Does Selective Mechanisation Make up for Labour Shortages in Rural Myanmar?

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Abstract. In Myanmar’s rural areas, a high proportion of the landless population is traditionally linked with landholders as farm labour. More recently, however, these linkages seem to be unravelling due to the emergence of new industries and increased urbanisation creating new opportunities outside of the agricultural sector. While agricultural development schemes encourage intensified agricultural production and mechanization, labour shortages increasingly arise at peak cropping periods. Landholders respond with farm mechanization that reduces labour requirement. Based on household surveys and focus group discussions in the Ayeyarwady Delta (AD) and Central Dry Zone (CDZ) regions of Myanmar, this paper examines the extent of labour shortages in crop production and the efficiency of farm mechanization in response to labour shortfalls. Data show that only a small percentage of landless households in either region rely on agricultural labour alone. Instead we can observe a shift towards more diverse livelihood portfolios and non-farm work. This trend further amplifies labour shortages and leads to production loss. Most farm machines, however, substitute animal power but cannot replace human labour sufficiently to make up for the shortages. Moreover, landholders suffer from the inadequate quality of farm machines and high maintenance cost. The paper highlights farm labour shortage as a result of non-farm development and argues that farm mechanisation projects are ineffective without concomitant infrastructure and services development.

1. Introduction

Myanmar’s current political context is shaped by ongoing social, political and economic reforms [13]. This process started in 1988 with the opening up of the formerly isolationist economy to foreign direct investment and relaxation of trade restrictions, among other reforms [12]. However, continued government intervention in market systems, inflation and external shocks such as the Asian Financial Crisis limited economic growth [11]. Constitutional reforms and a new administration have contributed to a renewed set of reform initiatives, both economic and political, which have led to eased international sanctions and ‘visibly improved’ the economy [11]. The structure of Myanmar’s economy is changing as a result. Agriculture made up 57% of GDP in 2000, compared to 27% in 2015 [2], meanwhile industry has grown from 10 to 35% of GDP in the same time [2].

Although it now competes with new industries for labour and other resources, agriculture continues to play a significant role in Myanmar, employing 66 percent of the population in 2012 [10]. Agricultural productivity is relatively low due to uneven land distribution, limited investment in agricultural research, weak extension services and limited infrastructure [18]. Landlessness is a significant phenomenon in Myanmar. According to national statistics, between 24–55 per cent of the rural population is landless [18], though in highly populated areas such as the Delta region, estimates are as high as 90 per cent of
rural households without rights to land for farming [18]. With precarious access to land, landless households are often dependent on wage labour [18]. As such, traditionally there have been strong links between landless households and farming households with access to land, with the landless providing an important source of farming labour. However, these traditional links are weakening with opportunities for non-agricultural jobs, increases in migration, and the patchy but increasing availability of agricultural machinery.

Structural reforms and expanding market and road infrastructure have expanded networks and connectivity across the country [19]. Migration was not uncommon prior to reforms, however [19] found migration has doubled in some areas since 2012, potentially changing local social relationships and networks. Due to the seasonal nature of agricultural employment, landless households were more likely to have members migrating than households with access to land [29]. Furthermore, though no discernible economic impacts were found for households sending labour away compared to others, migration created additional burden for family members left behind, and created perceptions of casual labour shortages [29].

The withdrawal of agricultural labour to non-farm activities can affect agricultural productivity depending on the availability of farm labour in the rural labour market [3]. If there is no surplus labour in the rural agricultural market, the withdrawal of this labour causes a reduction of labour availability and affects agricultural output [17].

At the same time, government development schemes are encouraging more intensified agricultural production and mechanisation in crop production in order to meet agricultural production targets [25]. Increasing intensity of agricultural production, coupled with a reduction in labour available and subsequent rising wage costs set favourable conditions for mechanisation [5]. Similar conditions could be observed in the mechanisation of rice farming in Thailand in the 1960s, with increased yields enabled by irrigation and intensive production making machinery more financially viable for small farms [7].

Efforts to support agricultural mechanisation in Myanmar can be traced back to British rule but had limited success [30]. During the socialist period, government programs promoted large machines which were mostly not well suited to farmer needs [24]. Since 2012, changes to import laws have made it easier to import small machines like power tillers, mostly from China [24]. [27] found rapid growth in the number, geographical distribution and sales of agricultural machines since 2011. Though dealerships are concentrated near Yangon, [28] speculate that the geographical spread of dealerships reflects the development of labour shortage across the country. Access to machinery has been supported through a combination of cheaper machines, access to credit and the emergence of machine rental services [28].

Processes of mechanisation can take widely different pathways and have different outcomes depending on the local context, policy and market [4]. Use of tillers, threshers and other machines in Myanmar has been recent, but reportedly spread rapidly near Yangon and in key agricultural regions such as the Ayeyarwaddy Delta (AD) and Central Dry Zone (CDZ). In this paper, we examine the dynamics of labour demand, availability and mechanisation in the AD and CDZ, considering the extent to which current types and rates of mechanisation can compensate for the withdrawal of labour to other sectors. We then go on to discuss current efforts to support increased mechanisation and implications for those trying to support increased mechanisation access throughout Myanmar.

2. Methods
This paper uses data from a household livelihood survey conducted in 2014 and follow-up survey in 2017. Separate questionnaires were used for landholders (those who have access to land) and
landless households to reflect the high proportion of landless households in the study area, and the
different livelihood strategies, constraints and opportunities of the two groups. Both surveys collected
data on basic household demographics, income, expenditure, ownership of assets and access to
services and farm machines. The questionnaire for farming households allowed for detailed
information on agricultural production. On the other hand, the questionnaire for landless households
allowed for more detailed information on labour and migration.

The survey was conducted in the Central Dry Zone (CDZ) and Ayeyarwaddy Delta (AD)
regions of rural Myanmar (Figure 1). These two regions are major agricultural areas in Myanmar.
The AD produces the majority of national rice yield, while the CDZ is a significant area for the
production of livestock and legumes. Four townships from each region were selected to be
representative of various agro- ecological conditions and the diversity of livelihoods in rural areas
(Figure 1). Six villages from each township were selected based on farming systems and livelihood
activities. Proportional stratified random sampling was used to select landholding and landless
households in each village. There were 748 respondents from AD, which covered 362 landholding
households and 386 landless households. For CDZ region, a total of 760 households were selected,
which included 486 landholding households and 274 landless households. Despite efforts to ensure
representative sampling, two key challenges were experienced. In the Ayeyarwaddy Delta, the
timing of the surveys coincided with heavy monsoon rains and townships to the South of the Delta
were not safely accessible. Data for the Delta is therefore skewed to the less saline/flood prone
areas in the north of the region. In the CDZ, the sample includes a larger number of respondents
with access to irrigation. Follow up surveys were conducted in 2 townships in each region and 2
villages in each township. Follow up surveys were designed to gather detailed information on key
issues of mechanization and landless labour shortages in crop production.

Focus group discussions (FGDs) were conducted to understand the dynamics and the
household drivers of decision making for the livelihoods in the study area. Two villages from each
township were selected and two FGDs per village were conducted; one each for landless and
landholding households. Between 8 to 15 people participated in each FGD.

Survey data were analysed using basic descriptive statistics, and qualitative data was
analysed using content analysis. The analysis presented here focuses on 1) what is the extent of
labour shortage in crop production and 2) whether mechanisation can compensate for labour
shortage.

3. Result

![Figure 1. Location of study](image_url)

The study was conducted in the Ayeyarwady Delta (AD) and Central Dry Zone (CDZ) regions of
Myanmar (Figure 1). Both regions are important for agriculture production in Myanmar. The AD
occupies only 5 percent of all national land in the Union, however, it is known as the rice bowl of
Myanmar as it produces most of the rice requirements of the country. Agriculture constitutes more than half of the land use in CDZ and makes up 35% of the country’s total cultivable land [8].

3.1. Characterisation of study sites
Of the households surveyed in both areas, 43.8% are landless. The average household size for a landless household is 4.6 people (smallest 1 person and largest 12 people). The average household size of landholding households is 5.11 people, (minimum 1 person and maximum 14 people). The dependency ratio (number of dependents to working aged household members) for landholders is 42% and landless is 51%. In both study areas, lowland (paddy land) and upland (dry land) are the main land types. AD is mostly lowland (about 90% of total area), while CDZ is mostly upland (about 60% of the total area [9]. Horticultural land is used for growing perennial crop as well as vegetable crops. Around 80% of households in surveyed in AD could access irrigation for agriculture, whereas only about half of the households in CDZ had access. This is not representative of the CDZ in general and reflects a certain bias in the selection of study villages. According to [15], access to irrigation in the CDZ is available for 12% of cultivated land. While most CDZ households depend on rainwater, in the AD, landholders can access water from streams and rivers to irrigate. Irrigation water sources for crop production in the CDZ are mainly from canals and reservoirs.

3.2. Labour demand for crop production
Irrigation enables crop production to be extended through the year, which creates demand for labour throughout the year. In contrast, rainfed production has intense, peak demand for labour with all landholders needing labour at the same time to conduct activities according to the season. The labour required varies based on the crops grown. In a study of labour use in CDZ, [26] reported higher labour demand in rice growing than upland crops such as sesame, pigeon pea, and chickpea. In rice production, the tasks harvesting, transplanting and weeding are the most labour-intensive tasks. For rice-rice systems, the average labour required is 183 days.

Compared to rice, pulses require less labour for weeding, fertiliser and pesticide application. The main labour requirement for pulses is harvesting and carrying crops from the field to the storage area, which requires 35 labour days. The average labour requirement for a rice-pulse farming system is 165 days per hectare. All tasks need to be finished with a specific period because rice production largely relies on certain climatic condition, such as rainfall.

3.3. Labour availability
The total cultivated area in the study areas is 4,920 hectares and cropping intensity is at 142.6% (Suvey,2014). Based on household surveys, the number of landless labourers in the study areas is estimated to be 1,783 people. The average number of working days per landless labourer in crop production is 118 days per year. Therefore, the average time spent by landless people working in agriculture is 42.7 days per hectare, per year in the study area.

Landholders, especially small-scale landholders (less than 2 hectares), provide labour on their own farms and work as labourers on other farms. According to the household survey in AD and CDZ, the average days spent by landholders working as farm labourers is 7.7 days per hectare per year. [23] reported the average days spent by family members working on their own farm in CDZ is 66.42 days per hectare, per year. We can therefore estimate the total working days for one hectare of crop production per year is 116.8 days per hectare per year.
3.4. Extent of agricultural labour shortages

Based on these data, Figure 2 and 3 highlight the gap between required labour for crop production and available labour in rice-rice farming system and in rice-pulse farming system. For double-cropped rice, landholders face a labour shortage of 65.8 days per hectare per year (figure 1). For rice-pulse crops, there is a shortfall of 48 days (figure 2). This means landholders are unable to meet 36% and 29% of labour needs in rice-rice and rice-pulses farming systems respectively.

![Figure 2. Labour shortage for rice-rice farming system](image1)

![Figure 3. Labour shortage for rice pulses farming system](image2)

During focus group discussions, landholders confirmed the problem of farm labour shortage and high labour costs in production. Landholders expressed their belief that an increase in non-farm job opportunities and migration are the main two reasons of labour scarcity in farming. This is explored in the next section.

3.5. Drivers of labour shortages

(i) Shift to non-farm employment

Figure 4 shows different livelihood patterns for landless households in the study area. Four main patterns were found in landless livelihoods, which are: 1) crop-labour households—households who rely only on income from working as labourers in crop production; 2) farm-labour, livestock and fishery households—households who have diverse agriculture-based income sources, including crop-labour, rearing livestock and fishing; 3) non-farm households—households who rely only on income from non-farm activities; and 4) farm and non-farm households—households have income from all activities.

Non-farm activities are defined as activities unrelated to agriculture. It is a broad category including self-employment, waged-work, services, enterprises and trading activities. Rural non-farm activities might be categorized as manufacturing, agro-processing, commodity trading, and wage labour (Davis, 2006).
Only a small number of landless households (16%) rely on agriculture alone for income (Figure 4). A majority of households engage in both farm and non-farm activities as their sources of livelihoods. Almost all landless mentioned that young people from rural areas are most willing to work in urban or cities, instead of working in the agriculture. Women especially expressed a preference for indoor work to agriculture because working under the sun is hard.

(ii) Migration
At the time of the household survey, 19 percent of landless households had a family member who was away for work or other activities (which is 11.3% of working aged people in the survey). Figure 5 shows the type of migration (seasonal, temporary or permanent). As the survey was conducted during the growing season, so many seasonal migrants had returned to their home village to work we could expect these results to be slightly lower than at other times of the year.

The majority of landless migrants (80%) had migrated temporarily(Figure 5). Temporary migration is common among young people who migrate from the villages to work in the cities and industries, such as garment factories, but plan to return eventually. Only 9% of migrated family members had migrated permanently. Most often, these people have founded families or acquired steady work, which provides them with superior economic opportunities. Among the reasons for migrating, most indicated their intention was to find a better job, regardless of migration type. Other reasons included education or marriage. In group discussions, landless households stated that farm mechanisation makes it difficult for them to find jobs in the village which pushes them to migrate. Of the three types of migration, only seasonal migration allows for availability of labourers for agricultural tasks in times of peak demand. The predominance of temporary migration indicates reduced access to labourers to support agricultural production.

3.6. The role of mechanisation in addressing labour shortages

Machines have higher efficiency than animals and humans in terms of time and work, especially for labour intensive work, such as weeding, and planting [1]. Reported that experiment results
comparing human and mechanical power in rice farming and showed that labour productivity improved by 25 times due to mechanisation on one hectare of rainfed lowland rice field. Table 1 shows comparisons of time required for farm activities between machines and draught animals. Motor plough and hand tractors are effective tools in saving time and labour for land preparation such as ploughing, harrowing and levelling. In terms of time required for ploughing, harrowing and levelling, motor ploughs take about 3 hours for one hectare, compared to 5.5 hours for hand tractors. Using hand tractors and motor ploughs saves significant time compared to animal draught: hand tractors saving 69.5 hours, and the motor plough saving 72 hours per hectare. (Table 1).

**Table 1.** Comparisons of average time required for land preparation activities between animal/human and machines

| Activities         | Hand tractor | Motor plough | Animal draught |
|--------------------|--------------|--------------|----------------|
| Ploughing (Hours/ha) | 1.5          | 1            | 30             |
| Harrowing (Hours/ha) | 1.5          | 1            | 37.5           |
| Levelling (Hours/ha) | 1.5          | 1            | 7.5            |
| Total (Hours/ha)    | 5.5          | 3            | 75             |

(Source Household Survey, 2017)

Harvesting is the one of most labour consuming tasks in rice production. Harvesting one hectare by hand took farmers an estimated 168 hours, or 28 working days, compared to just 2 hours if using a combine harvester (Household Survey, 2017).

3.7. **Ownership of, and access to machinery**

Table 2 shows that the use of combine harvester is increasing, especially in AD where there is a higher area under rice production, and double cropping is common. Combine harvesters reduce labour shortage during harvesting because it includes the tasks of harvesting, threshing and bagging. However, landholders still need to hire male labour for carrying rice bags to storage. Few households own combine harvesters (Table 7) due to the high costs. Instead, farmers are able to hire combine harvesters provided by private companies or machine owners throughout the rural areas. In FGDs, landholders from CDZ reported that harvester owners who operate hire services will travel from the AD to the CDZ at the time of harvesting to hire out their machines. Landholders contact middle men or machine operators before the harvest. Combine harvesters can only be hired if there are at least 0.4 hectares to be harvested in the same location. Moreover, there needs to be access via good farm roads and suitable soil conditions in order to tolerate the weight of the combine harvesters.

Table 2 highlights a rapid increase in use of the combine harvester between 2014 and 2017 (Table 2). Of those who did not use the harvester, the main reason was due to land conditions and transport limitations.

**Table 2: Usage of Combine harvester in study areas**

|          | 2014 | 2017 |
|----------|------|------|
| AD       | 10.6 | 54.8 |
| CDZ      | 1.6  | 9.9  |

(Source: Household Survey, 2014 and 2017)
AD because of lack of labour and high labour cost at harvest time and also farmers are able to access more combine harvesters hiring services than 2014.

The most common types of farm machines owned in study area are hand tractors and water pumps. Water pumps are used in the wet season to control the frequency and timing of irrigation. In the dry season, water pumps enable double cropping, allowing for transfer of water from wells or rivers to fields, which would otherwise lack sufficient water during the dry season. This in turn encourages further mechanisation to ensure tasks such as harvesting and land preparation can be done in time for the second crop to be planted in a timely manner. Landholders also use the engines from water pumps in transportation, for example, by attaching the motor to boats.

Table 3 compares farm households who owned machines in the AD and CDZ between 2014 and 2017. Table 3 shows landholders of both regions own more machines, particularly hand tractors, in 2017 than 2014. Landholders expressed the reason for buying hand tractors, which is to substitute animal power as it is cheap and affordable.

The data shows that landholders in AD own more farm machines than CDZ. This is to be expected given the suitability of the AD for intensive production. The AD is well known as the rice basket of Myanmar, and has higher irrigation access and more paddy growing area. Myanmar’s agriculture policy has focused on paddy production for many years. Nationally, AD has the highest use of power tillers and represents one-third of total machines used in Myanmar (DOA, 2014). According to FGDs, the rise in use of hand tractors in the AD is also related to non-government organisations rehabilitation support after Cyclone Nargis in 2008. According to landholder discussions, rent and share systems are also used for hand tractors and motor ploughs in land preparation.

Table 3. Ownership of farm machines in study areas

|                | AD 2014 | AD 2017 | CDZ 2014 | CDZ 2017 |
|----------------|---------|---------|----------|----------|
| Hand tractor   | 34.5    | 46.0    | 16.0     | 23.1     |
| Motor plough   | 4.4     | 3.2     | 9.1      | 12.4     |
| Harvester      | 0.2     | 4.0     | 1.1      | 0.0      |
| Combine harvester | 0     | 1.6     | 0        | 0        |

(Source: Household survey, 2014 and 2017)

According to FGD results, the main purpose of buying a hand tractor is to prepare land in a short time, particularly when irrigation is not available and rainfall patterns have become more irregular. Landholders farming pulses in the CDZ were particularly concerned about speedy land preparation because they need to use the soil moisture after harvesting the rice crop for cultivation of pulses. The spread of tractors allows farmers to get around key bottlenecks, for example one landholder from a rainfed village in the CDZ wanted to buy a hand tractor to avoid the difficulty of hiring draught animals because all landholders in his area have to finish land preparation at the same time as they rely only on rainwater, it can be difficult to hire animals.

Hand tractors and motor ploughs also save labour required to look after draught animals, such as providing fodder. For example, one landholders did not want to use draught animals because his children, who used to take care of the cattle, have now moved to the city to pursue a better education and there is no one else available to take that responsibility.

Although the initial investment for hand tractors and motor ploughs are higher than buying cattle, ongoing maintenance costs are not significantly different, with hand tractor annual maintenance less than cattle. Most respondents in the survey have no access to extension services, for either information on the operation and maintenance of machines or rearing cattle. Landholders are
very familiar with rearing cattle based on their traditional experience, however have very limited experience in operating and maintaining machines. This lack of services and information has been a key barrier to use and maintenance of machines.

3.8. Ownership of machinery by farm household types

This section considers which types of farmers currently have access to different machines. Ownership of farm machines is varied based on landholding size in the AD. Large landholders (over 8 hectares) own more farm machines than medium, small and very small-scale landholders (Figure 6). There is a greater return on investment for larger landholders to invest in machinery, but they are also more able to make the initial investment. The Myanmar Government provides loans for landholders based on the land size, farmers can get government loans for 10 cultivated area of rice. Furthermore, private agro-chemical companies and money lenders are more willing to lend money to large-scale landholders than small-scale, because they need to use higher amount of inputs (e.g. fertilizer) and they have large area of land which can be used as a mortgage. However, landholding size is not the determining factor for machine ownership in the CDZ. Access to irrigation water determines whether landholders can double-crop and are therefore more likely to require time-saving machinery. Figure 7 shows that landholders who can access irrigation water possess more farm machines than rainfed landholders. Hand tractors are the most common machines owned.

![Figure 6. Ownership of farm machines by household types in AD](image)

Machine ownership in CDZ can further be understood by analysing the livelihood and income activities that households rely on. Farm households can be categorized into: 1) farming only i.e., household income relies on crop production, 2) farming and other, i.e., more than 50% of household income comes from crop production and 3) other and farming, i.e., less than 50% of household income comes from crop production.

Among the landholders who are able access irrigation, farming and other households own more machines for crop production than other households. Figure 7 shows that a slightly lower proportion of households in the other plus farming category own tractors or motor ploughs compared to other categories. Farming and other households can invest more in buying machines because more than 50% of these household’s income rely on crop production and they have enough financial liquidity to buy machines as they have other income sources as well. Also, they need to save household labour to be able to work in nonfarm activities.
4. Discussion and Conclusions

The results highlight several key points in relation to agricultural production and mechanisation. First, labour available for agriculture in the study areas is not sufficient to cover current labour needs; second, that labour shortages are likely to increase; and third, that mechanisation has been a key strategy for some farmers to overcome labour shortages, however use of machines is varied between the two study areas, and within different farming and household types. In this section we discuss these findings and their implications more broadly.

Labour shortages were a key concern for farmers interviewed in AD and CDZ study townships. In the future, labour shortages in agriculture are likely to continue to increase, due to the growing industrial sector. Industrial jobs will make it attractive for young rural people to leave farm-based employment and join the industrial labour force. For example, the emergence of garment industries in Myanmar has increased the movement of rural women labour to cities by providing unskilled jobs [6]. Currently, landless households are migrating temporarily to seek non-farm jobs and have no intention to migrate permanently, but the trend of temporary migration has been increasing over the last 10 years. Unlike farming households, landless households are more mobile and have higher potential to leave rural areas. [16] show that the possibility of migration is also raised with better education. As landless people encourage their children to pursue education this could further reduce the labour available in agriculture in the future. As a result, the number of landless labour available for crop production is decreasing, driving labour costs higher, especially for peak growing seasons.

Current mechanisation in Myanmar can overcome some of the labour shortage in agriculture because of the nature of selective mechanisation. The machines landholders choose cover labour shortages for specific tasks in the production cycle, such as land preparation and rice harvesting, but other labour-intensive tasks such as pulse harvesting or rice transplanting are currently unmechanised. Therefore, mechanisation cannot yet address the problem of labour shortages as a whole. Landholders are still facing labour shortages for critical labour-intensive tasks such as transplanting or harvesting and these tasks need to be finished within a specific time period. [21] claimed that completing certain farming operations such as planting and harvesting in a timely manner ensures yields and improves profitability. Delayed harvesting for one week after maturity, for instance, can lead to substantial yield losses [22]. To adequately address labour shortages, consideration should be given to supporting introduction of machines for transplanting, weeding and harvesting operations.

Mechanisation cannot cover labour shortage as much as landholder’s demand. Moreover, introducing selective machines can exacerbate labour shortages as it decreases livelihood opportunities for landless labour, further driving landless labourers into non-farm jobs.

Misuse or poor upkeep of machinery and equipment can be a result of breakdowns, fragmented land,
and poor farm infrastructure (irrigation and farm roads) and service support systems. Therefore, farm mechanisation programs should include consideration for improving landholders’ capacity and rural infrastructure development (irrigation, farm road, and electricity). Furthermore, it is needed to encourage private/public sector to implement farm machines’ rent and share programs to increase better utilization of machines.

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