the semi-arid Dry Zone, where just 2 percent of households fish and only 0.1 percent engage in aquaculture (Table 6).

Table 6: Share and number of rural households engaging in fishing and aquaculture, by agroecological zone

Activity	Delta	Coastal	Dry Zone	Hills	Total
Share of rural households involved (%)					
Fishing	18	18	2	13	11
Aquaculture	0.5	1.5	0.1	0.4	0.4
Number of rural households involved (weighted)					
Fishing	530,939	132,884	58,325	184,970	907,117
Aquaculture	16,273	10,766	1,458	5,660	34,157

The majority of fishing households are landless (62 percent nationally and 75 percent in the Coastal zone). Somewhat surprisingly, 31 percent of households practicing aquaculture are reported as landless, compared to only 11 percent of households involved in crop farming. This might reflect a tendency for fish farmers to access land via rental markets, but it is also possible that the result is an anomaly driven by the small number of households practicing aquaculture included in the sample.

Among landed fishing households, the average area owned is 2.6 ha – almost the same as the average area owned by farming households (2.7 ha). In contrast, landed aquaculture households own an average of 4.9 ha, nearly double the average agricultural landholding,

suggesting that they tend to be better off than average, and perhaps reflecting their concentration in the Delta, where average landholdings are larger than in the rest of the country (Belton et al., 2020).

Ownership of fishing assets by fishing households is rather limited, reflecting the small-scale nature of most fishing activities practiced by households in the sample. Only 38 percent of fishing households own a boat, and just 15 percent own a boat engine, indicative of low average levels of capital intensity and fishing capacity. About two-thirds of fishers own fishing nets, except in the Hills where only one-third do. About one-quarter of fishers own other fishing gears, such as fish traps. As expected, boat ownership and levels of motorization are highest in the Coastal zone (61 percent and 47 percent respectively), and lowest in the Hills (5 percent and 1 percent). Approximately 20 percent of fishing households report processing part of their catch (e.g., by drying or fermenting), and this share is similar across zones (Table 7).

Table 7: Share of fishing households with fishing assets, by agroecological zone

	Delta	Coastal	Dry Zone	Hills	Total
Boat used for fishing	44	61	30	5	38
Engine for fishing boat	13	47	4	1	15
Nets	61	69	68	34	57
Other fishing gears (including traps)	28	29	20	22	26
Other fishing equipment	18	29	33	41	25
Households processing fish products (%)	21	17	19	17	19

Table 8 presents the imputed gross annual income earned by fishing and fish farming households, calculated as the total value of fish originating from own production, whether sold, consumed by the household, or gifted to others. The small sample size for aquaculture households makes it difficult to interpret or clean anomalies in reported costs of production, so we do not attempt to calculate average net incomes.

Table 8: Average gross household income (USD) from aquaculture and fishing, and marketed surplus (share of value of fish sold), by zone

	Delta	Coastal	Dry Zone	Hills	Total
			Aquaculture		
Gross aquaculture income	965	654	1,119	166	735
Marketed surplus (%)	94	84	95	68	89
N (unweighted)	13	16	4	21	54
			Fishing		
Gross fishing income	453	1,426	561	59	524
Marketed surplus (%)	86	88	87	37	86
N (unweighted)	431	236	54	434	1,155

Average gross incomes earned from fishing and aquaculture are roughly 2.5 and 5 times higher than gross incomes from livestock keeping, respectively. Fishing incomes are highest in the Coastal zone, consistent with the higher levels of motorized boat ownership in this area, and lowest in the Hills. Aquaculture incomes are highest in the Delta and Dry Zone (though with very

small sample sizes in each), and lowest in the Hills. Interestingly, despite the evidently small-scale nature of much fish production captured by the survey, a large majority of the fish produced is sold (89 percent of aquaculture fish and 86 percent of capture fish). This pattern is consistent across all zones, apart from the Hills, where the marketed surplus is somewhat lower (68 percent and 37 percent for aquaculture and capture, respectively).

4. CHARACTERISTICS OF LARGER-SCALE PRODUCTION

4.1 Commercial poultry and pig farming

The data presented above indicate that most rural households raising chickens in Myanmar do so on a very small scale. In such 'traditional' or 'backyard' poultry systems, most birds are native breeds. Scavenging is the main source of feed, supplemented by unformulated feeds like rice and kitchen scraps, and most birds are unhoused (Birhanu et al. 2021).

On specialized larger-scale intensive poultry farms, flocks of improved breeds of broiler (meat) or layer (egg laying) chickens, usually numbering in the 1000s, are raised in enclosed feedlots using commercially manufactured formulated diets. Farms of this kind grew extremely rapidly in the peri-urban zones around larger cities in Myanmar from 2011-2019 (Belton et al. 2020). Broiler production is especially concentrated in Yangon, Mandalay and Eastern Bago, each accounting for 24 percent, 15 percent and 14 percent, respectively of Myanmar's broiler population. Southern Shan, where cooler average temperatures favor egg production, has the highest concentration of layer farms, accounting for 28 percent of Myanmar's layer population (LBVD 2019).

Two-thirds of poultry farms in the peri-urban zone around Yangon are integrated with fishponds, whereby poultry houses are constructed above fishponds, allowing poultry manure and uneaten feed to be utilized as inputs for fish cultivation (Fang et al. 2021). Analysis of satellite images shows that the number of chicken feedlots built over fishponds within a 100 km radius of Yangon more than doubled from 2014 to 2018, growing from 1898 to 3868. The number of village tracts in this zone with integrated chicken-fish farms increased from 121 to 230 (Belton et al. 2020).

A national livestock census conducted in 2018 indicated that 10,747 holdings are raising broilers and 6,278 holdings raising layers, accounting for less than 1 percent of poultry producers in Myanmar. However, the combined population of broiler and layer farms is 29.2 million birds (16.2 million broilers and 13 million layers). In contrast around 4 million holdings raised 45 million native chickens (LBVD 2019). These figures suggest that approximately 40 percent of Myanmar's standing chicken population in 2018 was comprised of 'improved' breeds reared under intensive conditions. The contribution of intensively reared chickens to Myanmar's total poultry and egg production is likely higher still, given that broilers attain market size much more quickly than native breeds, with an average production cycle of 45 days (Fang et al. 2021), and layers produce eggs at a higher rate than native birds.

It has been estimated that only 40 percent of broilers produced in Myanmar are grown by 'independent' farms. The remaining 60 percent are thought to be produced by vertically integrated international firms and contract farmers linked to them as out growers (Birhanu et al. 2021). The largest of these companies is CP Myanmar, a subsidiary of the Thai multinational that was the

first company to initiate broiler production in Myanmar in the 1990s. CP is estimated to command a 40-45 percent share of Myanmar's broiler market (Birhanu et al. 2021). However, there was a big increase in foreign direct investment in the poultry sector from 2011-2019, with companies from China (New Hope), South Korea (Sunjin), Vietnam (Greenfeed), Indonesia (Japfa), and the Netherlands (De Heus) establishing feed milling and distribution operations, in addition to numerous domestic companies (Belton et al. 2020).

Pig farming is undergoing a transformation similar to poultry. Over two million households raised 5.8 million pigs in 2018, predominantly as a traditional 'backyard' activity, but swine production is becoming increasingly commoditized, particularly on the periphery of large cities (LBVD 2019). For instance, Hlegu, a peri-urban township in the Northern outskirts of Yangon, has relatively large-scale pig farms with 70 or more pigs, including some of the largest pig farms in Myanmar with herd sizes numbering in the thousands (Ebata 2022).

A recent survey of mainly medium-scale pig farms in the Yangon peri-urban zone found that improved breeds were much more common than local breeds, with the latter accounting for about only 25 percent of pigs raised. Local breeds have a longer production cycle than improved breeds, and their meat is fattier and less valuable than that of improved pigs, but they can be raised wholly or partly on a diet containing low-cost ingredients such as kitchen scraps. In contrast, improved breed pigs must be raised using more expensive commercially manufactured formulated feeds for optimum performance. Until 2010, most surveyed farms used non-formulated feeds, but by 2019, 89 percent used formulated feeds, reflecting the recent shift toward the intensification of production (Belton et al. 2020).

4.2 Marine and inland capture fisheries

Myanmar's fisheries statistics are notoriously unreliable, causing FAO to take the unusual step of revising Myanmar's national fish production statistics downward from about 5.6 million metric tons to 3 million metric tons in 2016 (Tezzo et al. 2018). The poor quality of official statistics makes it impossible to estimate the share of catch landed by small-scale and large-scale fishers with any degree of confidence. However, similar to the poultry sector, it is clear that small-scale fishers account for a large majority of households involved in fishing as owner-operators, while large fishing businesses are far less numerous but account for a major share of total fish landings. A high degree of concentration is evident in marine fisheries, where wealthy boat owners or fishing companies often own multiple large offshore fishing vessels, and in inland fisheries, where powerful leaseholders control fishing rights to many of the most productive fishing grounds (Tezzo et al. 2018).

Small-scale fishing activities occur wherever there are waterbodies containing fish, and are thus widely distributed along the coasts, the Ayeyarwady Delta, and the courses of major rivers. Larger-scale marine fishing activities are concentrated mainly in a relatively small number of ports, including Kaw Thaung and Myeik in Tanintharyi, Ye in Mon State, the city of Yangon, and Pyapon township in Ayeyarwady. Large-scale inland fishing occurs in fishing lots in the delta and floodplains of the Ayeyarwady River.

Myanmar's highly productive inland fisheries have long provided an important source of state revenue and have been administered as leasable fishing lots since the British colonial period

(Reeves et al. 1999). In contrast, marine capture fisheries development was very limited until the socialist period (1962-88) and accelerated rapidly afterwards as the SLORC military government established international joint ventures with predominantly Thai vessel owners to generate foreign exchange aimed at shoring up a collapsing economy (Barbesgaard 2019). Most fish captured under these joint ventures was transshipped directly to Thailand.

Inflows of capital, technological advances such as motorization of boats, the introduction of new fishing gears, and the establishment of cold chain facilities, all contributed to the intensification of domestic fishing effort since the 1990s, partially to fulfil domestic consumption needs, and partially for export to China and other countries in the region (Belton et al. 2019). Most fishing licenses granted to foreign owned vessels were revoked under the USDP government from 2010 and transferred to Myanmar vessels (Tezzo et al. 2017).

Analysis of logbook records collected from offshore fishing vessels operating out of Tanintharyi Region from 2009 to 2018 show declines in catch per unit effort (a measure of the abundance of fish stocks) of between -27 percent and -64 percent, for five types of fishing gear (Hosch et al. 2021). This pattern is consistent with stock assessments that show a decline of -89 percent in Myanmar's marine fishery biomass between 1980 and 2013 (Krakstadt et al. 2014), and with anecdotal reports of rapidly declining catches by inshore fishers (e.g., Belton et al. 2019; World Bank 2019a). Anecdotal reports also point to significant declines in inland fish catches in recent years (e.g. Radford and Lamb 2020).

Fisheries conflicts are frequently reported, particularly in Tanintharyi and Rakhine, caused by large offshore vessels that are legally required to fish beyond 5 km from the coastline encroaching on inshore fishing grounds that are allocated exclusively to smaller inshore vessels (Barbesgaard 2019; Hosch et al. 2021; World Bank 2019a). Since 2020, most offshore vessels in Myanmar's fishing fleet have been fitted with vessel monitoring systems (VMS), allowing their positions to be tracked in real time and recorded to demonstrate an absence of illegal, unreported, and unregulated (IUU) fishing - a requirement for export to the European Union. By logging violations of spatial or temporal fishing restrictions, VMS could support a much more highly regulated fishery management regime. However, the extent to which this new information has been used to enforce regulations is not well understood, particularly since the beginning of the coup.

Conflicts between larger-and smaller-scale actors are also evident in the governance of inland fisheries. Reforms introduced to support leasing of some fishing concessions to groups of small-scale fishers by the regional NLD government in Ayeyarwady were met with stiff political resistance by powerful absentee licensees ultimately leading to the reversal of the policy and some of the initial redistributions of fishing rights that accompanied it (Nyein et al. 2020, Zin 2019).

Recent research (Nyein and Mathew 2017, Belton et al. 2019) and media coverage from Myanmar (BBC 2018) highlights extremely dangerous and exploitative working conditions present in some marine fisheries. The offshore raft fisheries in Ayeyarwady and Mon states utilize domestic migrant workers who receive seasonal wages in advance, compelling them to spend around eight months at sea on bamboo rafts exposed to the elements without access to safety equipment or medical treatment. These workers are often subject to malnutrition and physical abuse, and large numbers (numbering in the hundreds) are thought to die at sea each year.

Entrenched governance problems and declining productivity in Myanmar's fisheries result in large part from the tendency of successive governments to treat them as a source of rents to be maximized in the short term, rather than a resource to be managed for long run sustainability (Nyein et al. 2020). Despite these issues, Myanmar's capture fisheries remain extremely important for domestic food and nutrition security, particularly for rural and lower income consumers (Scott et al. forthcoming), providing an estimated 80 percent of the aquatic food consumed in 2015, with aquaculture supplying the remaining 20 percent (Aung et al. in press).

Moreover, despite steep declines, Myanmar's fish stocks probably remain in better health than in many other parts of the region due to the late onset of intensive exploitation of marine fisheries compared to the other countries of Southeast Asia (Butcher 2004) and the relatively intact nature of inland fisheries habitats (e.g., few hydropower dams in Ayeyarwady basin compared to the Mekong). For these reasons, Myanmar's capture fisheries should be understood as a cornerstone of nutrition security and rural livelihoods that can be maintained over the long term given adequate governance and management approaches.

4.3 Aquaculture

Similar to marine capture fisheries, the growth of aquaculture in Myanmar accelerated from the 1990s onwards, driven by the policy decision of the SLORC government to promote export oriented industrial-scale forms of agriculture and aquaculture to secure foreign exchange. Large tracts of 'wasteland' (the official designation of land unregistered in cadastral maps) were allocated to individuals and companies linked to the military in the Ayeyarwady delta west of Yangon in the form of concessions. 'Wastelands' allocated to concessions were comprised of a mix of uncultivated wetlands and agricultural land worked by farmers without formal land use rights, resulting in widespread appropriation of land from farmers and loss of access to former common pool fishing and grazing areas. Some land concessions in the Delta were initially intended for paddy cultivation and others designated for aquaculture, but most were ultimately converted to fishponds due to the higher profits and less complex management requirements compared to paddy. The initial expansion of large-scale aquaculture was thus highly inequitable (Mark and Belton 2020).

Aquaculture has continued to grow since this time. Growth has been driven by continued expansion of very large farms and the emergence of numerous commercially oriented small and medium sized farms. Many of the smallest commercial farms are nurseries, raising fingerlings for sale to larger grow-out farms. Successive land use policies and legislation up to the present have sought to safeguard rice production by prohibiting the conversion of paddy land to non-agricultural uses. However, the implementation of these rules in areas of the Delta where clusters of large fish farms are already established has been partial. In these areas, local authorities have often turned a blind eye to the conversion of paddy land to ponds, perhaps facilitated by 'unofficial' payments (Belton et al. 2015). Thus, although land use policies have slowed the speed and extent of aquaculture expansion in Myanmar, in some parts of the Delta they have also been widely circumvented, contributing to continuing brisk aquaculture growth despite few new concessions being granted to fish farms during the past decade (Belton et al. 2018).

This history has given rise to a 'top heavy' aquaculture farm size distribution in the Delta, where operations sized 200 ha and above account for 1 percent of farms but 32 percent of farm area,

while those sized 4 ha and below account for 49 percent of farms but only 4 percent of area. In most other parts of Asia very large farms account for a much smaller share of operations and total farm area than in Myanmar (Belton et al. 2018).

This highly concentrated farm structure has important implications for the distribution of economic spillovers from aquaculture. Based on a Local Economy-wide Impact Evaluation model (LEWIE), Filipski and Belton (2018) estimated that large fish farms (defined as >4 ha) and small fish farms in the Ayeyarwady delta both generate substantially larger economic impacts per hectare than crop farms, directly (through farmer profits) and indirectly (through wages paid to workers and the use of farm profits and wages to purchase locally traded consumption goods and production inputs). However, while large and small fish farms generate similar levels of direct income, small fish farms generate considerably bigger indirect income spillovers than large farms, because the former are more labor intensive, and purchase more locally traded goods and services. Moreover, these authors find that putting additional land into production as part of a large fish farm would increase economic inequality within the local economy, whereas increasing the area under a small fish farm would reduce inequality, primarily through income spillovers to landless workers (Filipski and Belton 2018).

Aquaculture in Myanmar is also somewhat unusual in being dominated by a single species, (rohu, a carp species native to Myanmar and South Asia), which accounts for 60 percent of total aquaculture production. Two similar native carp species, mrigal and catla, combined account for a further 21 percent for production. Pangasius catfish and tilapia are also produced, and the mix of species farmed in Myanmar is diversifying gradually but remains far less diverse than in most other countries in the region. Some rohu is exported to the Gulf states where it is mainly eaten by migrant workers from South Asia, but most of Myanmar's farmed fish is destined for domestic markets, particularly in the cities, and has rapidly been assimilated into urban diets (Tezzo et al. 2021).

Fish farming techniques in Myanmar are generally simple, and average yields are modest at 4.8 t/ha. Rice bran and peanut oilcake - byproducts from agricultural processing - are the most widely used feeds (Belton et al. 2017). However, use of floating pelleted fish feeds which can support faster growth rates and more efficient feed use has increased in recent years as several poultry feed manufacturers have begun to produce and distribute these. As noted above, rapid growth of poultry farming prior to 2020 also stimulated co-expansion of aquaculture through the establishment of integrated chicken-fish farms on the Yangon periphery (Belton et al. 2020).

Myanmar once had a burgeoning export-oriented shrimp industry, concentrated primarily in Rakhine State in extensively managed ponds. The sector collapsed during the mid-2000s due to a confluence of factors including sanctions, cyclone damage, shrimp disease, and a decline in the natural recruitment of shrimp larvae caused by mangrove destruction, and has shown no signs of recovery since this time (World Bank 2019a; Joffre and Aung 2012).

5. IMPACTS OF COVID-19 AND THE COUP

The COVID-19 pandemic severely impacted Myanmar's economy. An initial lockdown and 'stay home' order was given in April 2020, but eased in July after a relatively low initial infection rate. A second wave of COVID-19 infections emerged in September 2020, accompanied by more stringent containment measures. A third extremely deadly COVID-19 wave peaked in July 2021, compounding the precipitous decline in welfare experienced in the aftermath of the coup.

Movement restrictions during the earliest stages of the pandemic affected supplies of production inputs and the distribution of livestock and fish products to market, but these logistical issues were overcome relatively quickly. Longer lasting impacts were felt in the form of depressed consumer demand caused by the economic downturn associated with the pandemic, which was transmitted upstream along livestock and fish supply chains. Fang et al. (2020) found that only 69 percent of surveyed broiler farms around Yangon remained operational in June 2020, although many closures were temporary and some farms subsequently reopened. In November 2020, 81 percent of surveyed broiler farms and 83 percent of layer farms were operational.

Broiler prices peaked during the first lockdown in May 2020 at 50 percent above average 2019 levels, before slumping to around half of the 2019 average in September, then gradually regained equilibrium by November. In contrast, from May to August 2020 the price of eggs increased by 30 percent, reflecting the slow response time of layer farms to market demand due to their long production cycle (Fang et al. 2020). Fang et al. (2020) found that more than 40 percent of chicken farm workers around Yangon had lost permanent employment by November 2020 and estimated a loss of approximately 10,000 full-time chicken farm worker jobs and a monthly wage loss USD 1,200,000 for Myanmar's chicken sector nationally.

In the case of farmed fish, farmgate, wholesale, and retail prices were approximately 10-20 percent lower in most months from March to September 2020 than prior to the beginning of the pandemic in February 2020. Conversely, fish feed prices increased by about 40 percent over same period. These trends suggest that the profitability of farming operations became increasingly squeezed over this period (Belton et al. 2021b). Two-thirds of surveyed actors in the fish value chain indicated that the incomes they earned from these businesses were lower in 2020 than in 2019. Forty-one percent of all fish value chain businesses reported incomes that were 10-30 percent lower in 2020 than in 2019, while 18 percent reported incomes 30-50 percent lower (Haas et al. 2021). The impacts of COVID-19 on fish value chains in Myanmar in 2021, compounded by the effects of the coup, were even more severe, causing sales of farmed fish to drop further as compared to 2020 (Hoong et al. 2021)

Data from a national phone survey implemented by IFPRI in late 2021, almost a year after the coup, indicate that 69 percent of households reporting fish and 78 percent reporting livestock as their major source of income had experienced difficulties related to production in 2021. Well over half reported challenges related to marketing in the three months prior to the survey. High input prices and difficulties hiring workers were the most common production challenges overall, especially among households dependent on livestock production. The inability to acquire production inputs was also a common problem for households of both types, whereas inability to reach fishing grounds or ponds affected 20 percent of fish producing households. Low prices

received for products were the most common marketing challenges reported, especially by livestock producers, and difficulties accessing buyers were a common problem for both (Table 9).

Hoong et al. (2021) report that the most common coping strategies employed by actors in fish value chains during these crises included borrowing cash to cover operating costs (reported by 40 percent of businesses), making transactions electronically (39 percent), drawing down savings (30 percent), buying inputs on credit (28 percent), and changing business working hours (25 percent). Notably, considerable numbers of businesses also reported donating (38 percent) or lending (25 percent) food to others, suggesting the existence of strong informal support mechanisms.

Table 9: Challenges faced by livestock and fish producing households during the past 3 months

Challenges for production activities	Fish	Livestock
No difficulties (%)	31	22
High prices of inputs (%)	15	27
Difficulties hiring workers (%)	4	36
Unable to acquire enough inputs (%)	15	12
Cannot reach farm/fishing location (%)	20	1
High price of fuel (%)	7	0
Water/irrigation supply problems (%)	4	1
Disruption to banking services, access to cash or loans (%)	3	2
Electricity/energy supply problems (%)	1	1
Difficulties in paying tax (%)	1	0
Challenges for marketing activities		
No difficulties (%)	46	39
Low prices for fish or fish products (%)	29	38
Difficult to access buyers (%)	18	19
High price of fuel/high transportation cost (%)	2	3
Markets are closed (%)	3	1
Payment problems (%)	2	1
Nr of obs: main source of income (fish/livestock business HH)	*148*	*298*

Source: data from Myanmar National Phone Survey, 2021

Reduced incomes are likely to have negatively impacted the welfare of many fish and livestock producers. Belton et al. (2021b) found the share of respondents in the fish value chain reporting that their households had purchased less food than usual rose steadily from 29 percent in May to 52 percent in September 2020. More broadly, the health status of low- and middle-income consumers, for whom fish and eggs are key sources of scarce micronutrients, are likely to have suffered substantially due to reduced intakes of these foods (Fang et al. 2020; Scott et al. forthcoming).

6. DISCUSSION: FUTURE DIRECTIONS AND PRIORITIES

The review above underlines the importance of the livestock and fisheries sectors for livelihoods, employment, the rural economy, and food and nutrition security in Myanmar, and their diversity in terms of production technologies, scale of operations, and organization of production. In this concluding section of the paper, we summarize key observations on the likely future direction of both sectors, and priority areas for attention.

Prior to the COVID-19 pandemic and the coup, Myanmar's poultry, pig, and aquaculture sectors were growing rapidly and transforming, particularly in the peri-urban zones around major cities. Small 'backyard' production units existed in large numbers, alongside a growing segment of intermediate-sized specialized farms, and a handful of large vertically integrated firms. The dynamism evident in these sectors corresponded with a period of rapid economic development that spurred rising real incomes and domestic urban demand for animal source foods. Production growth was also supported by large foreign and domestic investments in sectors like feed milling, as well as by the investments of small and medium enterprises (SMEs) such as traders which also grew rapidly during this period (Belton et al. 2018).

The economy contracted by 18 percent in 2021, following very weak growth in 2020, becoming around 30 percent smaller than it would have been in the absence of COVID-19 and the coup (World Bank 2021). Human welfare declined dramatically, with more than half the population estimated to fall below the poverty line by then end of 2021 (IFPRI 2022; Diao and Mahrt 2021). Animal source foods are relatively expensive and are highly income-elastic. The economic shock depressed domestic consumer demand for such foods, stalling, and perhaps partially reversing, the expansion of specialized intensive peri-urban animal husbandry. Moreover, international prices for maize, a key ingredient used in feed manufacturing, reached a ten-year high in 2022. Coupled with a weak Myanmar Kyat, which will raise the price of imported feed ingredients such as vitamin premixes and high-grade fishmeal, these market conditions seem set to squeeze the profitability of specialized livestock and fish farming operations, many of which operated on quite thin margins even prior to the crisis.

Pressure on producer profitability is likely to result in concentration, as more efficiently operated farms and/or those benefitting from economies of scale endure, and less well-managed and/or smaller farms fail. It may also result in extensification, as producers seek to reduce costs by lowering stocking and feeding rates, and/or substituting low-cost feeds (e.g., rice bran, brewery waste) for costly nutritionally complete formulated feeds. Concentration is likely to be most pronounced in the feedlot poultry sector where the bio-economics of production offer farmers little flexibility in modifying production practices (Fang et al. 2021). Extensification is likely to be most common in aquaculture as fish can be raised using naturally occurring feed (plankton), and small-medium scale pig farming as local pig breeds can be grown using low-cost feeds such as kitchen waste such as broken rice.

Urban and rural food insecurity has increased sharply in Myanmar since 2020 (Headey et al. 2022). Consumption of animal source foods, which are a particularly rich source of multiple micronutrients essential for human health, has almost certainly declined during this period. Such a trend is likely to have reversed modest improvements in nutrition indicators achieved over the preceding decade, exacerbating levels of malnutrition that were persistently high even prior to

2020 (Scott et al. forthcoming). However, the income elasticity of animal source foods means that demand could rebound quite quickly if economic conditions improve in future, prompting remaining producers to scale-up production, or stimulating investment by new entrants.

Over the longer term, climate change is likely to present increasing challenges to both sectors by impacting production of feed crops such as maize, causing feed prices and production costs to fluctuate unpredictably and/or increase. Climate change is also likely to cause shifts in the geographical distribution of wild fish stocks in ways that are difficult to predict. A changing climate is also set to increase the risk of flooding, with potentially negative implications for aquaculture profitability, as occurred in 2016 when many fish farms in the Delta lost a substantial share of their crop (Belton et al. 2017). Saline intrusion in coastal and deltaic areas is also likely to increase, possibly altering the mix of aquatic animals farmed in favor of saline tolerant species such as shrimp.

Rapid and widespread agricultural mechanization over the decade prior to 2020 is likely to have reduced cattle and buffalo populations, as many farms, particularly in the Delta and the Hills, substituted power tillers and rented four-wheel tractors for animal traction. However, rising demand for beef from neighboring China in recent years has stimulated the growth of cross-border exports of live cattle, which were in the process of being formalized prior to the crisis (Diao et al. 2020). Resurgent demand from China in the future might encourage more rural households to raise cattle primarily for sale rather than as draft animals if the live cattle trade resumes on a large scale.

However, weakly regulated cross-border movements of live animals are highly risky given their potential to act as vectors for potentially catastrophic animal diseases, some of which are also potential zoonoses. Pig grandparent stock and piglets are often imported to Myanmar, particularly from Thailand. Day-old chicks are also imported on occasion. Imports of live cattle are also thought to enter Myanmar from India and Bangladesh. Much of this trade is informal or semi-formal, and there is very limited animal quarantine capacity within Myanmar (Belton et al. 2020).

Access to veterinary services and information is patchy and mainly obtained through private providers. Few livestock or fish farmers have ever received formal training on farm management, and famers' knowledge about important livestock diseases such as African swine fever is limited (Belton et al. 2020). Indiscriminate use of antibiotics, particularly in intensive poultry farming, also gives rise to health concerns, given high potential for antimicrobial resistance to emerge. Food safety and standards are likely to become an increasing public health concern in the longer run (Ebata 2022), particularly if the growth of modern retail resumes, and could contribute to farm consolidation if significant investments are needed to comply.

Marine and inland capture fisheries in Myanmar face serious governance challenges and unsustainable levels of resource exploitation. These challenges must be addressed if their important contributions to livelihoods and nutrition security are to be maintained over the long run. However, doing so would require a high level of political commitment to enacting the changes required, including shifting from governance strategies that favor resource extraction in the short-term to those promoting long-term stewardship.

Our analysis reveals the population engaged in fishing activities exceeds that involved in aquaculture by a factor of 26. Approximately half of all fishing and fish farming households live in

the Delta. Future donor sponsored programs aiming to alleviate poverty or improve nutrition by promoting aquatic food production should be attentive to the relative size of the two sectors and their geographical concentration when prioritizing resource allocation and site selection.

Finally, data on the livestock and fish sectors in Myanmar is very patchy, with little known about the important dynamic segment of specialized livestock enterprises that emerged over the past decade or the larger-scale commercial fishing fleets. Given the unique characteristics of businesses in these sectors and the high level of spatial clustering of larger enterprises, specially designed targeted surveys may be required in the future, as an alternative to the random household sampling approach of MLCS.

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