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Risk Perception and Behavior in Pesticide Use by the Horticultural Producers of Maputo

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This *flash* examines the perceptions of horticultural farmers in the province of Maputo with regard to pesticides, as well as the behavior that these producers exhibit concerning use of these chemicals. The analyses are based on data from a baseline survey conducted within the trilateral project (Mozambique, Brazil and the United States) also known as the horticultural food security project (PSAL). The survey took place from May to June of 2013 in the green belt of Maputo, and in the nearby districts of Boane and Moamba. The results of this study indicate that the most-used pesticide among farmers in these areas - Methamidophos - is classified as highly toxic by both the Environmental Protection Agency of the United States (EPA) and the World Health Organization (WHO). Producers in these areas generally hold the perception that almost all pesticides are highly toxic (even those that are less toxic according to the EPA and WHO), yet do not take proper precautions of pesticide handling or use.

INTRODUCTION: The use of pesticides is quite high among the horticultural farmers in Mozambique producing for market, however generally speaking pesticide use across Mozambique as a whole is very low. Results from the TIA agricultural survey show that only about 6% of producers used pesticides in the 2011/2012 season and these were primarily producers of tobacco and cotton, where contract farming is prevalent. Although the TIA is nationally representative, it does not capture well information concerning crops that are locally produced, such as vegetables, which are largely produced along river banks or in centralized irrigation units and with extensive use of pesticides.

Using data from the horticultural survey performed under the trilateral project, which covers the green belt of Maputo city (Ka Mabucuane, Ka Mavota, and Matola) and the districts of Moamba and Boane, this study analyzes risk perception and behavior in pesticide use by the horticultural producers of Maputo. Another study by Cairns et al, (2013) explores channels of input purchases from horticultural producers in terms of their formality, frequency, location and value, and provides a lot of information on pesticides which can additionally serve as a reference for those interested to know more about the pesticide value chain or of that of other inputs.

PRODUCTION AREAS AND SAMPLE: The horticultural production areas of the districts of Matola, Ka Mabucuane, 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*) and farmers with larger land areas producing tomato, onion, cabbage, and other horticultural crops. A less numerous group of farmers in these districts operates with individual irrigation along the rivers, outside the *blocos*. We refer to these 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 individually represent all producers with less than 5 hectares of cultivated land 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.

KEY ISSUES AND METHODS OF PEST AND DISEASE CONTROL: Across all the locations of the study, pests and disease are cited as the most serious problem for horticultural production compared to other problems such as high costs of inputs, lack of water or theft (Figure 1).

Physical control, cultural control, plant or tree leaf extract and use of pest and disease-tolerant varieties are alternative methods of controlling pests and diseases which have reduced adverse environmental effects and are being explored by the producers in the *zonas verdes* and Moamba/Boane. However, the use of chemical pesticides is the most common method used by farmers in these areas, most likely due to its speed and efficacy in controlling pests and disease (Table 1).

Table 1. Use of different pest control methods

Method	% of producers who used	
	ZV	M/B
Physical Control	3%	1%
Cultural Control	6%	4%
Tree Leaf Extract	2%	0%
Chili Extract	3%	1%
Garlic Extract	3%	1%
Other	1%	0%
Chemical Pesticides	98%	77%
Tolerant Varieties	4%	2%

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

PESTICIDE TOXICITY ACCORDING TO THE EPA AND WHO: In the *zonas verdes* as well as in Moamba and Boane, the five chemicals that were most widely used by producers in the past 12 months, in order, were Methamidophos, Mancozeb, Cypermethrin, Abamectin and Acetamiprid (Table 2). According to the classification of the Environmental Protection Agency of the USA (EPA), these range from highly toxic (Methamidophos) to slightly toxic (Mancozeb, Abamectin and Acetamiprid). Of the names of pesticides collected in the survey, it was possible to assign a toxicity rating to 95.1% and 95.2% of the given chemicals listed, using the classification systems of the EPA and the World Health Organization of the United Nations (WHO), respectively. Results reveal that most of the pesticides used in these areas are highly toxic (47% of the pesticides used, according to the EPA and 56%, according to the WHO). However, these results also show that a good portion of pesticides are considered to have low toxicity (31% according to the EPA and 20% according to the WHO) (Tables 3 and 4).

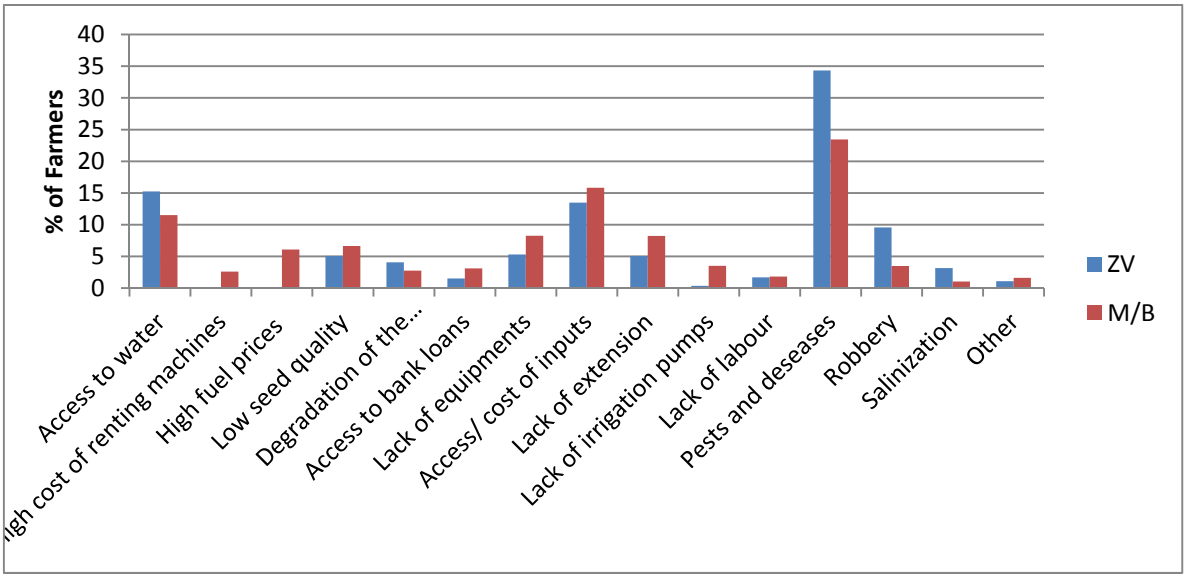

Figure 1: Horticultural Production Problems. ZV - Zonas verdes; M/B - Moamba/Boane

Table 2. Most-used pesticides among producers of Moamba, Boane and the *zonas verdes* of Maputo

	% of producers that used		Corresponding pesticide toxicity class	
Pesticide	ZV	M/B	EPA	WHO
Methamidophos	87,0%	56,5%	1 – Highly toxic	Ib – Highly hazardous
Mancozeb	38,8%	49,6%	4 -- Slightly toxic	U – Unlikely to present hazard
Cypermethrin	33,5%	42,9%	3 – Somewhat toxic	II – Moderately hazardous
Abamectin	19,8%	12,5%	4 – Low toxicity	Ib – Highly hazardous
Acetamiprid	7.9%	0.3%	4 – Low toxicity	Not clearly defined

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

Table 3. Pesticides classified by the Environmental Protection Agency classification

Item	
Class 1-- Highly toxic	47,2%
Class 2-- Moderately toxic	1,8%
Class 3 – Slightly toxic	18,2%
Class 4 – Practically nontoxic	31,0%
Total	100%

Table 4. Pesticides classified by the World Health Organization classification

Item	
Ia – Extremely hazardous	0.1%
Ib – Highly hazardous	55.5%
II – Moderately hazardous	24.2%
III – Slightly hazardous	0.3%
U – Unlikely to present hazard	19.9%
Total	100%

PRODUCER PERCEPTIONS REGARDING THE USE OF PESTICIDES: Producers of horticultural crops commonly have the perception that all pesticides are highly toxic to humans. Eighty-seven percent of the pesticides ranked as highly toxic by the EPA were correctly classified as highly toxic. However, 84% of pesticides classified as moderately toxic, 85% of the pesticides ranked as slightly toxic and 76% of those ranked as having low levels of toxicity by EPA, were incorrectly classified by producers as being highly toxic (Table 5).

Despite the fact that producers consider most of the pesticides they use as highly toxic, a large percentage of them wash their pesticide spraying equipment in the water channels of the farm (27% in the *zonas verdes* and 16% in Moamba and Boane), and/or throw away their used pesticide bottles on the ground in the farming areas (60% in the *zonas verdes* and 35% in Moamba and Boane) (Tables 6 and 7). Such practices are inadvisable as they can contribute to the contamination of irrigation water and cause harm to the other living creatures in the ecosystem.

Table 5. Producers' perception concerning pesticide toxicity to humans vs. true pesticide toxicity according to the EPA

Producer perceptions concerning pesticide toxicity for humans	EPA Pesticide Toxicity Classification				
	Class 1 (highly toxic)	Class 2 (moderately toxic)	Class 3 (slightly toxic)	Class 4 (low toxicity)	Total
	---------- Percent of Producers ----------				
Yes, highly toxic	87%	84%	85%	76%	83%
Yes, moderately toxic	10%	8%	12%	13%	11%
Not toxic	1%	0%	2%	1%	93%
Do not know	3%	8%	2%	10%	5%

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

Table 6. Location where producers wash pesticide application equipment after use

Washing Location	ZV	M/B
In the river	2%	8%
In the water channel of the farm	27%	16%
In the farm	67%	69%
At home	1%	1%
Another place	1%	4%
Do not wash	3%	2%
Do not know	1%	1%
Total	100%	100%

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

Table 7. What producers do with used pesticide packaging

What producers do	ZV	M/B
Leave on the ground in the farming areas	60%	35%
Throw out in the backyard	1%	0%
Throw out in another place	2%	3%
Burn	18%	26%
Bury	19%	14%
Reuse for another purpose	2%	0%

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

PRECAUTIONS TAKEN BY PRODUCERS IN PESTICIDE STORAGE, PREPARATION AND APPLICATION: Seventy-nine percent of producers of the *zonas verdes* and 54% of producers in Moamba/Boane reported that they store their pesticides in the field. Some of the producers, however, keep pesticides in a room of their home (3% of producers of the green zones) or in a pantry (1% in the *zonas verdes*, and 3% in Moamba/Boane). A low percentage of producers store their pesticides in a special warehouse (4% in the green zones and 9% in Moamba/Boane) (Table 8).

Table 8. Location of pesticide storage

Item	*Zonas verdes*	Moamba/ Boane
In the field	79%	54%
In their room	3%	0%
In a pantry	1%	3%
In the garage	1%	0%
In another part of the house	6%	7%
In a special warehouse	4%	9%
In the yard of the house	4%	1%
In another place outside of the house	2%	1%
Not applicable	2%	2%

Both pesticide preparation and application is primarily performed by family members (> 70% of the interviewed families in the two zones) (Table 9), often being the head of household (60% of green areas and 77% in Moamba and Boane) or his spouse (31% in the *zonas verdes* and 17% in Moamba and Boane) (Table 10). Among the children involved, there is often a greater involvement in the process of pesticide application than pesticide preparation. In the *zonas verdes*, 1.5% of the family members preparing pesticides are between the ages of 13 and 16, while 1.8% and 1.4% of family members applying pesticides within the *zonas verdes* and Moamba/Boane, respectively, are between the ages of 12 and 16.

Both in the *zonas verdes* and in Moamba and Boane, there is generally low use of protective clothing during application of pesticides: all producers reported having used less than two items of protective clothing, consisting of boots, gloves, overalls or a mask. Specifically, those who wear protective clothing primarily wear boots (53% of those in the *zonas verdes* and 73% in Moamba and Boane) and/or masks (36% of those in the *zonas verdes* and 33% of those in Moamba and Boane) (Table 11). Surprisingly, boots are used more often than masks. Whereas masks can protect against the inhalation of pesticides, the most common form of ill-exposure, boots provide skin protection, and only work most effectively when additionally accompanied by the use of appropriate pants.

There are differences between producers in terms of pesticide handling care. Producers located in the highest quintiles of cultivated horticultural area[1] among all the producers in the study take greater precautions when handling pesticides. The number of protective items of clothing worn by the person applying pesticide, the percentage of producers who can read the package labels and the percentage of farmers applying pesticides at the right time of day increase from the producers located in the lower quintiles of horticultural cultivated area to the third quintile of horticultural cultivated area. Surprisingly, this percentage lowers in the fourth quintile and increases again in the quintile of largest area (Table 12).

[1] Area measurement is calculated for the cool season

Table 9. Relationship to AF of persons who prepare and apply the pesticides used

Item	Who prepares the pesticides?		Who applies the pesticides?	
	ZV	M/B	ZV	M/B
Someone from the family	89%	78%	88%	71%
Permanent labor	6%	11%	7%	17%
Temporary labor	2%	4%	2%	6%
Contracted labor	2%	2%	2%	2%
Other	1%	4%	1%	3%
Total	100%	100%	100%	100%

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

Table 10: Family members who prepare and apply the pesticides used

Relationship to the Household Head	Who prepares the pesticides?		Who applies the pesticides?	
	ZV	M/B	ZV	M/B
Himself	59.6%	78.8%	59.8%	76.6%
Wife	31.8%	17.7%	31.2%	16.8%
Child	4.7%	3.4%	4.3%	4.4%
Sibling	0.4%	0.0%	0.8%	0.7%
Parent	0.4%	0.0%	0.8%	0.0%
Nephew/Niece	0.3%	0.7%	0.3%	0.7%
Grandchild	1.1%	0.0%	1.1%	0.7%
Another relative	1.5%	0.0%	1.5%	0.0%
Not related	0.3%	0.0%	0.0%	0.0%

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

Table 11. Use of protective clothing

Protective Clothing	Percent of producers	
	ZV	M/B
Overalls	7%	16%
Mask	36%	33%
Boots	53%	73%
Gloves	18%	25%
Other protective clothing	19%	11%

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

Table 12. Producer behavior with regard to pesticides by quintile of land area

Quintiles of area cultivated with horticulture in the cool season		Average area cultivated with horticulture in the cool season		Average number of protective clothing items used during pesticide application		Percent of persons that prepare pesticides who can read the label or ask for help to do so		Percent of AFs that applied pesticides at the correct hour of the day	
		ZV	M/B	ZV	M/B	ZV	M/B	ZV	M/B
Least Area	1	0.01	0.01	0.92	0.60	59%	32%	54%	17%
	2	0.04	0.17	1.04	0.85	69%	36%	59%	29%
	3	0.07	0.61	1.27	1.01	74%	65%	62%	51%
	4	0.12	1.36	1.13	1.49	79%	77%	57%	46%
Most Area	5	0.75	4.79	1.33	1.64	86%	84%	59%	52%

Compared to Moamba and Boane, the *zonas verdes* have the highest percentage of producers who can read the pesticide labels or ask for help from someone who can. This zone also has the highest percentage of producers who apply pesticides at the most optimal time of day – at sunrise or sunset, when the sun is not so strong (Table 13). The fact that the producers in the *zonas verdes* generally have a higher educational level and apply pesticides more intensively throughout the year could be contributing factors to their better understanding of pesticide management norms.

Tabela 13. Producer behavior with regard to pesticides by typology classes of technological capacity [2]

	Average number of protective clothing items used during pesticide application		Percent of persons that prepare pesticides who can read the label or ask for help to do so		Percent of AFs that applied pesticides at the correct hour of the day	
	ZV	M/B	ZV	M/B	ZV	M/B
Cluster One	.29	.12	.27	.12	.49	.15
Cluster Two	.49	.38	.44	.51	.57	.51
Cluster Three	.62	.67	.78	.81	.62	.38
Cluster Four	.45	.49	.49	.69	.67	.62

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

PESTICIDES AND THEIR RELATIONSHIP TO THE CROPS ON WHICH THEY ARE USED: On average, each producer uses 2.2 pesticides in the *zonas verdes* and 2.8 pesticides in Moamba and Boane. With increasing quintiles of horticultural cultivated area, an increasing number of pesticides are used (Table 14).

The same occurs across the typology cluster: generally, the producers in cluster four use the greatest number of different pesticides (Table 15)[3].

Table 14. Number of pesticides used by quintile of area cultivated in the cool season

Quintiles of area cultivated with horticulture in the cool season		*Zonas Verdes*	Moamba / Boane
Least area	1	1.9	1.6
	2	2.0	1.3
	3	2.1	1.2
	4	2.5	1.8
Most area	5	3.0	2.8

Table 15. Number of pesticides used by typology classes of technological capacity

Typology Cluster	*Zonas Verdes*	Moamba / Boane
Cluster One	1.7	1.3
Cluster Two	1.8	1.5
Cluster Three	2.9	3.4
Cluster Four	2.7	3.5

[2] This typology classification groups producers into four categories, or clusters, by their technological capacities. The generation of the typology indicator is discussed in further detail in *flash* 70.

[3] This typology classification groups producers into four categories, or clusters, by their technological capacities. The generation of the typology indicator is discussed in further detail in *flash* 70.

Methamidophos, Mancozeb, Cypermethrin, Acetamiprid and Abamectin are the five most commonly used pesticides during production on the crops of cabbage, lettuce, pumpkin leaves, onions, beets, cabbage and tomato, both in the *zonas verdes* as in Moamba and Boane (Tables 16a, 16b, and 16c).

Methamidophos is classified as highly toxic by the EPA, and holds the largest share of pesticides used for each of the aforementioned crops in both zones of the study. This means that Methamidophos is the most commonly used chemical of all the pesticides used among these crops. In the *zonas verdes*, its share ranges between 44% and 56% of the total pesticide varieties used, with onion and beets being the crops on which the most Metheamidophos was, comparatively, applied. In Moamba and Boane, Methamidophos accounted for between 22% to 36% of all pesticides used, with lettuce, cabbage and tomato being the crops with the highest shares.

Cypermethrin is used more commonly than Mancozeb on onion and cabbage crops, in contrast to cabbage, lettuce, pumpkin leaves, beets and tomato, where Mancozeb is applied more frequently than Cypermethrin. Acetamiprid is among the five most used pesticides for onion, beets and tomato, but not for rape, lettuce, pumpkin leaves and cabbage. Among the former, Acetamiprid is listed as used by producers more than Abamectin. Of the selected crops, Abamectin played the largest role in the production of cabbage.

TECHNICAL ASSISTANCE BY EXTENSION AGENTS IN PESTICIDE STORAGE, MANAGEMENT AND APPLICATION PRACTICES: More producers in the *zonas verdes* received extension advice regarding pesticide storage, management or application, generally, compared to producers in Moamba or Boane. There is no direct relationship between extension assistance and increased horticultural cultivated area (Table 17). But when we analyze the relationship between technical assistance and level of technological capacity, we verify that the least technologically advanced producers (those in cluster one) receive less technological assistance compared to the more technologically advanced producers (Table 18).

The percentage of producers in the *zonas verdes* that received technological assistance in pesticide application is also slightly and consistently higher than the percentage that received technical assistance on pesticide storage or management (Table 18).

CONCLUSIONS: This flash uses data from the Trilateral horticultural survey which took place from May to June of 2013 in the greenbelt of Maputo (Ka Mubucuane, Ka Mavota and Matola) and the districts of Moamba and Boane in Maputo province, to analyze the perceptions of producers in relation to pesticides, as well as the behavior that these producers have in relation to these chemicals.

Results of this study indicate that although there are other circulated methods for pest and disease control which are less harmful to the environment and human health, chemical pesticides are the most common method used, likely due to its rapid action and efficacy.

In the *zonas verdes*, as in Moamba and Boane, the most used pesticides are Methamidophos, Mancozeb, Cypermethrin, Acethameprid and Abamectin. These have toxicity levels, according to the EPA, which vary between highly toxic (Methamidophos)

Table 16a. Shares of pesticides used for selected crops by producers in Moamba, Boane and the *zonas verdes* of Maputo

Chemical Name	Rape	Lettuce	Pumpkin Leaves	Onion	Beets	Cabbage	Tomato
	Share of each pesticide used by crop						
Methamidophos	47.9%	46.4%	47.5%	49.7%	51.9%	41.8%	38.1%
Mancozeb	14.5%	19.4%	19.2%	13.6%	17.3%	12.5%	22.5%
Cypermethrin	14.4%	14.5%	17.1%	15.9%	7.7%	15.2%	14.8%
Acetamiprid	-	-	-	6.9%	8.4%	3.3%	6.4%
Abamectin	9.1%	9.1%	5.6%	3.9%	6.8%	13.6%	5.7%

Table 16b. Shares of pesticides used for selected crops by producers in the *zonas verdes* of Maputo

Chemical Name	Rape	Lettuce	Pumpkin Leaves	Onion	Beets	Cabbage	Tomato
	Share of each pesticide used by crop						
Methamidophos	48.6%	46.8%	47.7%	53.1%	52.4%	44.2%	44.3%
Mancozeb	14.1%	19.3%	19.2%	12.0%	17.2%	10.7%	23.1%
Cypermethrin	14.2%	13.9%	17.2%	14.5%	7.4%	13.7%	10.9%
Acetamiprid	-	-	-	7.9%	8.5%	3.7%	10.5%
Abamectin	9.4%	8.5%	5.6%	3.9%	7.0%	14.5%	5.6%

Tabela 16c. Shares of pesticides used for selected crops by producers in Moamba and Boane

Chemical Name	Rape	Lettuce	Pumpkin Leaves	Onion	Beets	Cabbage	Tomato
	Share of each pesticide used by crop						
Methamidophos	35.2%	36.2%	-	26.6%	22.9%	29.3%	30.6%
Mancozeb	22.9%	21.4%	-	24.7%	23.0%	22.2%	21.8%
Cypermethrin	20.4%	22.4%	-	25.5%	22.6%	23.2%	19.4%
Acetamiprid	2.8%	-	-	4.2%	-	-	-
Abamectin	-	3.0%	-	-	-	8.9%	5.7%

Table 17. Percent of producers that received extension advice concerning storage, management and application of pesticides, by quintile of cultivated horticultural area in the cool season

Area Quintiles	Storage		Management		Application	
	ZV	M/B	ZV	M/B	ZV	M/B
Least area 1	12%	6%	13%	6%	15%	8%
2	18%	10%	19%	10%	23%	10%
3	28%	0%	29%	0%	32%	0%
4	21%	9%	20%	9%	22%	9%
Most area 5	23%	20%	23%	21%	32%	23%

ZV - Zonas verdes; M/B - Moamba/Boane. *Note that extension advice here refers to advice not just from extension workers, but from anyone the producer said they received any advice from, neighbors, informal sales-persons of inputs, etc.

Table 18. Percent of producers that received extension advice concerning storage, management and application of pesticides, by typology classes of technological capacity

Typology Cluster	Storage		Management		Application	
	ZV	M/B	ZV	M/B	M/B	M/B
Cluster One	5%	3%	5%	3%	7%	3%
Cluster Two	17%	7%	20%	7%	24%	7%
Cluster Three	27%	26%	26%	26%	28%	32%
Cluster Four	43%	30%	39%	32%	49%	34%

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

and low toxicity (Mancozeb, Acetamiprid, and Abamectin)

Although producers have the perception that almost all pesticides are highly toxic, most of them wash their equipment in the farm irrigation canals, leave the used pesticide receptacles splayed on the ground in the farm areas, and often use boots as their only protective clothing while spraying.

Results of this study also reveal that most of the producers in both the *zonas verdes* as well as Moamba and Boane store their pesticides in hidden places on the farm. A low percentage of producers keep pesticides in a room or in a pantry where food is stored.

Despite there being (a) low use of protective clothing, (b) a considerable percentage of producers who cannot read package labeling nor ask for help to do so, and (c) a considerable percentage of farmers who apply pesticides at inappropriate times, there are differences between producers by quintiles of horticultural cultivated area. The larger the area, (1) the greater the number of protective clothing items that are used while spraying, (2) the greater the percentage of producers who know how to read the labels, and (3) the greater the percentage of farmers applying pesticides at the correct time of day.

When comparing the *zonas verdes* with Moamba and Boane, it appears that in the *zonas verdes* there is a higher percentage of farmers applying pesticides at the correct times of day and a higher percentage of producers who can read the package labels or ask for help to do so.

Generally, the least technologically advanced producers (those belonging to cluster one) received less extension assistance in aspects related to storage, handling and application of pesticides than the more technologically advanced producers.

It would have been interesting to include questions concerning a) producer perceptions concerning the proper pre-harvest waiting interval after pesticide application and b) the use of pesticides which have not been registered in Mozambique. However, this was not possible to include these analyses in this flash. These issues will very probably be discussed in forthcoming editions.

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