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The Economics of Coffee Production in Hawai'i

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Introduction

Coffee is an important part of Hawai'i's agriculture sector. The islands' tropical environment and rich volcanic soil provide an ideal location to grow coffee, and farmers have been dedicated for generations to producing some of the finest coffees in the world. The purpose of this paper is to provide an overview and a different perspective on the economics of coffee production in Hawai'i before the arrival of Coffee Berry Borer (CBB) during late 2010[1], using data from the 2007 USDA Agriculture Census. In particular, production, sales, cost, profitability, and labor usage for Hawai'i coffee farms will be discerned. This information will be used as a baseline for Hawai'i coffee before the arrival of CBB.

World Overview of the Coffee Industry

Coffee is a major commodity in the world market, and many countries and citizens depend on coffee production for income. The production of coffee cherry takes place between the Tropic of Capricorn and the Tropic of Cancer, where the humid and hot environment allows coffee trees to thrive. The three time periods when it is optimal to harvest are April, July, and October, and each country falls within one of these groups. During these periods, the coffee cherry is harvested, processed into the well-known coffee bean, and then readied for the market in 60 kg bags containing the green coffee bean. Worldwide coffee production has steadily increased by 17% from 2009 to 2013, with an annual growth of 4%, whereas the exportable product has increased by 12%, with an average growth per year of 3% (Table 1). Consumption has also increased during this period at 12%, with an average growth per year of 4%. The largest bean exporters for 2013 were Brazil, Vietnam, Columbia, Indonesia, and India, which made up 67% of total exports (Table 2). The largest bean importers were the European Union, United States, and Japan, making up 76% of total bean imports. The European Union and United States were the top consumers, making up 48% of total consumption worldwide.[2]

Hawai'i's Coffee Industry

Hawai'i's production of coffee makes up only 0.04% of total world production. Coffee production in Hawai'i has varied over the years, with an overall decline since 2003 of about 16% over the decade (Table 3). The negative change throughout the decade is mainly from decreases since 2010. Between 2003 and 2010, Hawai'i saw an increase in coffee production of 6% with an annual growth rate of about 3%, but since 2010, production has decreased by over 20%, with each year steadily decreasing by about 5%. Another metric calculated from production is yield per acre, and this shows a much larger decline, of 31%, between 2010 and 2013. Currently, when including all farms, green coffee yield in Hawai'i is at a 10-year low of 960 lbs per acre. While multiple years between 2003 and 2010 saw declines in production, the consistent decline after 2010 has not been seen within

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Table 1. World Coffee Overview (Green Bean)

Year	Total Production (1,000 Bags)	Bean Exports (1,000 Bags)
2008 / 2009	128,622	96,295
2009 / 2010	122,798	96,927
2010 / 2011	133,355	104,573
2011 / 2012	134,140	113,157
2012 / 2013	144,611	N/A

* Source: International Coffee Organization
** Bag = 60kg = 132 lbs

Table 2. 2012/2013 Coffee Exports (Green Bean)

Country	Thousands of Bags	Percent of Total
Brazil	33,508	29.6%
Vietnam	17,675	15.6%
Columbia	7,734	6.8%
Indonesia	6,159	5.4%
India	5,840	5.2%

* Source: International Coffee Organization
** Bag = 60kg = 132 lbs

the last 10 years. This decline could be due to a number of factors, but the cause is likely to be a combination of drought and CBB. It should be noted that CBB is limited to Hawai‘i (Big) Island, where a large portion of coffee is produced. Statistics are no longer available by island or county to differentiate these factors.

Coffee Sales, Profitability, Cost of Production, and Labor Usage

There are more than 800 individual coffee farms across Hawai‘i. Sales, costs, and labor utilization vary between each farm, but as a whole, average numbers and breakdown by size can offer some useful information on how these farms produce coffee. The following data were drawn from the USDA's Agriculture Census Data from 2007.

Table 3. Hawai‘i Coffee Production

Year	Parchment (1,000 lbs)	Green Coffee Yield lbs/acre
2003	8,300	1,410
2004	5,600	965
2005	8,200	1,340
2006	7,400	1,170
2007	7,500	1,170
2008	8,700	1,380
2009	8,700	1,380
2010	8,800	1,400
2011	7,600	1,210
2012	7,000	1,110
2013	7,000	960

Source: USDA NASS Survey (Coffee)

Summary of Acreage and Total Sales

The majority of coffee farms are generally small, with sales of less than $10,000, and thus are classified by the USDA as non-commercial farms (Hoppe et al. 2010). The average sales of these farms are $3,273 per year (Table 4) and comprise 60% of all farms; however, they only make up 6.7% of total coffee sales for all of Hawai‘i. The average size of these farms is 1.67 acres, and in aggregate they make up 13% of total acreage of all farms.

Small commercial farms, which maintain sales from $10,000 to $250,000, are the next largest group, and account for 38% of farms. Within this range, farm sales accounted for 44% of total sales for Hawai‘i, averaging $33,882 for the year. Their average size was 5.8 acres, with a 28% share of total land for coffee in Hawai‘i.

Only 9 farms are classified as large commercial farms, with sales of $250,000 to $1,000,000 for the year, and these make up 15% of acreage and 17% of total sales. The remaining 2 farms make over $1,000,000 a year, but figures are not provided due to disclosure rules.[3]

Summary of Profitability

In the following paragraphs, four key indicators are used to describe farm profitability. The first two, output–input

Table 4. Coffee Acreage and Sales

	Acreage			Sales		
Sales Range	Farms	Average		Total Sales	Average	Average/Acre[2]
More than $1 million [1]	2	n.d.		n.d.	n.d.	n.d.
$250,000–1,000,000	9	108.56		$4,381,000	$486,829	$4,484
$10,000–250,000	327	5.76		$11,079,000	$33,882	$5,884
<$10,000	516	1.67		$1,689,000	$3,273	$1,956

Source: USDA NASS Census Data (2007)
[1] More than 1 million not reported due to disclosure rules (denoted by n.d.)
[2] Calculated by sum of total sales / sum of total acres

ratio (OIR)[4] and return on assets (ROA),[5] help to provide an overall efficiency measurement for the farms. OIR describes the level of sales from a dollar of expenditure, whereas ROA describes how a farm is able to utilize assets to produce a return for each dollar invested. The last two indicators, gross profit per acre[6] and net profit per acre,[7] detail how a farm is performing when its profit (before income tax) does not account for fixed costs (gross profit) and when it does (net profit). Both indicators can provide insight into how a farm would operate in the short run and long run, and how fixed costs affect its profits.

Taking into account all coffee farms in Hawai'i, 65% have positive net profits and a positive ROA and OIR (See Tables 5 and 6). However, data relating to farm size provide a more detailed look at which size farms are operating more efficiently and are profitable. Generally, and as expected, non-commercial farms (those making less than $10,000) are inefficient on average, with an OIR of less than 1 and a negative ROA of -1%. Interestingly, these farms have an average gross profit per acre of $129.88, meaning that they are able to cover their variable cash costs of production. However, when fixed costs are accounted for in profit, their net profit per acre is -$699.07. Surprisingly, 45% of non-commercial farms in Hawai'i have positive net profits even though on the average they have an inefficient OIR and negative ROA. If the other 55% of non-commercial farms with negative net profits were operating as businesses and continue to operate at a loss, problems will arise, as they are not able to cover fixed costs and may be forced out of business. The continuing existence of the unprofitable farms could be explained by the fact that many of these coffee farmers consider farming as a life-style rather than a venture for profit, and/or due to tax considerations (Bittenbender 1993, Blank 2002).

Small commercial farms ($10,000–$250,000) have the highest OIR of all the groups at 1.52 and have a ROA of 1%. These small-size commercial farms are the most efficient but are just barely receiving a return on their assets. These farms can comfortably cover all variable costs, as their gross profit per acre is $1,741 (compared to revenues of $5,884 per acre), which is significantly more than that of non-commercial farms ($130 gross profit per acre / $1,956 revenue per acre) and about half that of the large farms ($3,426 gross profit per acre / $4,484 revenue per acre). Furthermore, after fixed costs are covered, they are earning a positive profit of $960 per acre. As compared to non-commercial farms, small commercial farms on average are able to operate in the long run as they are making a profit after covering all expenses. When all small-size farms are included, 72% are profitable after covering variable and fixed expenses. Even though they have a relatively low ROA, the efficiency of small commercial farms is what allows them to return such a high profit, considering they are able to utilize their inputs to increase outputs, as can be seen by their OIR. (See Tables 4 and 5).

And lastly, large commercial farms ($250,000–$1,000,000) also have a positive OIR and ROA, of 1.25% and 7% respectively. These farms are efficient with their inputs and able to provide the highest return on assets

invested of all the farms in the data. Large commercial farms on average also have the highest gross profits ($3,426 per acre) and net profits ($2,531 per acre); i.e., with a positive net profit, they are able to cover all variable and fixed costs with a profit returned in the end. The significance of this discussion is that it appears there are increasing returns-to-scale within the coffee industry of Hawai'i, meaning that a higher level of production provides a more-than-proportionately higher level of profits for a farm. These farms are efficient, have a higher level of return on assets, and, given a higher production capability, are able to receive more profits in the long run. This can be seen from the data in Table 6, which shows that 78% of these farms are profitable.

An interesting point to note about Hawai'i coffee farms when compared to all Hawai'i farms is that coffee farms have a much higher level of economic performance across the board (Tables 5 and 7). In 2007, Hawai'i coffee farms had higher output-input ratios and higher return on assets than farms in general. Hawai'i coffee farms also show much higher performance in terms of net profit per acre and gross profit per acre.

When comparing all farms vs. coffee farms in Hawai'i, all non-commercial Hawai'i farms maintain a negative (-$190/acre) gross profit, whereas non-commercial Hawai'i coffee farms have a positive ($130/acre) gross profit. However, net profit per acre is significantly lower for Hawai'i coffee farms (-$699/acre) than for farms in general (-$332/acre). This is the only major negative difference when comparing economic performance. Small commercial coffee farms' net profit per acre is $961, whereas across all Hawai'i farms it averages only $3 per acre. For large commercial coffee farms, net profit per acre is particularly high at $2,531, whereas large commercial farms in Hawai'i in general net only $20 per acre. The performance of Hawai'i coffee farms when compared to all Hawai'i farms is exceptionally high. It should be noted that these numbers do not provide a side-by-side comparison but are only used as a reference to show the significance of Hawai'i coffee farms' economic performance.

Table 5. Summary of HI Coffee Farms' Profitability by Size

Sales Range		Farms	Average
Output–Input Ratio			
	More than $1 million	2	n.d.
	$250,000–1,000,000	9	1.25
	$10,000–250,000	327	1.52
	<$10,000	449	0.84
	Total	785	1.20
Return on Asset			
	More than $1 million	2	n.d.
	$250,000–1,000,000	9	7%
	$10,000–250,000	327	1%
	<$10,000	449	-1%
	Total	785	2%
Gross Profit per Acre			
	More than $1 million	2	n.d.
	$250,000–1,000,000	9	$3,426
	$10,000–250,000	327	$1,741
	<$10,000	449	$130
	Total	785	$1,765
Net Profit per Acre			
	More than $1 million	2	n.d.
	$250,000–1,000,000	9	$2,531
	$10,000–250,000	327	$961
	<$10,000	449	-$699
	Total	785	$931

Source: USDA NASS Census Data (2007)

Table 6. Profitable Hawai'i Coffee Farms

Sales Range	Farms	% profitable farms[1]
More than $1 million	2	n.d.
$250,000–1,000,000	9	77.8%
$10,000–250,000	327	71.9%
<$10,000	449	44.5%
Total	785	64.7%

Source: USDA NASS Census Data (2007)
[1] Calculated by number of farms with positive Net Profit Per Acre / Total number of farms for each sales range

Summary of Cost Breakdown

Labor is the highest cost for coffee farming, making up 39% of total cost for the farms. This should come as no surprise, given the amount of work that goes into farming and harvesting the cherries, especially in Hawai'i, where worker wages are high. The next highest cost component is fertilizer and chemicals, which makes up 14% of total cost. Next are all other components (including storage and warehousing, marketing expenses, insurance, etc.), followed by maintenance and custom work (see Table 8).

Table 7. Summary of Profitability for All Hawai'i Farms by Size

	Sales range	Average
Output–Input Ratio		
	More than $1 million	1.03
	$250,000–1,000,000	1.21
	$10,000–250,000	1.01
	<$10,000	0.23
	All	0.96
Return on Asset		
	More than $1 million	0.8%
	$250,000–1,000,000	1.9%
	$10,000–250,000	0.2%
	<$10,000	-1.1%
	All	-0.1%
Gross Profit per Acre		
	More than $1 million	$131
	$250,000–1,000,000	$92
	$10,000–250,000	$74
	<$10,000	-$190
	All	$67
Net Profit per Acre		
	More than $1 million	$20
	$250,000–1,000,000	$52
	$10,000–250,000	$3
	<$10,000	-$332
	All	-$17

Source: Comparison of Cost Structure and Economic Performance of Hawai'i and U.S. Mainland Farms

When broken down by farm size, labor is the highest cost in both small and large-size commercial farms, at 35% and 44% respectively. Labor cost accounts for only 14% of total costs of non-commercial farms, which have the largest percentage of taxes, depreciation, and interest when compared to other farms. Interestingly, all farms across the board make up about the same cost percentage for fertilizer and chemicals and for machinery and land rent, and they are also close on utility and fuel.

The disparity between labor cost of non-commercial and small to large commercial farms may be explained by the fact that many non-commercial farms do not need to hire as much labor as larger farms. Non-commercial farmers are able to hand-pick their entire farm, given the average size is about 1.5 acres. Based on the average revenue per acre, many also apparently do not fully harvest their acreage and so will utilize proportionately less labor. Small and large commercial farms average close to 7 acres of land and require more labor to harvest production, so labor costs will increase.

The reason for non-commercial farms having relatively higher interest and taxes can be explained by real estate assets associated with the farm. Considering their acreage compared to larger operations, non-commercial coffee farms have proportionately more assets in real estate, such as homes and farm buildings, than in farm-

Table 8. Percentage Cost Breakdown of Coffee Farming

Cost Item	%
Machinery and land rent	2.2%
Utility and fuel	7.9%
Labor	38.8%
Operator labor	3.4%
Fertilizer and chemicals	13.7%
Maintenance and custom work	8.0%
Interest	5.7%
Taxes	3.8%
Depreciation	6.7%
All other	9.8%

Source: USDA NASS Census Data (2007)

Table 9. Percentage Cost Breakdown of Coffee Farming by Farm Size

Cost Item	Sales Range		
	$250,000–1,000,000	$10,000–250,000	<$10,000
Machinery and land rent	3.0%	2.1%	2.8%
Utility and fuel	7.5%	10.1%	8.9%
Labor[1]	44.4%	35.8%	14.4%
Operator labor[1]	5.3%	1.4%	4.5%
Fertilizer and chemicals	9.9%	13.0%	11.6%
Maintenance and custom work	6.3%	5.1%	12.6%
Interest	5.7%	0.7%	17.3%
Taxes	2.5%	3.8%	13.1%
Depreciation	8.0%	6.3%	9.2%
All other	7.4%	21.8%	5.7%

Source: USDA NASS Census Data (2007)
[1] See endnote 8 for data description of labor

Table 10. Summary of Labor by Size

	# of Farms	Average
Workers, including operators		
More than $1 million	2	n.d.
$250,000–1,000,000	9	9.5
$10,000–250,000	327	2.4
<$10,000	516	1.2
Hired and contract labor		
More than $1 million	n.d.	n.d.
$250,000–1,000,000	7	11.4
$10,000–250,000	297	1.7
<$10,000	454	0.4

Source: USDA NASS Census Data (2007)
* Note: The number of farms are different when determining averages, so a comparison is not appropriate and is only provided as a general reference to the reported numbers

Fig. 1

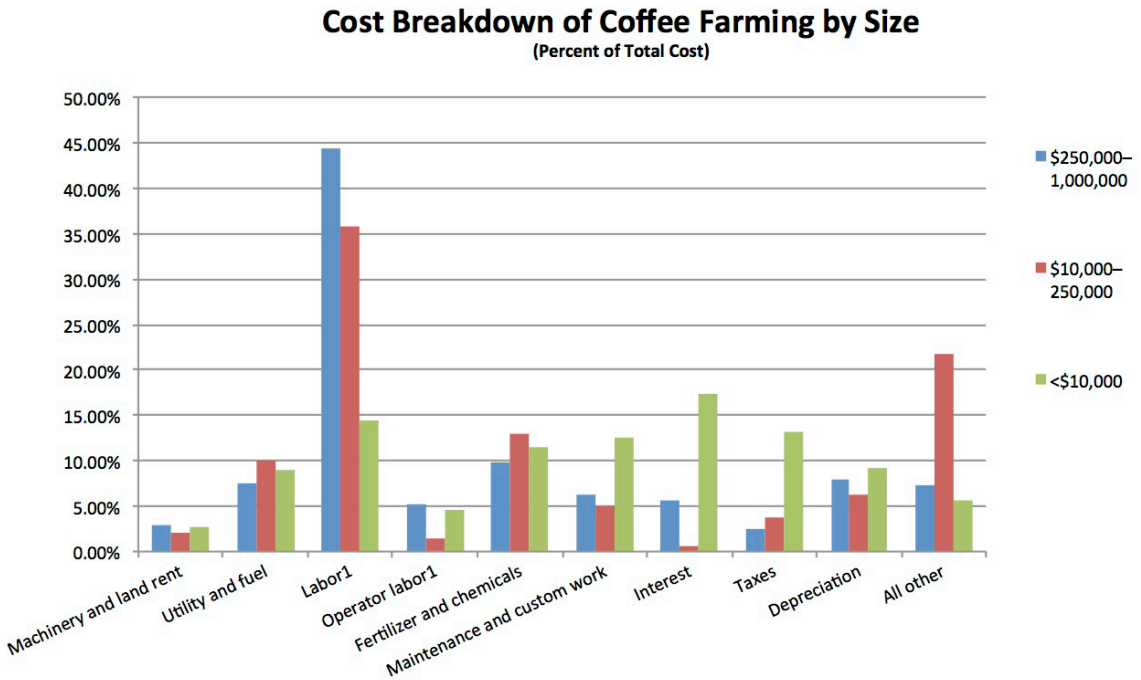

Table 11. Summary of Labor by Size

Workers, including operators					
	# of Farms	Average	Total Labor	Total Acres	Labor/Acre
More than $1 million	2	n.d.	n.d	n.d	n.d
$250,000–1,000,000	9	9.5	86	977	0.09
$10,000–250,000	327	2.4	797	1,883	0.42
<$10,000	516	1.2	635	864	0.73

Source: USDA NASS Census Data (2007)

land. The interest cost on such assets will therefore be higher relative to the operating costs of the smaller farm. The non-commercial farms also pay relatively higher property taxes.

Summary of Labor

A more detailed look at labor by farm size further shows the difference in labor cost for farms. Farms that are considered non-commercial do not hire workers on average, so their hired and contract labor is below one (Table 10). However, when including operator labor, total labor is greater than one. The number of workers further verifies the minimal labor cost for non-commercial farms. Non-commercial farms are typically managed by a single operator, or together as a family. Farms in the small commercial group use between two and three workers, including operators. The largest farms hire more than nine workers on average as part of their labor costs. These numbers are also consistent with labor cost discussed previously. Overall, larger farms use less labor per acre (Table 11).

An interesting observation about small commercial farms is the relative lack of an increase in labor workers over non-commercial farms. This may be explained since there is not as large of a jump in average acres from non-commercial (1.67 acres) to small commercial farms (5.76 acres). Given the large size range for small commercial farms, the minimal labor size difference could also be explained by the majority of small commercial farms falling towards the lower bound in sales (~$10,000), thus aligning more closely with non-commercial farms. However, a significant jump in average acres for large farms to 108 explains the jump in workers, including operators. A larger labor force is required for the larger acreage, although fewer workers are needed per acre because of mechanization (Table 11).

Outlook of Industry and CBB

Considering that CBB is relatively new to Hawai'i, having just arrived within the past few years, it is hard to give a definite outlook on its effects throughout the industry. Many other factors go into projections throughout the year, and it is hard to find relative trend lines to provide a comparison. However, given the 2007 USDA Census data, a baseline for pre-CBB analysis can be set and compared with future data points. Furthermore, the cost structure breakdown from the census data can also help to provide projections for the industry. Given the data discussed and our understanding of the issues regarding CBB, a broad outlook on the coffee industry is provided below as an exercise in using this information as a baseline.

We consider the cost structure across the industry and the actual size of the farm for potential effects on coffee farms. First, the majority of farms that are between 1.5 to 6 acres of land may be able to monitor and manage CBB more efficiently than the larger farms, which have larger acreages. This could have potential benefits in catching early CBB infestations before they become too large to handle. Due to the relatively small size of the farms, coffee farmers should have a better understanding of what is happening on their farm and be able to respond quickly to any issues that may come up.

However, non-commercial farms are shown to be inefficient, with an OIR of less than one and a negative net profit per acre. While these farms hold the lowest percentage cost of labor, these costs may increase due to the inability of current staff to maintain production with CBB infestation levels. Furthermore, an increase in labor costs will arise from the need for more pesticide spraying, monitoring of CBB infestation levels, increased sanitation measures, and maintenance of farm equipment, as a few examples. Other increases in farm cost as a result of CBB infestation will show up in utility and fuel, fertilizer and chemicals, and maintenance and custom, which would further reduce any profits realized by the farms. Any increase in variable cost would reduce gross profit for the farm and further bring down net profit. This will likely have a drastic effect on the non-commercial farms' ability to operate, and we expect fewer farms and lower total acreage as a result.

These same problems will arise for small to large commercial farms, as any increase in infestation levels will ultimately lead to an increase in the need for additional labor and in the costs related to controlling CBB. Furthermore, larger farms may be more susceptible to CBB infestation, as they have more acres and thus a higher probability for infestation. This will indeed increase the costs for the farms to operate from the start of the season, as greater awareness of CBB will be required to control infestation levels.

However, where small to large farms differ from non-commercial farms is in how they are able to handle infestation levels more efficiently. One example is the method for monitoring CBB, which involves a sampling technique originally developed for large farms. This method allows large farms to apply the same number of sample points as non-commercial farms and produce the same results. Larger and more efficient sprayers can be used over larger acreage. Another strategy that can be utilized is stump (Beaumont-Fukunaga-style) pruning by block, which can provide cost savings since pruning is a necessary cultural practice even without CBB. Stump pruning by block is generally more efficient in terms of labor and management, and while its CBB impact will be less on non-commercial farms, it could still reduce CBB in the first crop following pruning. Therefore, larger farms are able to make more efficient use of labor and utilize these different methods to control the increase in costs associated with CBB infestation. An unknown factor is that CBB management strategies specifically for mechanized farms in Hawai‘i have not been fully adapted/developed.

The likely increase in costs for farms controlling for CBB infestation will have an impact on profits regardless of size. Adjustments in costs will vary between farms, as each size will need to control differently, as discussed previously. In general, CBB management will increase costs, while quantity and quality of the crop will be reduced. The effect on price is still not clear, as the market will need to adjust accordingly. Farms that are already operating on the edge will likely be hardest hit and could possibly be driven out of business. Further analysis incorporating post-CBB data will help to verify these assertions and provide the magnitude to which CBB infestations are affecting farms.

Conclusion

Typical coffee farms on Hawai‘i are family-run operations that have less than 2 acres of land. These non-commercial farms (less than $10,000 in revenues per year) make up the majority of farms in Hawai‘i but only provide 6.7% of total coffee sales. On average, non-commercial farms have a low output–input ratio and a negative return on assets and are not able to cover fixed costs, thus resulting in negative net profits. However, when considering all coffee farms, the majority are profitable and efficient. Taxes and interest make up the largest percentage of costs for non-commercial farms, whereas labor is the largest portion for all other farms. The majority of farms hire very few workers, but the larger farms hire significantly more workers (9+) and operate on larger acreages.

The projections for the effects of CBB infestation are clearly just possibilities that may arise on farms in Hawai‘i. The actual outcomes on farms cannot be known from the 2007 census data, since these numbers are from before the CBB infestation. Data from after the infestation will need to be obtained and analyzed to accurately assess the effects of CBB.

Endnotes

1. Hawai‘i Department of Agriculture News Release (2010): Serious Coffee Pest Detected in Kona
2. Overview of coffee statistics worldwide was pulled from International Coffee Organization (ICO). U.S. statistical reference is only found through the USDA's Foreign Agriculture Service (FAS), which includes all goods imported and then exported, so the ICO statistics provided better data for production of individual countries.
3. According to USDA disclosure rules, information on any category of farms where there are less than 3 observations is prohibited.
4. Output–input ratio (OIR): total sales / (variable cash expenditures + fixed cash expenditures + depreciation)
5. Return on assets (ROA): 100 x (net profit + total interest paid) / (value of land and buildings + value of machinery and equipment)
6. Net profit/acre: (total sales – variable cash expenditures – fixed cash expenditures – depreciation) / farm acreage
7. Gross profit/acre: (total sales – variable cash expenditures) / farm acreage
8. Labor/Operator Data Description: Labor includes paid family members, and workers hired and contracted. Operator labor includes all operators on the farm. Total operators and workers were adjusted for part-time (< 150 days annually) and full-time (>150 days annually) workers and then multiplied by a constant wage rate to give total cost for labor and operator labor.

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