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Typology of Horticultural Producers Supplying Maputo

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Using data from the 2013 horticultural baseline study conducted as part of the trilateral partnership between Mozambique, Brazil, and the United States, this *flash* characterizes the smallholder horticultural producers supplying the city of Maputo. Cluster analysis is used to partition households into four groups based on 32 dimensions of technology endowment, capacity, and behavior. Results of this study indicate that there is a great diversity of horticultural producers in Maputo, ranging from those generally characterized by low land endowment, access to extension or training advice, and diversity of horticultural sales (cluster one) to those with high levels of the same indicators (cluster four). Level of technological capacity among the producers does not correspond with specific geographic regions of our study, as the producers of Moamba and Boane most commonly appear among the least technified farmers (primarily the dispersed producers in these areas), but also frequently appear among the most technified producers (generally those with shared central irrigation systems). Producers in the *zonas verdes* tend to be more uniform in the level of technology they apply, making up most of the two middle clusters (two and three).

INTRODUCTION: Mozambique has a great diversity of horticultural producers in terms of knowledge and access to information, technology use and production and marketing behavior. For this reason, it is important to learn more about the different types of producers in order to design interventions specific to each group and by so doing, increase the probability that interventions will result in adoption of improved practices and higher profits for farmers.

The trilateral project (a partnership between Mozambique, Brazil and the United States) has been testing new technologies to be transferred to the horticultural project areas of Moamba, Boane and the *zonas verdes* of Maputo (Ka Mubuacuane, Ka Mavota and Matola). One of the planned activities of this project is defining a producer typology.

In this *flash*, data from the baseline horticultural survey and the method of cluster analysis is used to generate a four-group typology of farmers in the study area, based on a range of indicators. These indicators cover knowledge and access to information, technology use, and production and marketing behavior. The trilateral project has been testing new technologies to be transferred to the horticultural production areas of Moamba, Boane and the *zonas verdes* of Maputo. This study allows recommendations to be formulated concerning which technologies and knowledge may offer the best prospects of adoption and improved performance.

PRODUCTION AREAS AND SAMPLE: The horticultural production areas of the districts of Matola, Ka Mubucuane, and Ka Mavota are normally referred to as the 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.

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, with sample sizes of 344 for *zonas verdes* (ZV) and 272 for Moamba and Boane (M/B). We report all results in this way. The dispersed producers of Moamba and Boane most commonly appear among the least technified farmers in those districts.

METHODOLOGY: In this report, cluster analysis is used to group households on the basis of their technological endowment and productive capacity. Cluster analysis groups data into classes so that objects within a class are similar but are dissimilar to objects in other classes (Babu 2009). In this analysis we used cluster analysis to differentiate farmers in terms of their knowledge and access to information, technology use, and production and marketing behavior. Grouping farmers in this way should allow the development of technological packages and related extension material more suited to each group's needs and capacities.

Table 1 presents a complete list of the 32 indicators used to differentiate farmers, along with each indicator's mean value. The indicators are divided into five categories:

a. Experience, training and agricultural information
b. Diversification of production and sales
c. Input expenditures and farm management practices
d. Post-harvest activity and crop loss
e. Pesticide management and toxicity awareness

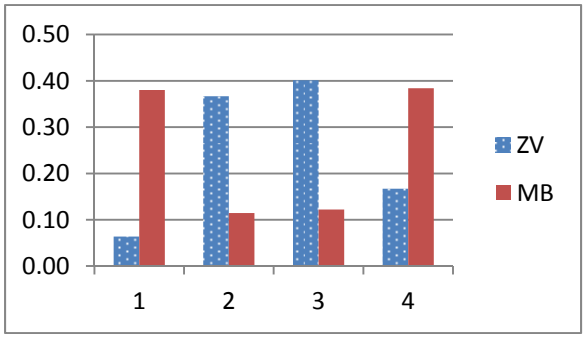
All 32 variables range in value from zero to one, giving each an equal weight in the clustering algorithm.

In this analysis, the k-means method of cluster analysis is used, where *k* clusters are specified. In the case of this study, four clusters are chosen after comparing the output of several different values of *k*. The algorithm begins by partitioning all 616 producers into four groups, each with its own initial set of means. In subsequent steps, the 616 cases are repartitioned to minimize the sum of the "distances" of each observation from the mean of the cluster to which it was assigned. For every subsequent partition, the sum of distances within each cluster becomes progressively smaller, meaning that the similarity of farmers within a given cluster becomes greater while the differences across clusters increase. The algorithm stops when it has minimized within-cluster distances.

FINDINGS: After weights are applied to account for relative representation across the sample areas, producers in Moamba and Boane with less than 5 hectares of horticultural crop land account for 11% of all the horticultural producers in the area. The mostly small producers in the *zonas verdes* account for the remaining 89% (43% from Ka Mavota, 28% from Matola, and 19% from Ka Mabucuane). In terms of area cultivated in horticulture, however, the two zones are nearly equal: Moamba and Boane show approximately 990 hectares during the cool season while *zonas verdes* show approximately 1,100 hectares.

Among the four clusters of farmers, clusters one and four hold the smallest percentages of producers in the study, 10% and 19%, respectively. These clusters form two extremes across the sample in terms of representation of technological capacity, low to high, and together account for 76% of the Moamba and Boane sub-sample (Figure 1); farmers in Moamba and Boane dominantly reside in one of these clusters, while those in *zonas verdes* reside primarily in the middle two clusters.

Figure 1. Percent of producers in each typology group by survey location



ZV - Zonas verdes; M/B - Moamba/Boane

The rest of this flash is organized as follows: First we broadly characterize each of the four groups. Then we focus on clusters two and three and the factors that distinguish them from clusters one and four. Note that clusters two and three hold 77% of all producers in *zonas verdes* (Figure 1) and 71% of all producers across the entire survey area.

A summary characterization of the four groups in Table 2 is as follows:

Cluster One - Low levels of land endowment, access to extension or training advice, and horticultural crop sales diversity

Cluster Two - Moderate levels of land endowment, access to extension or training advice, and horticultural crop sales diversity

Cluster Three - High levels of land endowment, high education/literacy, and moderate horticultural crop sales diversity

Cluster Four - High levels of land endowment, access to extension or training advice, horticultural crop sales diversity and mechanized irrigation use

In the first six categories in table 2, mean values progress steadily from low to high across the clusters, beginning with cluster one. The only exception is use of mechanized irrigation, which is practiced by a greater percentage of farmers in Moamba and Boane in cluster one than in cluster two.

In all clusters, rape and lettuce are the most frequently grown crops, but their dominance falls steadily across the clusters; these two crops account for 64% of all crops grown during the cool season in cluster one, but only 28% in cluster four. Several other crops are commonly produced by farmers in cluster four, including tomatoes (11%), beets (9%) and onion (9%) (Table 2).

Though not shown in the table, patterns of diversification into non-horticultural crops are opposite in the two regions. Generally, farmers in Moamba and Boane grow fewer non-horticultural crops as one moves across the clusters (i.e., cluster four is more specialized in horticulture than is cluster one), whereas producers in the *zonas verdes* tend to diversify more into non-horticultural crops as one moves across the technology capacity groupings.

The last five categories in table 2 (#7 to #11) do not show a steady progression in values across clusters, but do highlight differences between clusters two and three, and how these differ from clusters one and four, in the following ways:

1. Producers in group three have the lowest dependency ratios (38% in ZV and 36% in

Moamba and Boane) and highest levels of adult literacy (80% in ZV and 71% in Moamba and Boane) across all four groups.

2. Producers in group three perform the best in the pesticide management categories of (a) use of protective clothing when applying pesticide and (b) ability to read pesticide labels across all four groups; and well in (c) the time of day pesticide is applied (Table 2).

Higher literacy undoubtedly plays a role in families' perceptions and behavior regarding pesticide application. More information about this trend and farmers' attitudes and management practices concerning pesticides among those in the baseline survey can be found in flash 69 (Cachomba, *et al.* 2013).

3. Producers in group three are generally the most likely to purchase inputs and spend the greatest amounts on these across all four groups (Tables 3 and 4). Only 73% of producers of Moamba and Boane in cluster one purchased seed for their harvest.

Generally, the producers who did not purchase their seed indicated that they used saved seed from their last or other previous seasons (37%). Others use seeds that were offered to them by another family (12%), relatives (7%) or even by their association (12%).

Table 1: Indicators Included in the Typology Creation

		Together		*Zonas Verdes*		Moamba/ Boane	
	Indicators of Experience, Training and Agricultural Information	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
1	A family member received information from an extension agent concerning horticulture	28%	0.55	29%	0.46	25%	0.42
2	A family member received information about horticultural prices	20%	0.49	20%	0.41	21%	0.41
3	A family member received credit for horticulture in the last 12 months. Top sources: Bank (33%), Relatives (17%), Government (14%), Association (14%)	7%	0.31	7%	0.26	11%	0.31
4	A family member participated in a training of at least three months in duration	9%	0.35	9%	0.29	11%	0.31
5	Percent of literate adults in the family	70%	0.27	71%	0.22	57%	0.29
6	Years of experience cultivating horticulture of the family member with the most experience in horticulture > 23 (median)	48%	0.62	50%	0.51	37%	0.49
7	The number of years of education of the most educated adult in the family > 9 (median)	48%	0.61	49%	0.51	32%	0.46
	Diversification of Production and Sales						
8	Total number of horticultural crops produced > 3	67%	0.57	68%	0.48	63%	0.49
9	Total number of horticultural crops produced > 5	28%	0.55	28%	0.45	33%	0.48
10	The family sold tomato	11%	0.33	7%	0.26	37%	0.47
11	The family sold tomato in both seasons of the year	4%	0.21	3%	0.17	13%	0.34
12	Total number of horticultural crops sold > 2	72%	0.54	73%	0.45	56%	0.49
13	Total number of horticultural crops sold > 4	28%	0.55	28%	0.45	29%	0.45

Note: Total Number of Observations = 616 (total); 344 in the *zonas verdes* and 272 in Moamba/Boane

Table 1: Indicators Included in the Typology Creation (cont.)

			Together		*Zonas Verdes*		Moamba/ Boane	
	Input Expenditures and Farm Management Practices	Obs	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
14	Index of seed purchase source formality (0 informal, 1 formal)	616	0.35	0.49	0.31	0.40	0.65	0.42
15	Percent of seed varieties used for which the producer could give the name	616	18%	0.17	18%	0.14	16%	0.17
16	Pump irrigation was used in at least one horticultural field	616	7%	0.16	1%	0.09	58%	0.42
17	Value of fertilizer used > 500 MZN (median)	616	50%	0.61	55%	0.51	10%	0.29
18	Valor of pesticide used > 1,000 MZN (median)	616	52%	0.61	53%	0.51	45%	0.47
19	Valor of seed used > 2,500 MZN (median)	616	49%	0.07	49%	0.51	45%	0.47
20	Employed part-time hired labor	616	90%	0.38	90%	0.32	95%	0.22
21	Employed full-time hired labor	616	20%	0.49	20%	0.41	24%	0.43
	Post-harvest activities and Crop Loss							
22	Selected the product before sale	616	7%	0.31	6%	0.25	12%	0.33
23	Washed the product before sale	616	9%	0.34	9%	0.29	7%	0.25
24	Used a personal car to transport produce to sell in a market	616	1%	0.11	1%	0.09	4%	0.19
25	Sold all the produce that was brought to the market (applicable in the case of tomato, cabbage, lettuce or rape)	616	15%	0.43	14%	0.36	21%	0.41
	Pesticide Management and Toxicity Awareness							
26	Percent of total pesticides for which respondent gave a verified correct assessment of true EPA **human** toxicity level	616	44%	0.40	46%	0.33	28%	0.32
27	Percent of total pesticides for which respondent gave a verified correct assessment of true EPA **bird** toxicity level	616	38%	0.43	40%	0.36	25%	0.30
28	Percent of total pesticides for which respondent gave a verified correct assessment of true EPA **fish** toxicity level	616	21%	0.35	21%	0.29	23%	0.31
29	Percent of total pesticides for which respondent gave a verified correct assessment of true EPA **bee** toxicity level	616	12%	0.29	12%	0.24	13%	0.23
30	The person who applied the pesticide(s) could read the label	616	53%	0.61	54%	0.51	46%	0.49
31	The person who applied the pesticide(s) used protective clothing beyond just boots (plastic overalls, mask/glasses, gloves, other)	616	48%	0.62	50%	0.51	36%	0.48
32	Pesticides were applied in the early morning or after sunset	616	56%	0.61	58%	0.50	39%	0.48

Note: Total Number of Observations = 616 (total); 344 in the *zonas verdes* and 272 in Moamba/Boane

Table 2. Typology

	Cluster One: Low levels of land endowment, access to extension or training advice, and horticultural crop sales diversity	**Cluster Two:** Moderate levels of land endowment, access to extension or training advice, and horticultural crop sales diversity	**Cluster Three:** High levels of land endowment, high education/literacy, and moderate horticultural crop sales diversity	**Cluster Four:** High levels of land endowment, access to extension or training advice, horticultural crop sales diversity and mechanized irrigation use
	10% of producers total: - 6% of all the ZV producers - 38% of all the M/B producers	34% of producers total: - 37% of all the ZV producers - 11% of all the M/B producers	37% of producers total: - 40% of all the ZV producers - 12% of all the M/B producers	19% of producers total: - 17% of all the ZV producers - 38% of all the M/B producers
These farmers are characterized by:				
1	**Least area cultivated with horticulture in the cool season** - Median of 0.04 ha in ZV - Median of 0.17 ha in M/B	**Moderate area cultivated with horticulture in cool season** - Median of 0.05 ha in the ZV - Median of 0.50 ha in M/B	**Most area cultivated with horticulture in cool season** - Median of 0.11 ha in ZV - Median of 1.00 ha in M/B	**Most area cultivated with horticulture in cool season** - Median of 0.12 ha in ZV - Median of 1.00 ha in M/B
2	**Least counsel and training received** - 12% of households have at least one member who received horticultural extension advice in ZV, 6% in M/B. - 0% receive a training of over 3 months in agriculture in ZV, 3% in M/B	**Moderate counsel and training received** - 29% of households have at least one member who received horticultural extension advice in ZV, 13% in M/B. - 8% receive a training of over 3 months in agriculture in ZV, 3% in M/B	**Moderate counsel and training received** - 30% of households have at least one member who received horticultural extension advice in ZV, 32% in M/B. - 12% receive a training of over 3 months in agriculture in ZV, 10% in M/B	**Most counsel and training received** - 58% of households have at least one member who received horticultural extension advice in ZV, 45% in M/B - 15% receive a training of over 3 months in agriculture in ZV, 21% in M/B
3	**Least informed concerning hort prices** - 14% have received hort price information in the last 12 months in ZV, 13% in M/B	**Moderately informed concerning hort prices** - 18% have received hort price information in the last 12 months in ZV, 13% in M/B	**Moderately informed concerning hort prices** - 19% have received hort price information in the last 12 months in ZV, 17% in M/B	**Most informed concerning hort prices** - 46% have received hort price information in the last 12 months in ZV, 34% in M/B
4	**Least diversity of hort crop production** - Frequency share of all crops produced in the cluster: Rape (33%), Lettuce (31%), Pumpkin Leaves (7%) in cool season.*	**Moderate diversity of hort crop production** - Frequency share of all crops produced in the cluster: Rape (24%), Lettuce (22%), Onion (12%), Pumpkin Leaves (11%), Beets (10%) in cool season	**Moderate diversity of hort crop production** - Frequency share of all crops produced in the cluster: Rape (25%), Lettuce (23%), Pumpkin Leaves (10%), Beets (10%), Onion (7%), Cabbage (7%) in cool season	**Greatest diversity of hort crop production** - Frequency share of all crops produced in the cluster: Rape (14%), Lettuce (14%), Tomato (11%), Beets (9%), Onion (9%), Cabbage (7%) in cool season

ZV - *Zonas verdes*; M/B - Moamba/Boane

Table 2. Typology

	Cluster One: Low levels of land endowment, access to extension or training advice, and horticultural crop sales diversity	**Cluster Two:** Moderate levels of land endowment, access to extension or training advice, and horticultural crop sales diversity	**Cluster Three:** High levels of land endowment, high education/literacy, and moderate horticultural crop sales diversity	**Cluster Four:** High levels of land endowment, access to extension or training advice, horticultural crop sales diversity and mechanized irrigation use
5	**Least number of crops sold** - Range of 0-3, mean 2 and median 2 in ZV. - Range of 0-3, mean 1 and median 0 in M/B	**Moderate numbers of crops sold** - Range of 0-10, mean 4 and median 4 in ZV - Range of 0-9, means and medians of 4 in M/B	**Moderate numbers of crops sold** - Range of 0-10, mean 4 and median 4 in ZV - Range of 0-6, means and medians of 3 in M/B	**Greatest number of crops sold** - Range of 5-10, mean 7 and median 6 in ZV - Range of 2-13, mean 6 and median 5 in M/B
6	**Moderately likely to use pump irrigation among producers of M/B** - 33% of the producers in M/B use pump irrigation, 0% in ZV	**Moderately likely to use pump irrigation among producers of M/B** - 12% of the producers in M/B use pump irrigation, 1% in ZV	**Moderately likely to use pump irrigation among producers of M/B** - 70% of the producers in M/B use pump irrigation, 0% in ZV	**Most likely to use pump irrigation** - 93% of the producers in M/B use pump irrigation, 7% in ZV
Characteristics that differentiate farmers in clusters two and three among the four clusters:				
7	**Greatest dependency ratio** - 50% in ZV and 53% in M/B	**Moderate Dependency Ratio** - 46% in ZV and 55% in M/B	**Lowest Dependency Ratio** -38% in ZV and 36% in M/B	**Moderate Dependency Ratio** - 43% in ZV and 44% in M/B
8	**Lowest Adult Literacy Levels** - 60% literate adults in the AF within ZV, and 47% in M/B	**Moderate Adult Literacy** - 67% literate adults in the AF within ZV, and 60% in M/B	**Highest Adult Literacy Levels** - 80% literate adults in the AF within ZV, and 71% in M/B	**High Adult Literacy** - 71% literate adults in the AF within ZV, and 69% in M/B
9	**Poorest pesticide management** - 27% of those applying the pesticides can read the label in ZV, 12% in M/B - 29% of those applying the pesticides use protective clothing other than boots in ZV, 12% in M/B ** - 49% apply at the right time of the day in ZV, only 15% in M/B	**Average pesticide management** - 44% of those applying the pesticides can read the label in ZV, 51% in M/B - 49% of those applying the pesticides use protective clothing other than boots in ZV, 38% in M/B - 57% apply at the right time of the day in ZV, 51% in M/B	**Outstanding pesticide management** - 78% of those applying the pesticides can read the label in ZV, 81% in M/B - 62% of those applying the pesticides use protective clothing other than boots in ZV, 67% in M/B - 62% apply at the right time of the day in ZV, 38% in M/B	**Average to High pesticide management** - 49% of those applying the pesticides can read the label in ZV, 69% in M/B - 45% of those applying the pesticides use protective clothing other than boots in ZV, 49% in M/B - 67% apply at the right time of the day in ZV, 62% in M/B
10	**Least likely to purchase, and spend the least on inputs** (See tables 3 and 4)	**Moderately likely to purchase, and spend moderate amounts on inputs** (See tables 3 and 4)	**Most likely to purchase, and spend the most on inputs, generally** (See tables 3 and 4)	**Moderately likely to purchase, and spend moderate amounts on inputs** (See tables 3 and 4)
11	**Moderate formality of input purchase channels used** (See table 5)	**Least formal input purchase channels used** (See table 5)	**Moderate formality of input purchase channels used** (See table 5)	**Most formal seed and fertilizer purchase channels used** (See table 5)

* Frequencies varied little between cool and hot seasons; ** Other items of clothing include plastic overalls, mask/glasses, gloves, other.

Table 3: Percent of Farmers Purchasing Inputs by Cluster

	Percent of Farmers Purchasing Inputs					
	Pesticides		Seed		Fertilizer	
	Zonas Verdes	Moamba/ Boane	*Zonas Verdes*	Moamba/ Boane	*Zonas Verdes*	Moamba/ Boane
Cluster One	*88%*	*29%*	*91%*	*73%*	*89%*	*36%*
Cluster Two	90%	45%	**100%**	90%	94%	41%
Cluster Three	**100%**	**100%**	99%	**100%**	**99%**	**94%**
Cluster Four	96%	95%	**100%**	**100%**	91%	92%

Note: Values in italics and a yellow cell color highlight the lowest values in each column, values in bold and pink cell color highlight the highest values in each column.

Table 4: Median Input Purchase Value Spent (MTN) by Cluster

	Median Input Purchase Value Spent (MTN)					
	Pesticide		Seed		Fertilizer	
	Zonas Verdes	Moamba/ Boane	*Zonas Verdes*	Moamba/ Boane	*Zonas Verdes*	Moamba/ Boane
Cluster One	*500*	*0*	*670*	*225*	*270*	*0*
Cluster Two	540	*0*	1,060	550	400	*0*
Cluster Three	**2,860**	**4,050**	7,670	**11,100**	**1,410**	**105**
Cluster Four	1,351	3,500	**9,485**	8,800	330	90

Table 5: Index of Input Channel Formality by Cluster

	Index of Input Channel Formality					
	Pesticide		Seed		Fertilizer	
	Zonas Verdes	Moamba/ Boane	*Zonas Verdes*	Moamba/ Boane	*Zonas Verdes*	Moamba/ Boane
Cluster One	0.40	0.94	0.27	*0.46*	0.62	**0.92**
Cluster Two	*0.35*	*0.86*	*0.15*	0.53	*0.53*	*0.87*
Cluster Three	**0.64**	**0.99**	0.46	0.84	0.58	0.89
Cluster Four	0.61	0.90	**0.50**	**0.86**	**0.64**	**0.92**

4. Producers in group two generally use the least formal input purchase channels across all four groups (Table 5).

These last two characteristics concerning input channels are driven by the dominance of producers from the *zonas verdes* in clusters two and three. More information concerning the differences between farmers in these two zones in regards to their respective input purchase channel formality, frequency, location and value can be found in Flash 68 (Cairns, *et al.* 2013)

Finally, it can be observed from table 2 that producers in Moamba and Boane consistently have more average area cultivated with horticulture in the cool season, are more likely to receive agricultural training of at least three months in duration, are more likely to use mechanized irrigation and are more likely to purchase their inputs from a formal channel than

producers in the *zonas verdes*, across all four groups.

Producers in the *zonas verdes*, on the other hand, consistently are more likely to receive advice from an extension agent, to receive horticultural price information in the last year, to apply pesticide at the proper time of day, to sell a greater number of horticultural crops, and to have a greater percentage of literate adults in the family than producers in Moamba and Boane, regardless of the cluster ranking into which these producers were grouped.

CONCLUSIONS: In this study, the cluster approach to grouping observations uses indicators such as training or counsel received, number of crops sold and practices concerning pesticide use to distinguish farmers into four groups. It does this by using an iterative exercise of minimizing the distance of means across a total of 32 dimensions.

Land endowment, access to extension or training advice, and crop sales diversification progress from low to high levels across the clusters, from one to four. Producers with the least crop diversity, least technified production practices, and lowest knowledge capacity are found in cluster one while those with the highest levels of each of these indicators tend to be found in cluster four.

Level of technological capacity does not correspond with specific geographic regions of this study, as the producers of Moamba and Boane most commonly appear among the least technified farmers (primarily the dispersed producers in these areas), but also represent a large share of the most technified producers (generally those with shared central irrigation systems). Producers in the *zonas verdes* tend to be more uniform in the level of technology they apply, making up most of the two middle clusters (two and three).

The sharpest distinctions across all factors are between clusters one and two, on the one hand, and clusters three and four, on the other. Because very few farmers in Moamba/Boane lie in clusters two and three, while very few households in *zonas verdes* lie in clusters one and four, the most pragmatic approach to designing an extension outreach program may be as follows. First, in Moamba/Boane, distinguish between households in cluster one and those in cluster four; group the limited number of cluster two households of this zone with cluster one, and group cluster three households with cluster four.

Second, in *zonas verdes*, distinguish between cluster two households and cluster three households (most differences between these groups are sharp in this region), again including the small number of cluster one households with cluster two, and cluster four households with cluster three. Methods for making these distinctions in the field (properly assigning all households to clusters, not just those that were surveyed in the baseline) can be developed in consultation with IIAM, MSU and EMBRAPA technical personnel, likely based on a simple questionnaire that would take little time to administer.

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