INITIATIVE ON
Asian Mega-Deltas

Agricultural Production and Nutrition Implications in Cambodia

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Asian Mega-Deltas

Contents

Executive Summary

Agriculture is a key sector in Cambodia, accounting for 22% of GDP in 2022, with 57% of households engaged in agricultural production. The vast majority of these households (94%) are involved in crop cultivation, primarily non-aromatic paddy rice, followed by mango and banana crops. Livestock and poultry farming are also significant, with 82% of farmers participating. However, aquaculture is practiced by only 6% of agricultural households. The sector remains vital for food security, despite its declining share in GDP because of structural changes in the economy. This study focuses on five provinces, examining household agricultural activities, including crop cultivation, livestock management, and aquaculture, based on a survey conducted in mid-2023. The objective is to comprehensively assess the productivity of agricultural households in Cambodia and to evaluate the nutrient content produced by their agricultural outputs.

Paddy rice cultivation is the central focus, dominating both in terms of land use and economic output. Rice farming is particularly significant in irrigated areas, where agricultural practices are more intensive and strategic, leading to higher productivity and income levels. On average, households earn an annual net income of USD 1,222 from agricultural activities, with paddy cultivation accounting for 53% of this total. Income disparities are notable between irrigated and non-irrigated villages, with irrigated areas generally achieving higher income levels.

In addition to paddy rice, the surveyed households also cultivate leafy vegetables, fruits, and other minor crops, although these are produced in much smaller quantities and on less land. The agricultural calendar is largely driven by seasonal patterns, with a marked focus on cultivation during the wet season, particularly for major cereals and livestock. The reliance on traditional seed varieties is gradually shifting toward the adoption of high-yielding varieties, especially rice and vegetables, reflecting an evolving agricultural landscape that balances traditional practices with modern agronomic approaches. The preparation of agricultural land is predominantly mechanized, with tractors being the primary tool, although some provinces like Kampong Thom still utilize a mix of manual and motorized tillage techniques. Investment in agricultural inputs is heavily skewed toward fertilizers, machinery, and seeds, with rice and vegetable farming incurring the highest input costs. This trend is particularly evident in irrigated regions, where the availability of water resources facilitates more efficient farming practices and reduces dependency on seasonal rainfall.

The study also highlights the importance of livestock rearing as a supplementary income source for many households. Native chickens and cattle are the most commonly reared animals, primarily for sale rather than consumption. Households raising goats or pigs face the highest rearing costs, averaging USD 756, but they also generate substantial income, with an average net income of USD 590. Cattle rearing, although less costly, yields the highest net income, at USD 942 annually. However, the economic returns from raising improved chicken breeds are relatively low, despite their widespread cultivation, with households earning an average net income of just USD 75.

Paddy rice remains central to Cambodia's agriculture. The study emphasizes the importance of enhancing irrigation, diversifying crops, and improving market access to increase productivity. Regional disparities in income and farming practices require tailored interventions. Additionally, focusing on nutrient diversity, governments and NGOs should support households with nutrient-rich seeds and sustainable farming training. Although the agricultural sector is progressing, ongoing efforts are essential to ensure inclusive, sustainable growth and a balanced production of essential nutrients.

1. Overview of the Agricultural Sector in Cambodia

Agriculture is a crucial economic pillar of Cambodia, accounting for 22% of the country's GDP in 2022 (FAO, 2023). The Cambodia Agriculture Survey in 2020 estimated that there were 2,038,000 household agricultural holdings in Cambodia. With 3,553,021 households in the country, according to the 2019 General Population Census, approximately 57% are engaged in agricultural production. In Cambodia, 61% of household agricultural holdings reported that their main intention for agricultural products was home consumption, while the remaining 39% indicated that their agricultural production was primarily for sale (NIS & MAFF, 2022).

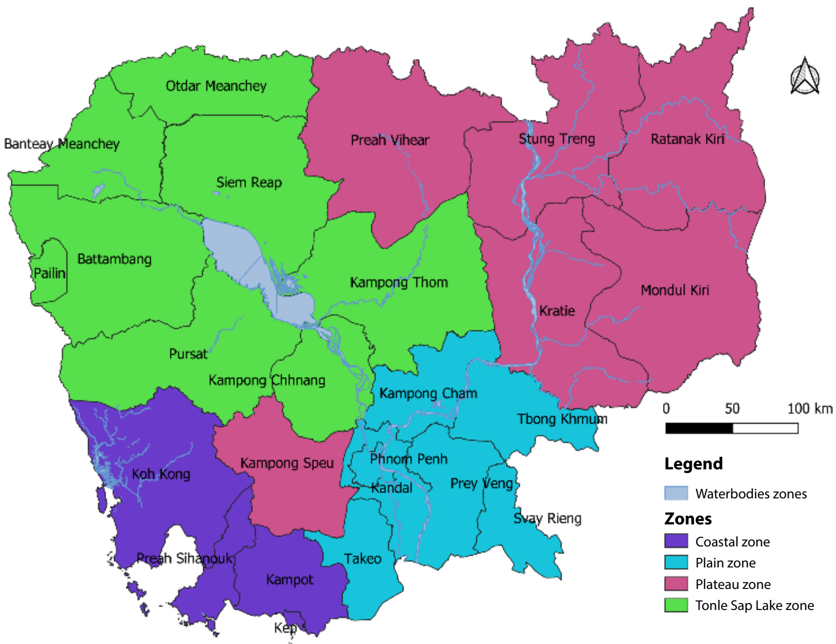
Approximately 94% of agricultural households are involved in crop cultivation. The most prevalent crop is non-aromatic paddy, with a planted area of approximately 2 million hectares and a harvested area of 1.89 million hectares. The average yield is around 2.5 tons per hectare, resulting in a total national production of approximately 4.68 million tons. Mango is the second-most popular crop among Cambodian farmers, followed by banana. Furthermore, livestock and poultry farming are a vital income source for farmers, with 82% of them participating in these activities. On average, households that raise cattle have 4.4 cattle per household, while those involved in poultry farming maintain an average of 41.4 birds per household. Conversely, aquaculture is practiced by only 6% of household agricultural holdings, while capture fishing is conducted by approximately 27% of these holdings (NIS & MAFF, 2022).

The agriculture sector remains strategically vital for ensuring food availability and achieving food security. Although its contribution to GDP dropped to 22% in 2022, from 33.5% ten years earlier, this reduction reflects the country's ongoing structural transformation (World Bank, 2023).

Cambodia is divided into four socio-geographic zones, as illustrated in Figure 1. Both zones in this study share similar predominant crop types, including non-aromatic paddy, mango, banana, and coconut. Despite the Plain Zone reporting the lowest proportion of households engaged in livestock or poultry farming, it paradoxically has the highest absolute number of households involved in these activities. Specifically, approximately 328,000 households raise cattle, 630,000 raise poultry, and 82,000 engage in aquaculture within this zone. Conversely, the Tonle Sap Zone ranks second in the number of households raising cattle and poultry but leads in the number practicing capture fishing (NIS & MAFF, 2022).

This study focuses on the provinces of Kampong Thom, Kandal, Prey Veng, Svay Rieng, and Takeo. Kampong Thom is situated within the Tonle Sap Zone, whereas the remaining areas fall under the Plain Zone. The survey dataset comprises 518 samples, with 105 samples drawn from each of Kampong Thom and Prey Veng, 103 samples from each of Kandal and Svay Rieng, and 102 samples from Takeo. The survey was conducted from May 15 to June 8, 2023. This study's dataset encompasses household production activities, including the cultivation of crops, vegetables, and paddy rice, and intercropping practices, aquaculture, and livestock management, along with the agricultural inputs utilized by these households.

Figure 1. Socio-geographic zones in Cambodia (NIS & MAFF, 2022, p. 3)



2. Household Characteristics

Households have relatively small agricultural land holdings, with the majority having one or less than one hectare, and only a small percentage possessing larger plots of land. Most households, comprising 52% of those surveyed, occupy one or less than one hectare of agricultural land. Approximately 22% of households had between one and two hectares, and 17% held between two and five hectares. Additionally, 6% of households had agricultural land ranging from five to ten hectares, while a mere 3% had more than ten hectares.

In terms of total cultivated agricultural land, only 35% of households engaged in crop production on parcels smaller than or equal to one hectare. Conversely, 23% of households cultivated plots ranging from one to two hectares or two to five hectares. Additionally, 12% of households farmed on land sizes between five to ten hectares, while a mere 7% engaged in cultivation on plots exceeding ten hectares.

Table 1. Distribution of agricultural households and agricultural land

Farm size (hectares)	% of agricultural households	% of total cultivated agricultural land
One or less	52%	35%
More than one to two	22%	23%
More than two to five	17%	23%
More than five to ten	6%	12%
More than ten	3%	7%
Number of observations	518	518

Note: *Each column adds up to 100%.*

The predominant farming system combines rice cultivation with livestock, reflecting a diverse range of agricultural practices among households. Approximately 41% of households have adopted this system, and 10% of households engage in a diversified agricultural approach encompassing rice, other crops, and livestock. In contrast, 13% of households abstain from farming activities entirely, while 12% focus exclusively on livestock farming 11% on rice cultivation. A smaller segment, comprising 4% of households each, is dedicated solely to crop cultivation or a combination of crop farming and livestock rearing. Lastly, 1% of households are engaged in rice and crop farming, a combination of livestock and aquaculture, or a comprehensive farming system that includes rice, other crops, livestock, and aquaculture.

There is significant variation in net agricultural income across different provinces and between irrigated and non-irrigated villages. A household's average annual net income from agricultural activities–encompassing crop cultivation, livestock management, and aquaculture–is USD 1,222, representing 38% of gross farm income. Income levels vary significantly across provinces, except for Kampong Thom, where households earn an average net agricultural income of USD 1,290 annually, accounting for 51% of their gross agricultural income. Conversely, average net incomes among households are USD 2,144 (37.5%) in Kandal, USD 707 (33.6%) in Prey Veng, USD 609 (35.5%) in Svay Rieng, and USD 1,810 (33.9%) in Takeo. When comparing income between irrigated and non-irrigated villages, those in irrigated areas earn significantly more, with an average of USD 1,432, compared to USD 712 for households in non-irrigated villages, with the differences being statistically significant (Table 31 of Annex 1).

Paddy cultivation is the primary source of net farm income for households. Households derive the bulk of their net farm income from paddy cultivation, constituting 53% of the total. Livestock rearing contributes approximately 20%, while fruit and nut cultivation accounts for 5%. Vegetable cultivation generates 3.4% of the income, followed by aquaculture at 1.4% and non-paddy grain cultivation at 0.2%. The residual income is sourced from the cultivation of animal feed (Table 31 of Annex 1).

Key takeaways: Although the surveyed farmers have diversified their income sources, they depend heavily on paddy rice as their primary source of farm income. To enhance the effectiveness of income diversification and mitigate income volatility, it is imperative to implement initiatives that promote the integration of diverse farming systems. These initiatives should focus on combining crop cultivation with livestock and aquaculture, supported by comprehensive training programs, financial incentives, and improved access to essential inputs such as seeds and livestock.

Table 2. Farming systems among households

Farming system	% share
None	13%
Rice only	11%
Crops only	4%
Livestock only	12%
Rice and crops*	1%
Rice and livestock	41%
Rice, crops, livestock	10%
Rice, livestock, aquaculture	2%
Crops and livestock	4%
Livestock and aquaculture	1%
All	1%
Number of observations	518

**Crops included vegetables, cashew, banana, watermelon, and mango.*

3. Paddy and Crop Cultivation

3.1. Produce and Land Utilization

Households predominantly produce major cereals (paddy rice), which not only constitute the largest volume of agricultural output but also have the highest economic value. Over the course of 12 months, households, on average, produce 6,873 kilograms of major cereals, 545 of leafy vegetables, 59 of other crops, 18 of vegetables, and less than 5 kilograms each of pulses, spices, and aquaculture species. In terms of total production value, major cereals amount to USD 1,666, leafy vegetables USD 281, fruits USD 34, other crops USD 36, and livestock USD 18. The respective values of pulses, spices, vegetables, and aquaculture are each less than USD 10 (Table 3).

The production value per household per hectare differs greatly among various commodities, with leafy vegetables showing the highest value, while non-leafy vegetables and spices have the lowest. On average, the production value per household per hectare amounts to USD 10,493.40 for leafy vegetables, based on data from 11 households. Fruits follow with an average value of USD 2,011.60 per hectare, supported by data from 7 households. Rice, a common staple, shows an average value of USD 2,056.8 per hectare, with the largest number of households represented, at 333. Other crops and aquaculture have lower average values of USD 1,066.30 and USD 243.80 per hectare, respectively, based on data from 14 and 2 households. Non-leafy vegetables and spices have the lowest average values, at USD 375.40 and USD 191.30 per hectare, respectively, with fewer households involved in their production.

In terms of harvested quantities, major cereals (paddy rice) are consumed by 35% of the households that cultivate this crop, while spices are consumed by a mere 3% of households engaged in their production. The consumption rates for vegetables and leafy vegetables are moderate, at 16% and 18% respectively. Fruits exhibit a slightly higher consumption rate, at 36%, whereas other crops are consumed at a notably lower rate of just 2%. Aquaculture products demonstrate a significant consumption rate of 55%, and livestock products are consumed at a particularly high rate of 78%, with eggs consumed by 73% of households and meat 79% (Table 3).

For major cereal crops, such as paddy rice, the total production cost amounts to USD 1,289.90, for an average net income of USD 820.70. Spices demonstrate a relatively low production cost of USD 71.70, generating a minimal net income of USD 0.20. In contrast, the production of vegetables incurs a cost of USD 291.40, resulting in a modest average net income of USD 1.80. Leafy vegetables, however, present a considerably higher production cost of USD 2,136.40, with a corresponding net income of USD 195.60. The production cost for fruits is USD 1,404.60, yielding a comparatively small net income of USD 9.90. Other crops incur a production cost of USD 352.30, with an associated net income of USD 34.80. Aquaculture reflects a relatively modest production cost of USD 134.60, resulting in a net income of USD 15.70. Lastly, the livestock production cost is USD 635.20, achieving a net income of USD 202.30 (Table 3).

The distribution patterns of agricultural commodity outputs, as detailed in Table 32 of Annex 1, reveal that the vast majority of certain commodities are predominantly sold, with 99% of pulses, 97% of spices, and 95% of other crops entering the market. Although major cereals (paddy rice) are still largely sold (43%), a significant proportion (21%) is retained in stock. Vegetables and leafy vegetables are sold at nearly the same rate (78% and 76%), with small percentages allocated as gifts. Fruits exhibit a more varied distribution, with 54% sold, 9% given as gifts, and 3% stored. Aquaculture is notable for its lower sale rate of 14%, contrasted by a higher stock retention rate of 28%. Livestock products demonstrate moderate sales rates, at 20% for eggs and 25% for meat, with only minimal amounts kept in stock or allocated to other uses.

Table 3. Production, by crop type

Commodity	Total volume (kg) produced	Average value of production per household per hectare (USD)	Total cost (USD) of produced in average	Average net income (USD) from own production	Share of consumption by food group from own production
Major cereals (paddy rice)	6,872.96	2056.8	1,289.9	820.7	35%
Pulses	1.22	314.4	396.3	-	0%
Spices	0.37	191.3	71.7	0.2	3%
Vegetables	18.75	375.4	291.4	1.8	16%
Leafy vegetables	545.88	1,0493.4	2,136.4	195.6	18%
Fruits	40.3	2011.6	1,404.6	9.9	36%
Other crops	58.74	1066.3	352.3	34.8	2%
Aquaculture	0.55	243.8	134.6	15.7	55%
Livestock	n/a	919.9	635.2	202.3	78%
All	7,541.92				
Sample (N)	411				

Table 4 presents the share of production area by commodity across various provinces and irrigated areas. The commodities include major cereals (specifically paddy rice), pulses, spices, vegetables, leafy vegetables, fruits, other crops, and aquaculture.

Paddy rice overwhelmingly dominates the agricultural landscape, accounting for 82.3% of the total cultivated area. This percentage is slightly higher in irrigated villages, where 83.2% of the area is dedicated to paddy rice, compared to 80.2% in non-irrigated villages. Other crops occupy significantly smaller shares of the cultivated land, at 4.1% for leafy vegetables, 2.3% for fruits, and 1.4% for vegetables, while aquaculture covers 1.2%.

There are notable variations in agricultural focus across the provinces. In Prey Veng and Svay Rieng, for instance, paddy rice occupies nearly all the agricultural land, with 95.9% and 98.8%, respectively. Conversely, Kandal exhibits a more diverse agricultural pattern, where only 37.1% of the cultivated area is allocated to paddy rice, with substantial portions dedicated to leafy vegetables (27.4%), fruits (15.6%), and vegetables (8.6%). The cultivation of other crops, including spices and aquaculture, is generally minimal across all provinces and irrigation areas, except for the provinces of Takeo, where aquaculture constitutes 3.7% of the area, and Kampong Thom, where 31.5% is used for other crops.

Furthermore, Table 4 highlights a significant disparity between irrigated and non-irrigated villages. Non-irrigated areas allocate a higher percentage of cultivated land to other crops (17.2%) and lack aquaculture activities, in contrast to irrigated villages.

Key takeaways: The households' substantial dependence on paddy rice renders them vulnerable to external shocks, such as climate change, water scarcity, or economic fluctuations within the rice market, which could critically undermine their income and food security. To mitigate these risks, it is imperative to introduce and promote the cultivation of higher-value crops in conjunction with paddy rice. These alternative crops should be strategically selected based on their superior market demand or enhanced resilience to climate variability.

Table 4. Share of production area, by commodity

Commodity	All	Irrigated villages	Non-irrigated villages	Kampong Thom	Kandal	Prey Veng	Svay Rieng	Takeo
Major cereals (paddy rice)	82.3%	83.2%	80.2%	64.4%	37.1%	95.9%	98.8%	91.2%
Pulses	0.1%	0.1%	-	-	0.7%	-	-	-
Spices	0.5%	0.4%	0.9%	1.1%	2.5%	-	-	-
Vegetables	1.4%	1.8%	0.5%	0.3%	8.6%	-	0.5%	1.7%
Leafy vegetables	4.1%	5.4%	1.1%	2.3%	27.4%	0.5%	0.3%	2.4%
Fruits	2.3%	3.2%	0.2%	0.2%	15.6%	1.9%	-	1%
Other crops	8.2%	4.2%	17.2%	31.5%	8.1%	0.6%	-	-
Aquaculture	1.2%	1.7%	-	0.1%	-	1.2%	0.4%	3.7%

Note: *Each column adds up to 100%.*

3.2. Seasonal Cultivation of Paddy Rice and Other Crops

Most households prioritize cultivation during the wet season, with a smaller proportion farming during the early wet season, dry season, and recession season. Approximately 68% of households engage in agricultural activities during the wet season. Meanwhile, 39% initiate cultivation earlier in the early wet season, 29% during the dry season, and only 17% during the recession season.

Table 5. Percentage of households doing cultivation, by season

Season	% of households
Early wet season (Apr/May–Jun/Jul)	39%
Wet season (Jun/Jul–Dec)	68%
Recession season (Oct–Mar)	17%
Dry season (Jan/Feb–Apr/May)	29%
Annual	26%
Sample (N)	386

Note: *Each column does not add up to 100%, as households cultivate in multiple seasons.*

Agricultural land use across the four primary seasons is predominantly allocated to the cultivation of major cereals. In contrast, a significantly smaller proportion of land is designated annually to produce leafy vegetables, fruits, other crops, and aquaculture. During the four main seasons—early wet season, wet season, recession season, and dry season—major cereals occupy 90% of the parcels of land dedicated to these production periods. In contrast, 22% of plots are allocated to leafy vegetables for annual production, 10% to fruits, 44% to other crops, and 14% to aquaculture .

Table 6. Main crops grown on parcels of land (in percentage of parcels), by season

Crop	Early wet season	Wet season	Recession season	Dry season	Annual
Major cereals	93%	96%	97%	94%	0%
Pulses	0%	0%	0%	0%	0%
Spices	0%	0%	0%	0%	3%
Vegetables	2%	1%	1%	2%	8%
Leafy vegetables	4%	1%	1%	3%	22%
Fruits	1%	0%	0%	2%	10%
Other crops	0%	1%	0%	0%	44%
Aquaculture	0%	0%	0%	0%	14%
Sample (N)	163	308	76	130	119

Single-season paddy cultivation is the most common, with the highest rate in Svay Rieng and the lowest in Prey Veng. Two-season and three-season cultivation are less common, with three-season farming notably higher in Takeo. Approximately 65% of households engaged in single-season paddy cultivation, with the proportion peaking in Svay Rieng, at 92%, and reaching its nadir in Prey Veng, at 41%. Cultivation across two seasons was less widespread, observed in 29% of households overall, yet was more pronounced in Prey Veng (56%) and Kandal (41%). The least frequent practice was three-season paddy cultivation, undertaken by just 17% of households, although it was significantly more prevalent in Takeo, where it accounted for 54%.

Table 7. Paddy rice cultivation cycle, per year

Number of seasons	All	Kampong Thom (n=67)	Kandal (n=17)	Prey Veng (n=85)	Svay Rieng (n=89)	Takeo (n=76)
One season only	65%	79%	53%	41%	92%	49%
Two seasons	29%	19%	41%	56%	7%	32%
Three seasons	17%	3%	6%	13%	1%	54%

Note: *Each column does not add up to 100%, as households have more than one plot and some plots can be cultivated multiple times per year depending on the availability of irrigation and level of land (susceptible to flooding or not).*

The wet season represents the peak period for land utilization. Kampong Thom and Kandal allocate the highest proportions of plots on an annual basis, while Prey Veng and Svay Rieng have higher plot usage during the wet season, and Takeo maintains a consistent distribution of plot usage across different seasons. During the wet season, 39% of agricultural plots are actively utilized, whereas 20% are used in the early wet season, 10% in the recession season, and 16% in the dry season, while 15% are dedicated to annual cultivation. Provincially disaggregated data reveal that Kampong Thom allocates the largest proportion of plots annually, at 37%, followed closely by Kandal, at 36%. Conversely, Prey Veng dedicates 42% of its plots to cultivation during the wet season, while Svay Rieng employs 81% in this period. Takeo demonstrates a balanced utilization with approximately 30% of plots in use across the early wet season, wet season, and dry season.

Table 8. Share of plots cultivated, by season

Season	All (N=796)	Kampong Thom	Kandal	Prey Veng	Svay Rieng	Takeo
Early wet season (Apr/May–Jun/Jul)	20%	15%	21%	23%	7%	30%
Wet season (Jun/Jul–Dec)	39%	27%	13%	42%	81%	29%
Recession season (Oct–Mar)	10%	6%	14%	14%	0%	12%
Dry season (Jan/Feb–Apr/May)	16%	15%	16%	18%	0%	26%
Annual	15%	37%	36%	4%	12%	4%

Note: *Each column adds up to 100%.*

Farmers in Kampong Thom cultivated perennial crops like cashew, whereas those in Kandal engaged in year-round vegetable farming. In contrast, agricultural activities in Prey Veng, Takeo, and Svay Rieng predominantly centered on rice cultivation, with Prey Veng and Takeo known for growing short-term rice varieties. As presented in Table 9, 32% of plots in Kampong Thom are dedicated to cultivating other crops. In Kandal province, 36% of plots are used for growing leafy vegetables, while 9% are allocated to non-leafy vegetables. In contrast, most plots in Prey Veng, Svay Rieng, and Takeo are primarily allocated to rice cultivation.

Table 9. Share of plots, by primary crops

Primary crop	Kampong Thom	Kandal	Prey Veng	Svay Rieng	Takeo
Rice	59%	36%	96%	88%	94%
Pulses	0%	1%	0%	0%	0%
Spices	1%	1%	0%	1%	0%
Non-leafy vegetables	3%	9%	0%	1%	2%
Leafy vegetables	3%	36%	1%	2%	1%
Fruits	1%	10%	2%	0%	1%
Other crops	32%	5%	1%	0%	0%
Aquaculture	1%	0%	1%	7%	2%

Note: *Each column adds up to 100%.*

In irrigated villages, 39% of plots are allocated for agricultural cultivation, whereas in non-irrigated villages, this figure rises to 64% (Table 33 of Annex 1). This indicates that the availability of irrigation infrastructure diminishes farmers' reliance on seasonal rainfall, allowing for more strategic and efficient water resource management. Consequently, farmers in irrigated areas may opt to shift their agricultural activities to periods outside the rainy season, where they can exert greater control over water usage. In contrast, farming communities in non-irrigated regions remain heavily dependent on natural rainfall, resulting in intensified agricultural activity during the rainy season when water resources are most accessible.

Key takeaways: The seasonal dependency underscores the close linkage between agricultural productivity and natural water availability, rendering farming practices susceptible to fluctuations in rainfall patterns. Considering this, it is crucial to invest in the development and expansion of irrigation systems, particularly in regions heavily reliant on seasonal rainfall. Enhanced irrigation infrastructure would enable farmers to cultivate crops across multiple seasons, reduce their vulnerability to unpredictable weather patterns, and boost overall agricultural productivity. Additionally, to facilitate the adoption of more efficient water management practices, it is essential to provide farmers with training and resources on techniques such as rainwater harvesting, drip irrigation, and soil moisture conservation.

3.3. Market

Food systems in Cambodia are evolving, shifting from smallholder, self-sufficient farming toward commercial production (Manohar et al., 2023). In this study, rice had a marketed surplus of 72%, suggesting that a substantial portion is retained for household consumption. Spices exhibit the highest marketed surplus, at 97%, indicating that nearly all spice production is intended for sale rather than own consumption. This is followed closely by leafy vegetables at 94% and non-leafy vegetables at 93%, while other crops stand at 100%, all of which have a significant majority of their production sold in the market. Fruits also have a relatively high marketed surplus of 77%.

Table 10. Share of market surplus

Commodity	Marketed surplus (value of product sold/total value of production*100)
Rice	72%
Spices	97%
Non-leafy vegetables	93%
Leafy vegetables	94%
Fruits	77%
Other crops	100%
Aquaculture	35%

Agricultural commodities are sold through various channels. A significant proportion of major cereals and leafy vegetables is sold directly at the farm gate. In contrast, fruits have a more varied market distribution, with sales occurring both at the farm gate and within village markets. For major cereals (paddy rice), approximately 46% are sold directly at the farm gate, with an additional 28% distributed through village markets. Leafy vegetables similarly favor farm gate transactions, with 63% sold through this channel. In contrast, fruits exhibit a more diverse market presence, with 27% sold at the farm gate and 33% within village markets. Pulses are exclusively marketed at the farm gate. For aquaculture, 28% of the output is sold at the farm gate, while 14% is marketed within villages (Table 11).

The primary buyers for these commodities are predominantly village-based middlemen, although this varies depending on the product. For example, spices are mainly bought by food processors, while pulses are exclusively purchased by external village middlemen. The primary buyers of major cereals are village-based middlemen (41%), followed by middlemen from other villages (35%), and end-use consumers (6%). Pulses are exclusively bought by external village middlemen, while spices are predominantly acquired by food processors (67%). Leafy vegetables are largely sold to village middlemen (52%) and domestic traders (41%). In the case of fish, external middlemen and consumers buy the same share (18%), followed by village middlemen (12%) and domestic wholesalers or traders (6%) (Table 12).

Key takeaways: Agricultural commodities are marketed through various channels, with a significant proportion of paddy rice, leafy vegetables, and pulses sold directly at the farm gate. In this regard, it is recommended to promote diversification into high-value crops such as leafy vegetables, given their superior production value. This could be facilitated by providing farmers with technical assistance, access to quality seeds, and training on best cultivation practices. Additionally, encouraging the expansion of market channels beyond the farm gate, particularly for fruits and other high-value crops, and supporting farmers in accessing village and regional markets could enhance their bargaining power and overall income.

Table 11. Sale location of agricultural commodities

Commodity	N	Farm gate	Village market (within own village)	Village market (outside own village)	Town market	Contract farming	Not applicable	Other (specify)
Major cereals	337	46%	28%	3%	0%	0%	54%	4%
Pulses	1	100%	0%	0%	0%	0%	0%	0%
Spices	3	0%	67%	0%	0%	0%	33%	0%
Vegetables	15	27%	47%	7%	0%	0%	40%	0%
Leafy vegetables	27	63%	37%	7%	7%	0%	22%	0%
Fruits	15	27%	33%	7%	0%	0%	47%	0%
Other crops	50	46%	32%	0%	0%	0%	30%	0%
Aquaculture	17	24%	18%	0%	0%	0%	82%	0%

Note: *Each row does not add up to 100% (multiple answers).*

Table 12. Buyers of agricultural commodities

Commodity	N	Middlemen in village	Middlemen from other villages	Wholesaler /trader inside country	Wholesaler /trader outside country	Auction market	Consumer	Food processor	Not applicable
Major cereals	337	41%	35%	2%	0%	0%	6%	0%	53%
Pulses	1	0%	100%	0%	0%	0%	0%	0%	0%
Spices	3	33%	0%	0%	0%	0%	33%	67%	33%
Vegetables	15	33%	47%	0%	7%	0%	27%	0%	40%
Leafy vegetables	27	52%	41%	11%	0%	0%	19%	0%	22%
Fruits	15	33%	27%	0%	0%	0%	20%	0%	47%
Other crops	50	48%	38%	0%	0%	0%	0%	0%	30%
Aquaculture	17	12%	18%	6%	0%	0%	18%	0%	82%

Note: *Each row does not add up to 100% (multiple answers).*

3.4. Seed Variety and Source

There is a pronounced preference among households for local seed varieties. A significant proportion of households, specifically 68%, utilize local varieties for their agricultural cultivation. In contrast, 47% prefer high-yielding varieties. This pattern is similarly reflected in the use of seed varieties for rice and vegetable cultivation. Over 60% of households favor local varieties; however, approximately 50% opt for high-yielding rice varieties, while about 30% apply these varieties in vegetable production (Table 13).

Table 13. Seed utilization among respondents

Seed variety	% planting seed	% planting rice seed	% planting vegetable seed
Local variety	68%	64%	67%
High yielding variety (HYV)	47%	49%	31%
Hybrid variety	2%	1%	13%
Do not know	2%	1%	8%
Sample (N)	382	337	39

Note: *Each column does not add up to 100% (multiple answers).*

Seed sourcing practices among households vary significantly depending on the type of crop cultivated. Households growing paddy rice, fruits, and spices mostly rely on seeds saved from previous harvests or obtained from neighbors and relatives. In contrast, those cultivating pulses exclusively purchase seeds from the market. Vegetable growers demonstrate a more diversified approach, utilizing a mix of saved seeds, seeds from neighbors and relatives, market purchases, and agricultural dealers. For aquaculture, the majority source their fry from hatcheries.

Most households cultivating paddy rice, fruits, and other crops primarily rely on seeds either saved from previous harvests or obtained from neighbors and relatives, representing 87%, 47%, and 38% of households, respectively. In contrast, 100% of households growing pulses purchase their seeds from the market (non-agricultural dealers), and 100% of those cultivating spices use either saved seeds or those sourced from neighbors and relatives. Vegetable cultivation, however, shows a more varied pattern in seed sourcing: about 47% of households growing vegetables and 44% of those cultivating leafy vegetables rely on their own saved seeds or those from neighbors and relatives. Meanwhile, 33% of vegetable growers and 56% of leafy vegetable cultivators purchase seeds from the market, with an additional 33% and 37%, respectively, obtaining seeds from agricultural dealers. Among households involved in aquaculture, 76% source their fry from hatcheries (Table 14).

Table 14. Source of seed

Commodity	N	Own saved seed, seed from neighboring farmers or relatives	Purchased from market (non-Ag dealer)	Purchased from agricultural dealer	Hatchery	Nursery	Mobile vendor
Major cereals (paddy rice)	337	87%	19%	18%	0%	0%	0%
Pulses	1	0%	100%	0%	0%	0%	0%
Spices	3	100%	0%	0%	0%	0%	0%
Vegetables	15	47%	33%	33%	0%	0%	0%
Leafy vegetables	27	44%	56%	37%	0%	0%	0%
Fruits	15	47%	7%	20%	0%	0%	0%
Other crops	50	38%	10%	16%	0%	0%	2%
Aquaculture	17	0%	0%	18%	76%	12%	0%

Note: *Each column does not add up to 100% (multiple answers).*

Although most respondents primarily rely on either saving seeds or sourcing seeds from neighboring farmers or relatives, the top-three paddy rice varieties cultivated are OM5451 (70%), IR66 (21%), and IR504 (13%). Significantly, two of these leading varieties, OM5451 and IR504, are of Vietnamese origin. A list of rice varieties used by farmers is illustrated in Table 34 in Annex 1.

Key takeaways: The choices in seed variety and sourcing by farmers reflect cultural preferences, practicalities, and perhaps economic considerations. The tendency to use saved seeds or those from known sources may be driven by trust, familiarity, and cost-efficiency, while market purchases and the use of specific high-yielding varieties suggest a selective adoption of new technologies. Therefore, considering the strong preference for local seed varieties alongside the selective adoption of certain high-yielding rice varieties, agricultural programs should aim to promote a balanced integration of both. This approach could enhance crop yields while preserving the genetic diversity and resilience inherent in local varieties.

3.5. Methods of Land Preparation

Tractors are predominantly used for land preparation across most provinces, with high usage rates in Kandal, Svay Rieng, Prey Veng, and Takeo. In Kampong Thom, however, there is a more varied use of land preparation methods, including tractors, hand tillage, and motorized tillers. Tractors are employed for land preparation on 84% of agricultural plots. This pattern is consistent across the provinces, with 84% of plots in Kandal, 87% in Svay Rieng, and 91% in both Prey Veng and Takeo utilizing tractors. In contrast, Kampong Thom exhibits a more varied approach: 63% of plots use tractors, 34% are prepared by hand tillage, and 22% employ motorized tillers (Table 15).

Key takeaways: Land preparation in agriculture relies predominantly on the use of tractors across most provinces, reflecting a high degree of mechanization. Consequently, enhancing infrastructure—such as roads and maintenance facilities—is essential to support the extensive use of tractors and other machinery. Improved infrastructure can lower operational costs and reduce downtime, thereby making mechanization more feasible and efficient. While advancing mechanization, it is also vital to ensure that land preparation methods remain sustainable. This may involve adopting practices such as minimum tillage or conservation agriculture, which help mitigate soil erosion and degradation, even with the use of tractors.

Table 15. Preparation methods, by share of plots

Method	All	Kampong Thom	Kandal	Prey Veng	Svay Rieng	Takeo
Hand tillage (hoe)	16%	34%	26%	7%	12%	10%
Animal traction	0%	0%	0%	0%	0%	0%
Motorized tiller	13%	22%	4%	11%	1%	18%
Tractor	84%	63%	84%	91%	87%	91%
Hand weeding	3%	5%	8%	1%	2%	2%
Zero tillage	2%	4%	4%	1%	2%	0%
Other (specify)	2%	0%	0%	1%	7%	1%
Sample (N) (plots)	796					

Note: *Each column does not add up to 100% (multiple answers).*

3.6. Cultivation Cost

Households mainly invest in fertilizers, machinery, and seeds for agriculture. Rice farmers prioritize fertilizers and machinery, and leafy vegetable producers focus on fertilizers, irrigation, and seeds, while fruit cultivators allocate funds to fertilizers, chemicals, and machinery. Households primarily allocate agricultural expenditures to fertilizers (35%), machinery (28%), and seeds (16%). In rice cultivation, 58% of farmers invest in fertilizers, 46% in machinery, and 23% in seeds. For leafy vegetables, approximately 30% of producers allocate funds to fertilizers and irrigation, with 25% investing in seeds. In fruit cultivation, about 20% of households spend on fertilizers and 16% on machinery (Table 16).

Key takeaways: Farmers allocate their resources according to the specific requirements of the crops they cultivate. Therefore, it is advisable to offer education and training to farmers on the optimal utilization of fertilizers, machinery, and seeds, enabling them to maximize their return on investment. This training should encompass best practices in crop management, efficient input usage, and cost-effective farming techniques.

Table 16. Percentage of production cost, by item

Item	% of crop production costs	% of rice production costs	% of other cereal production costs	% of leafy vegetable production costs	% of non-leafy vegetable production costs	% of fruit production costs	% of fish production costs
Seed	16%	23%	11%	25%	12%	12%	22%
Fertilizers	35%	58%	27%	33%	27%	21%	0%
Pesticides	11%	14%	0%	21%	14%	18%	0%
Feed (aquaculture)							24%
Irrigation	14%	22%	4%	31%	27%	6%	2%
Hired labor	8%	11%	0%	13%	4%	7%	2%
Machinery	28%	46%	12%	10%	9%	16%	8%
Transportation and marketing	5%	8%	3%	3%	5%	2%	1%
Sample (N)	365	334	3	27	15	64	17

Note: *Each column does not add up to 100% (multiple answers).*

4. Agricultural Inputs

This study groups the main agricultural inputs into three categories: fertilizers, manure, and pesticides. As listed in Table 35 in Annex 1, the fertilizers consist of urea, NPK, DAP, and NPKS, while the pesticides consist of insecticide, fungicide, and herbicide.

A significant portion of households involved in agricultural production utilizes various inputs, mostly fertilizers, followed by pesticides and manure. The usage patterns of these inputs vary depending on access to irrigation and provincial location. Approximately 72% of all households (equivalent to 373 households) engage in agricultural production using various inputs. Among these, 90% utilize fertilizers, 57% use pesticides, and only 31% employ manure. These households possess an average land size of 0.82 hectares. When disaggregating by access to irrigation, 82% of households in irrigated areas apply fertilizers, 42% use manure, and 36% use pesticides. In contrast, 93% of households in non-irrigated areas utilize fertilizers, with 66% using pesticides and 26% using manure (as detailed in Table 17).

Across the provinces, over 90% of households apply fertilizers, except for Kampong Thom, where only 67% of households do so. However, 49% of households in Kampong Thom utilize manure, compared to approximately 30% in Prey Veng and Svay Rieng, and less than 20% in Kandal and Takeo. Regarding pesticide usage, around 60% of households in Kandal and Prey Veng employ these chemicals, while 36% in Kampong Thom, 55% in Svay Rieng, and 76% in Takeo do the same (Table 17).

Table 17. Share of households using agricultural inputs, by location

	All (N=518)	Irrigated villages (N=388)	Non-irrigated villages (N=130)	Kampong Thom (N=105)	Kandal (N=103)	Prey Veng (N=105)	Svay Rieng (N=103)	Takeo (N=102)
% of N	72%	68%	85%	77%	37%	82%	85%	78%
Fertilizers	90%	82%	93%	67%	93%	98%	99%	95%
Manure	31%	42%	26%	49%	18%	33%	31%	15%
Pesticides	57%	36%	66%	36%	63%	59%	55%	76%
Average land size (ha)*	0.82	0.7	1.06	1.27	0.43	0.5	0.86	0.73

Conditional upon on using agricultural inputs.

Note: *The percentages of fertilizers, manure, and pesticides do not add up to 100% (multiple choices).*

The use of agricultural inputs differs notably depending on the crop type, with a larger proportion of paddy growers relying on fertilizers, whereas vegetable growers and those cultivating other crops demonstrate a more balanced application of fertilizers, manure, and pesticides. This suggests that input practices are closely aligned with the specific needs of each crop, with paddy cultivation showing the greatest dependence on fertilizers. When analyzed by crop type, 93% of paddy growers apply fertilizers, with 59% utilizing pesticides and 28% incorporating manure into their agricultural practices. In comparison, 67% of vegetable growers use fertilizers, 49% employ manure, and 46% rely on pesticides. For cultivators of other crops, 58% report using fertilizers, 31% utilize manure, and 27% apply pesticides. Comprehensive data on the distribution of households employing agricultural inputs across different commodities, irrigation areas, and provinces can be found in Table 20.

Fertilizers dominate annual agricultural input costs, especially in irrigated villages, where they make up most expenditures. In contrast, non-irrigated villages allocate a larger share of costs to manure, although fertilizers still constitute a significant portion. Pesticide expenditures vary by province, with Kandal spending the most. In terms of expenditure, fertilizers account for the largest share of annual input costs, making up 81% of total expenditures, with households spending an average of USD 1,148 on fertilizers. This trend is more pronounced in irrigated villages, where fertilizers comprise 83% of input costs. In non-irrigated villages, manure accounts for a higher proportion of costs (18%), with fertilizers still making up 76% of expenditures. Pesticide use varies notably by province, with households in Kandal averaging the most spent on pesticides (USD 990), which represents 16% of their total input costs. Kampong Thom shows a distinct pattern with a higher reliance on manure, which accounts for 28% of its input costs (Table 18).

Table 18. Average annual input expenditure per hectare, by household

Average input cost (USD)								
Expenditure	**All**	**Irrigated villages**	**Non-irrigated villages**	**Kampong Thom**	**Kandal**	**Prey Veng**	**Svay Rieng**	**Takeo**
Fertilizers	1,148	1,548.30	239.5	408	1,562	1,202	329	2,590
Manure	89	105.6	50.4	139	74	89	19	117
Pesticides	214	299.5	18.4	28	990	143	28	339
% of input cost								
Fertilizers	81%	83%	76%	63%	81%	84%	88%	86%
Manure	9%	5%	18%	28%	4%	5%	4%	3%
Pesticides	10%	12%	6%	10%	16%	11%	8%	11%

The input costs for agricultural production vary significantly depending on the type of crop and location. Paddy and vegetable cultivation generally incur higher expenses, especially in irrigated villages and specific provinces like Kandal and Takeo. Fertilizer and pesticide costs are particularly substantial, with some regions showing notably higher expenditures. Table 21 presents a comprehensive analysis of input costs for various crop types, categorized by location. In the context of paddy cultivation, the average household expenditure per hectare on fertilizers is USD 1,203, with additional expenses of USD 245 for manure and USD 224 for pesticides. These costs are notably higher in irrigated villages, where fertilizer expenses reach USD 1,550 per hectare and manure costs rise to USD 361 per hectare, in contrast to the significantly lower expenditures in non-irrigated areas.

For other cereals, the average cost of fertilizers is USD 392 per hectare, with Kandal registering the highest at USD 917 per hectare. Pesticide expenditure is particularly prominent in this category, especially in Kandal, where households spend an average of USD 741 per hectare. Vegetable cultivation incurs the highest overall input costs, with fertilizers averaging USD 2,032 and pesticides USD 2,316 per hectare. Kandal, in particular, records exceptionally high pesticide expenses, at USD 3,113 per hectare (Table 21).

Regarding other crops, input expenditures exhibit greater variation, with average costs per hectare of USD 264 for fertilizers, USD 238 for manure, and USD 93 for pesticides.

Takeo is noteworthy for its elevated expenditure on manure for other crops, amounting to USD 1,063 per hectare, which is considerably higher than in other provinces (Table 21).

For households involved in aquaculture, farm-made mixed feed constitutes the highest input cost. The inputs utilized in aquaculture include antibiotics, sinking fish feed, floating fish feed, farm-made mixed feed, rice bran, snails, and fish meal, as detailed in Table 19. The largest expenditure is attributed to farm-made mixed feed, with an average cost of USD 199 per household. This is followed by fish meal, which averages USD 112 per household. Sinking fish feed (commercial pellet) also incurs a substantial cost, at USD 99 per household. Additional inputs include floating fish feed (commercial pellet) at USD 36, antibiotics at USD 29, rice bran at USD 18, and snails at USD 8 per household.

Key takeaways: The use and costs of agricultural inputs among farmers vary significantly based on crop type, location, and farming practices. Therefore, it is advisable to promote the adoption of integrated input management practices that leverage the synergy between different inputs, such as combining organic and inorganic fertilizers, to optimize costs and enhance crop productivity. This approach can be reinforced through training programs and demonstration plots that illustrate the benefits of integrated methods. Given the unique input requirements of different crops, agricultural extension services should prioritize educating farmers on efficient input utilization tailored to specific crops. For example, paddy farmers could benefit from targeted fertilizer application techniques, while vegetable growers may be guided on the balanced use of fertilizers, manure, and pesticides.

Table 19. Inputs used in aquaculture

Inputs	N	% of sample	Average cost per household (USD)
Antibiotics	4	24%	29.4
Sinking fish feed (commercial pellet)	1	6%	99.0
Floating fish feed (commercial pellet)	5	29%	36.4
Own farm-made mixed feed	2	12%	198.8
Rice bran	3	18%	18.0
Snails	1	6%	7.5
Fish meal	3	18%	111.7
Number of samples	17		

Table 20. Share of households using agricultural inputs, by agricultural commodity and location

Location	Paddy			Other cereals			Vegetables			Other crops		
	Fertilizers	Manure	Pesticides	Fertilizers	Manure	Pesticides	Fertilizers	Manure	Pesticides	Fertilizers	Manure	Pesticides
All	93%	28%	59%	75%	-	25%	67%	49%	46%	58%	31%	27%
Sample (N)	334	334	334	4	4	4	39	39	39	67	67	67
Irrigated villages	97%	22%	68%	100%	-	33%	80%	40%	57%	65%	35%	38%
Non-irrigated villages	84%	42%	37%	-	-	-	22%	78%	11%	50%	27%	13%
Kampong Thom	69%	48%	37%	67%	-	-	22%	89%	-	53%	30%	26%
Kandal	100%	6%	65%	100%	0%	100%	100%	18%	82%	75%	25%	25%
Prey Veng	100%	34%	60%	-	-	-	50%	0%	0%	25%	25%	25%
Svay Rieng	99%	29%	55%	-	-	-	20%	80%	20%	100%	100%	0%
Takeo	100%	9%	79%	-	-	-	83%	67%	50%	100%	67%	67%

Note: *The percentage of fertilizers, manure, and pesticides combined does not add up to 100% (multiple choices).*

Table 21. Average expenditure (USD) on inputs per hectare per household, by agricultural commodity and location

Location	Paddy			Other cereals			Vegetables			Other crops		
	Fertilizers	Manure	Pesticides	Fertilizers	Manure	Pesticides	Fertilizers	Manure	Pesticides	Fertilizers	Manure	Pesticides
All	1,203.4	245.2	223.5	392.2	-	740.7	2,031.9	910.6	2,316.1	263.7	237.7	92.9
Irrigated villages	1,550.1	360.7	266.0	392.2	-	740.7	2,186.7	1,236.7	2,476.2	341.7	342.3	100.9
Non-irrigated villages	292.2	136.2	47.8	-	-	-	406.3	95.4	75.0	138.8	63.2	65.0
Kampong Thom	621.1	134.3	70.5	130.0	-	-	1,731.3	1,112.0	-	142.8	119.7	51.6
Kandal	752.5	939.0	112.3	916.7	-	740.7	2,645.5	563.9	3,112.5	478.3	90.9	117.8
Prey Veng	1,221.6	399.0	234.5	-	-	-	650.0	-	-	105.0	150.0	500.0
Svay Rieng	316.4	106.6	49.2	-	-	-	475.0	46.7	75.0	937.5	-	-
Takeo	2,663.4	558.3	444.3	-	-	-	1,021.8	1,430.6	142.8	455.0	1,062.5	100.0

5. Rearing Farm Animals

For a more structured presentation, livestock is categorized into distinct groups: cattle, goats/pigs, improved chicken breeds, native chickens, and other poultry. The cattle category includes bullocks, buffaloes, and cows, while the goat/pig category primarily comprises pigs. The improved chicken breeds encompass layers, broilers, and cockerels. The "other poultry" category includes geese, pigeons, Muscovy ducks, ducks, and various other poultry species. The top-five commonly reared livestock, as outlined in Table 22, are native chickens, cows, ducks, pigs, and buffaloes.

Table 22. List of livestock

Livestock	N	% of sample
Native chickens	274	75%
Cows	188	51%
Ducks	57	16%
Pigs	39	11%
Buffaloes	36	10%
Muscovy ducks	25	7%
Chickens (broiler)	13	4%
Geese	10	3%
Chickens (cockerel)	5	1%
Other poultry	2	1%
Pigeons	1	0%
Number of samples	366	

Note: *Each column does not add up to 100% (multiple answers).*

Native chickens and cattle are predominantly reared by households, while other poultry, improved chicken breeds, and goats or pigs are raised by smaller proportions of households. Most households rear native chickens and cattle, accounting for 53% and 43%, respectively. Additionally, 16% of households report raising other avian species, 8% rear goats or pigs, and a mere 3% cultivate improved chicken breeds (Table 22). As of April 2023, the average number of livestock per household includes 21 native chickens, 5 cattle, 28 improved chickens, 15 other poultry, and 10 goats or pigs (Table 24). These differences are statistically significant.

Table 23. Share of households raising livestock

Livestock	% of households
Cattle (bullock/buffalo/cow)	43%
Goats/pigs	8%
Improved chicken breeds (layer/broiler/cockerel)	3%
Native chickens	53%
Other poultry	16%
Sample (N)	518

Note: *Each column does not add up to 100% (multiple answers).*

Table 24. Average number of livestock owned (as of April 2023)

Livestock	Sample N	Average number owned in April 2023 (head)
Cattle (bullock/buffalo/cow)	222	5
Goats/pigs	39	10
Improved chicken breeds (layer/broiler/cockerel)	18	28
Native chickens	274	21
Other poultry	83	15

Native chickens are mainly used for consumption, while cattle and goats or pigs are predominantly raised for sale. Improved chickens are primarily reared for both consumption and sale. Native chickens are used solely for consumption by 53% of households, while 40% of households utilize them for both consumption and sale, and only 7% raise them exclusively for sale. Conversely, cattle are predominantly raised for sale purposes, accounting for 91% of households. A similar pattern is observed among households raising goats or pigs, with 85% raising them for sale. Regarding improved chickens, 67% of households raise them for both consumption and sale, while 28% raise them exclusively for sale (Table 25). The variation in the utilization of different types of livestock for various purposes (i.e., consumption only, consumption and sale, and sale only) is statistically significant.

Table 25. Livestock utilization

Livestock	Sample N	Consumption only	Consumption and production	Production only
Cattle (bullock/buffalo/cow)	222	4%	5%	91%
Goats/pigs	39	3%	13%	85%
Improved chicken breeds (layer/broiler/cockerel)	18	6%	67%	28%
Native chickens	274	53%	40%	7%
Other poultry	83	45%	40%	18%

Note: *Each column of % does not add up to 100% (multiple answers).*

Cattle command the highest average market value among livestock, with improved chickens, and goats or pigs valued lower. Most households sell improved chickens, while fewer sell cattle or native chickens. As of April 2023, cattle have the highest average market value among livestock, at USD 2,284, followed by goats or pigs at USD 1,243. Improved chickens are valued at USD 154, while native chickens are valued at USD 81 and other poultry at USD 124. Over the previous year, 78% of households sold improved chickens, 62% sold goats or pigs, and approximately 30% each sold cattle or native chickens (Table 26). The differences in the market value of these livestock are statistically significant.

Table 26. Market value of livestock and share of households selling livestock

Livestock	Sample N	Average market value in April 2023 (USD)	% of households selling in the previous year
Cattle (bullock/buffalo/cow)	222	2,283.93	32%
Goats/pigs	39	1,242.98	62%
Improved chicken breeds (layer/broiler/cockerel)	18	154.11	78%
Native chickens	274	81.3	28%
Other poultry	83	112.47	22%

Note: *Each column of % does not add up to 100% (multiple answers).*

Cattle and goats or pigs have higher average market values than other livestock. Households raising goats or pigs face the highest costs, while those raising cattle have the highest net income. Improved chickens yield the lowest net income and market value. These differences in values, costs, and incomes are statistically significant. Among the 32% of households that sold cattle, the average total value was USD 1,086, compared to USD 1,304 for goats or pigs. Improved chickens averaged USD 103, native chickens USD 163, and other poultry USD 179 (Table 27). In terms of livestock raising costs, households raising goats or pigs incur the highest average expenses at USD 756, while those raising cattle spend USD 379. Households raising improved chickens, native chickens, and other poultry spend USD 66, USD 75, and USD 106, respectively (Table 28). Regarding net income, households raising cattle achieve the highest average income of USD 942, followed by those raising pigs at USD 590, with improved chickens yielding the lowest income of USD 75 over the previous 12 months (Table 29).

Key takeaways: Households engaged in cattle rearing achieve the highest net income, despite incurring relatively high costs. In contrast, those raising improved chickens generate the lowest net income and market value, indicating that these chickens are less profitable than other livestock. In this regard, programs supporting cattle, goats, and pigs could prove advantageous. Such programs may include access to veterinary services, enhanced breeding practices, and financial support through loans or grants to help households manage the higher costs associated with these animals. Furthermore, improving market access for all livestock types, particularly those with lower market values like native and improved chickens, could enable households to increase their income from sales. This could be achieved through the development of local markets, enhancement of transportation infrastructure, or the establishment of cooperative selling groups.

Table 27. Average total value of livestock sold in the previous 12 months

Livestock	Sample N	Average total market value in the previous 12 months (USD)
Cattle (bullock/buffalo/cow)	70	1,085.54
Goats/pigs	24	1,304.11
Improved chicken breeds (layer/broiler/cockerel)	14	103.04
Native chickens	77	162.79
Other poultry	18	178.82
All animals	153	813.61

Table 28. Average cost of rearing livestock in the previous 12 months

Livestock	Sample N	Average cost of rearing in the previous 12 months (USD)
Cattle (bullock/buffalo/cow)	192	378.91
Goats/pigs	38	756.24
Improved chicken breeds (layer/broiler/cockerel)	17	65.61
Native chickens	226	75.8
Other poultry	69	105.6
All animals	336	335.18

Table 29. Table 29. Average net income of livestock rearing in the previous 12 months

Livestock	Sample N	Average net income from rearing in the previous 12 months (USD)
Cattle (bullock/buffalo/cow)	60	941.59
Goats/pigs	19	589.63
Improved chicken breeds (layer/broiler/cockerel)	12	74.98
Native chickens	53	79.92
Other poultry	9	107.89
All animals	122	585.54

6. Produced Nutrients

The World Health Organization (2020) indicated that maintaining a healthy diet plays a crucial role in safeguarding against various forms of malnutrition and in reducing the risk of noncommunicable diseases (NCDs), such as diabetes, heart disease, stroke, and cancer.

For energy intake, an adult is advised to consume 2,900 kcal per day for men and 2,200 kcal for women (National Library of Medicine, n.d.).[1] Recommended daily intake is 55 grams for protein, 1,000 milligrams for calcium, 363 milligrams for magnesium, 13 milligrams for iron, and 10 milligrams for zinc (National Institute of Health, n.d.).

The daily intake for Vitamin A, expressed as VARAE (Vitamin A Retinol Activity Equivalents), is 900 micrograms, amounting to 328,500 micrograms annually. Vitamin B12 intake is suggested at 2.5 micrograms per day, leading to 913 micrograms annually. Vitamin C is recommended at 83 milligrams daily, with an annual total of 30,295 milligrams. For the B vitamins, the recommended daily intakes are as follows: 1.2 milligrams of Vitamin B1 (Thiamine), 1.3 milligrams of Vitamin B2 (Riboflavin), 16 milligrams of Vitamin B3 (Niacin), and 1.3 milligrams of Vitamin B6, resulting in annual totals of 438, 475, 5,840, and 475 milligrams, respectively. Folate (Fol) is recommended at 400 micrograms per day, amounting to 146,000 micrograms per year (National Institute of Health, n.d.).

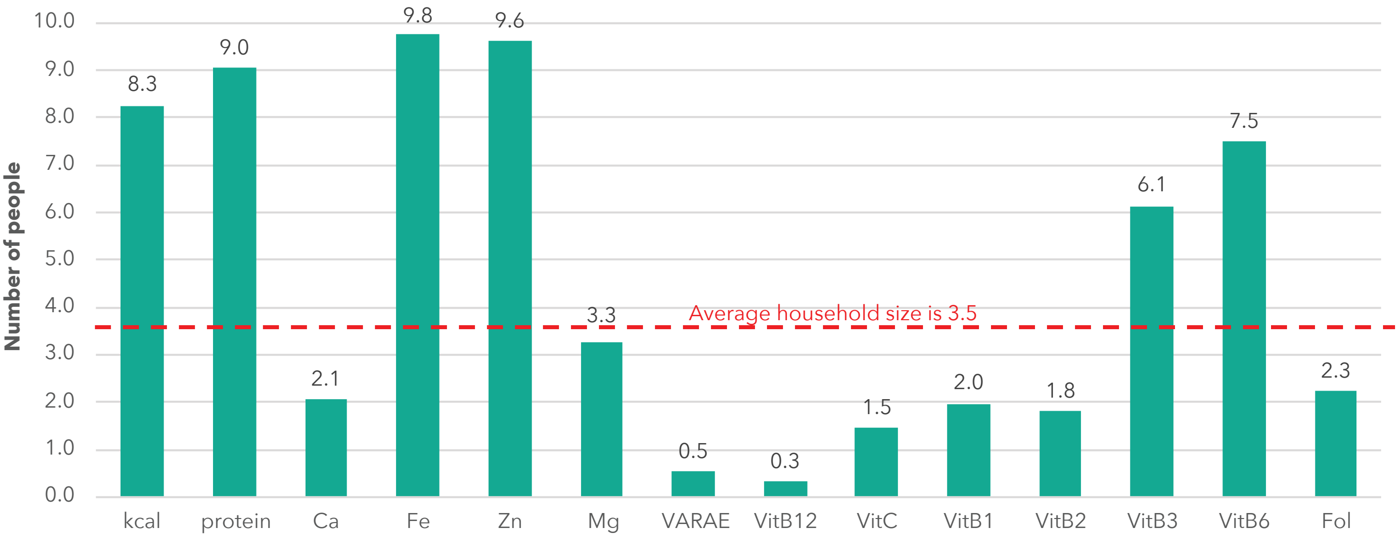
Given that the majority of households have adopted a rice and livestock farming system, it is expected that the nutrients produced from agricultural outputs are primarily concentrated in energy, protein, iron, zinc, Vitamin B3, and Vitamin B6. The following figure illustrates the number of adults that a household's annual agricultural production can sustain over a year, based on the annual nutrient requirements of an adult. The iron, protein, and zinc produced, on average, by the survey households can support nearly ten adults annually. In contrast, the energy output can sustain up to eight adults, while the produced Vitamin B3 and Vitamin B6 can support six and eight adults, respectively. However, other essential nutrients, such as VARAE and Vitamin B12, are insufficient to fully support even one adult. The produced magnesium can sustain up to three adults, whereas nutrients like calcium, Vitamin C, Vitamin B1, Vitamin B2, and folate can only support two or fewer adults. On average, the households in this study consist of 3.5 adults, indicating that most critical nutrients produced by these households are barely sufficient to meet their own nutritional needs. It is also important to note that most of these households primarily sell their agricultural products.

Key takeaway: As many of these households sell their agricultural products rather than consume them, they might substitute their diet with a lower quality product, which could lead to unhealthy food consumption.

Table 30. Recommended dietary nutrients for an adult

Nutrient	Per day	Per year
kcal	2,550	930,750
protein	55	20,075
Ca	1000	365,000
Fe	13	4,745
Zn	10	3,650
Mg	363	132,495
VARAE	900	328,500
VitB12	2.5	913
VitC	83	30,295
VitB1	1.2	438
VitB2	1.3	475
VitB3	16	5,840
VitB6	1.3	475
Fol	400	146,000

Figure 2. Number of people that can be sustained by the average nutrient content of households' annual produce



[1] Hence, the average of energy taken for this study is 2,550 kcal.

7. Conclusion

Paddy rice remains the cornerstone of agricultural production. Although the sector continues to be a major contributor to the national economy, the declining share of agriculture in the GDP reflects broader economic changes.

The study underscores the importance of enhancing agricultural productivity through improved irrigation, diversified cropping patterns, and better market access. The significant variation in agricultural income across regions and the differences in input use and land preparation methods highlight the need for tailored interventions to address the unique challenges faced by different provinces. Moreover, since household nutrient production is focused on certain nutrients, governments and NGOs could support households by providing seeds for nutrient-rich crops and/or offering training on sustainable farming methods to ensure a more diverse production of essential nutrients.

Overall, the findings suggest that while Cambodia's agricultural sector is on a positive trajectory, continued efforts are needed to ensure that growth is inclusive and sustainable, addressing economic and ensuring more diverse and balanced production of essential nutrients in the country.

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Annex 1. Supporting Tables

Table 31. On-farm income of households

	Sample N	All	Kampong Thom	Kandal	Prey Veng	Svay Rieng	Takeo	Irrigated villages	Non-irrigated villages
Average net income (USD) originating from own farm (agriculture+livestock+aquaculture)	405	1,222.43	1,290.49	2,143.93	706.82	609.36	1,810.48	1,431.95	712.83
% of net income originating from own farm	405	38.0%	51.0%	37.5%	33.6%	35.5%	33.9%	37.0%	42.0%
Average net income (USD) originating from cultivating paddy, conditional upon having farm income	405	769.92	761.81	487.77	521.42	384.06	1597.07	919.55	406.02
% of net farm income originating from cultivating paddy	405	53.0%	43.4%	25.7%	65.4%	55.1%	64.6%	54.0%	52.0%
Average net income (USD) originating from non-paddy grain, conditional upon having farm income	405	2.53	11.14	0.00	0.00	0.00	0.00	0.00	8.686
% of net farm income originating from non-paddy grain	405	0.20%	1.09%	0.00%	0.00%	0.00%	0.00%	0.00%	0.80%
Average net income (USD) originating from vegetables, conditional upon having farm income	405	178.75	1.64	1429.36	18.44	7.96	14.86	249.67	6.275
% of net farm income originating from vegetables	405	3.4%	0.1%	23.4%	0.7%	0.8%	1.5%	4.6%	0.6%
Average net income (USD) originating from fruits or nuts, conditional upon having farm income	405	50.67	162.41	71.78	0.98	0.00	23.78	40.76	74.75
% of net farm income originating from fruits or nuts	405	5.2%	17.0%	8.3%	1.1%	0.0%	0.4%	3.3%	9.9%
Average net income (USD) originating from livestock, conditional upon having farm income	405	202.31	314.02	99.31	161.52	190.42	194.97	200.93	205.685
% of net farm income originating from livestock	405	19.5%	23.2%	17.6%	17.0%	27.4%	10.8%	17.6%	24.1%
Average net income (USD) originating from aquaculture, conditional upon having farm income	405	7.77	0.00	0.00	2.74	11.58	21.61	10.49	1.15
% of net farm income originating from aquaculture	405	1.4%	0.0%	0.0%	1.1%	2.6%	2.9%	2.0%	0.1%

Table 32. Share of the distribution of outputs of commodities

Commodity	N	Sold	Consumed	Gifted	Given to tenant/ sharecropper	Stocked	Other
Major cereals (paddy rice)	333	43%	35%	0%	0%	21%	1%
Pulses	1	99%	0%	0%	0%	0%	0%
Spices	2	97%	3%	0%	0%	0%	0%
Vegetables	13	78%	16%	3%	0%	3%	0%
Leafy vegetables	27	76%	18%	2%	0%	4%	0%
Fruits	14	54%	36%	9%	0%	0%	1%
Other crops	38	95%	2%	0%	0%	3%	0%
Aquaculture	14	14%	55%	3%	0%	28%	0%
Livestock	153	20%	78%	0%	1%	0%	1%
Eggs	14	25%	73%	0%	0%	0%	2%
Meat	139	20%	79%	0%	1%	0%	1%

Note: *Each row adds up to 100%.*

Table 33. Percentage of plots cultivated in irrigated and non-irrigated villages, by season

Season	Irrigated villages	Non-irrigated villages
Early wet season	20%	10%
Wet season	39%	64%
Recession season	10%	0%
Dry season	16%	0%
Annual	12%	26%
Sample (N) (plots)	616	180

Table 34. List of rice varieties grown by farmers

Rice variety	N	% of sample
OM5451	236	70%
IR 66	71	21%
IR 504	45	13%
OM501	39	12%
OM4900	33	10%
Krasang teab	32	9%
Pka Romdual	30	9%
Neang Om	22	7%
Others	19	6%
IR 72	13	4%
Riang Chey	13	4%
Yeay ta	11	3%
Sen Pidor	9	3%
CAR 11	7	2%
Neang puon	6	2%
Phka Knhey	5	1%
Neang Minh	5	1%
Phka Malis	4	1%
IR 85	4	1%
Red Rice	4	1%

Rice variety	N	% of sample
Tanong rice	4	1%
IR Kesar	3	1%
Neang Kong	3	1%
Pouch kaun srauv	3	1%
Sen Kra Ob	2	1%
American	2	1%
Changkom Ipek	2	1%
Konsrov	2	1%
OM 95	2	1%
Phlow chngrut	2	1%
Black rice	1	0%
Heavy red variety	1	0%
KraNhnanh	1	0%
Neang Ong	1	0%
Neang Pen	1	0%
Neang khmaw	1	0%
Pka Tom	1	0%
Pleur Jong Rit	1	0%
Prong	1	0%
Number of samples	337	100%

Table 35. List of fertilizers

Fertilizer	N	%
Urea	276	74%
NPK	226	61%
DAP	136	36%
NPKS	19	5%
Number of samples	373	

Table 36. List of agricultural commodities for nutrient calculations

Commodity	Category	Commodity	Category
Aromatic paddy	Major cereals	Sugarcane	Grass[2]
Banana	Fruits	Ash gourd	Vegetables
Boroi (bitter plum)	Fruits	Bitter gourd	Vegetables
Cashew	Other crops	Cucumber	Vegetables
Cassava	Other crops	Eggplant	Vegetables
Cauliflower	Vegetables	Green papaya	Vegetables
Coconut / green coconut	Fruits	Kalmi Shak (water spinach)	Vegetables
Green mustard	Leafy vegetables	Lemon grass	Spices
Lime/lemon	Fruits	Lettuce	Leafy vegetables
Mango	Fruits	Pumpkin	Vegetables
Morning glory	Leafy vegetables	Scallion (spring onion)	Leafy vegetables
Non-aromatic paddy	Major cereals	Snake gourd	Vegetables
Other vegetables	Vegetables	Water gourd	Vegetables
Pok choy	Leafy vegetables	Watermelon	Fruits
Mung	Pulses	Yard long bean	Vegetables
Tomato	Vegetables	Bamboo shoot	Vegetables
Ataa (sugar apple)	Fruits	Chili	Fruits[3]
Danta (Amaranth)	Leafy vegetables	Fish	Meat
Garlic	Vegetables	Buffalo meat	Meat
Mint	Herb	Cow meat (beef)	Meat
Orange	Fruits	Pig meat (pork)	Meat
Taro	Vegetables	Duck meat	Meat
Turmeric	Spices	Muscovy duck meat	Meat
Bringal (Thai eggplant)	Vegetables	Geese meat	Meat
Chaisim (mustard green)	Leafy vegetables	Eggs of chickens, ducks, Muscovy ducks, geese	Eggs
Fun Jen Cabbage	Leafy vegetables		

Table 37. Average annual nutrient productivity of households

Nutrient	Quantity
kcal	12,229,294.64
protein	289,473.29
Ca	1,201,035.98
v	73,879.21
Zn	55,833.90
Mg	696,201.40
VARAE	290,550.86

Nutrient	Quantity
VitB12	475.07
VitC	73,420.62
VitB1	1,406.72
VitB2	1,406.41
VitB3	57,275.08
VitB6	5,708.67
Fol	538,930.12

[2] Moore, Paterson, & Tew, 2013
[3] International Agency for Research on Cancer, 2003

Annex 2. Statistical Test Results

Section: Household Characteristics

```
. anova farm_net_income Division_Province

                         Number of obs =        405    R-squared     =  0.0310
                         Root MSE      =    3166.53    Adj R-squared =  0.0213

                  Source | Partial SS         df         MS        F    Prob>F
              -----------+----------------------------------------------------
                   Model |   1.284e+08         4     32103022      3.20  0.0132
                         |
              Division_~e|   1.284e+08         4     32103022      3.20  0.0132
                         |
                Residual |   4.011e+09       400     10026890
              -----------+----------------------------------------------------
                   Total |   4.139e+09       404     10245466
```

```
. ttest farm_net_income, by (province_1)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     313    1202.427    194.4454     3440.09    819.8364    1585.017
       1 |      92    1290.486    230.8971    2214.687    831.8374    1749.135
---------+--------------------------------------------------------------------
Combined |     405     1222.43    159.0517    3200.854    909.7578    1535.102
---------+--------------------------------------------------------------------
    diff |           -88.05949    380.0463               -835.1803    659.0614
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -0.2317
H0: diff = 0                                     Degrees of freedom =      403

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.4084         Pr(|T| > |t|) = 0.8169          Pr(T > t) = 0.5916
```

```
. ttest farm_net_income, by (province_2)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     357    1098.531    120.7123    2280.791    861.1322     1335.93
       1 |      48     2143.93     996.673    6905.153    138.8827    4148.978
---------+--------------------------------------------------------------------
Combined |     405     1222.43    159.0517    3200.854    909.7578    1535.102
---------+--------------------------------------------------------------------
    diff |           -1045.399    489.9337               -2008.544   -82.25426
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -2.1338
H0: diff = 0                                     Degrees of freedom =      403

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0167         Pr(|T| > |t|) = 0.0335          Pr(T > t) = 0.9833
```

```
. ttest farm_net_income, by (province_3)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     316    1367.649    197.5759    3512.186    978.9137    1756.384
       1 |      89    706.8221    168.8062    1592.515    371.3551    1042.289
---------+--------------------------------------------------------------------
Combined |     405     1222.43    159.0517    3200.854    909.7578    1535.102
---------+--------------------------------------------------------------------
    diff |            660.8268    383.1742                 -92.443    1414.097
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   1.7246
H0: diff = 0                                     Degrees of freedom =      403

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9573         Pr(|T| > |t|) = 0.0854          Pr(T > t) = 0.0427
```

```
. ttest farm_net_income, by (province_4)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     315    1397.592    201.4617    3575.591    1001.207    1793.978
       1 |      90    609.3628    100.7048      955.37    409.2644    809.4611
---------+--------------------------------------------------------------------
Combined |     405     1222.43    159.0517    3200.854    909.7578    1535.102
---------+--------------------------------------------------------------------
    diff |            788.2295    381.0319                39.17116    1537.288
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   2.0687
H0: diff = 0                                     Degrees of freedom =      403

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9804         Pr(|T| > |t|) = 0.0392          Pr(T > t) = 0.0196
```

```
. ttest farm_net_income, by (province_5)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     319    1063.897    174.3159    3113.382    720.9389    1406.855
       1 |      86    1810.477    373.3591     3462.39    1068.139    2552.815
---------+--------------------------------------------------------------------
Combined |     405     1222.43    159.0517    3200.854    909.7578    1535.102
---------+--------------------------------------------------------------------
    diff |           -746.5801    387.6119               -1508.574    15.41378
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -1.9261
H0: diff = 0                                     Degrees of freedom =      403

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0274         Pr(|T| > |t|) = 0.0548          Pr(T > t) = 0.9726
```

```
. ttest farm_net_income, by (irrigated)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     118    712.8274    109.0636    1184.734    496.8327    928.8221
       1 |     287    1431.953      218.86    3707.724    1001.172    1862.734
---------+--------------------------------------------------------------------
Combined |     405     1222.43    159.0517    3200.854    909.7578    1535.102
---------+--------------------------------------------------------------------
    diff |           -719.1258    348.6334               -1404.493    -33.7585
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -2.0627
H0: diff = 0                                     Degrees of freedom =      403

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0199         Pr(|T| > |t|) = 0.0398          Pr(T > t) = 0.9801
```

Section: Produce and Land Utilization (land utilization rate of rice cultivation)

```
. ttest per_area_crop_1, by (province_1)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     298    1.151007    .0365453    .6308689    1.079086    1.222927
       1 |      88    .8522727    .0524722    .4922333    .7479785     .956567
---------+--------------------------------------------------------------------
Combined |     386    1.082902    .0312737    .6144307    1.021413     1.14439
---------+--------------------------------------------------------------------
    diff |             .298734    .0730684                .1550698    .4423982
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   4.0884
H0: diff = 0                                     Degrees of freedom =      384

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0001          Pr(T > t) = 0.0000
```

```
. ttest per_area_crop_1, by (province_2)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     346    1.153179    .0310225    .5770527    1.092162    1.214196
       1 |      40        .475    .0946485    .5986095    .2835554    .6664446
---------+--------------------------------------------------------------------
Combined |     386    1.082902    .0312737    .6144307    1.021413     1.14439
---------+--------------------------------------------------------------------
    diff |            .6781792    .0967416                .4879697    .8683887
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   7.0102
H0: diff = 0                                     Degrees of freedom =      384

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

```
. ttest per_area_crop_1, by (province_3)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     299    1.053512    .0374767    .6480322    .9797593    1.127264
       1 |      87    1.183908    .0504689    .4707425    1.083579    1.284237
---------+--------------------------------------------------------------------
Combined |     386    1.082902    .0312737    .6144307    1.021413     1.14439
---------+--------------------------------------------------------------------
    diff |           -.1303963    .0746479               -.2771661    .0163734
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -1.7468
H0: diff = 0                                     Degrees of freedom =      384

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0407         Pr(|T| > |t|) = 0.0815          Pr(T > t) = 0.9593
```

```
. ttest per_area_crop_1, by (province_4)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     297    1.037037     .037037    .6382847    .9641477    1.109926
       1 |      89    1.235955     .053054    .5005105    1.130521    1.341389
---------+--------------------------------------------------------------------
Combined |     386    1.082902    .0312737    .6144307    1.021413     1.14439
---------+--------------------------------------------------------------------
    diff |            -.198918    .0736498               -.3437254   -.0541106
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -2.7009
H0: diff = 0                                     Degrees of freedom =      384

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0036         Pr(|T| > |t|) = 0.0072          Pr(T > t) = 0.9964
```

```
. ttest per_area_crop_1, by (province_5)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     304    1.009868     .032446    .5657157    .9460204    1.073716
       1 |      82    1.353659    .0783217    .7092328    1.197823    1.509494
---------+--------------------------------------------------------------------
Combined |     386    1.082902    .0312737    .6144307    1.021413     1.14439
---------+--------------------------------------------------------------------
    diff |           -.3437901    .0745202               -.4903088   -.1972715
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -4.6134
H0: diff = 0                                     Degrees of freedom =      384

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

```
. ttest per_area_crop_1, by (irrigated)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     117    1.051282    .0540793    .5849573    .9441711    1.158393
       1 |     269    1.096654    .0382522     .627382    1.021341    1.171967
---------+--------------------------------------------------------------------
Combined |     386    1.082902    .0312737    .6144307    1.021413     1.14439
---------+--------------------------------------------------------------------
    diff |           -.0453722    .0680944               -.1792567    .0885123
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -0.6663
H0: diff = 0                                     Degrees of freedom =      384

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.2528         Pr(|T| > |t|) = 0.5056          Pr(T > t) = 0.7472
```

Section: Agricultural Inputs

```
. oneway Input Type, tabulate

            |  Summary of (sum) valueX_fertilizer
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
  fertilize |   1177.7055    1813.815         386
     manure |    88.09011   356.06033         386
  pesticide |   483.30882   3826.2703         386
------------+------------------------------------
      Total |   583.03482   2492.3155       1,158

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      234899830       2    117449915     19.51     0.0000
 Within groups     6.9520e+09    1155   6019016.14
------------------------------------------------------------------------
    Total          7.1869e+09    1157   6211636.53

Bartlett's equal-variances test: chi2(2) =  1.4e+03    Prob>chi2 = 0.000
```

```
. oneway Input Type if Province_1==1, tabulate

            |  Summary of (sum) valueX_fertilizer
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
  fertilize |   407.55999   1118.2527          88
     manure |   139.13469    426.5441          88
  pesticide |   27.688832   67.251559          88
------------+------------------------------------
      Total |   191.46117   707.71283         264

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups     6710716.12       2   3355358.06      7.01     0.0011
 Within groups      125014793     261   478983.883
------------------------------------------------------------------------
    Total           131725510     263   500857.451

Bartlett's equal-variances test: chi2(2) = 404.3037    Prob>chi2 = 0.000
```

```
. oneway Input Type if Province_2==1, tabulate

            |  Summary of (sum) valueX_fertilizer
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
  fertilize |   1813.2574   2169.2406          40
     manure |   68.038574   259.59321          40
  pesticide |   3534.0478   11536.652          40
------------+------------------------------------
      Total |   1805.1146   6870.4058         120

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      240268373       2    120134187      2.61     0.0775
 Within groups     5.3768e+09     117   45955779.3
------------------------------------------------------------------------
    Total          5.6171e+09     119   47202475.2

Bartlett's equal-variances test: chi2(2) = 298.4782    Prob>chi2 = 0.000
```

```
. oneway Input Type if Province_3==1, tabulate

            |  Summary of (sum) valueX_fertilizer
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
  fertilize |   1202.1523    1543.337          87
     manure |   88.863636   359.47545          87
  pesticide |    143.2021   264.18586          87
------------+------------------------------------
      Total |   478.07267   1057.0393         261

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups     68548452.6       2   34274226.3     39.84     0.0000
 Within groups      221957913     258    860301.99
------------------------------------------------------------------------
    Total           290506366     260   1117332.18

Bartlett's equal-variances test: chi2(2) = 289.9653    Prob>chi2 = 0.000
```

```
. oneway Input Type if Province_4==1, tabulate

            |   Summary of (sum) valueX_fertilizer
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
  fertilize |   328.68339   550.47545          89
     manure |   19.007491    68.64801          89
  pesticide |   27.906969   56.718525          89
------------+------------------------------------
      Total |   125.19928   351.66114         267

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      5531196.14      2   2765598.07     26.68     0.0000
 Within groups      27363842.8    264    103650.92
------------------------------------------------------------------------
    Total             32895039    266    123665.56

Bartlett's equal-variances test: chi2(2) = 480.7449    Prob>chi2 = 0.000
```

```
. oneway Input Type if Province_5==1, tabulate

            |   Summary of (sum) valueX_fertilizer
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
  fertilize |   2589.7401   2348.4899          82
     manure |   117.25102   472.51923          82
  pesticide |   339.22409   476.64608          82
------------+------------------------------------
      Total |   1015.4051   1795.8171         246

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups       306879439      2    153439720     77.16     0.0000
 Within groups       483235540    243   1988623.62
------------------------------------------------------------------------
    Total            790114979    245    3224959.1

Bartlett's equal-variances test: chi2(2) = 268.7494    Prob>chi2 = 0.000
```

```
. oneway Input Type if irrigated==1, tabulate

            |   Summary of (sum) valueX_fertilizer
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
  fertilize |   1585.7554   2016.8933         269
     manure |   104.46396   411.96513         269
  pesticide |   685.52046   4571.1525         269
------------+------------------------------------
      Total |   791.91328   2954.4384         807

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups       299690569      2    149845285     17.89     0.0000
 Within groups      6.7356e+09    804   8377669.71
------------------------------------------------------------------------
    Total           7.0353e+09    806   8728705.98

Bartlett's equal-variances test: chi2(2) = 992.0171    Prob>chi2 = 0.000
```

Section: Farm Animal Rearing

```
. oneway livestock Type, tabulate

            |        Summary of (max) cattle
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
     cattle |   .42857143   .49535003         518
        pig |   .07528958   .26411308         518
      breed |   .03474903   .18332053         518
     native |   .52895753   .49964327         518
      birds |   .16023166   .36717535         518
------------+------------------------------------
      Total |   .24555985   .43050176       2,590

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      100.762162      4   25.1905405    171.79     0.0000
 Within groups      379.061776   2585   .146638985
------------------------------------------------------------------------
    Total           479.823938   2589   .185331764

Bartlett's equal-variances test: chi2(4) = 647.5175    Prob>chi2 = 0.000
```

```
. oneway number_livestock Type, tabulate

            |   Summary of (max) number_cattle
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
     cattle |   5.4234234   5.3485729         222
        pig |   9.6666667   8.4707961          39
      breed |        27.5   29.878676          18
     native |   20.536496   45.134968         274
      birds |   15.156627    20.02954          83
------------+------------------------------------
      Total |   14.089623   31.881273         636

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      32155.4278      4   8038.85694      8.27     0.0000
 Within groups      613268.464    631   971.899309
------------------------------------------------------------------------
    Total           645423.892    635   1016.41558

Bartlett's equal-variances test: chi2(4) = 743.7064    Prob>chi2 = 0.000
```

```
. oneway uses_livestock_1 Type, tabulate

            |   Summary of (max) uses_cattle_1
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
     cattle |   .03603604   .18680103         222
        pig |   .02564103   .16012815          39
      breed |   .05555556   .23570226          18
     native |   .52554745   .50026062         274
      birds |   .44578313   .50007346          83
------------+------------------------------------
      Total |   .30031447   .45875548         636

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups        35.18223      4    8.7955575     56.37     0.0000
 Within groups      98.4577071    631   .156034401
------------------------------------------------------------------------
    Total           133.639937    635   .210456594

Bartlett's equal-variances test: chi2(4) = 247.3879    Prob>chi2 = 0.000
```

```
. oneway uses_livestock_2 Type, tabulate

            |   Summary of (max) uses_cattle_2
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
     cattle |   .04954955   .21750285         222
        pig |   .12820513   .33868843          39
      breed |   .66666667   .48507125          18
     native |   .40145985   .49109065         274
      birds |   .39759036   .49237501          83
------------+------------------------------------
      Total |   .26886792   .44372011         636

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      20.4907215      4   5.12268037     30.92     0.0000
 Within groups      104.532863    631   .165662224
------------------------------------------------------------------------
    Total           125.023585    635   .196887535

Bartlett's equal-variances test: chi2(4) = 149.9294    Prob>chi2 = 0.000
```

```
. oneway uses_livestock_3 Type, tabulate

            |  Summary of (max) uses_cattle_3
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
     cattle |   .91441441   .28038333         222
        pig |   .84615385   .36551777          39
      breed |   .27777778    .4608886          18
     native |    .0729927    .2606005         274
      birds |   .18072289   .38712758          83
------------+------------------------------------
      Total |   .43396226   .49600993         636

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      99.3352044      4   24.8338011    275.44     0.0000
 Within groups      56.8912107    631   .090160397
------------------------------------------------------------------------
    Total           156.226415    635   .246025851

Bartlett's equal-variances test: chi2(4) =  36.1475    Prob>chi2 = 0.000
```

```
. oneway value_livestock Type, tabulate

            |   Summary of (max) value_cattle
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
     cattle |   2283.9262   2726.3492         222
        pig |   1242.9808   1431.0133          39
      breed |   154.11111   185.61492          18
     native |   81.299726   110.98126         274
      birds |   112.46837   190.14403          83
------------+------------------------------------
      Total |   927.50452   1944.8522         636

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups       674437996      4    168609499     61.59     0.0000
 Within groups      1.7274e+09    631   2737587.74
------------------------------------------------------------------------
    Total           2.4019e+09    635   3782450.17

Bartlett's equal-variances test: chi2(4) =  1.7e+03    Prob>chi2 = 0.000
```

```
. oneway sold_livestock Type, tabulate

            | Summary of (max) sold_yes_cattle
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
     cattle |   1085.5357   1147.7321          70
        pig |   1304.1146   1271.2521          24
      breed |   103.03571   84.325255          14
     native |   162.79058    685.9874          77
      birds |   178.81944   233.59816          18
------------+------------------------------------
      Total |   613.21367   1030.6723         203

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      49734771.1      4   12433692.8     14.93     0.0000
 Within groups       164846898    198   832560.093
------------------------------------------------------------------------
    Total            214581670    202   1062285.49

Bartlett's equal-variances test: chi2(4) = 102.9594    Prob>chi2 = 0.000
```

```
. oneway cost_livestock Type, tabulate

            |      Summary of (max) cost_cattle
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
     cattle |   378.90547   1353.8971         192
        pig |   756.23684   1403.5433          38
      breed |   65.610294   75.934438          17
     native |   75.795465   357.02048         226
      birds |   105.60435    140.7594          69
------------+------------------------------------
      Total |   234.35185   936.80921         542

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups        21671274      4   5417818.5      6.42     0.0000
 Within groups       453116541    537   843792.441
------------------------------------------------------------------------
    Total            474787815    541   877611.488

Bartlett's equal-variances test: chi2(4) = 575.2239    Prob>chi2 = 0.000
```

```
. oneway income_livestock Type, tabulate

            |     Summary of (max) income_cattle
       Type |        Mean   Std. dev.       Freq.
------------+------------------------------------
     cattle |    941.5875   1064.1304          60
        pig |   589.63158   504.78647          19
      breed |   74.979167   74.982533          12
     native |   79.917453   161.86699          53
      birds |   107.88889   114.03619           9
------------+------------------------------------
      Total |   482.38317   801.45593         153

                        Analysis of variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      24709477.8      4   6177369.45     12.54     0.0000
 Within groups      72924927.7    148   492735.998
------------------------------------------------------------------------
    Total           97634405.5    152   642331.615

Bartlett's equal-variances test: chi2(4) = 188.9003    Prob>chi2 = 0.000
```

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