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CROP PRODUCTION AND PROFITABILITY IN AYEYARWADY AND YANGON

By

Ame Cho, Ben Belton and Duncan Boughton

Food Security Policy *Research Papers*

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EXECUTIVE SUMMARY

Agriculture is central to Myanmar's rural economy, and Ayeyarwady and Yangon regions are considered to be the country's 'rice bowl'. Yet few detailed data are available on the characteristics of agriculture in this important area. The Myanmar Aquaculture-Agriculture Survey (MAAS) addressed this knowledge gap through a statistically representative survey of 329 agricultural households in Maubin, Nyaungdon, Twantay and Kayan townships in Ayeyarwady and Yangon regions, as part of a larger survey of 1,102 rural households. The following key results stand out:

1. Levels of landlessness are high: 56% of households have no agricultural land.
2. Most farms are small, and land is unequally distributed. Forty-nine percent of farming households have less than 5 acres of land. The third of households with the smallest landholdings own just 3% of all crop land.
3. Paddy dominates agriculture in monsoon (when virtually all farmers produce it), but green gram and dry season paddy are the two most important crops in terms of income.
4. The smallest farms are the most diversified, earning proportionally more of their incomes from vegetables, livestock and other crops than large farms, whereas large farms derive most of their farm income from dry season paddy.
5. Access to irrigation in the dry season is limited, with the smallest farms having least access.
6. Average paddy yields are low in comparison to most other Asian countries, at 3.3 t/ha.
7. Average profits from the main field crops are low: the most widely grown crop, monsoon paddy, generates a gross margin of $217/ha (105,615 MMK/acre). Dry season paddy generates a higher return at $355/ha (172,700 MMK/acre) but also has high production costs. Green gram generates the highest average gross margins, at $ 638/ha (309,765 MMK/acre), and has intermediate production costs.
8. Casual labor, fertilizers and agricultural machinery account for the majority of production costs in both paddy and green gram cultivation
9. Farms that use combine harvesters to harvest paddy use less than half as much labor as farms that harvest paddy manually.
10. Farms of all sizes are very strongly commercially oriented: farms producing monsoon paddy (including the smallest) sell three quarters of the paddy they produce, while an even higher percentage of dry season paddy and green gram is sold.
11. The share of households using herbicides and improved varieties of seed for dry season paddy cultivation increased significantly between 2006 and 2016, but from a low base. Dry season paddy yields also increased, from 3.4 to 3.82 tons/ha (66 to 74 baskets per acre) over this period, but there was little change in input use or yields for monsoon paddy.
12. Seeds for monsoon and dry season paddy and green gram are overwhelmingly sourced from farmers' own reserves, or from other farmers, with little seed purchased from specialized input traders, government or other sources.

Based on these results, the following recommendations are advanced: (a) undertake benefit-cost analysis of improved drainage to allow increased paddy cultivation in low lying areas in the monsoon season; (b) increase access to irrigation for dry season crops cultivation; (c) enhance access to improved varieties for all major crops; (d) identify pulses varieties that allow mechanized harvesting; (e) encourage crop and livestock diversification; and (f) improve the productivity and profitability of green gram production (varieties, irrigation access, integrated pest management).

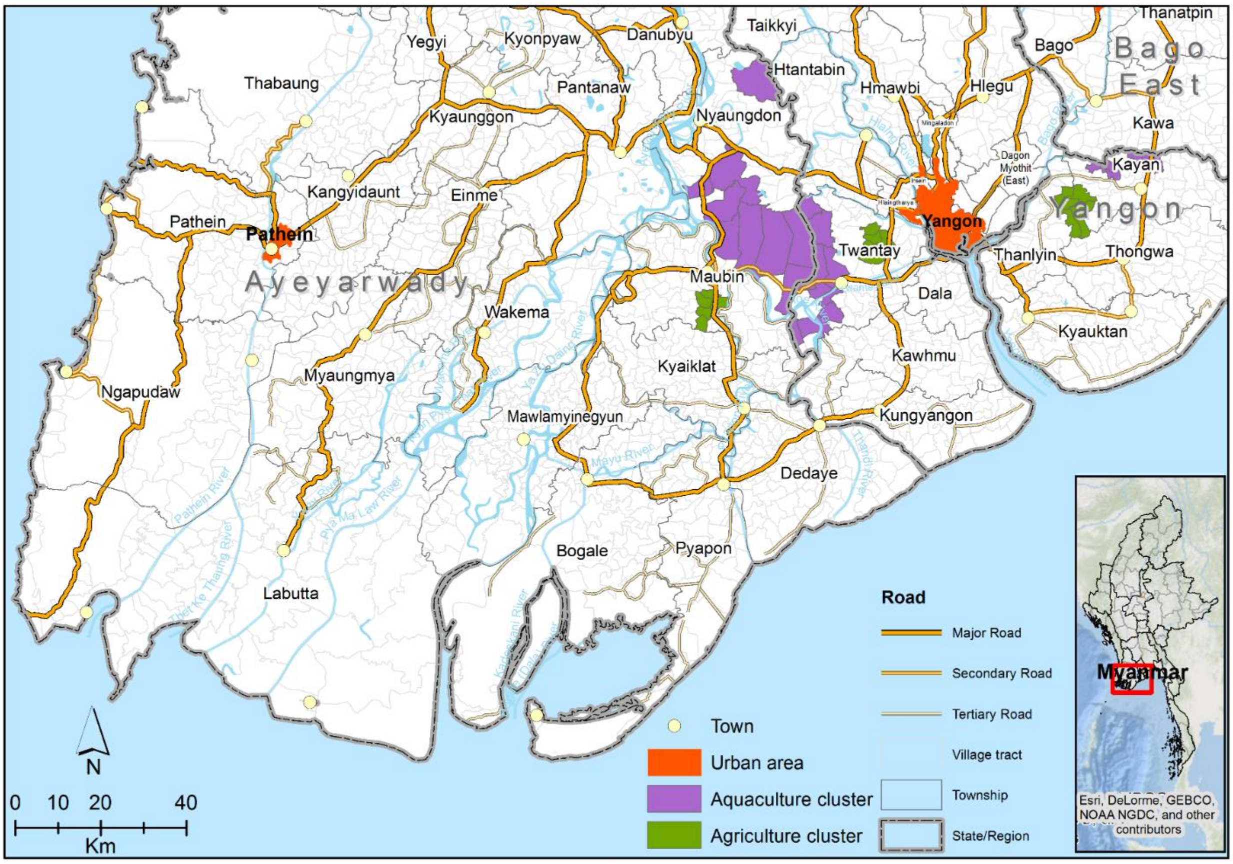
TABLE OF CONTENTS

INTRODUCTION

The technical and economic characteristics of agriculture in Myanmar are understudied and poorly understood. This report addresses this knowledge gap by presenting data from a statistically representative survey of 329 agricultural households in Maubin, Nyaungdon, Twantay and Kayan townships in Ayeyarwady and Yangon regions, an area considered to be part of Myanmar's 'rice bowl'. These interviews were conducted in May 2016 as part of the Myanmar Aquaculture-Agriculture Survey (MAAS), a larger survey of 1102 fish farming, crop farming and landless households in 40 village tracts in rural townships in Ayeyarwady and Yangon.

A total of 329 crop farming households were interviewed in a two 'clusters' of village tracts: 15 village tracts where cultivation of paddy and pulses was the main agricultural activity, and 25 village tracts with high concentrations of fish ponds (Figure 1). These are referred to, respectively, as the 'agriculture cluster' and 'aquaculture cluster' in the remainder of this report. Two hundred and sixteen crop farming households were surveyed in agriculture cluster village tracts, and 113 crop farming households were surveyed in village tracts in the aquaculture cluster. The farms surveyed were representative of the entire population of crop farming households in these village tracts. A more detailed description of the survey methodology can be found here.

Figure 1: Location of Surveyed Village Tracts



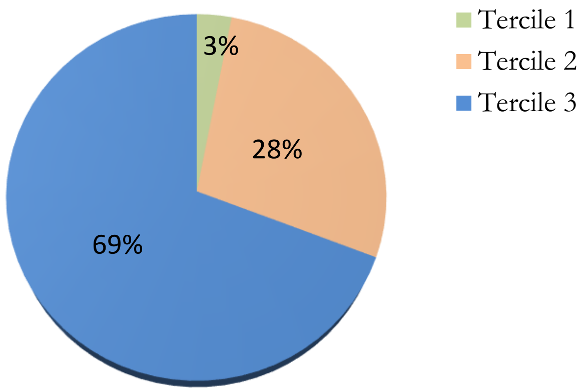
Overview of sampled households

Among the households sampled, 26% were crop farming households (mainly paddy and pulses), 56% were non-farm (landless) households, 9% were fish farming households and 13% were 'other' farming households (fruits, horticulture, etc.). Landless households accounted for 51% of those in the agriculture cluster and 58% of households in the aquaculture cluster.

The results presented in the rest of this paper pertain exclusively to crop farming households. Most of these are small farmers: almost two thirds of crop farming households (63%) cultivated less than 5 acres, 20% cultivated between 5 and 10 acres, and 17% cultivated more than 10 acres. The area cultivated ranged from 0.6 acres up to 70 acres with a median value of 5.5 acres. The average area of operated land for farms in the agriculture cluster (10.2 acres) was larger than that in the aquaculture cluster (7.8 acres).

Among land holding terciles[1], the average area of cultivated land in the highest tercile was 18.1 acres, followed by 5 acres for tercile 2 and 1.5 acres for the lowest tercile. The operated land in the largest tercile accounted for 69 % of total cropped land area (Figure 2).

Figure 2: Share of agricultural land owned by landholding tercile



For the purposes of analysis, farm cropping patterns were categorized into four types: 'single paddy', 'double paddy', 'single other' and 'double mixed'. As the names suggest, single and double paddy farms produced one and two crops of paddy per year, respectively. 'Single other' farms produced one non-paddy drop, and 'double mixed' farms produced one paddy crop and one non-paddy crop (mainly green or black gram).

The most common farm type in the agriculture cluster, was double season mixed-crop. More than half of households (57%) grew paddy in the monsoon season and non-paddy crops in the dry season (Figure 2). Secondly, 23% of farms were double paddy farms, growing paddy in both monsoon and dry seasons. Twenty-one percent of households cultivated paddy in one season (single paddy farms).

The cropping pattern in the aquaculture cluster was markedly different. Most land in the aquaculture cluster is low lying and affected by flooding, so cannot be cultivated in the monsoon

[1] Farms were ranked from smallest to largest, based on the area of agricultural land operated, and divided into three equal groups (landholding terciles). Landholding tercile 1 is comprised of the third of farms operating the smallest landholdings. Landholding tercile 3 is the third of farms with the largest landholdings. Landholding tercile 2 is intermediate.

season. As a result, 58% of farms were 'single paddy' producers and only 3% were 'double paddy' producers. Thirty three percent practiced 'double mixed' cropping (Figure 3).

Figure 3: Share of households, by cropping pattern and cluster

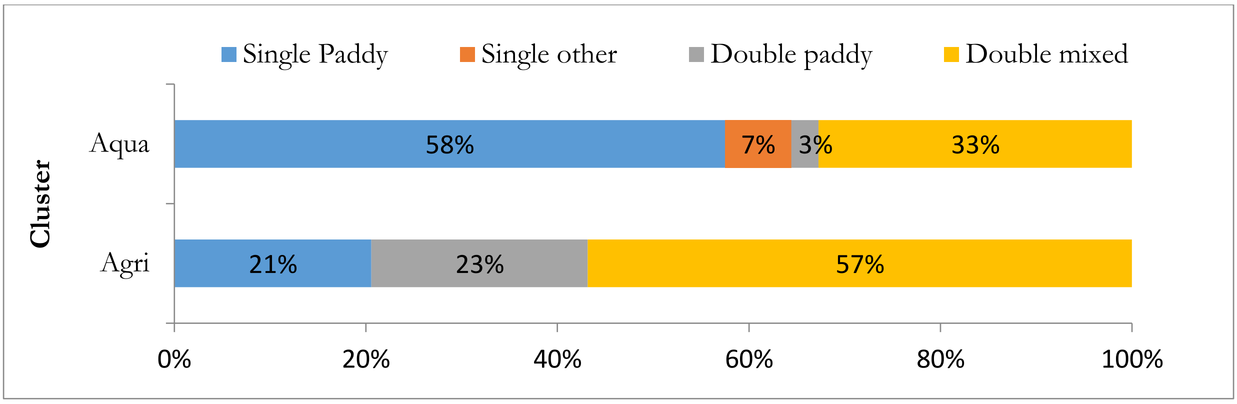
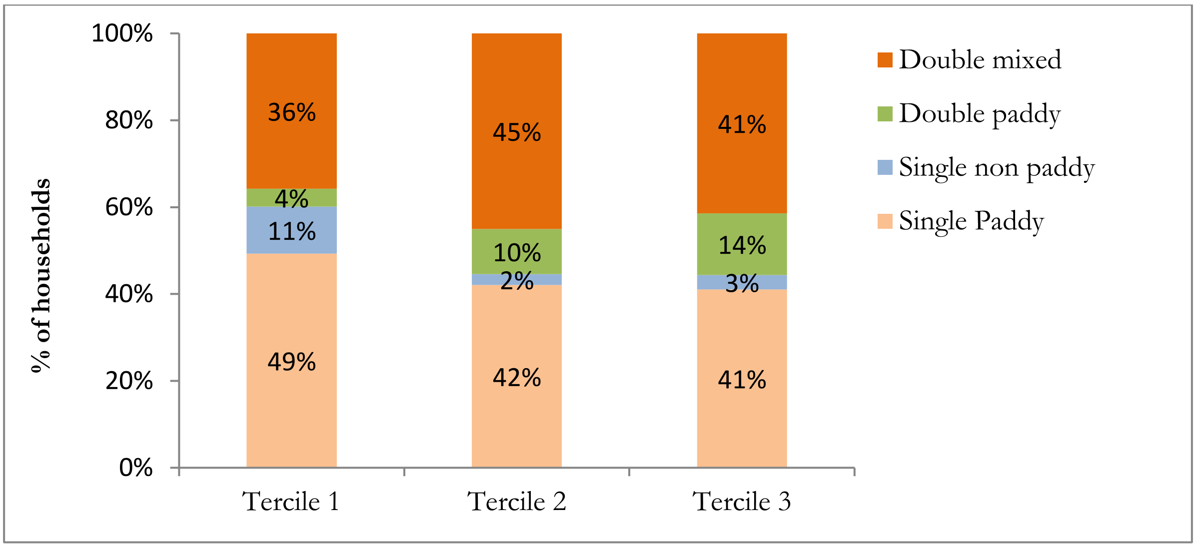


Figure 4 illustrates the frequency of cropping pattern by landholding tercile. Households in the top two terciles are more likely to grow crops for two seasons than those in the bottom tercile (55% compared to 40%). This pattern is reflected in cropping intensity (the ratio of gross crop area planted over the course of a year to physical area farmed) The average cropping intensity was 149%, and was lower for households in tercile 1 (140%) than those in terciles 2 and 3 (152% and 150%, respectively). However, average cropping intensity among households in all terciles is low compared to that in many other countries in the region.

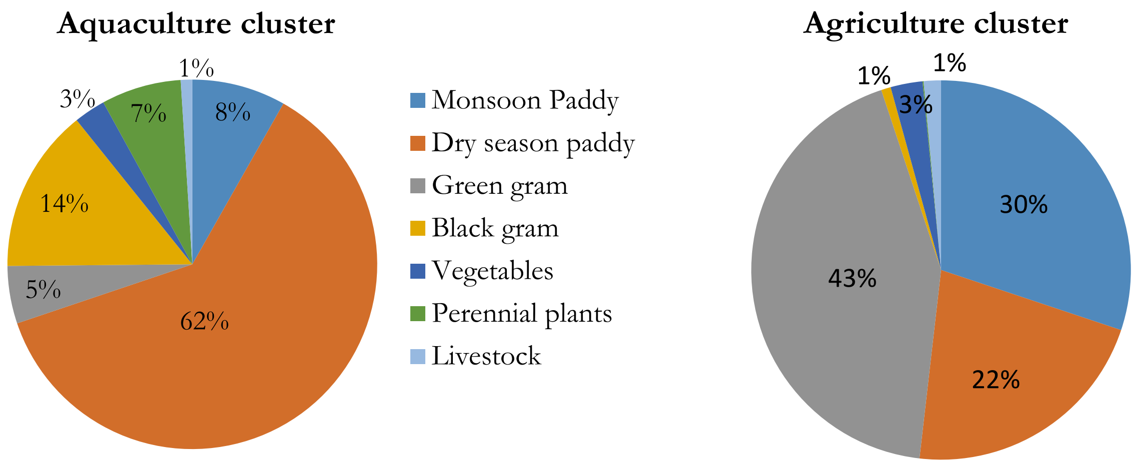
Figure 4: Share of households by cropping pattern and landholding tercile



In terms of income earned from crop production, dry season paddy was the most important crop in the aquaculture cluster (generating 62% of the value of all crop gross margins), followed by black gram (14%) and monsoon paddy (8%).

Green gram was the main income generating crop for farmers in the agriculture cluster, followed by monsoon paddy and dry season paddy. Forty-three percent of total farm gross margins were earned from green gram, 30% from monsoon paddy and 22% from dry season paddy (Figure 5).

Figure 5: Crop contributions to whole farm gross margins, by cluster



CROP PRODUCTION

This section presents data on crop management and utilization of harvested output for each major crop and season. The results are based primarily on the largest parcel operated by each farm household. Most of these households (66%) cultivated only a single agricultural parcel. Where results presented depend on a data source other than the sample parcel, this is noted in the explanation.

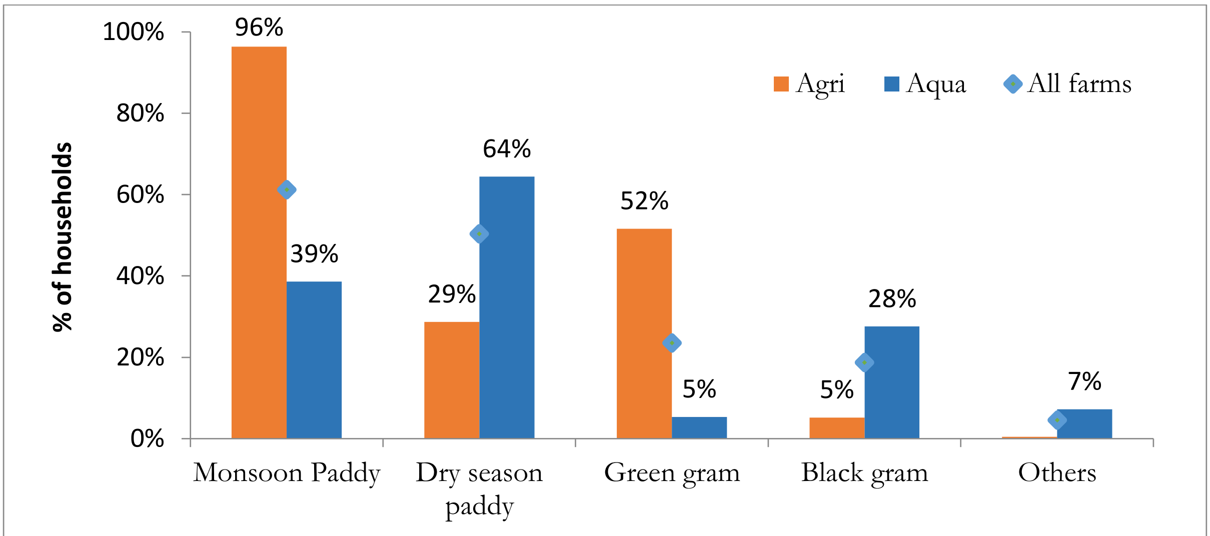
Monsoon season crop production

The mean area of monsoon paddy land cultivated in the agriculture cluster (10.4 acres) was nearly five times larger than that in aquaculture cluster (2.3 acres).

Ninety-seven percent of all agricultural parcels in agriculture cluster were planted during monsoon season. In the aquaculture cluster, only 39% of parcels were planted during monsoon (Figure 6). Most of these parcels remained uncultivated because they were in low lying areas affected by flooding.

Farming during the monsoon season was totally dominated by paddy cultivation in both clusters. Paddy occupied all cultivated parcels (100%) in the agriculture cluster and 99% of cultivated parcels in aquaculture cluster.

Figure 6: Share of households by crop produced and cluster

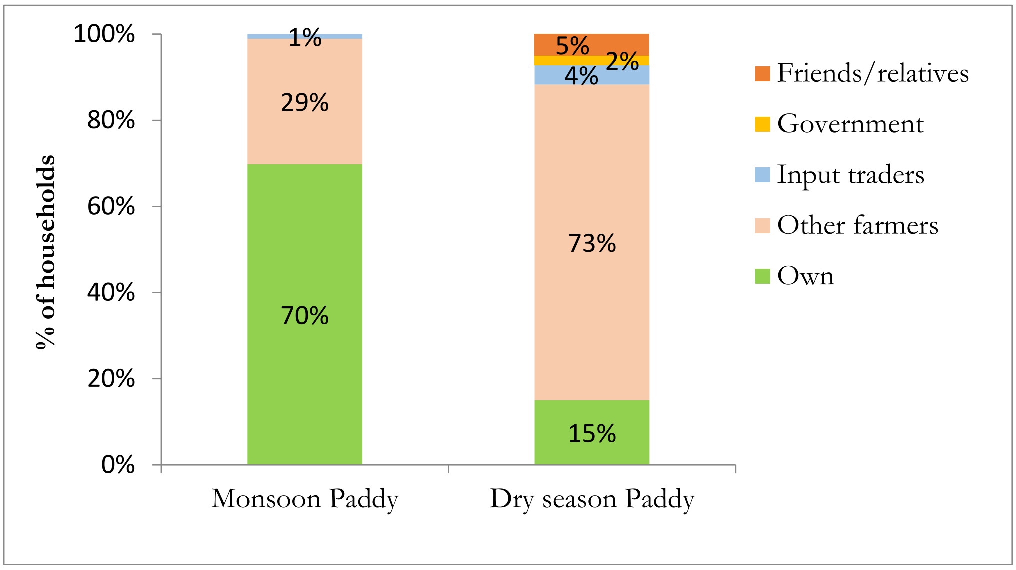


Crop management

Seeds: Farmers sowed an average of 2.4 baskets[2] (50.16 kg) of paddy seed per acre. The majority of farmers (70%) retained their own seeds for monsoon paddy cultivation, followed by purchasing from other farmers (29%). Very few farmers purchased paddy seed from input traders (1%) (Figure 7). Those farmers who purchased seed paid MMK 6,668 per basket on average (MMK 15,768/acre).

[2] 1 basket of paddy = 20.9 kg

Figure 7: Sources of paddy seeds for monsoon and dry season

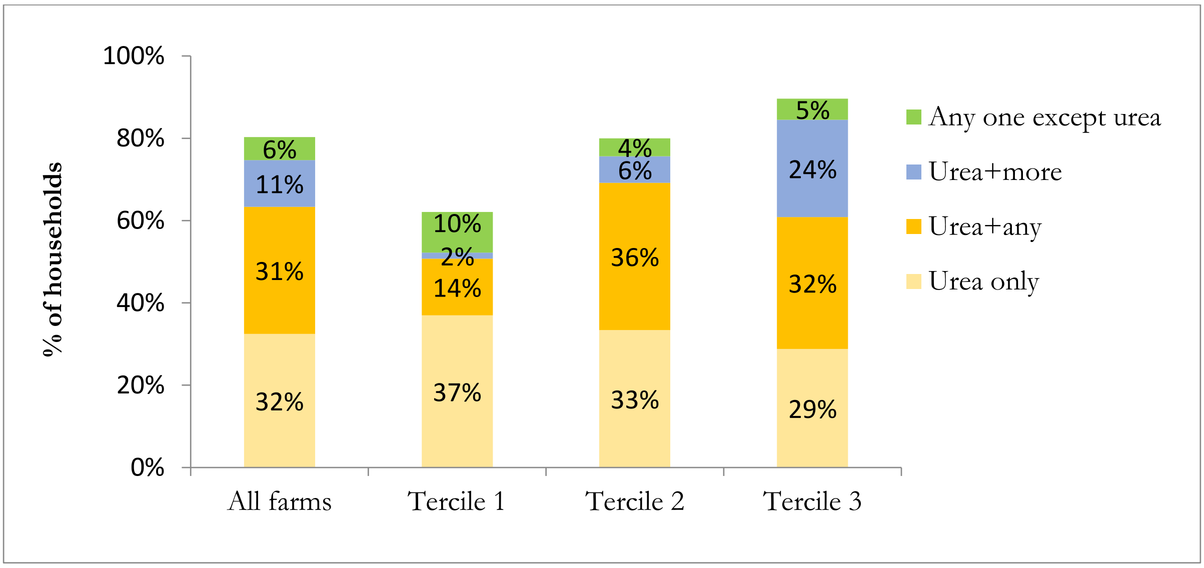


Monsoon season paddy was overwhelmingly established by direct seeding (a labor saving approach). Almost 90% of farm households in the agriculture cluster and three quarters of households in the aquaculture cluster established paddy in this way.

Inputs: Most households (87%) used some kind of fertilizer during monsoon season. Eighty percent of households used inorganic fertilizers and 27% applied organic fertilizers.

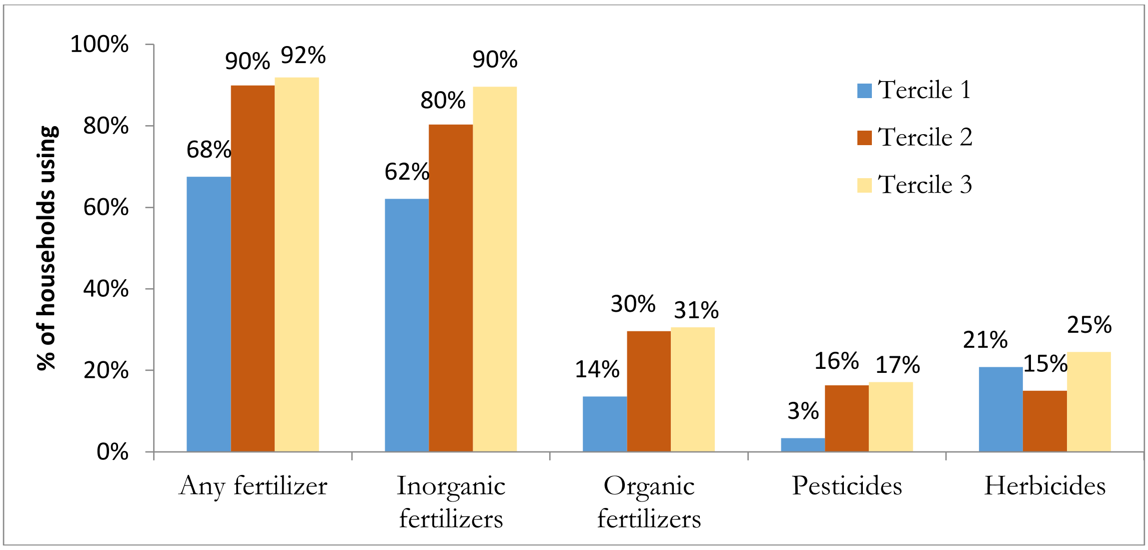
Figure 8 shows the share of households using urea (the most commonly used inorganic fertilizer), on its own and in combination with other inorganic fertilizers, by landholding tercile. The graph indicates that farm households in the upper landholding terciles use more types of fertilizer than those in tercile 1.

Figure 8: Number of fertilizers used, by landholding tercile



Similarly, Figure 9 shows that the percentage of households using inputs (fertilizers, pesticides and herbicides) for monsoon paddy cultivation increases slightly with land holding tercile, suggesting that operators of larger farms are better able to shoulder the investment costs associated with higher input use.

Figure 9: Type of inputs used by land holding tercile

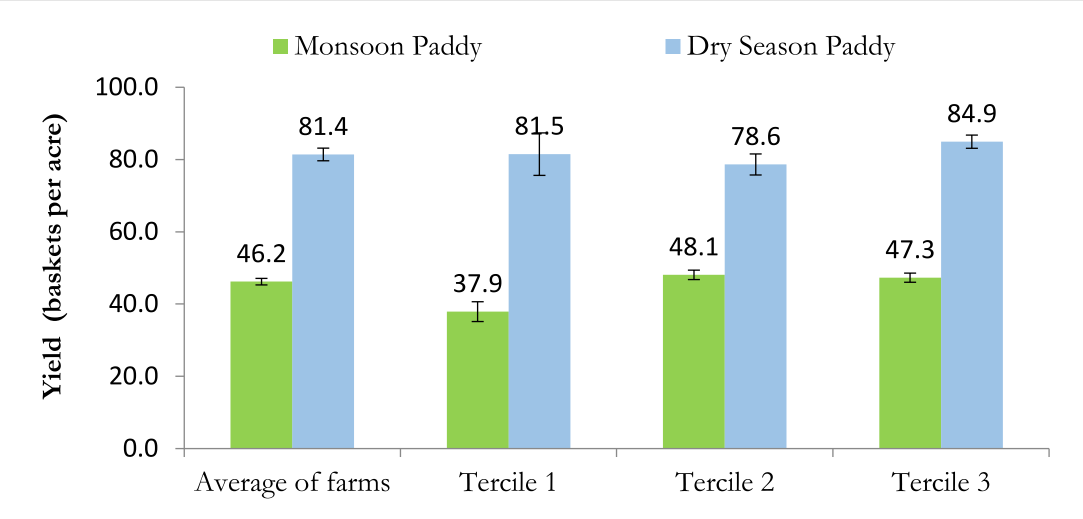


Interestingly, farmers applied similar amounts of fertilizer per acre regardless of the type of fertilizer used: 59 kg per acre for urea, 56 kg per acre for T-super (a phosphate based fertilizer), 43 kg per acre for potash and 48 kg per acre for compound fertilizer. The total amount of inorganic fertilizer applied was the highest in tercile 3 (110 kg), followed by terciles 2 and 1 (90 kg and 55 kg respectively).

Irrigation: As expected, almost all households (99%) reported that rainfall was the primary source of water for monsoon paddy cultivation.

Yields: The average yield of monsoon paddy was 46.2 baskets per acre (2,385 kg/ha). The average yield of farms in the lowest landholding tercile was lower than those in tercile 2 and 3 (Figure 10). Over half of total monsoon paddy production (64%) was produced by households in the largest land holding tercile, one third came from households in tercile 2 while households and only 3% in the lowest tercile. This pattern reflects the uneven distribution of land amongst these households.

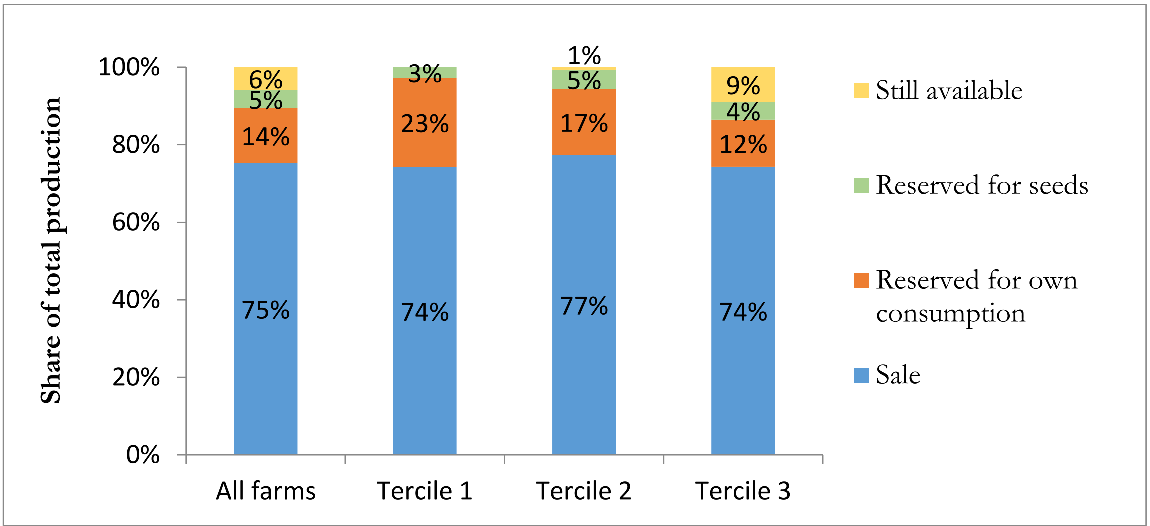
Figure 10: Average yields of monsoon and dry season paddy (basket/acre) by landholding tercile.



Sales and use: Monsoon paddy is a highly commercial crop, even for the smallest farmers.

Figure 11 shows the share of monsoon paddy sold by households in all landholding terciles. Households in all terciles sold about three quarters of their monsoon paddy.

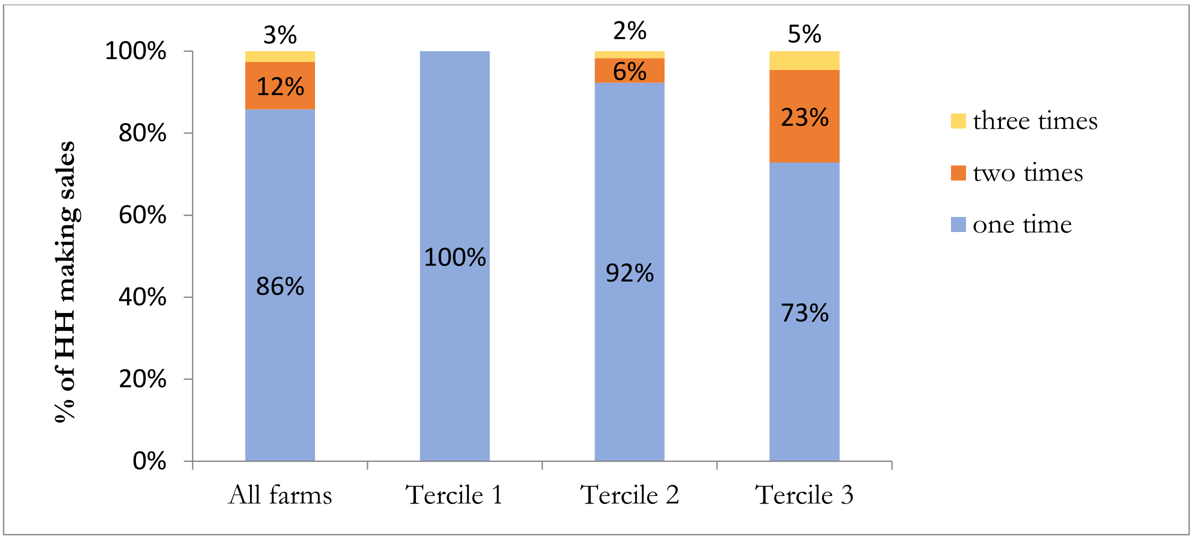
Figure 11: Disposal of monsoon paddy by use and landholding tercile



At the time of the survey, three quarters of monsoon paddy had been sold and 6% of paddy was still available for sale. Fourteen percent was reserved for own consumption and 5% was reserved for seed. The share of monsoon paddy reserved for own consumption in tercile 1 (23% of production) was higher than those in tercile 2 (17% of total production) and 3 (12%).

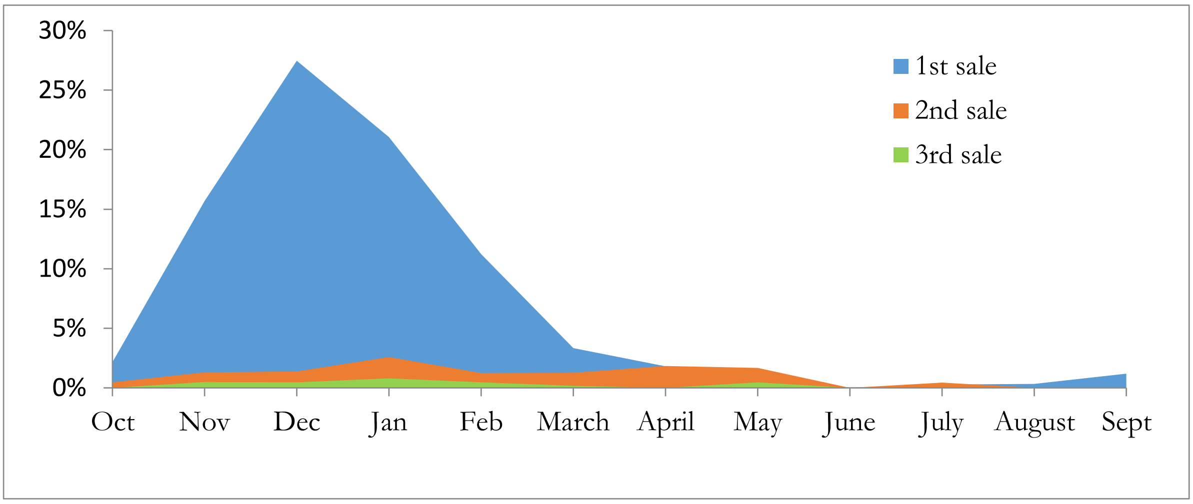
The majority of crop farming households (86%) sold their monsoon paddy on a single occasion, 12% made two sales and only 2% sold three times. All households in tercile 1 made only one sale. The larger the landholding tercile, the more likely farmers were to sell their paddy on more than one occasion (Figure 12).

Figure 12: Number of sales of monsoon paddy by tercile



Peak monsoon paddy sales occurred from November to February, with most concentrated in December and January (Figure 13). A few households made second and third sales between November and May.

Figure 13: Frequency of monsoon paddy sales, by month



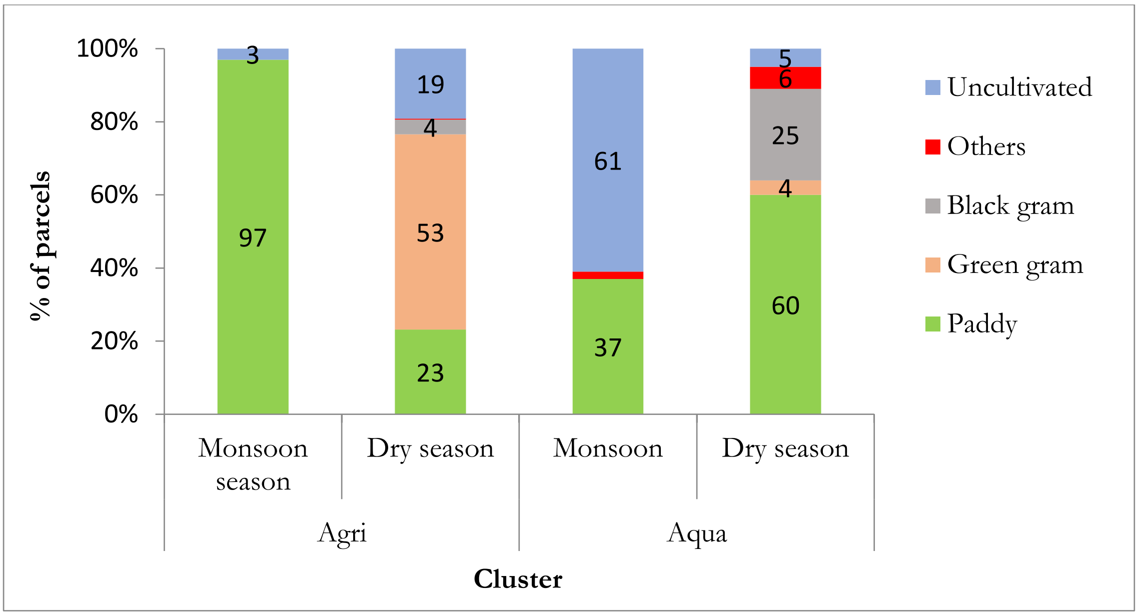
Most sales of monsoon paddy took place at the homes of farm households (49%). Secondary, locations of sale were at mills (25%) and on farm (21%). The main buyers were traders (63%) and millers (32%). The average sale price for monsoon paddy was about MMK 5,200 per basket (MMK 249/kg). The average sales price for monsoon paddy was highest in May (MMK 6,794) and lowest in September (MMK 4,500).

Dry season crop production

Most households farmed in the dry season (83% in the agriculture cluster and 94% in the aquaculture cluster). Green gram was the main crop produced in the agriculture cluster in dry season (cultivated in 53% of parcels), with paddy the second most important crop (23% of parcels). Black gram was grown on 4% of parcels, leaving 19% of parcels uncultivated (Figure 14).

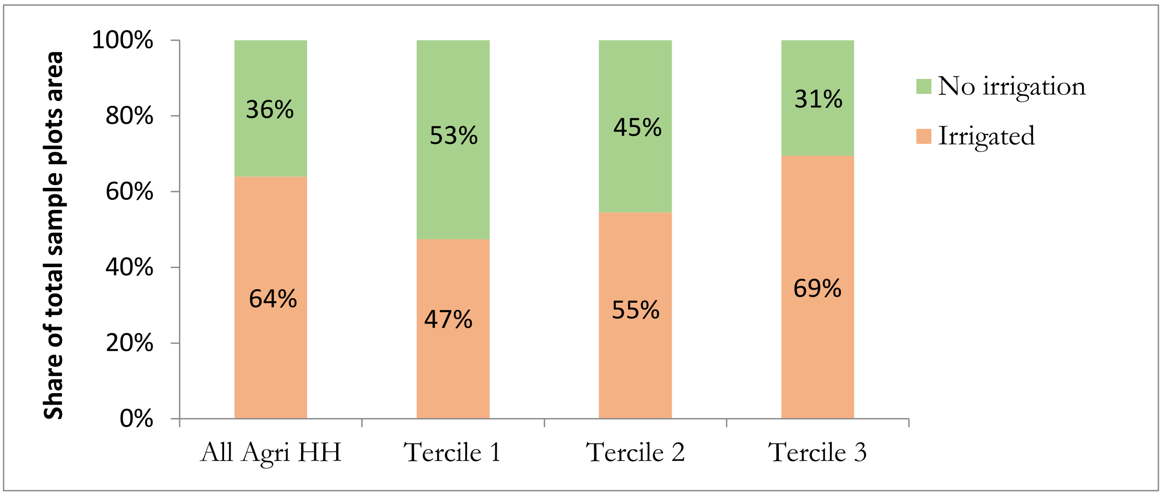
The dominant dry season crop in the aquaculture cluster was paddy, followed by black gram. Paddy was cultivated in more than half of parcels (60%). Black gram was cultivated in 25% of parcels, green gram in 4% of parcels and other crops in 6% of parcels. Five percent of parcels remained uncultivated.

Figure 14: Share of cropped and uncultivated land, by crop type and clusters



Almost two thirds (64%) of the total cultivated area of sample plots was irrigated in the dry season. Analysis by landholding tercile reveals that the share of land irrigated during dry season increases with landholding tercile (from 47% to 69%) (Figure 15).

Figure 15: Share of cultivated area of sample plots irrigated in dry season



Dry season paddy

In the following sections, we present the results for dry season paddy and pulses separately.

Dry season paddy shared 45% of total cropped land in the agriculture cluster but dominated in the aquaculture cluster covering three quarters (74%) of total cropped land.

Crop management

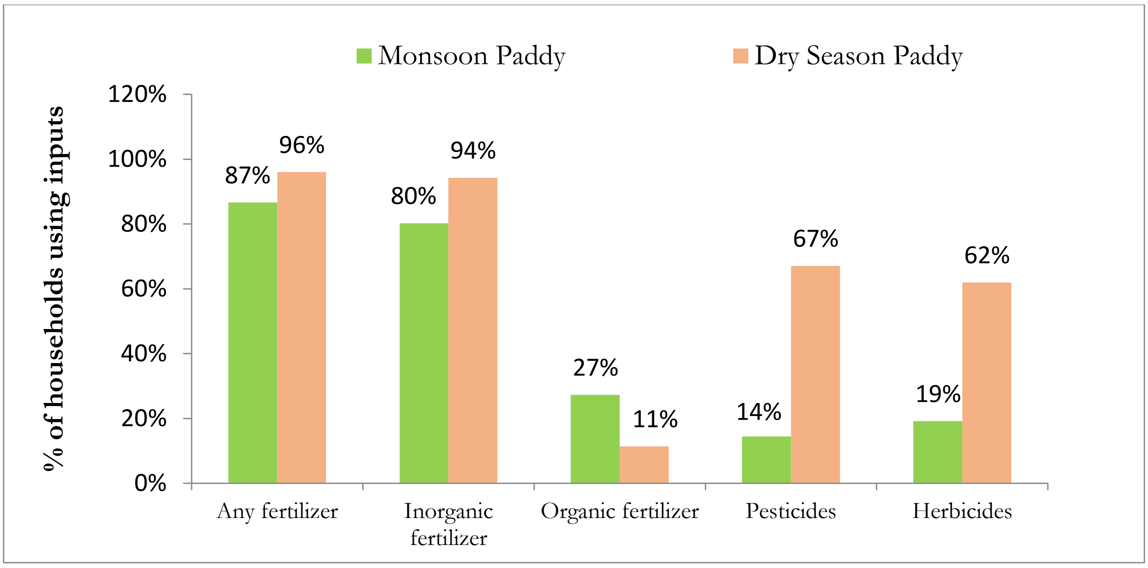
Seeds: Unlike in monsoon season, the main source of paddy seed in dry season was other farmers. Nearly three quarters of households (73%) purchased paddy seeds from other farmers. Only 15% of households used their own reserved seeds. However, very few farmers bought seeds from commercial sources such as input traders, or from government.

As in monsoon season, paddy was mainly established by direct seeding in both clusters: 95% of farms in agriculture cluster and 83% in aquaculture cluster. The average amount of seed used in dry season was 3.15 baskets (65.83 kg) per acre. Farmers who purchased seeds spent an average of MMK 22,153/acre on seed.

Irrigation: Almost all households (99%) who grew dry season paddy reported irrigating the crop. For half of households (52%) primary source of irrigation water was a river or stream, closely followed by canals (47%). Irrigation is already very largely mechanized. Nearly 90% of households who irrigated their land did so by surface water pump. Six percent of households did so manually, and just 3% by hand- or pedal-operated water pump. The average cost of irrigation for dry season paddy was MMK 30,389 per acre.

Inputs: The percentage of households using inputs was slightly higher in the dry season paddy cultivation than in the monsoon paddy cultivation, with the exception of organic fertilizer which was lower (Figure 16).

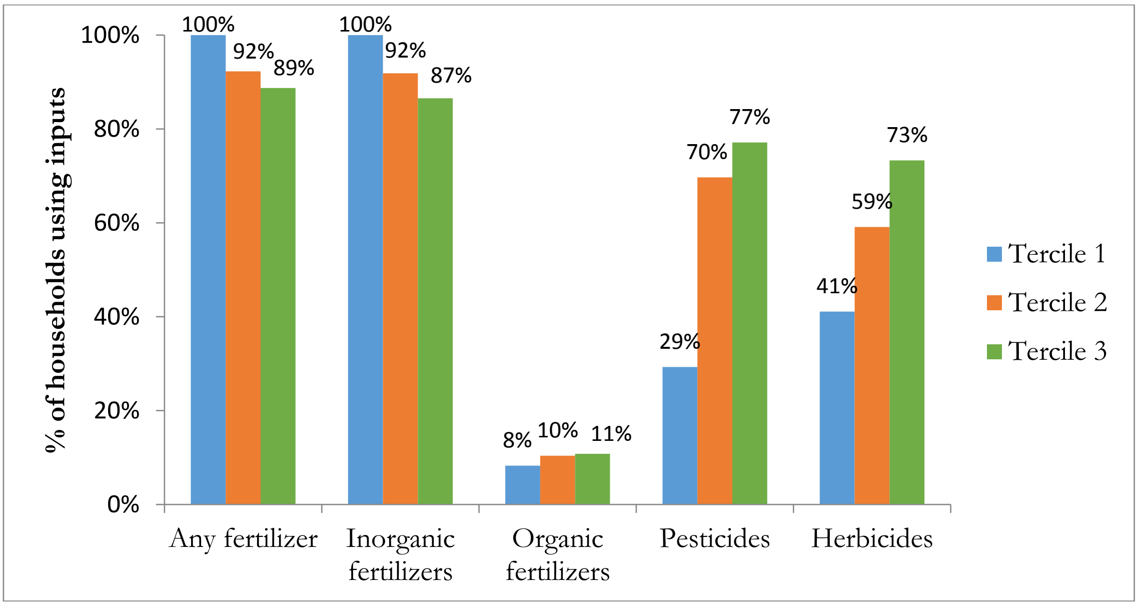
Figure 16: Share of households using inputs for paddy cultivation, by input and season



Almost all households (96%) used some kind of fertilizer for dry season paddy cultivation. Ninety-four percent of households used inorganic fertilizers, while only 11% applied organic fertilizers. Pesticide and herbicide use on dry season paddy was much higher than on monsoon paddy, with 4 out of 5 households applying pesticides to dry season paddy, compare to less than one in five for monsoon paddy.

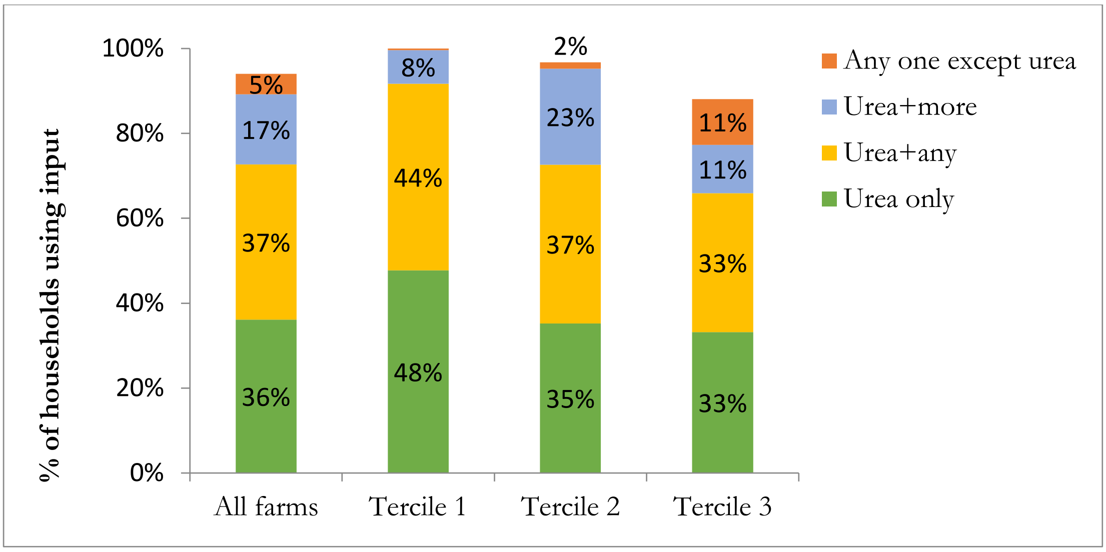
Unlike during monsoon season, the percentage of households using inorganic fertilizers decreased slightly from landholding terciles 1 to 3. However, the percentage of households using pesticides and herbicides rose as landholdings increased (Figure 17).

Figure 17: share of households using inputs on dry season paddy by landholding tercile



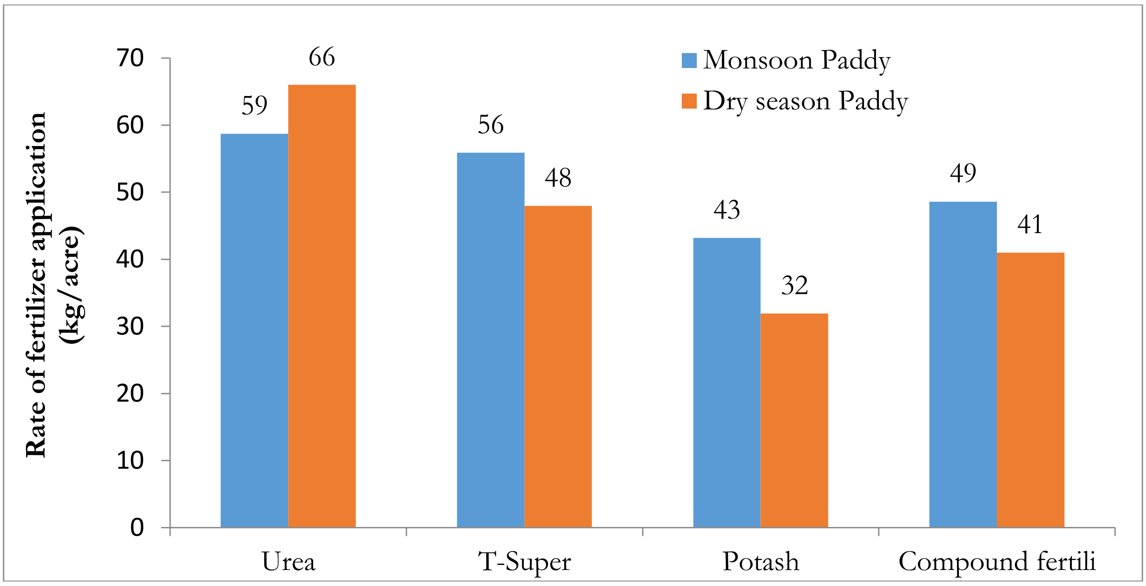
As in monsoon season, smaller farms tended to use fewer inorganic fertilizers than those in upper landholding terciles (Figure 18).

Figure 18: Combination of fertilizers used on dry season paddy, by landholding tercile



The average quantities of fertilizer applied per acre in dry season paddy cultivation by farmers who used them were 66 kg of urea, 48 kg of T-super, 32 kg of potash and 41 kg of compound fertilizer (Figure 19). The average amount of urea applied on dry season paddy was higher than that in monsoon paddy but the average amounts of other inorganic fertilizers were lower. The amount of cow manure applied was 1 bag per acre: 70 % lower than that in monsoon paddy cultivation.

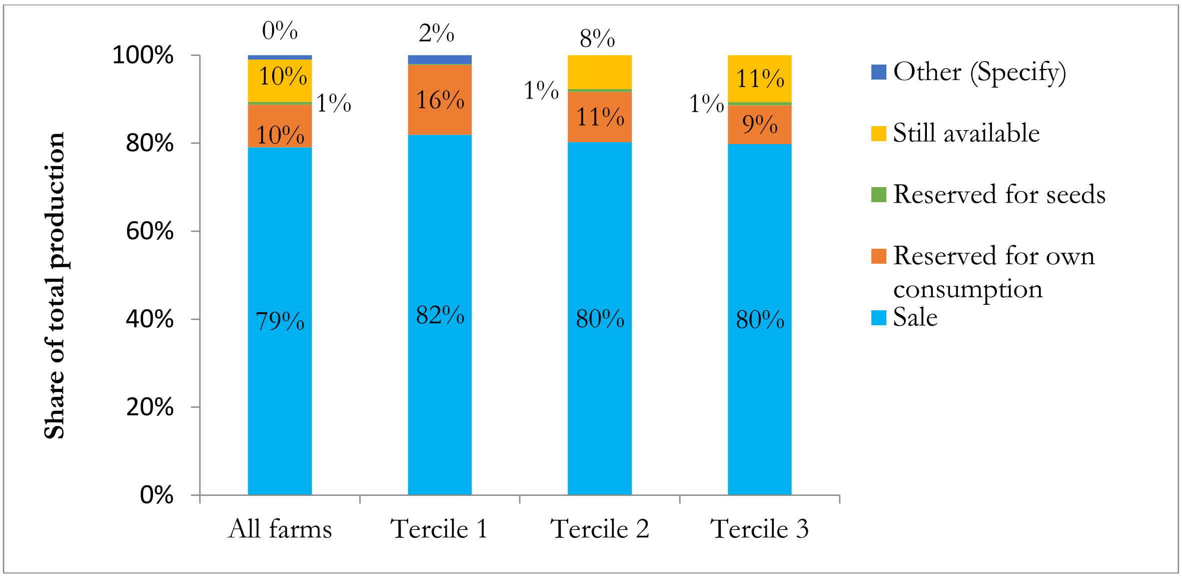
Figure 19: Average amounts of inorganic fertilizers applied on paddy, by season (kg/acre)



Yields: The average yield of dry season paddy (81.4 basket/acre or 4,202 kg/ha) was nearly double that of monsoon paddy (46.2 basket/acre or 2,385 kg/ha). This reflects the higher percentage of households using improved varieties and higher rates of urea application in the dry season. Households in the tercile 3 accounted for by far the largest share of dry season paddy production (71% of total production), followed by tercile 2 (27%). Households in tercile 1 accounted for just 2% of dry season paddy production.

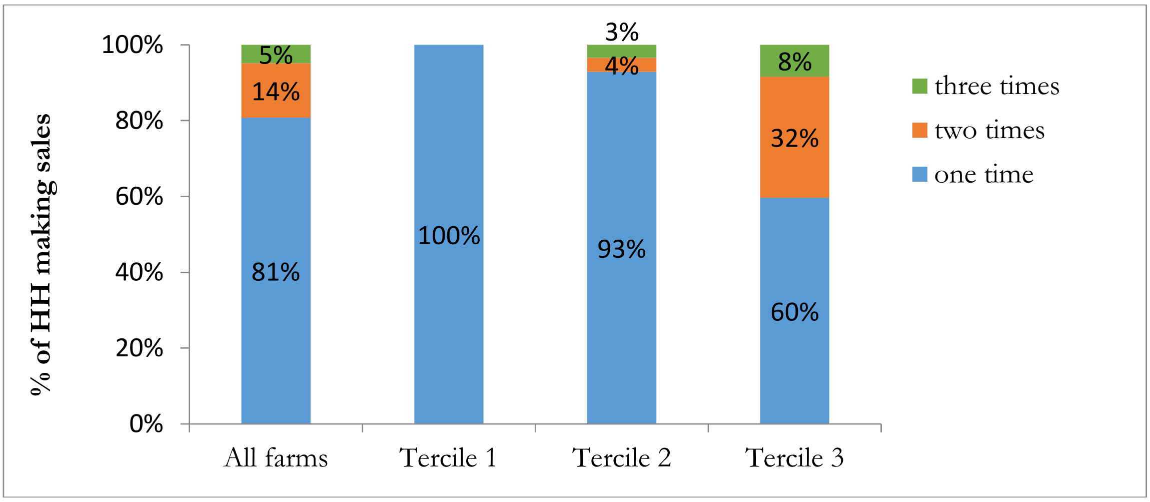
Sales & Use: The vast majority (79%) of dry season paddy harvested from sampled parcels was traded. Only 1% was reserved for seed. At the time of our survey 10% was still available for sale and the same amount was reserved for own consumption. While the share sold was similar across terciles, households in tercile 1 reserved more paddy for their own consumption (16%) than those in tercile 2 (11%) or tercile 3 (9%) (Figure 20).

Figure 20: Share of total dry season paddy utilization by landholding tercile



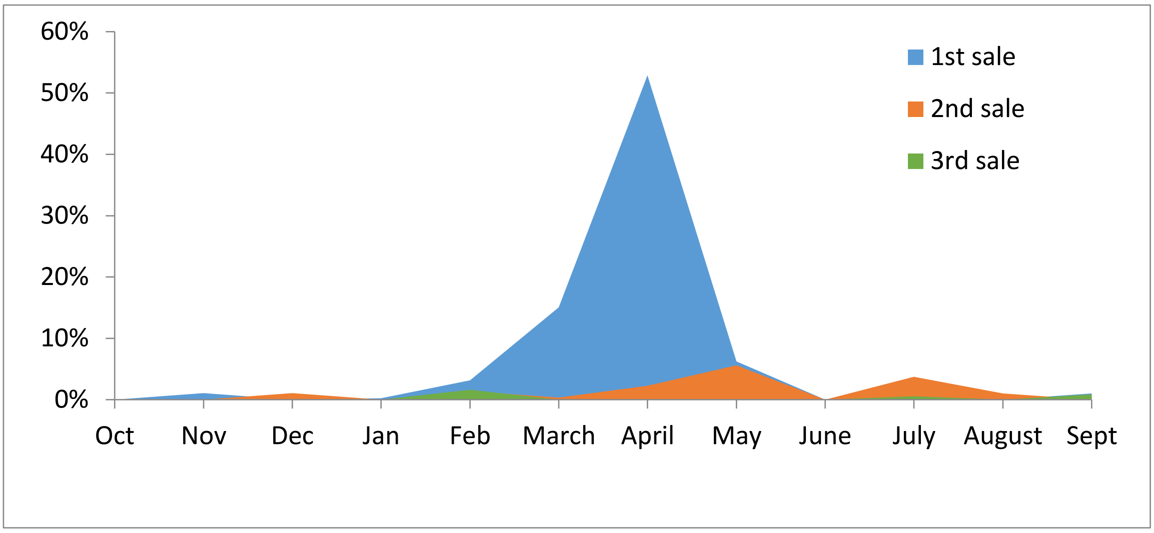
Four out of five households sold their dry season paddy in a single transaction. 14% of households made two sales, and 5% made three. All households in tercile 1 sold their paddy on a single occasion, while households in the upper terciles made sales on one to three occasions (Figure 21).

Figure 21: Percentage of households making sales of dry season paddy



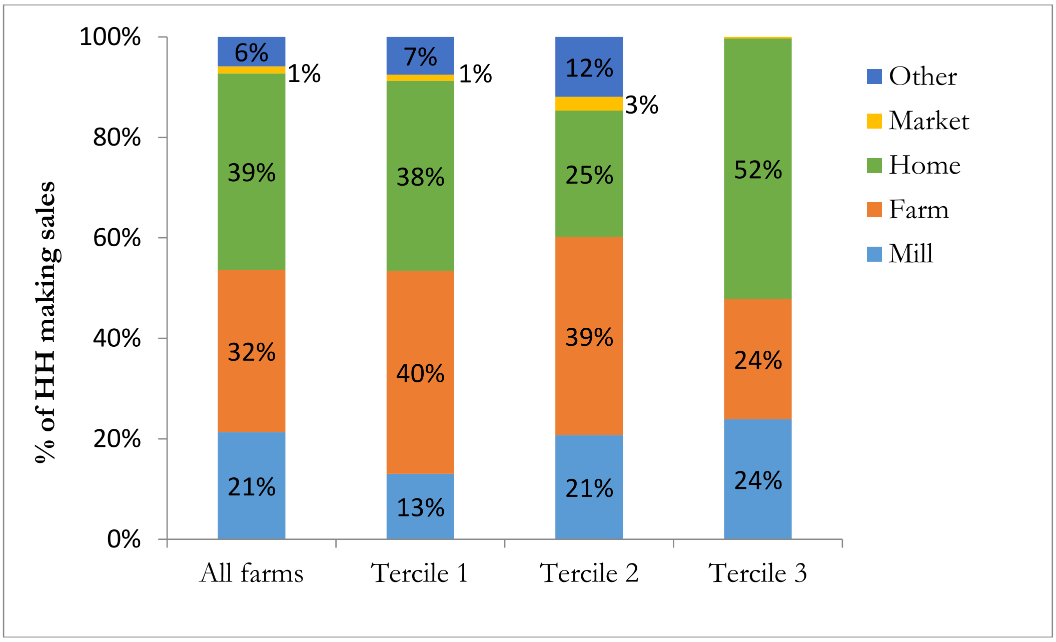
Most dry season paddy sales were made between February and June, peaking in April (Figure 22).

Figure 22: Frequency of households making sales of dry season paddy



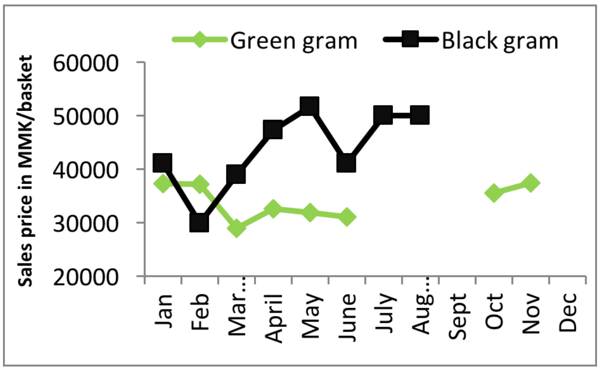
Traders (70%) and millers (29%) were the main buyers for dry season paddy. As shown in Figure 23, most paddy was sold at home (39% of households), on-farm (32%) and at mills (21%). Among households in tercile 1, two out of five households sold paddy on their farm (40%), 38% at their home and 13% at a mill. In tercile 3, 52% of households sold their paddy at home and equal percentages of households made sales on-farm and at mills (24% each respectively).

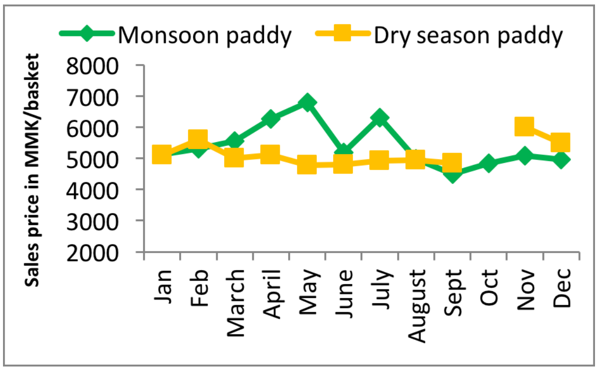
Figure 23: Percentage of households making sales of dry season paddy at different places



The average sales price of dry season paddy was lower than that of monsoon paddy, at MMK 5,075 per basket. The price peaked in November (MMK 6,000), and was lowest in November (MMK 4,771) (Figure 24).

Figure 24: Average sales price of green gram and black gram by month





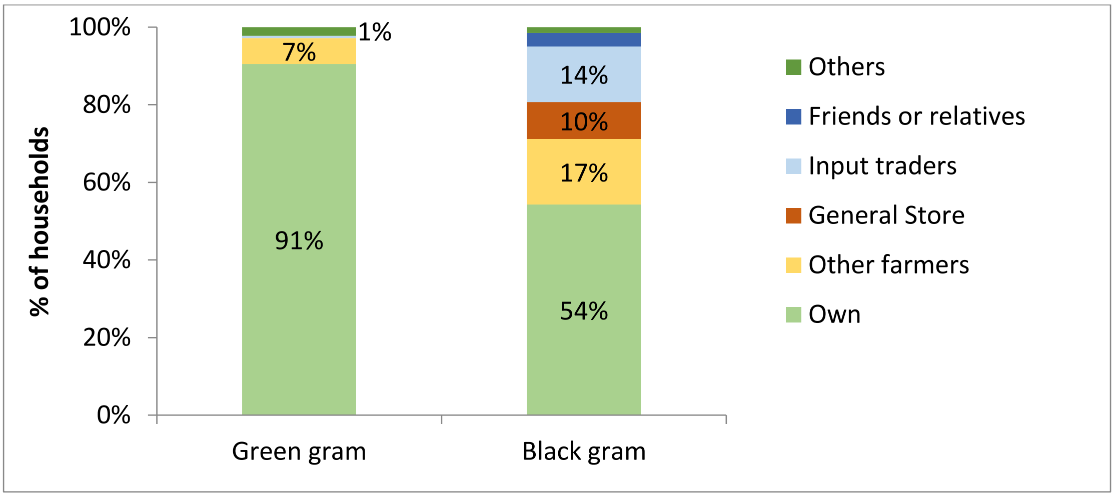
Pulses

Green gram was the main dry season crop in the agriculture cluster, cultivated by 52% of households and accounting for half of total cropped area. In the aquaculture cluster, only 5% of households grew green gram, which accounted for 4% of total cropped land. Black gram was the second crop in the aquaculture cluster, being cultivated by 28% of households and accounting for 26% of total cropped area. Very few households the agriculture cluster, grew black gram, which accounted for only 4% of total cropped land.

Crop management

Seeds: The majority of households reserved green gram seeds for cultivation (91%) and few farmers purchased green gram seeds from other farmers or input traders (Figure 25). In general, farmers planted nearly 1 basket of green gram seeds per acre. Among farmers who purchased green gram seed, the cost per acre of seed was MMK 54,313.

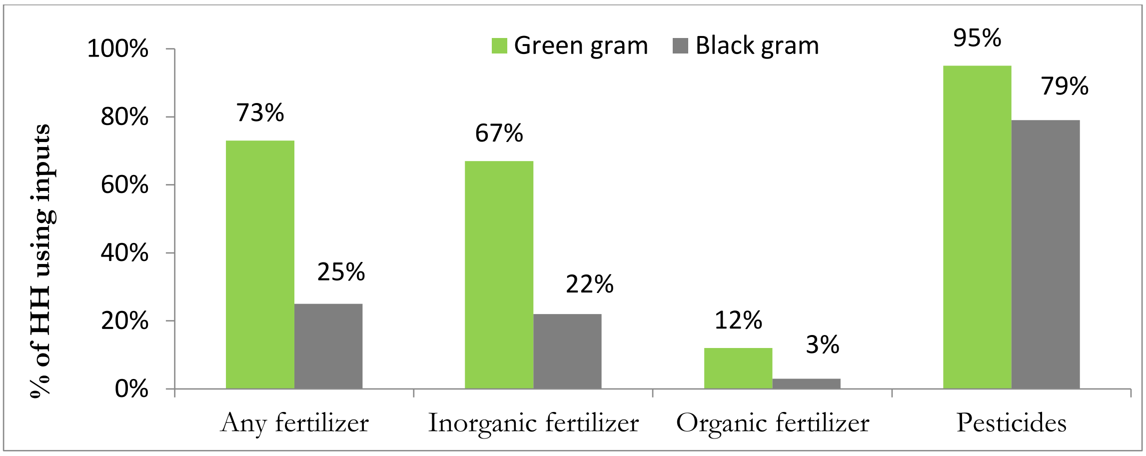
Figure 25: Sources of pulse seed



For black gram cultivation, about half of households used their reserved own seeds. Other sources of black gram seed were other farmers (17%), input traders (14%), general stores (10%), and friends or relatives. The average amount of black gram seed planted per acre was 0.75 baskets (24.5 kg/acre), at a cost of MMK 77,800 per basket.

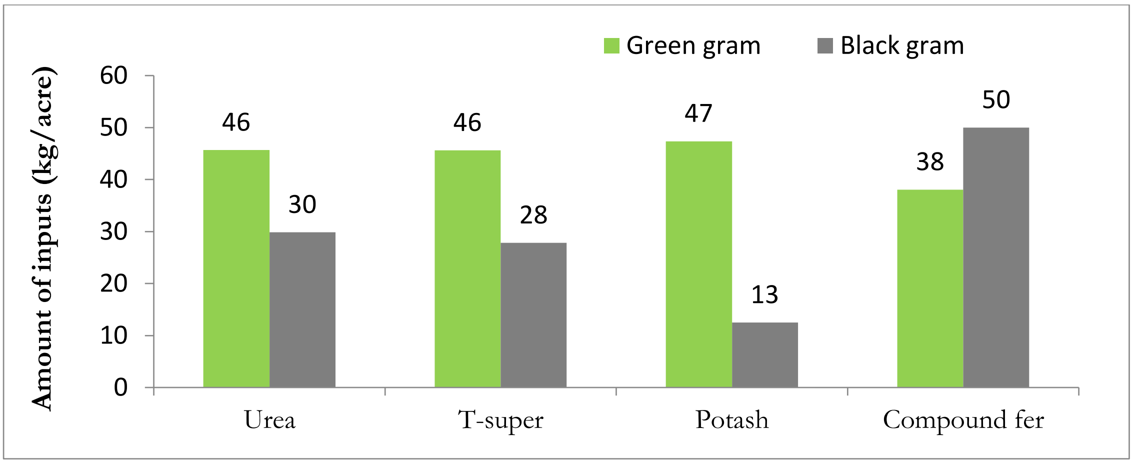
Inputs: The share of households using organic fertilizers and pesticides in pulses cultivation was similar to that in dry season paddy cultivation, but the share using inorganic fertilizers (especially urea) was lower. Only 37% and 21% of households, respectively, used urea for the cultivation of green gram and black gram (Figure 26). Farmers are less likely to apply urea in pulses cultivation because green gram and black gram are leguminous plants that fix nitrogen.

Figure 26: Percentage of households using inputs in pulses cultivation



The quantity of inorganic fertilizers applied on green gram was higher than that on black gram, with the exception of compound fertilizer. The quantity of inorganic fertilizers applied to pulses was lower than that of paddy. (Figure 27)

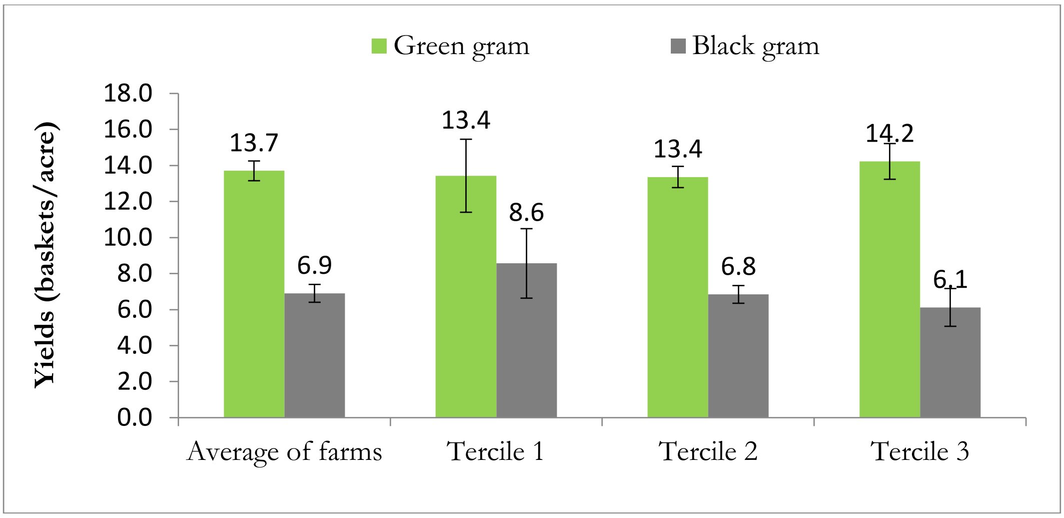
Figure 27: Amount of input applied to pulses (kg/acre)



Irrigation: Most households growing green gram and black gram did so using only residual soil moisture. Only 5% and 2% of households reported rainfall as the primary source of water for green gram and black gram. Eight percent of households reported that canals provided the primary source of water for black gram cultivation. Surface water pumps were used by 3% of households to irrigate green gram and 13% of households to irrigate black gram. The irrigation cost for households who irrigated was MMK 26,450/acre.

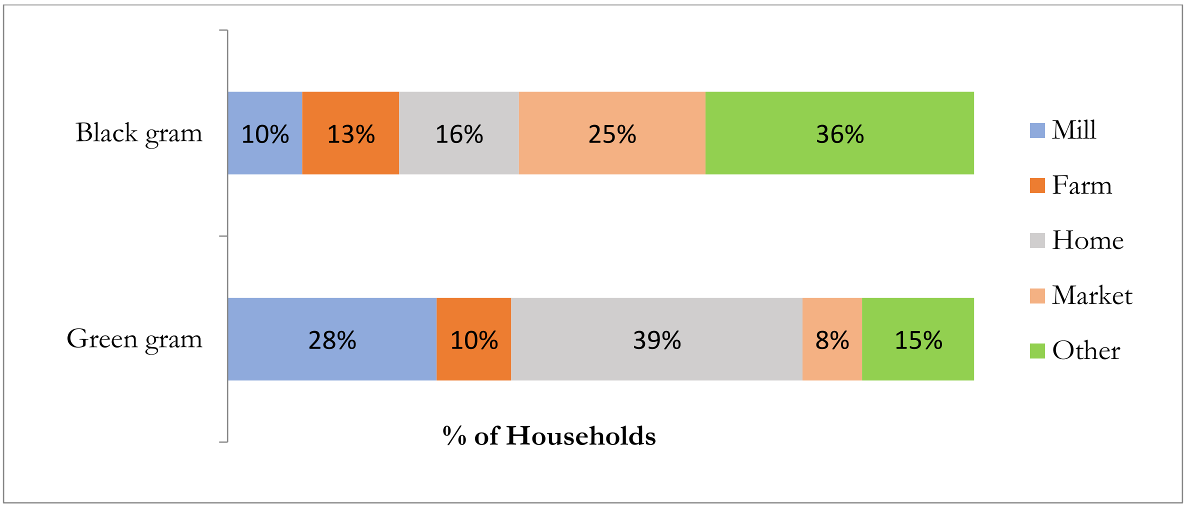
Yields: The average yield of green gram was 13.7 baskets/acre (1,106 kg/ha); approximately double that of black gram (6.9 baskets/acre or 557 kg/ha). There was little difference in average green gram yields among landholding terciles. The average yields of black gram fell slightly lower as landholding tercile increased from 1 to 3 (Figure 28).

Figure 28: Yields of green gram and black gram (baskets/acre)



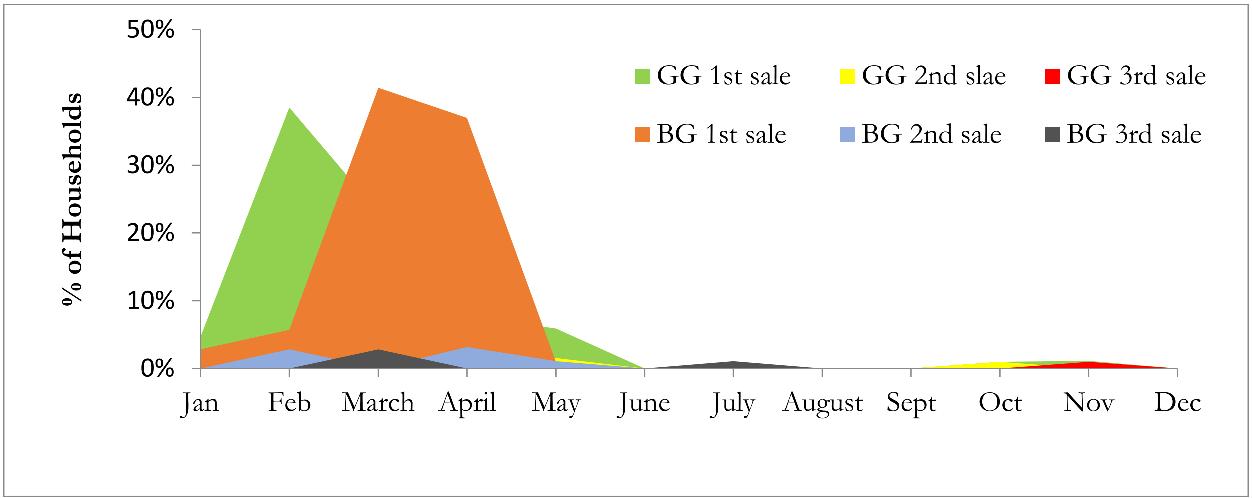
Sales & Use: Green gram is a highly commercial crop. Among the green gram produced from households' sample parcels, 88% was already sold and 6% was still available for sale at the time of the survey. Five percent of green gram was reserved for seeds, and only 1% for own consumption. Traders (70%) and millers (29 %) were the main buyers of green gram. Green gram was mostly sold at farmers' homes (39%), mills (28%) and other locations (15%) (Figure 29).

Figure 29: Percentage of households making sales of pulses, by locations



Almost all black gram (98%) was sold. Black gram was sold, mostly at 'other' locations (36%) and at markets (25%). The main buyers of black gram were traders (82%) and millers (12%). The peak sales season for green gram was February. Most black gram was sold in March and April (Figure 30).

Figure 30: Frequency of green gram and black gram sales by month



The average sales price of black gram (MMK 42,288 per basket or MMK 1,293/kg) was higher than that of green gram (MMK 33,487 per basket or MMK 1,024 /kg). Farmers earned the highest sales price for black gram in May (MMK 51,619/ basket) and lowest in February (MMK 29,902/basket). Famers earned the highest price for green gram in November (MMK 37,332/ basket). The average sales price of green gram in March was 22% lower than that in November (MMK 28,935/basket).

The average yield per acre of dry season paddy was 75% higher than that of green gram and 87% higher than that of black gram. However, but the average price of paddy was 85% lower than that of green gram and 88% lower than that of black gram.

CROP PRODUCTION COSTS AND PROFITABILITY

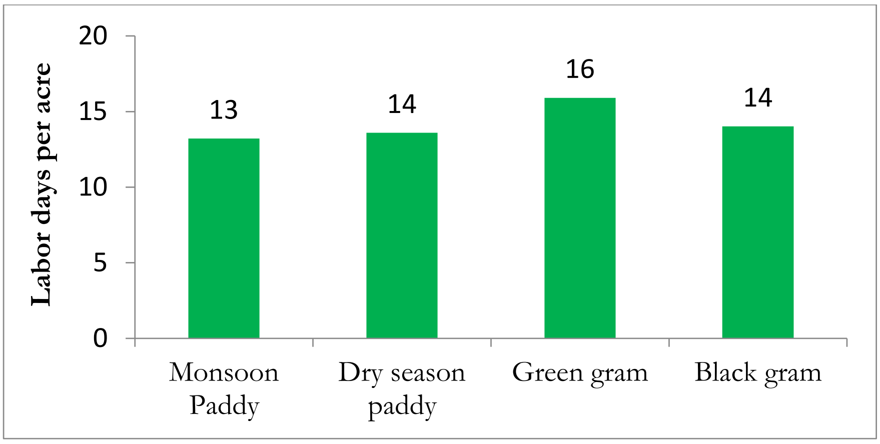
Long-term Labor

Twenty-four percent of agricultural households hired long term labor for their farms. Households in landholding tercile 3 hired the majority of long term labor (71%). Households in tercile 2 accounted for 29% of long term workers. No small farm household employed any long term labor. Most long term laborers were men (93%). On average, households hired permanent labor for 176 days, at an average wage of MMK 4,123 per day. The duration of long term employment varied from 10 days to 360 days. The cost of long term labor for the whole farm ranged from MMK 131,250 to 720,000 per year.

Casual Labor

This section presents information on the family and hired casual labor used by farm households in crop production. The average demand for labor per acre for each of the four main crops is shown in Figure 31. There is little difference in the demand for labor per acre between crops, ranging from 14 to 16 days per acre.

Figure 31: Average labor days per acre, by crop



Households using combine harvesters to harvest paddy had a much lower average demand for labor than households who harvested manually: 8 labor days/acre versus 16 labor days/acre in monsoon paddy production, and 9 labor days/acre versus 25 labor days/acre in dry season paddy production. This finding has potentially important implications for the availability of rural jobs, as well as for farm profitability.

The share of labor days used in specific farming activities varies among crops. In monsoon paddy production, about half of the labor days was used in harvesting and post-harvest activities, with the other half allocated to seedling and land preparation and other crop management activities. For dry season paddy production, which is more highly mechanized than monsoon paddy cultivation, only one third of labor days were used for harvest and post-harvest activities. Conversely, more labor days were allocated to land and seedling preparation and transplanting. Harvesting (which, for pulses, has yet to be mechanized) is the most labor intensive activity and accounts for the largest share of labor days in the cultivation of both green gram (72%) and black gram (61%) (Table 1).

Table 1: Share of labor days per acre, by crop and farming activity (%)

Activity	Monsoon paddy	Dry season paddy	Green gram	Black gram
Seedling preparation	9	11	0	0
Land preparation	14	18	3	8
Transplanting	10	17	0	0
Sowing seed	7	7	3	7
Weeding	8	8	1	3
Fertilizer/pesticides application	4	7	12	6
Field monitoring	0	2	0	0
Harvesting	39	19	72	61
Threshing/ drying	8	6	5	12
Hauling/Transporting	3	4	3	3
Other	0	1	0	0

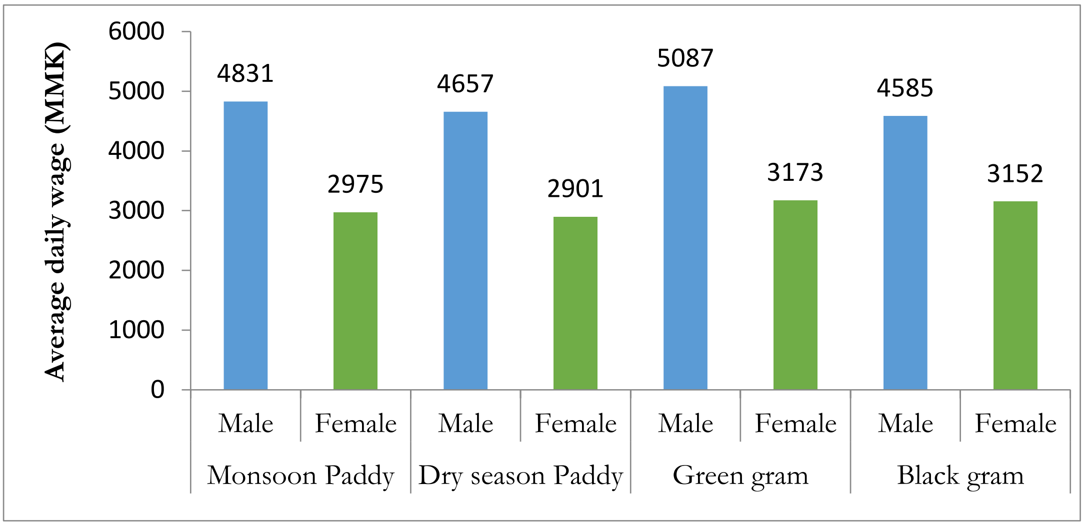
Almost all crop farming households (95%) hired casual labor. Considering all farms, the number of days worked by hired labor was slightly greater than that worked by family labor (12 days/acre hired, versus 10 days/acre family). However, households in landholding tercile 1 utilized twice as much family labor as hired labor (18 days/acre family, versus 9 days/acre hired). Among crop farming households, those in smallest tercile (tercile 1) generated the highest demand for causal and family labor (27 labor days/acre/year). Crop farms in largest tercile generated only 16 labor days/acre/year, likely reflecting greater use of long term labor (Table 2).

Table 2: Average annual labor days/acre worked by family labor and hired casual labor, by landholding tercile

	Family labor			Hired casual labor			Total labor (Family + Hired)		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
All farms	8	3	10	7	5	12	14	8	22
Farms in Tercile 1	14	5	18	5	4	9	19	9	27
Farms in Tercile 2	7	3	10	8	6	14	15	9	24
Farms in Tercile 3	5	2	7	6	4	9	11	5	16

There is a large gender gap in wages for agricultural labor. Female workers obtained about two thirds of the daily wage earned by male labors (MMK 2,975 compared to MMK 4,831 in monsoon paddy production for example). A similar pattern was found for all crops (Figure 32).

Figure 32: Men's and women's wage rates by crop



Crop production costs

The production costs of each major crop were calculated on a per acre basis for each household. Table 3 presents the average value and share of production costs allocated to different types of input by households growing monsoon paddy and dry season paddy. As expected, dry season paddy production costs are higher than those for monsoon paddy production (MMK 190,000/acre, versus MMK 115,000/acre).

Table 3: Average value and share of monsoon paddy, dry season paddy production costs per acre

	Monsoon Paddy		**Dry season paddy**	
Type of Input	**Cost per acre (MMK)**	**Share (%)**	**Cost per acre (MMK)**	**Share (%)**
Seed	4,860	4	18,728	10
Casual labor	37,003	32	40,623	21
Irrigation	686	1	29,248	15
Inputs	35,339	31	48,293	25
Draft animals	506	0	977	1
Machinery	34,591	30	48,847	26
Transport	1982	2	3,879	2
All	114,967	100	190,595	100

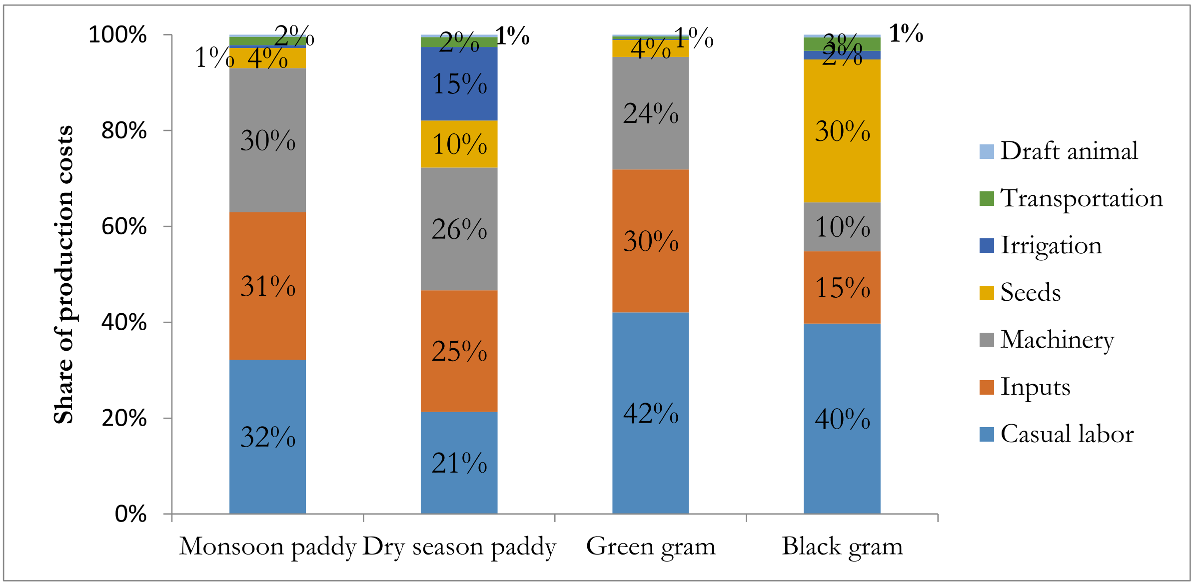
Table 4 presents the value and share of production costs for green gram and black gram. Production costs for green gram (MMK 113,000/acre) are similar to those for monsoon paddy, but returns are much higher, making it the most profitable for the four crops. Black gram production costs are the lowest among the four major crops at MMK 87,000/acre; less than half the cost of producing dry season paddy

Table 4: Average value and share of green gram and black gram production costs per acre

	Green gram		Black gram	
	Cost per acre (MMK)	Share (%)	Cost per acre (MMK)	Share (%)
Seed	3978	4	25880	30
Causal labor	47633	42	34443	40
Irrigation	267	0	1595	2
Inputs	33785	30	13125	15
Draft animals	423	0	497	1
Machinery	26653	24	8831	10
Transportation	578	1	2406	3
All	113,316	100	86,777	100

The following figure (Figure 33) presents the budget shares of production costs for paddy, green gram and black gram. Casual labor, machinery and inputs each account for a similar share of production costs, for monsoon paddy, totaling 93% of total costs. These are also the most important costs in dry season paddy cultivation, but agricultural machinery accounts for a slightly higher share of production costs (26%), than casual labor (21%), reflecting the greater extent of mechanization dry season paddy, as compared to monsoon. Irrigation accounts for 15% of costs in dry season paddy. In the case of green gram and black gram, casual labor accounts for the highest share of production costs (42% and 40% respectively). This reflects the fact that pulse harvesting is not yet mechanized.

Figure 33: Composition of production costs, by crop



Crop Profitability

We calculated gross margins for each of the four major crops to compare their profitability. The gross margin is the difference between the value of revenue from crop sales and the variable costs of their production. Variable costs include costs of seeds, fertilizer, chemicals, hired labor and machinery. Gross margins are derived from analysis of production from the sample parcel of each household. Table 5 shows the average and median gross margins per acre (MMK) of major crops of the households in different land holding terciles.

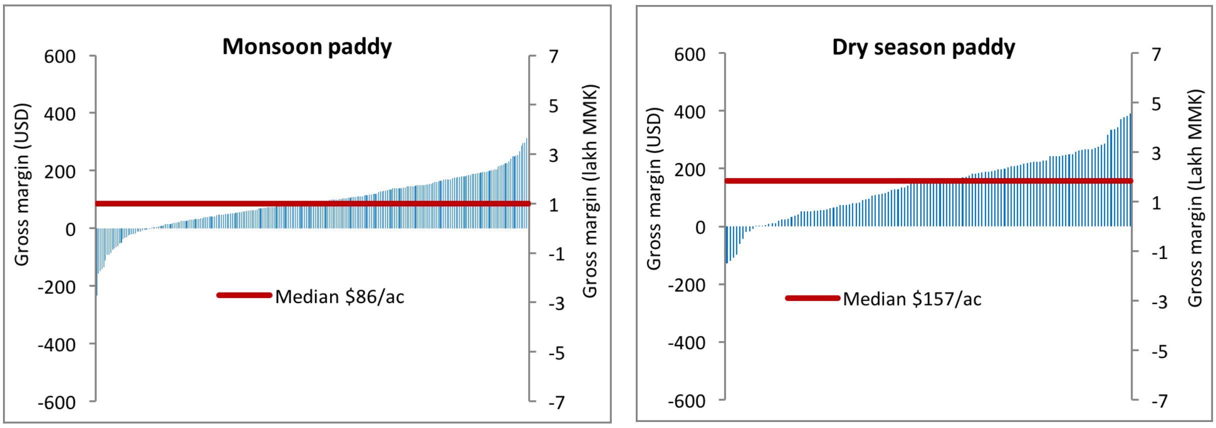
Table 5: Average and median gross margins of major crops by different land holding terciles (MMK/acre)

	Monsoon Paddy		Dry season Paddy		Green gram		Black gram	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Tercile 1	115,632	106,933	167,619	187,000	306,252	318,000	152,734	238,500
Tercile 2	105,669	101,457	158,000	155,000	324,148	340,607	181,574	183,000
Tercile 3	100,370	109,014	191,392	204,025	295,034	283,819	164,196	157,153
Overall	105,615	103,667	172,701	189,100	309,765	320,500	172,630	178,875

Paddy

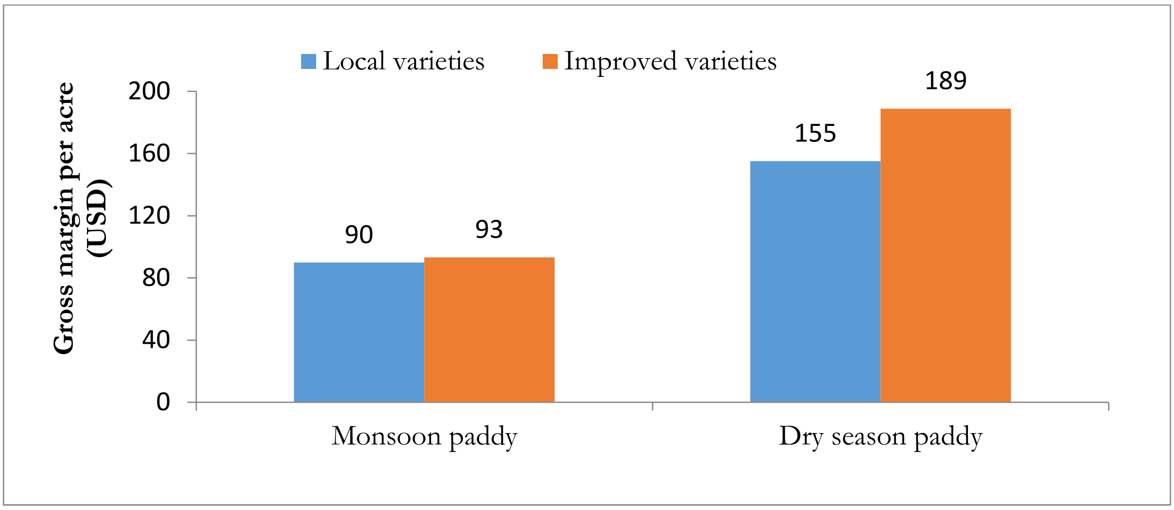
Figure 34 shows the distribution of gross margins for monsoon and dry season paddy. The average gross margin for monsoon paddy, weighted by the number of farms in the survey area was 105,615 MMK/acre ($217/ha). These gross margins ranged from -279,527 MMK (implying a financial loss) to 390,500 MMK/acre ($-575 to $803/ha). The median gross margin was also 103667 MMK/acre ($212/ha). As described above, paddy yields during dry season are higher than during monsoon. The weighted average gross margin for dry season paddy is 172,701 MMK/acre ($355/ha) with the median value of $389/ha. The range is from negative 153,476 to 470,250 MMK/acre ($-315 to $967/ha).

Figure 34: Distribution of gross margins for monsoon and dry season paddy per acre



The farmers were asked if the rice varieties they grew were improved or local. The average gross margin gained from growing improved varieties was 18 % higher than that from local varieties in dry season, but not much different in monsoon season (Figure 35). The share of households using improved varieties is low in both monsoon (16%) and dry season (37%).

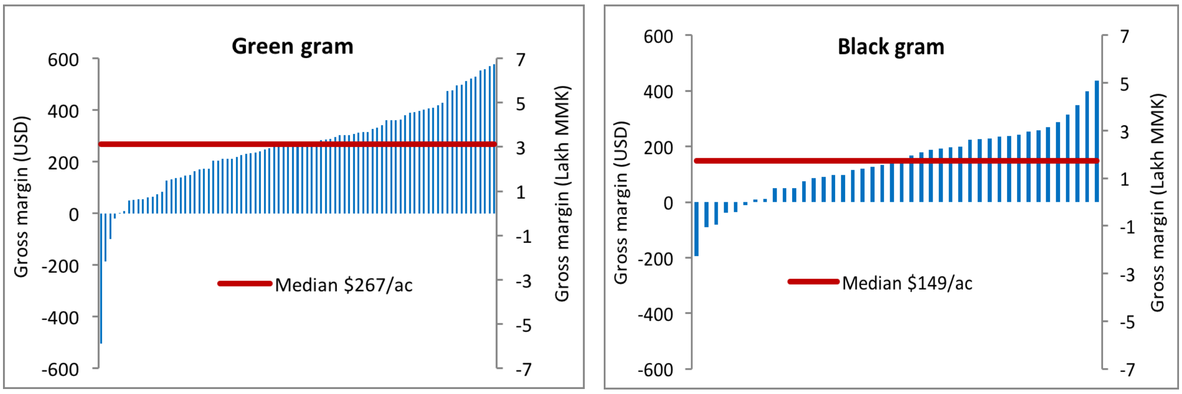
Figure 35: Average gross margins for monsoon and dry season paddy by varietal type



Pulses

Farmers received the average gross margin of 309,765 MMK/acre ($637/ha) (median by 660 $/ha) growing green gram, making it by far the most profitable of the four crops. Farmers in landholding tercile 2 obtained the highest profits ($667/acre). Returns for households in landholding terciles 1 and 3 were 306,252 MMK/acre and 295,034 MMK/acre ($630/ha and $607/ha) (Figure 36).

Figure 36: Distribution of gross margins of green gram and black gram per acre



The average yield of black gram (6.9 basket/acre) was about half that of green gram (13.7 basket/acre). This is reflected in the average gross margins for black gram 172,629MMK/acre ($355/ha), which are considerably lower than those of green gram. The median value was 178,875 MMK/acre ($368/ha). As for green gram, farms in landholding tercile 2 returned the highest gross margins 181,573 MMK/acre ($373/ha), with terciles 3 and 1 obtaining similar returns 164,195 MMK/acre ($337/ha) and 152,734 MMK/acre ($314/ha).

LIVESTOCK FARMING

Livestock is an important component of agriculture in Myanmar, particularly as livestock are important assets for rural households. Twenty-one percent of all surveyed households (farm + non-farm) reared animals of some kind. Livestock raising is relatively more important for landless households than for landed. Some 57% were landless households raise animals or poultry.

Chickens and pigs were the most common animals raised. More than half of livestock farming households raised chickens (56%) or pigs (57%). More than half of livestock farming households had sold animals within the past 12 months. Table 6 presents the share of households rearing different types of animal, and the share of rearing households that sold them (e.g. 56% of households raised chickens, of which 44% had sold birds within the past 12 months). In the past year, households keeping chickens and ducks had sold an average of 24 and 32 birds each. Households raising pigs and cattle sold an average of 3 and 1 animals each on average.

Table 6: Percentage of households rearing and selling animals

Animals	% of households rearing animals	% of households selling animals
Chicken	56	44
Ducks	22	26
Pigs	57	59
Cow/oxen	8	34
Water buffalo	1	61
Other animals	5	23

Table 7 shows the average number of animals sold, the average price per animal, and gross margins earned from sales of livestock and poultry within in the past year. Households earned about MMK 400,000 per cow, MMK 138,000 per pig, and MMK 4,200 per chicken. With the exception of cattle and buffalo, average gross margins were modest, reflecting the small scale of production, and indicating that livestock/poultry rearing is a source of supplementary income for most households, rather than a primary livelihood strategy.

Table 7: Average numbers of animals sold, price per animal and their gross margins

Animal Type	Average number of animals sold	Average price per animal (MMK)	Gross margins (MMK)
Chicken	23	4,229	182,878
Duck	32	2,926	-71,411
Pig	3	137,964	168,137
Cow/Oxen	1	400,283	550,155
Water Buffalo	5	112,374	342,174

Some households also sold byproducts from their livestock (e.g. eggs, milk, hides). One third of households sold duck eggs, but very few households marketed the byproducts from cattle (7%) or chickens (3%). This suggests that any chicken eggs and cow's milk produced was consumed mainly at home. Almost all animals were sold live.

Households rarely hired labor to help raising animals. Use of purchased feed inputs for raising livestock and poultry was common. Depending on the type of animal raised, between 40% and 81% of households used purchased feeds, with the exception of those raising water buffalo, for which purchased feed was not used. The highest feed costs were observed for pig farming (MMK 128,256 per household), followed by ducks (MMK 81,936) and cattle (MMK 79,907).

The average gross margin earned by households who grew and sold animals was MMK 158,329. The average gross margin obtained by landless households rearing livestock and poultry was lower than that of landholding households MMK 136,802, versus MMK 201,024, indicating that households with access are better able to raise large livestock (e.g. cattle) than landless households.

Among livestock raising households, the highest average gross margins were obtained by crop farming households (MMK 241,732), followed by fish farming households (MMK 189,300) and non-farm households (MMK 127,461). Among crop farming households, landholding size and gross margins were positively correlated. Households in landholding tercile 3 reported gross margins of around MMK 336,304, while households in landholding tercile 1 gained an average of only MMK 79,627.

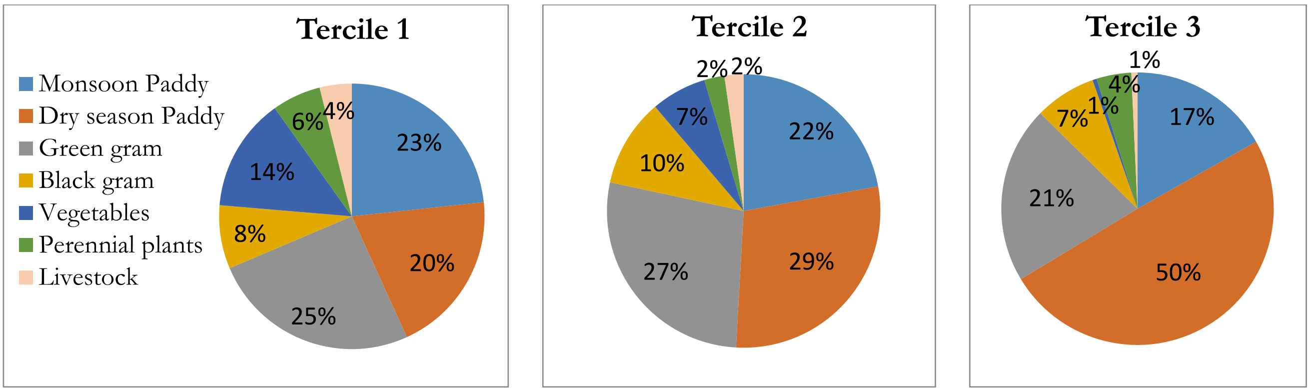
FARM GROSS MARGINS

Whole farm gross margins were estimated by summing, for each farm household, the gross margins of the main field crops with gross margins from perennial plants (e.g. fruit trees), vegetables and livestock. As already stated, 66% of households had only one parcel of farm land. To calculate whole farm crop margins for those households, we simply used their sample parcel margins. For households with more than one parcel, whole farm crop margins were estimated in two steps. For sample parcels, we use the sample parcel margins. For the margins of non-sample parcels, we substituted the median margin of the crop/s produced. We then summed sample parcel margins with non-sample parcel margins to estimate whole farm crop margins.

The average whole farm gross margin of households in different farm size categories was $1,785/year. The average whole farm gross margin of households in tercile 3 ($3,761/year) was 3.8 times higher than that in tercile 2 ($970/year) and 14 times higher than that in tercile 1 ($267/year).

The mean whole farm gross margin of households in the agriculture cluster ($2,214) was higher than those in aqua-cluster ($1,506). This was because the average area of operated land in the agriculture cluster was larger than that in aquaculture cluster. The average annual gross margin earned from one acre of land was $213. Households in landholding tercile 3 ($225/acre) earned higher profits per acre than those in tercile 2 tercile ($218/acre) or tercile 1 ($174/acre).

Figure 37: Share of whole farm gross margins of agricultural households, by landholding tercile



Farm diversification is inversely proportional to landholding size. Farmers in landholding tercile 1 have a greater degree of farm diversification than farmers in higher land terciles. The average shares of whole farm gross margins derived from green gram, monsoon paddy and dry season paddy are not much different for households in tercile 1, at 20-25% each (totaling 68%). A mix of black gram, vegetables, perennial plants and livestock account for the remaining one third of farm incomes for this group. The share of gross margins from dry season paddy is positively correlated with landholding size. Half of the whole farm margins of households in landholding tercile 3, are derived from dry season paddy (Figure 37). This pattern is likely to reflect differences in investment capacity and access to irrigation.

The contribution of agriculture to household incomes can be seen by comparing average expenditure per capita among farm and non-farm households (expenditure is a proxy for income). Average annual expenditure per capita across all households was MMK 890,000.

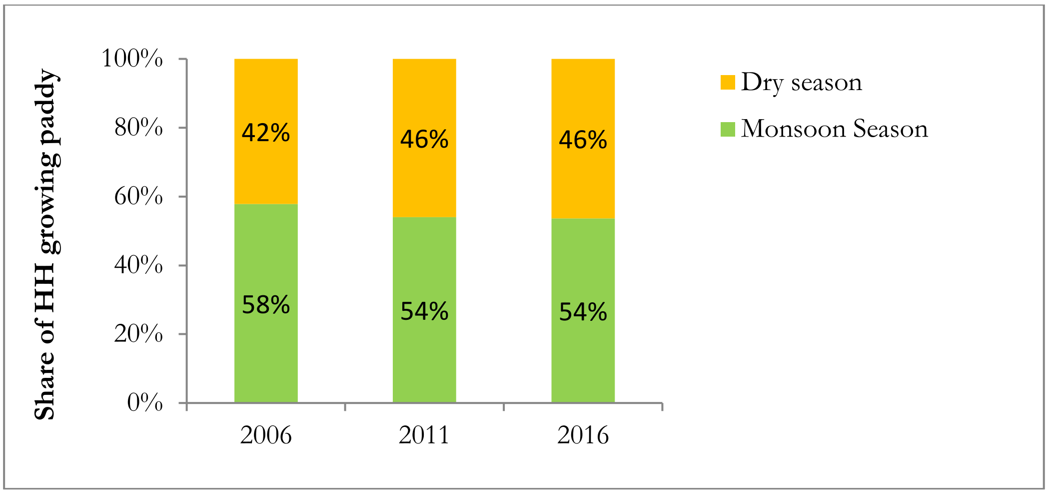
Average expenditure per capita for crop farming households (MMK 1,100,000) is higher than that of non-farm households (MMK 780,000). Landholding size is positively correlated with higher expenditure per capita. The average expenditure per capita of for households in tercile 1 is about MMK 849,000, rising to MMK 918,000 and MMK 133,000 in terciles 2 and 3.

CROP TECHNOLOGY ADOPTION DYNAMICS

This section presents the history of agricultural practices by surveyed households over a 10-year recall period (2016, 2011, 2006) to identify patterns of technological change. The dominant trend observed over this period is that the productivity of dry season paddy increased in response to increasing use of improved inputs, whereas the productivity of monsoon paddy remained stagnant.

Respondents were asked to identify their main paddy cultivation season. There was a small increase in the share of households reporting dry season paddy as their main paddy crop (up from 42% in 2006 to 46% in 2016) (Figure 38). This share is high because the sample included many farms in areas that are deeply flooded during monsoon season and thus produce only a single dry season paddy crop.

Figure 38: Percentage of households growing paddy in monsoon and dry season



The share of households using herbicides on the monsoon paddy doubled from 11% in 2006 to 22% in 2016, but remained low overall. The share of households using herbicides in dry season paddy production was higher, and increased sharply from 43% in 2006 to 73% in 2016 (Figure 39).

Figure 39: Share of households using herbicides

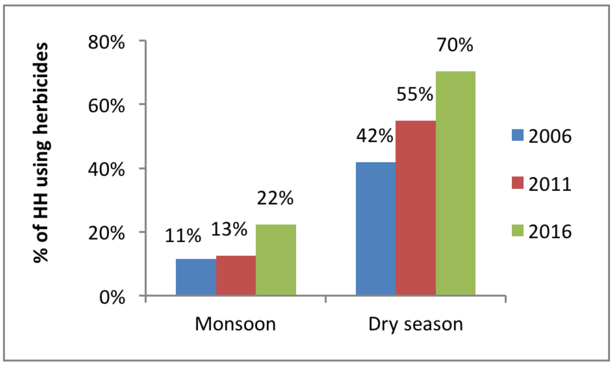
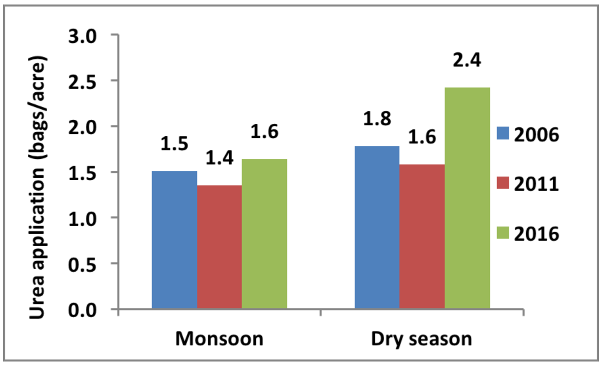


Figure 40: Average amount of urea applied (bags/acre)



There was little change in the average amount of urea applied on monsoon paddy over 10 years. However, in dry season paddy cultivation, application increased from 1.8 bags/acre (90 kg/acre) of urea in 2006 to 2.4 bags/acre (120 kg/acre) in 2016, following a slight reduction to 1.6 bags/acre (80 kg/acre) in 2011 (Figure 40).

The share of households using improved paddy varieties during monsoon season remained low at under 20%. However, the use of improved varieties during dry season increased significantly, almost doubling from 20% to 37% in ten years (Figure 41).

Figure 41: Share of households using improved varieties

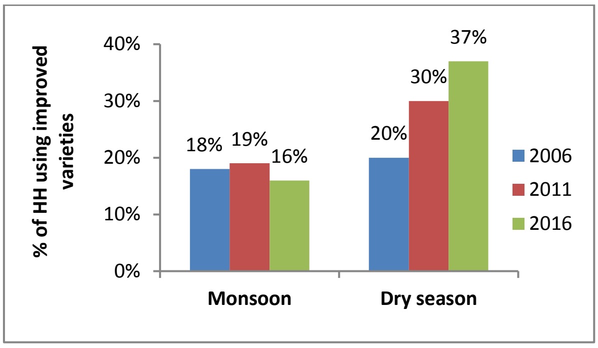
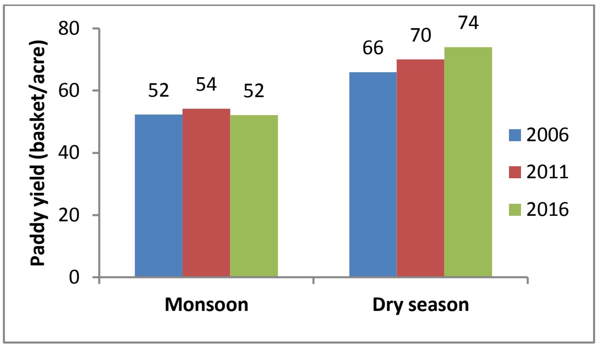


Figure 42: Average paddy yield (basket/acre)



Use of improved varieties and input use during dry season resulted in a gradual increase in average dry season paddy yields, which grew by 12% from 66 baskets/acre (3,407 kg/ha) in 2006 to 74 baskets/acre (3,820 kg/ha) in 2016. Monsoon paddy yields remained unchanged throughout this period, at a little over 50 baskets (2581 kg/ha) (Figure 42). The failure of monsoon paddy yields to increase can be explained by a lack of locally adapted improved monsoon paddy varieties. The local varieties planted tend to be relatively unresponsive to chemical inputs. This helps to account for the lack of technological change in monsoon paddy cultivation.

Figure 43*:* Share of households using machinery for harvesting paddy by season

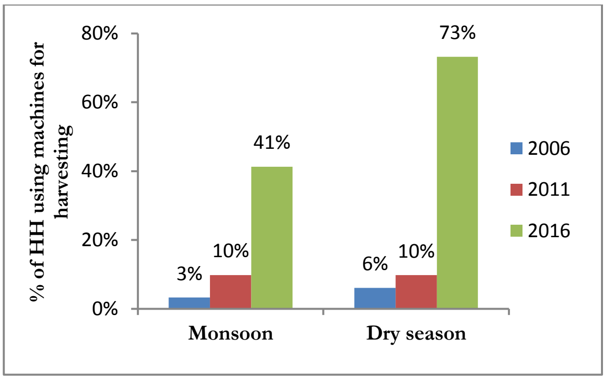
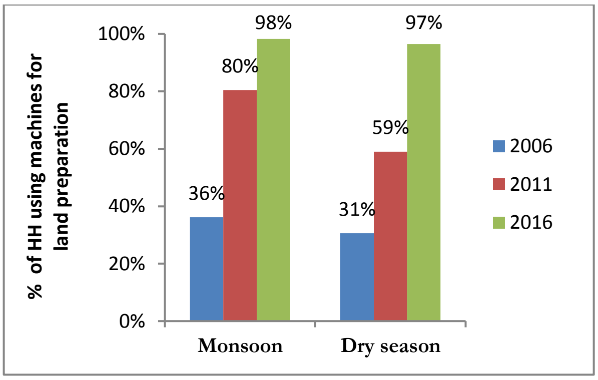


Figure 44: Share of households using machinery for paddy land preparation, by season



Seventy percent of farmers reported using machinery (mainly combine harvesters) to harvest their dry season paddy in 2016, as compared to 41% of those harvesting monsoon season paddy. As combine harvesters result in reduced post-harvest losses, this innovation may also have contributed to the increasing average yield of dry season paddy.

Figure 43 and Figure 44 show the share of households using any kind of machinery for land preparation and harvesting of paddy from 2006 to 2016. The percentage of households using machinery for land preparation steadily increased and nearly tripled in both monsoon and dry season over the 10-year period. In the case of harvesting, the share of households using machinery was low in the earlier years and jumped sharply to 41 % in the monsoon season and 73 % in dry season.

CONCLUSIONS AND RECOMMENDATIONS

The rural economy of Yangon and Ayeyarwady is transforming rapidly. Rapid outmigration is driving increased rural wages, in turn encouraging strong demand for mechanization services. Several factors are holding back agriculture from making a stronger contribution to broad-based rural economic growth and poverty reduction. First, access to land is highly unequal. More than half the rural population has no access to farm land, and one third of farmers own just 3% of all farm land. Second, access to irrigation, essential for crop production in the potentially high-yielding dry season, is also unequal. The farmers with the largest landholdings also have more access to irrigation. Third, diversification into high value enterprises such as vegetables, horticulture, small-scale aquaculture and livestock production is limited considering proximity of the surveyed areas to the large urban market of Yangon. Fourth, adoption of improved varieties is extremely limited. Even for dry season paddy, which has seen the most rapid adoption of improved varieties and chemical input use, yields gains are quite modest compared to potential yields. Monsoon paddy production has undergone little technological change (with the exception of mechanization), and yields have stagnated.

The following recommendations could unlock the potential for more rapid agricultural growth, and broader participation of poor rural households in the benefits of that growth:

1. Allow all smallholder farmers to convert up to one acre per family into high value enterprises such as aquaculture or horticulture without penalties.
2. Explore the feasibility of expanding irrigation and drainage access to increase the area and productivity of land under monsoon and dry season paddy and non-paddy crops.
3. Accelerate testing and dissemination of improved varieties of paddy and pulses through farmer participatory on-farm testing, and encourage small-scale seed multiplication enterprises and dissemination of trial packs.
4. Identify erect varieties of pulses that will allow mechanized harvesting in order to reduce production costs.
5. Strengthen extension services with particular attention to soil testing and adapted fertilizer recommendations, and integrated pest management and pesticide safety.
6. Encourage crop and livestock diversification, in particular for small farms, which are already the most highly diversified
7. Prioritize improvements the productivity and profitability of green gram production, (e.g. through improved varieties, irrigation, integrated pest management), as a crop which has relatively low production costs and high gross margins, and is relatively more important to smaller farms.