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A Case Study of Lettuce, Kale, Tomato and Onion Gross Margins and Costs of Production Among the Horticultural Producers Supplying Maputo

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Using data from the 2014 horticultural multiple visits study conducted as part of the trilateral partnership between Mozambique, Brazil, and the United States, this *flash* characterizes the costs, sales and gross margins of lettuce and kale in the green zones of Maputo, and of onion and tomato in the nearby districts of Moamba and Boane supplying Maputo's horticulture market. A typology of ranked technological sophistication of the farmers included in this study is used to disaggregate and compare the results. Findings indicate that within each technological sophistication bracket, higher costs spent are correlated with less gross income earned. The greatest cost of those earning the largest gross margins per kilogram harvested across crops is for seed and/or seedling, and these farmers also evidence an increased share of costs spent on labor, particularly salaried labor. Producers in the *zonas verdes* tend to sell a greater share of the harvest they produce in comparison with producers in Moamba and Boane. And finally, costs spent on pesticide are generally low across all groups, however the producers that spend the most on pesticide per kilogram of product harvested tend to be characterized by less appropriate perceptions of pesticide toxicity and generally poorer pesticide management behavior.

INTRODUCTION: Cost of production estimates are useful for measuring producer spending, however they also serve as valuable indicators of opportunities for improving the management of productive establishments, risk prevention initiatives, public policies and government programs. In any economic sector of a given geographic area, the characterization and calculation of production costs are essential for targeting private and public performance strategies (Cribb, *forthcoming*). In this flash, I characterize the costs, sales and gross margins of lettuce and kale in the green zones of Maputo, and of onion and tomato in the nearby districts of Moamba and Boane supplying Maputo's horticulture market, using data from the 2014 horticultural multiple visits study conducted as part of the trilateral partnership between Mozambique, Brazil, and the United States. A typology of the farmers is then used to disaggregate and compare the results.

PRODUCTION AREAS AND SAMPLE: The horticultural production areas of the districts of Matola, Ka Mubucuane, and Ka Mavota are normally referred to as the *zonas verdes* of Maputo. Production in this area often takes place within or near the administrative boundaries of the municipality and is dominated by very small farmers (typical land holding of 0.1 ha), producing primarily green leafy vegetables under individual irrigation. The districts of Moamba and Boane, in contrast, are primarily characterized by centralized irrigation areas (*blocos*) in which farmers with larger land areas produce tomato, onion, cabbage, and other horticultural crops. A less numerous group of farmers in Moamba and Boane operates with individual irrigation along the rivers, outside the *blocos*. We refer to this latter group as the dispersed producers of those districts. Land holdings among both these types of farmers average 2.3 ha. (Cairns et al., 2013)

Because of the distinctly different production systems in each zone, the sample was stratified to represent all producers with less than five hectares of land cultivated with horticultural crops in each zone. The dispersed producers of Moamba and Boane most commonly appear among the least technologically sophisticated farmers in those districts. Lettuce and kale (commonly known as *couve*) were selected as the crops of study within the *zonas verdes* of Maputo (ZV), and tomato and onion as the crops of study within the districts of Moamba and Boane (M/B), on the basis of the highest frequency of crops produced in these respective areas. These crop cycles are spread across 4 "clusters" of farmers ranked according to a range of indicators of technological sophistication per the typology of farmers created using the data from the baseline study conducted by this same project in 2013 (see table 1).

Table 1: Crops and ranked clusters considered in this study (1 representing the group of least technologically advanced producers)

	Crop				
Typology Cluster	Kale	Lett-uce	Onion	Tom-ato	Total
1	0	0	2	4	6
2	1	4	0	0	5
3	4	5	0	0	9
4	0	0	4	3	7
Total	5	9	6	7	27

As the majority of farmers in Moamba and Boane fell in the highest and lowest groupings across this spectrum, only producers from these areas were selected from clusters 1 and 4 for the study. Similarly, as the majority of the farmers in the *zonas verdes* fell in the two middle groups, only producers from the *zonas verdes* were selected from clusters 2 and 3. See flash 70E for more detail on how this typology was formed, and features that characterize the farmers in each group. There are 5 kale cycles, 9 lettuce cycles, 6 onion cycles and 7 tomato cycles across the cluster groupings included in this study. Each crop cycle captures all activities beginning with land preparation and planting, and ending with harvest of the area planted.

GROSS MARGIN ESTIMATES BY CROP:
Of the 4 selected crops of this study, tomato production varied the most in terms of gross margins, and so this group of crop cycles was divided into two separate groups – tomato cycles by producers in cluster 1, the least technologically sophisticated group, and those on the other end of the spectrum, in cluster 4. Gross margins per kilogram of product harvested are greatest for tomato by cluster 4 farmers (median 5/9 mzn/kg), followed by onion (by cluster 1 or 4 farmers, median ~5/6 mzn/kg), kale (3/4), lettuce (1.5/2) then tomato by cluster 1 farmers (-1.5/.5), see table 2.

Gross margin estimates vary greatly among the tomato cycles represented given many of these producers have difficulties selling in the markets at high enough prices to justify their costs and/or are not able to overcome the pressures of pests and diseases affecting these more susceptible crops. Evidently however, producers of tomato in these areas that are able to achieve a successful harvest have some of the greatest per kilogram gross margin estimates of the cycles considered in this study.

Gross margins per square meter of product harvested are greatest for kale (median 14/16 mzn/m2), followed by lettuce (6/7 mzn/m2), tomato by cluster 4 farmers (3/5 mzn/m2), onion (~1 mzn/m2) then tomato by cluster 1 farmers (-.5/.2 mzn/m2). This is because the kale and lettuce producers of the *zonas verdes* tend to cultivate small areas of land, but very intensively.

Table 2. Gross margin estimates by crop

		Obs.	Gross Margin (MZN/kg)				Gross Margin (MZN/kg), including labor			
			Mean	Med	Min	Max	Mean	Med	Min	Max
Zonas Verdes	Kale	5	4.3	4.2	2.2	5.7	3.8	3.9	1.4	5.7
	Lettuce	9	2.8	1.9	-0.5	8.9	1.5	1.4	-5.8	8.9
Moamba/ Boane	Onion	6	7.2	6.3	3.0	14.1	5.1	5.4	-5.9	14.1
	Tomato-Clust 1	4	-2.2	1.0	-15.2	4.4	-3.4	-1.4	-15.2	4.4
	Tomato-Clust 4	3	6.6	8.8	-0.7	11.7	4.1	5.4	-1.8	8.8
		Obs.	Gross Margin (MZN/m2)				Gross Margin (MZN/m2), including labor			
			Mean	Med	Min	Max	Mean	Med	Min	Max
Zonas Verdes	Kale	5	16.5	16.4	10.1	23.4	14.6	14.0	6.6	23.4
	Lettuce	9	11.2	7.5	-2.2	38.4	6.3	6.4	-23.7	38.4
Moamba/ Boane	Onion	5	1.5	0.9	0.5	4.0	1.1	0.7	-0.7	4.0
	Tomato-Clust 1	4	0.0	0.2	-1.4	1.0	4.0	-0.6	-0.6	-1.4
	Tomato-Clust 4	3	3.9	5.6	-0.1	6.3	2.6	3.4	-0.3	4.7

*Labor includes an estimate of the portion of salaried permanent help as well as temporary or contracted labor for crop-related activities. It does not include a valuation of family labor.

To contextualize these overall estimates, the median total costs and sale values per kg and per m2 for each crop category are shown in table 3 at the end of this report. Per kg costs are greatest among the cluster 1 (least developed) tomato cycles (8.5 mzn/kg harvested), followed by onion (7.3), cluster 4 tomato (6.4), lettuce (2.9) then kale (0.9). Costs per square meter however tell a different story, with onion cycles having the least total cost per square meter (1.9 mzn), followed by cluster 4 tomato (2.1), cluster 1 tomato (2.5), kale (18.4), then lettuce (21.3). Similarly, total per kg sale values (before costs are taken into account) are greatest for onion cycles, followed by cluster 4 tomato, cluster 1 tomato cycles, kale then lettuce. Total per m2 sale values are greatest for lettuce, followed by kale, cluster 4 tomato, onion then cluster 1 tomato. It is interesting to note, however, that when costs and sales are isolated by clusters (grouping both crops within each cluster), higher costs spent are correlated with less gross income earned (table 5).

COST ESTIMATES BY CROP AND CLUSTER: Producer's reported costs are divided into the following categories and standardized by quantity of product harvested: seed, seedling, fertilizer, pesticide, salaried work, temporary/contracted work, and other. (See tables 3 and 5).

Among these, costs are greatest for fertilizer in the case of kale and lettuce producers in terms of value spent (.3 and .4 mzn per kg respectively, or 1.3 and 1.4 mzn per m2), and correspondingly, the greatest share of the expenses among kale cycles is for fertilizer (42%), followed by permanent labor (27%). The greatest share of the expenses among lettuce crop cycles however is for seedling (25%), followed by seed (20%, compared to fertilizer at 17%). Cluster 2 producers of lettuce and kale spend close to 3 times more in total value on fertilizer than cluster 3 producers -- a median 3.3 mzn per m2 of product harvested (0.7 mzn per kg harvested) compared to a median of 1.3 mzn per m2 (0.3 mzn per kg). And whereas cluster 3 producers spend the greatest share of their expenses on combined costs of seed and seedling (46%), cluster 2 producers, those characterized by very average levels of appropriate perceptions and pesticide-use precautions (especially compared to their cluster 3 counterparts), spend the greatest share of their expenses on pesticide (32%), spending 4-8x greater per unit value on these as well, followed by a 31% cost share spent on fertilizer (see tables 5 and 6).

Although pesticide costs are smallest across the cost categories and crop cycles considered in this study (never more than .4 mzn/kg harvested), the cycles of lettuce evidence the greatest share of pesticide applied across all cost categories – 18% compared to 9% for kale, 5% by tomato cluster 4 producers, and 0% for onion or tomato cluster 1 cycles (table 4).

Costs are greatest for seedling in the case of tomato and onion producers in terms of value spent, followed by seed. Seedling costs are 3.5, 1.2 and 2.2 mzn per kg harvested for tomato cluster 1, 4 and onion cycles respectively. The greatest share of expenses among both onion and tomato cluster 1 producers, correspondingly, is for seed and seedling (combined at 52% and 59% respectively - table 4), with this share rising to 66% for seed and seedling for cluster 1 producers overall (table 6). Tomato and onion sellers in cluster one (the least technologically advanced farmers) spend 5 times greater median values for seedling than those in cluster 4 - a median value of 4.1 mzn compared to 0.6 mzn per kg of product harvested.

The largest costs in the "other" costs category are also found among the tomato and onion cycles. These costs include transport, fees to use water pump, renting a tractor or the per-season applied cost of a new sprayer, watering can or any other equipment purchased for use on the farm. For cluster 4 tomatoes, this per kg cost is slightly greater than the cost for seedling (1.3 mzn/kg harvested), driven primarily by the costs of transporting large quantities of product to the market, and occupies a 17% share of the cluster's overall cost portfolio.

Salaried or contracted/temporary labor costs are among the lesser of the costs attributed to these crop cycles generally, in value spent and in terms of shares although these costs do not include the obvious omission of any valuation for family labor on the farm (when 86% of the time at least 2 family members are reported to be involved in horticultural farming as their primary activity and many more reported having secondary help from additional family members as well according to the data from the baseline study). No crop category exceeded a combined 27% cost share for labor costs except for cluster 4 tomato cycles, where a combined share of 49% of the expenses incurred are spent on temporary (19%) or permanent (30%) labor, the greatest combined share of expenses for this group (table 4). Among the cluster 4 cycles overall (including the cluster 4 onion cycles), the same shares of cost are spent on temp/perm labor as on seed/seedling, both at a 34% share, in contrast to cluster 1 producers which spend a clear majority of their expenses on seed and seedling alone (66%), and only 15% on labor, primarily for temporary work (table 6)

SHARES OF HARVEST SOLD: Compared to the other areas in our study supplying Maputo's horticultural market in the peri-urban zonas verdes, producers in these two nearby districts typically have larger plots of cultivated land. Even the producers living in these areas which are grouped in cluster one, the least technologically advanced farmers, have average areas of land dedicated to the selected crop of interest of 170 square meters, in comparison with the farmers in the *zonas verdes* considered more technologically advanced, who have average areas of cultivated land of 14 square meters in cluster 2 and 15 square meters in cluster 3. For comparison, farmers in cluster 4 included had an average 280 square meters of land dedicated to the crop of interest, 15-20 times the size of the plots in clusters 1, 2 and 3.

Given the generally larger land sizes in Moamba and Boane, it is perhaps not surprising to have found that the greatest costs these producers have in their tomato and onion production tends to be seed (or seedling). Tomato and onion seed in these areas are purchased primarily from stores or other formal channels (such as a state-owned *casa agrária*) in the agricultural areas in which they farm, although also occasionally from stores in South Africa, and no clear difference in per gram seed prices was found in this study among different channels from which seed was purchased (formal or informal, in or outside the city).

Whereas producers of lettuce and kale in the *zonas verdes* tend to sell a greater share of the harvest they produce (less goes to waste or personal consumption, gift-giving, etc) compared to producers of onion and tomato in Moamba and Boane (see table 7), regression analysis does show that holding constant which crop was produced, the more land a producer has in cultivation and the more that he spends on seed, the greater the share of her harvest she manages to sell. Those spending the most on seed however (the tomato and onion farmers in M/B) are by in large earning the least in net profit from their sales. Given that producers in M/B with larger land plots are further from the city and have much greater transport expenses than those in the *zonas verdes*, we can speculate that this is likely because these farmers simply don't have the same benefits as producers located within or very close to the city limits in terms of market access, and have to deal with the many associated transaction costs involved in getting their product to market or to the consumers that might be most willing to pay higher prices for them.

Table 7. Share of harvest sold by crop

	Kale	Lettuce	Onion	Tomato
Share sold is greater than 2/3rds	100%	89%	50%	71%

Finally, regression analysis indicates that the purchase of any other input besides seed has a negative (although insignificant) relationship to share of harvest sold. Note that this could potentially indicate that applying less pesticide is weakly correlated with greater shares of harvest sold, and likewise, that those applying greater amounts of pesticides are not selling as much of their harvest, which might be a sign of pest resistance due to excessive pesticide used. According to Snyder et al., 90% of farmers in the *zonas verdes* of Maputo are using highly toxic chemicals on their horticultural crops (76% in M/B), and are cropping intensively with little crop diversity. Also, those in the lower clusters of technological sophistication (and pesticide management practices) are using twice the rate of the active ingredient than those in the upper clusters. These factors all contribute to greater evolving pest resistance and the felt need to apply increasing levels of more toxic pesticide (Snyder et. al 2015).

DISCUSSION: Implications of this study confirm that horticultural producers closest to the city are those standing most to gain in terms of gross margins given their proximity and facilitated access to centers of consumption, while producers in M/B benefit from their large areas of cultivated land in terms of the scale of their operations and the diversification of the crops they grow. For neither group of farmers is the increase of input purchases recommended (except in the case that additional land could be obtained in the *zonas verdes*), rather benefits that have not been explored in the current analysis could exist for minimizing the amount of inputs applied. Minimizing pesticide use among producers of lettuce and kale in the *zonas verdes*' cluster 2 seems to be called for in particular, where farmers are spending the greatest portion of their collective per kg harvest costs on pest prevention, 6 times the share and 4-8 times the amounts spent by their more technologically advanced cluster 3 neighbors, while at the same time are generally characterized in comparison as possessing lower levels of literacy to read product labels (less than 50%), wearing less protective clothing (if it all) while spraying (less than 50% using protective clothing other than boots), and adhering more loosely to other recommended pesticide behavioral protocol (Cairns et al., 2013).

Finally, this study corroborates the evidence emphasizing the importance of an improved post-harvest value chain, especially for the farmers in nearby districts to Maputo who could supply more of the demand of the city, given transaction costs could be minimized. Improved road infrastructure, cold-chains, information exchange, and perhaps the reduction of intermediaries along the value chain could be recommendations in this regard.

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Table 3. Median standardized costs and sale values by crop group

Costs and Sales (MZN/Kg harvested) (medians)										
Crop	Obs.	Seed	Seedling	Fertilizer	Pesticide	Other	Salar-ied Work	Temp/ Contracted Labor	Total Costs	Total Sale Value
Kale	5	0.0	0.1	0.3	0.1	0.0	0.0	0.0	0.9	5.6
Lettuce	9	0.0	0.3	0.4	0.1	0.0	0.0	0.0	2.9	5.3
Onion	5	1.5	2.2	0.7	0.0	0.3	0.0	0.3	7.3	13.4
Tomato-1	4	2.8	3.5	2.3	0.0	0.0	0.0	0.0	8.5	9.5
Tomato-4	3	0.0	1.2	0.2	0.4	1.3	0.8	0.4	6.4	11.8
Costs and Sales (MZN/m2 harvested) (medians)										
Crop	Obs.	Seed	Seedling	Fertilizer	Pesticide	Other	Salar-ied Work	Temp/ Contracted Labor	Total Costs	Total Sale Value
Kale	5	0.0	0.6	1.3	0.4	0.0	0.0	0.0	18.4	20.1
Lettuce	9	0.1	1.0	1.4	0.5	0.0	0.0	0.0	21.3	22.6
Onion	5	0.3	0.1	0.1	0.0	0.1	0.0	0.2	1.9	2.2
Tomato-1	4	0.6	0.4	0.4	0.0	0.0	0.0	0.0	2.5	1.3
Tomato-4	3	0.0	0.5	0.1	0.1	0.3	0.5	0.2	2.1	6.8

Table 4. Cost Shares by Crop Grouping

Cost	Kale	Lettuce	Onion	Tomato-cluster 1	Tomato-cluster 4
Seed & Seedling	21%	45%	52%	59%	28%
Seed	2%	20%	24%	30%	2%
Seedling	18%	25%	28%	29%	27%
Fertilizer	42%	17%	20%	19%	3%
Pesticide	9%	18%	0%	0%	5%
Other, including transport	1%	0%	12%	0%	15%
Labor	27%	20%	15%	22%	49%
Temporary	0%	2%	15%	18%	19%
Permanent	27%	17%	0%	4%	30%

Table 5. Median standardized costs and sale values by cluster

Costs and Sales (MZN/Kg harvested) (medians)									
Typology Cluster ID	Seed	Seedling	Fertilizer	Pesticide	Other	Salaried Work	Temp/ Con-tracted Labor	Total Costs	Total Sale Value
1	1.6	4.1	2.0	0.0	0.0	0.0	0.0	7.4	1.3
2	0.0	0.8	0.7	0.4	0.0	0.0	0.0	2.6	18.4
3	0.0	0.1	0.3	0.0	0.0	0.0	0.0	1.6	21.3
4	0.2	0.7	0.2	0.1	1.3	0.0	0.6	6.5	2.2
Costs and Sales (MZN/m2 harvested) (medians)									
Typology Cluster ID	Seed	Seedling	Fertilizer	Pesticide	Other	Salaried Work	Temp/ Con-tracted Labor	Total Costs	Total Sale Value
1	1.1	0.6	0.3	0.0	0.0	0.0	0.0	2.5	12.7
2	0.0	3.1	3.3	1.6	0.0	0.0	0.0	10.6	5.2
3	0.2	0.6	1.3	0.2	0.0	0.0	0.0	6.3	5.6
4	0.0	0.4	0.1	0.0	0.3	0.0	0.2	1.9	11.8

Table 6. Cost shares by cluster

Cost	1	2	3	4
Seed & Seedling	66%	19%	46%	34%
Seed	26%	0%	21%	16%
Seedling	40%	19%	25%	18%
Fertilizer	19%	31%	23%	13%
Pesticide	0%	32%	5%	2%
Other, including transport	0%	0%	1%	17%
Labor	15%	18%	25%	34%
Temporary	12%	4%	0%	21%
Permanent	3%	14%	25%	13%