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Food Safety in Horticultural Markets in Harare

Report No.1

Survey of Horticultural Producers in Seke, Chihota and Epworth

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Food Safety in Horticultural Markets in Harare: Survey of Horticultural Producers in Seke, Chihota and Epworth

Executive Summary

This report presents the findings of a formal survey of 280 smallholder horticultural producers in Seke, Chihota and Epworth, plus a follow-up survey of 20 producers in Seke. The initial survey was undertaken by staff of Agritex and the University of Zimbabwe in June-July 2001; the follow-up survey by staff of AREX (Agritex) in October 2003. The surveys focused on smallholder horticultural producers who regularly produce for market. They examined their production practices, with particular reference to fertilizer and chemical application on leafy vegetables and tomatoes, plus their choice of marketing channels and their perceptions of consumer demand for their products.

Horticulture was the most important source of income for 204 of the 280 surveyed households. The mean size of horticultural garden was 0.56ha. In total, it was estimated that the surveyed households produced a total of 2800 tons of leafy vegetables (rape, viscose, covo and tsunga) per annum, plus 1500 tons of tomatoes, carrots and onions. Mean production of leafy vegetables was 9993kg per household, worth almost Z$500,000 (US$2900). 95-97% of each of the main leafy vegetables and 99% of the tomatoes, onions and carrots produced by the respondent households were marketed, with the vast majority being sent to Mbare and Chikwanha markets. Most households in Chihota sent their produce to Mbare. More households in Seke sent produce to Chikwanha than to Mbare. However, larger consignments of produce were sent to Mbare and hence households in Seke still sent a larger total volume of produce to Mbare than to Chikwanha. It is estimated that in 2001 producers in Seke and Chihota between them sent over 18,000 tons of horticultural produce to Mbare per year. Producers in Epworth rely primarily on buyers (mainly hawkers) coming to the farm-gate. However, small quantities of produce are also sent to markets elsewhere in Harare.

When asked to list the attributes that customers valued most highly in leafy vegetables and tomatoes, the vast majority of respondents cited *"search" attributes* (e.g. size, appearance) as being of most importance. Only a few producers of leafy vegetables cited "experience" attributes (freshness, taste when cooked) and only five cited a single, safety-related "credence" attribute (low input). These perceptions of consumers' preferences appear to drive production practices, encouraging producers to apply large quantities of inorganic fertilizer and crop protection chemicals in order to achieve large, unblemished, dark green leaves and large, red, unblemished tomatoes.

Over 90% of producers of rape, covo, tsunga and viscose applied inorganic fertilizer, with the most popular type in 2001 being Compound X (a local mixture of Compound D and AN). Producers of rape, covo and viscose were found to apply, on average, around 30 tons of Compound X per hectare per year, as they apply fertilizer after every picking (every two weeks). The quantities of nitrogen thereby applied are 14-15 times the recommended rates. One of the objectives of the 2003 follow-up survey was to verify or refute this rather startling finding. The producers interviewed in 2003 used more AN than Compound X, but still applied fertilizer at similar rates.

In the case of tomatoes, the preferred fertiliser was Compound S. Application rates on tomatoes in 2001 were also found to be high (2-3 times recommended rates), but not as high

as for leafy vegetables. In the 2003 follow-up survey, application rates were found to be close to recommended rates.

Turning to chemical application, producers reported using a wide range of chemicals on tomatoes. However, in the majority of cases, their declared purpose in using the chemical was not a purpose for which the chemical in question was recommended or registered. Producers were asked to give details of their most recent pesticide application, so as to provide insights into application rates for pesticides. Application rate can be divided into tank (or bucket) mix concentration and the volume applied per unit area of crop. A difference in tank mix concentration was observed between chemicals that come in powder form and in liquid form, with low concentrations of the former, but high concentrations of the latter (on average 1.5 – 2 times recommended concentration rates), being observed. Spray volumes were also generally found to be high, with a mean volume over six times the recommended rate. In the 2003 follow-up survey, the most popular chemical was found to be Dithane M45 (which comes in powder form). As in the original survey, tank mix concentrations of this chemical were generally found to be low, but spray volumes were well in excess of recommended levels. Overall, the application rate of active ingredients per hectare of crop was found to be near the recommended levels for the majority of respondents. However, it appears that some cases of excessive pesticide application are occurring. Some respondents also reported spraying after every picking of tomatoes (i.e. every two weeks), which runs the risk of tomatoes being picked whilst pesticides are still present.

In the case of leafy vegetables, Rogor was the dominant pesticide, used by 250 growers (92%). Of these, 234 growers indicated that they used it for the control of aphids, which is a correct usage. However, both average tank mix concentrations and spray volumes were found to be high for Rogor. These findings were confirmed by the 2003 follow-up survey, where all ten respondents (users of Rogor on viscose) reported application rates of the active ingredient above the recommended level, with the mean figure being more than twelve times the recommended level. During the follow-up survey, some respondents indicated that they had stopped using Rogor, as it had lost its strength and was no longer effective in chemical control. This may be because regular use at excessive levels has started to produce resistance in aphids.

These findings highlight a clear need for enhanced extension advice to producers of tomatoes and leafy vegetables, to show them that good quality produce can be obtained using lower levels of fertilizer and pesticides. This should be in their economic interest, as excessive input usage reduces the returns to production. However, if they are to change their production practices, they will have to be persuaded that they can still produce tomatoes and leafy vegetables that are acceptable to consumers without applying such high quantities of inputs. In turn, consumers may also need some education that deep green leaves and deep red tomatoes are not always the best. The need for enhanced extension advice also raises the need for greater attention to be given to horticulture within AREX, including in the training that its staff receive.

Introduction

This work is an output of a research programme exploring food safety in horticultural markets in and around Harare. One component of this programme was to examine production practices amongst smallholder horticultural producers in urban and peri-urban areas. A separate report (Hanyani-Mlambo and Goodland 2001) examines production practices amongst smallholder horticultural producers in Chinamhora and Murewa, chosen to represent areas that are more distant from Harare, but are still closely linked into Harare horticultural markets. This report covers Seke, Chihota and Epworth, chosen to represent urban and near-peri-urban areas.

The work reported here was conducted in three stages:

- Firstly, open meetings, organized at ward level by Agritex extension staff, were held with horticultural producers in the three areas of interest: Seke, Chihota and Epworth. These aimed to get an overview of horticultural production activities in the three areas. The detailed findings of these meetings are not reported here, but a separate report can be obtained on request from agritex@africaonline.co.zw
- Secondly, between 26/06/2001 and 13/07/2001 a formal survey of 280 producers was undertaken by staff of the Zimbabwe national extension service, Agritex, assisted by additional enumerators from University of Zimbabwe.
- Thirdly, a follow-up survey of 20 producers in Seke (Mandedza and Ngome wards) was undertaken between 08/10/2003 and 13/10/2003. The objective of this survey was to validate some of the findings of the earlier survey in regard to fertiliser and pesticide use by horticultural producers in the area.

This report primarily records the findings of the formal survey conducted in 2001, supplemented where relevant by the findings of the 2003 follow-up survey.

1. Sampling Procedure

For the 2001 survey, a list of producer households was drawn up by field extension officers in Seke, Chihota and Epworth, in collaboration with local producers who were contacted during the PRA meetings. The producer households included in the lists were those known to produce marketed surpluses of horticultural produce. Lists were compiled by production clusters within each district and ward.

A similar sample frame was used by van Santen (1997). He defined a "horticultural producer" as someone with at least 0.1ha of farm land (not always the same 0.1ha) regularly cultivated with vegetables and/or fruit designated for fresh consumption. Cultivation could be seasonal or permanent. However, the intention was to capture producers selling regular surpluses to market. Using this definition in 1996-97,

- 330 producers were identified in Seke district, primarily in Ngome (155), Zhakata (70), Mandedza (55), and Mutiusinazita (40) wards;
- 740 producers were identified in Chihota district, of which 200 were in ward 17, 150 in ward 15, 110 in ward 18 and 95 each in wards 11 and 14.

Seke

In Seke in 2001 there were three main wards where horticulture was important[1]: Ngome, Mandedza and Mapfuti. (A ward has +/-600 households). It is about 40km from the first to the last of these wards along the main road. The nearest ward is 15 km from Chikwanha and about 40km from Harare. In each ward, 100-130 households producing regular marketed surpluses of horticultural produce were identified. For the survey, 114 households (32%) were chosen by stratified random sample (based on cluster lists). Of these, 62 were from Ngome ward, 27 from Mandedza and 25 from Mapfuti.

Chihota

In Chihota, 895 horticultural producers were identified, spread across nine wards and including one irrigation scheme. It was decided to sample from five of these wards: 11, 14, 15, 16 and 18. For the survey, 129 households (14%) engaging in dryland horticultural production were chosen by stratified random sample. In addition, 20 members of a small irrigation scheme were interviewed[2].

In practice, one of the respondents in Chihota turned out to be new to horticultural production and had not yet marketed any produce. This questionnaire was, therefore, discarded.

Epworth

In Epworth a focus group discussion had already been conducted with a group of 30 or so producers who produce their crops together and share the proceeds. This discussion had covered, amongst other things, their horticultural management practices. Therefore, the formal survey instead concentrated on farmers who grow vegetables along a seasonal tributary of the Ruwa River[3]. It was decided to interview as many of these producers as possible (more of a census than a sample). In practice, 17 interviews were conducted.

Table 1: Summary of Producers Sampled

Area	Ward / Location	Number Sampled
Seke	Ngome	62
	Mandedza	27
	Mapfuti	25
Chihota	11, 14, 15, 16 and 18	129
	Irrigation scheme	20
Epworth	Plots along Mukuvisi River	17
TOTAL		280

[1] However, horticultural production activity still takes place in all wards in Seke.
[2] Given the small number of farmers on the irrigation scheme, it was decided to sample a sufficient number of irrigators to make the visit there worthwhile.
[3] Some of these are also members of the group, but cultivate plots along the Mukuvisi on an individual basis.

2. Respondent Characteristics

Production in all three areas is organised on a family basis, so questionnaires were administered to the first adult member of the household available. Questions were intended to capture household (not individual) asset holdings and production activities.

However, as part of the interview, respondents were also asked to provide some personal information. This referred to them as individuals, not to the household head or household as a whole. There turned out to be little difference between the personal details supplied by those who were household heads and by the sample as a whole.

Status, Gender and Age

A total of 150 men and 130 women were interviewed. Of the 280 respondents, 115 were household heads. 27 of the women were heads of their households. The vast majority of respondents (199) were married. Of the remainder, 51 were single (never married), whilst 30 were either widow(er)s or divorcees. The ages of respondents ranged from 17 to 76 (with every age in this range represented, except 68, 71, 72 and 75!). The average age of the sample was 38. The average age of household heads was slightly greater at 44 (Table 2):

Table 2: Age of Respondents

AGE RANGE	WHOLE SAMPLE		HOUSEHOLD HEADS	
	No.	%	No.	%
17-25	63	23	8	7
26-40	102	36	42	37
41-60	94	34	53	46
61+	21	8	12	10
TOTAL	280	101	115	100

Education

Most respondents had received either secondary or primary education. The average education status of household heads was slightly below that of the sample as a whole (Table 3).

Table 3: Formal Education Received by Respondents

EDUCATION	WHOLE SAMPLE		HOUSEHOLD HEADS	
	No.	%	No.	%
Tertiary	2	<1	1	1
Secondary	137	49	42	37
Primary	118	42	59	51
No formal education	23	8	13	11
TOTAL	280	100	115	100

By contrast, relatively few respondents had any specific agricultural qualification. However, the proportion of master farmers in the sample was higher than for smallholder producers in the country as a whole (Table 4).

Table 4: Agricultural Education Received by Respondents

TRAINING	WHOLE SAMPLE		HOUSEHOLD HEADS	
	No.	%	No.	%
Agricultural Diploma or Certificate	6	2	1	1
O Level or Other School Qualification	21	8	7	6
Advanced Master Farmer	2	<1	1	1
Master Farmer	41	15	19	17
Trainee Master Farmer	14	5	5	5
None	186	69	78	70
TOTAL (excl. missing responses)	270	100	111	100

Extension Contact

Respondents claimed to have varying levels of contact with their extension officer. Around 50% claimed to see their extension officer less than once every six months or never (Table 5).

Table 5: Frequency of Contact with Extension Officer

FREQUENCY OF CONTACT	WHOLE SAMPLE		HOUSEHOLD HEADS	
	No.	%	No.	%
Once per fortnight or more	37	13	16	14
Once per fortnight to once per month	55	20	17	15
Once per month to once every six months	51	18	23	20
Less than once every six months	30	11	9	8
Never	107	38	50	44
TOTAL	280	100	115	101

3. Scope of Horticultural Production Activities

Importance

Respondents were asked to rank the most important sources of income relied upon by the household. Only 241 respondents listed horticulture at all, even though they weren't limited in the number of sources that they could list[4]. Nevertheless, according to the responses that were

[4] Possible reasons for the failure of the remainder to mention horticulture are either that they answered this question in an individual capacity (rather than on behalf of the household) or that they included horticulture

given (Table 6), horticulture is the most important source of income for the households in the sample as a whole. We might, therefore, expect that, if markets were to begin to demand more reliably safe produce, such households would have a strong incentive to make the changes necessary to deliver such produce.

Table 6: Ranking of Income Sources Received by Respondent Households

SOURCE	RANKED 1	RANKED 2	RANKED 3	RANKED 4	TOTAL
Horticulture	204	33	4		241
Crops	36	29	9	1	75
Wages / Salaries	23	27	1		51
Pension / Welfare	5	7	2	1	15
Self-Employment / Crafts	4	23	7	1	35
Remittances	3	4	1		8
Poultry	2	13	5		20
Cattle / Small Ruminants	1	7	9		17
Others	1	2	1		4
TOTAL	279	145	39	3	

Area of Gardens

By the respondents' own estimations[5], the mean size of horticultural garden in the sample was 0.56 ha (median: 0.4 ha). Four respondents in Epworth had plots of 40 sq.m. or less, whilst, at the other end of the scale, 40 respondents claimed that their plots were one hectare or more in area (maximum: 4.0 ha). However, it should be noted that not all of this area is cultivated at any given time. There is some seasonal rotation, in addition to which the total area planted at any given time depends on water availability (obviously higher during or just after rains).

Total Production

Respondents were asked to state how much of each crop their household harvested per month and the main months during which they harvested. The production estimates in Tables 7a and 7b are based on multiplying these two figures. There are, however, three possible sources of error in these estimates:

- Some respondents might not have included quantities consumed at home (for which information was also collected) in their estimate of average monthly harvest, although the calculations have been done as if they did. To the extent that this occurred, the resulting figures are understated.

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under the more general heading of "crops" (intended to cover the major field crops such as maize and groundnuts).

[5] One enumerator appears to have influenced responses and generated implausibly high estimates. Therefore, seven responses were removed from the data. The figures quoted in the text are from 273 cases.

- Some respondents only quoted one, two or three *main* months during which they harvested crops such as viscose, which are generally harvested all year round. The impact of this is also that the resulting figures will be understated.
- On the other hand, other respondents might have quoted the harvest yields for the main months, whilst asserting that such harvesting rates continued year round. This would cause the resulting figures to be overstated.

The figures given below must, therefore, be taken as ball-park figures. We hope that the conflicting biases roughly equal each other out!

Table 7a: Annualised Volumes of Leafy Vegetables Produced

	RAPE	COVO	VISCOSE	TSUNGA	TOTAL
No. of Households Producing	175	119	153	43	
Mean Production by Producing Households (kg)	4821	5664	7526	2992	
Maximum by One Hh (kg)	243,000	60,300	108,150	56,000	
Minimum by One Hh (kg)	48	45	72	20	
TOTAL Volume (tons)	843.8	674.0	1151.5	128.6	2798.0

Table 7b: Annualised Volumes of Other Main Crops Produced

	TOMATOES	ONIONS	CARROTS	TOTAL
No. of Households Producing	81	95	31	
Mean Production by Producing Households (kg)	10133	3641	9579	
Maximum by One Hh (kg)	324,000	120,000	160,000	
Minimum by One Hh (kg)	50	8	36	
TOTAL Volume (tons)	820.8	345.9	296.9	1463.6

Only four households in the survey recorded no leafy vegetable production of any kind. At the other end of the scale, four reported production of over 100 tons per year. Mean production of leafy vegetables was 9993kg per household, whereas the median figure was 3948kg, reflecting the presence of a few very large producers in the sample.

In June 2001, a 3kg bundle of rape sold in Mbare and Chitungwiza producers' markets for around Z$50. Therefore, 3948 kg represents almost Z$200,000 or US$1150 at the "blend" exchange rate commonly used at the time[6]. Production of 9993kg was worth almost Z$500,000 or US$2900 at the same "blend" exchange rate. These, of course, are gross income figures. Net income from leafy vegetable production is discussed in the final section of this paper (*A Final Note on Methodology*).

[6] In mid-2001 the official exchange rate was US$1 = Z$55, but the parallel rate was US$1 = Z$250.

In addition to the crops recorded in Tables 7a and 7b, small quantities of the following crops were also recorded (the number of respondents is given in brackets):

- beans (9)
- peas (7)
- potatoes (6)
- sugarloaf (5)
- sugarcane (3)
- sweet potatoes (3)
- banana (2)
- sugar beans (2)
- broccoli (2)
- green beans (1)
- butternut (1).

4. Produce Marketing

Marketed Surpluses

An indication of the level of commercialisation of the production activities covered by the survey is that 95-97% of each of the main leafy vegetables and 99% of the tomatoes, onions and carrots produced by the respondent households were marketed[7]. The volume of produce going to different markets is shown in Tables 8a and 8b.

Table 8a: Volume of Leafy Vegetables Sent to Different Markets (tons)

	RAPE	COVO	VISCOSE	TSUNGA	TOTAL
Local Sales	41.8	35.3	43.3	2.1	122.5
Mbare	653.4	507.1	849.7	89.9	2100.1
Chikwanha	108.7	76.4	153.9	21.9	360.9
Other Markets	11.4	18.8	48.6	11.3	90.1
TOTAL	815.6	637.6	1096.6	125.3	2675.1

Table 8b: Volume of Other Main Crops Sent to Different Markets (tons)

	TOMATOES	ONIONS	CARROTS	TOTAL
Local Sales	31.9	4.2	0.3	36.4
Mbare	575.0	294.4	276.1	1145.5
Chikwanha	170.2	40.7	19.0	229.9
Other Markets	37.5	4.0	0.3	41.8
TOTAL	814.6	343.3	295.8	1453.7

[7] It should be remembered, however, that the original sampling frame set out to capture those households who produce regular surpluses of horticultural produce for market. If we only consider the 43 households that produced less than one ton of leafy vegetables per year, then the percentages of these crops marketed fall to 89% for rape, 81% for viscose and 75% for covo. Only one of these 43 households produced tsunga and it sold all that it produced.

In Tables 8a and 8b, local sales are predominantly farm-gate sales to neighbours and others who come to buy from the household. However, a few respondents also sell small quantities of produce besides a nearby main road. Other markets include Marondera market and markets within Harare such as Independence wholesale market and Solani.

The best estimate of total flows of horticultural produce passing through Mbare market is 280,000-350,000 tons p.a., with smallholder production accounting for perhaps 120,000 tons of this (Gordon 1997). If the current sample represents 32% of the market-oriented horticultural producers in Seke and 16.5% in Chihota, then we can estimate total marketed surplus sent from these areas to Mbare as being around 18,291 tons p.a. or 15% of total smallholder supplies to Mbare[8].

We are not aware of any reliable estimates of total flows passing through Chikwanha market. However, our data suggests that Seke and Chihota send around 2,600 tons of horticultural produce to Chikwanha per year. As a percentage of total flows, this is likely to be considerably in excess of the percentage just calculated for Mbare.

Channels Used by Producers in Different Areas

The origin of these flows (disaggregated by production area) is given in Tables 9a to 9c.

Table 9a: Flows of Produce from Respondent Households in Seke

	NO. of HHs GROWING	NUMBER OF HOUSEHOLDS SENDING PRODUCE TO:							
		LOCAL		MBARE		CHIKWANHA		OTHER	
		No.	Tons	No.	Tons	No.	Tons	No.	Tons
RAPE	81	22	17.0	49	73.5	65	70.3	0	0
COVO	45	15	9.9	28	108.7	33	60.9	0	0
VISCOSE	57	13	25.8	39	207.7	48	117.3	0	0
TSUNGA	12	2	0.3	8	4.3	12	9.2	0	0
TOMATOES	28	7	20.9	18	53.4	22	64.6	2	1.0
ONIONS	21	2	1.7	15	14.4	16	13.3	2	0.3
CARROTS	6	0	0	3	0.7	3	0.7	2	0.3
TOTAL			75.6		462.7		336.3		1.6

[8] It should be emphasised that this is very much a ball-park figure. It may be an overestimate for two reasons: 1) total flows at Mbare may have increased since the original estimate of flows was made in 1990; 2) the sample used here was not totally random (for example, the sample was "overweight" on irrigation producers, which boosted figures for marketed output – see footnote 7).

Table 9b: Flows of Produce from Respondent Households in Chihota

	NO. of HHs GROWING	NUMBER OF HOUSEHOLDS SENDING PRODUCE TO:							
		LOCAL		MBARE		CHIKWANHA		OTHER	
		No.	Tons	No.	Tons	No.	Tons	No.	Tons
RAPE	87	15	8.8	77	579.9	21	38.5	9	11.4
COVO	63	13	4.9	57	398.4	18	15.6	5	17.3
VISCOSE	94	22	17.0	87	642.0	24	36.6	10	48.5
TSUNGA	30	7	1.8	27	85.7	6	12.7	8	11.3
TOMATOES	48	15	5.0	42	521.7	16	105.6	5	36.5
ONIONS	68	18	2.2	59	280.0	25	27.3	9	3.7
CARROTS	25	3	0.3	21	275.4	10	18.3	0	0
TOTAL			40.0		2783.1		254.6		128.7

Table 9c: Flows of Produce from Respondent Households in Epworth

	NO. of HHs GROWING	NUMBER OF HOUSEHOLDS SENDING PRODUCE TO:							
		LOCAL		MBARE		CHIKWANHA		OTHER	
		No.	Tons	No.	Tons	No.	Tons	No.	Tons
RAPE	7	7	15.9	0	0	0	0	0	0
COVO	11	10	20.4	0	0	0	0	2	1.5
VISCOSE	2	2	0.5	0	0	0	0	1	0.2
TSUNGA	1	1	0.02	0	0	0	0	0	0
TOMATOES	5	5	5.9	0	0	0	0	0	0
ONIONS	6	6	0.3	0	0	0	0	0	0
CARROTS	0	0	0	0	0	0	0	0	0
TOTAL			43.0		0		0		1.7

These tables show a number of important facts:

- 78% of all the produce marketed by respondent households came from households in Chihota (53% of the sample)[9];
- Producers in Chihota send the vast majority of their produce (87%) to Mbare;
- Producers in Seke send more produce to Chikwanha than do producers in Chihota;
- More producers in Seke send (some of their) produce to Chikwanha than send produce to Mbare. However, larger consignments of produce are sent to Mbare, where sales are "guaranteed" and where they are less likely to depress market prices. (This is particularly noticeable in the figures for covo and viscose);
- Producers in Epworth rely primarily on buyers (mainly hawkers) coming to the farm-gate. However, small quantities of produce are also sent to markets elsewhere in Harare.

[9] Although the 20 households on irrigation plots marketed slightly above-average quantities of produce (11.3% of the total compared with their 7.1% representation in the sample), this does not account for the overall predominance of surpluses from Chihota.

5. Perceptions of Customer Requirements

Respondents were asked to list the attributes that customers valued most highly in leafy vegetables and tomatoes. (No prompts were given to these answers). Tables 10a and 10b show the attributes that respondents perceived customers to be looking for in their produce.

Table 10a: Attributes of Leafy Vegetables Felt (by Producers) to be Valued by Customers

ATTRIBUTE	NO. of RESPONDENTS
Dark Green Leaves	213
Big or Long Leaves	200
Absence of Aphids or Spots	90
No Holes or Scratches	70
Fresh	25
Good Taste when Cooked	7
No Purple or Yellow Colour	7
Low input	5
Other	3

Table 10b: Attributes of Tomatoes Felt (by Producers) to be Valued by Customers

ATTRIBUTE	NO. of RESPONDENTS
Ripe / Red	25
Big	21
Free of Red Spider Mite	16
Unblemished / Uncut Skin	15
Good Looking	14
Shiny	11
Firm	7
Not Over-ripe / Greenish	2
Uniform Grade and/or Variety	2

The most important point to note here is that the vast majority of respondents cited *"search" attributes* (e.g. size, appearance) as being of most importance. Only a few producers of leafy vegetables cited "experience" attributes (freshness, taste when cooked) and only five cited a single, safety-related "credence" attribute (low input). One respondent cited cleanliness of the selling environment, which is recorded in Table 10a as "other".

In other words, insofar as low-middle income consumers of leafy vegetables and tomatoes *do* value the safety of these products, the necessary signals are *not* being transmitted down the marketing chain to producers in Seke, Chihota and Epworth.

Furthermore, in an attempt to produce crops possessing the "search" attributes that they perceive to be the most important in consumers' eyes, some producers may be encouraged to apply excess fertiliser or chemicals. It is quite plausible that pursuit of the four major leafy vegetable attributes and the top six tomato attributes could lead producers down such a path. Table 11 shows the measures that respondents claimed to take in order to obtain the desired quality of produce. As, in many cases, the answers to the relevant question within the questionnaire did not make a distinction between measures taken on leafy vegetables and on tomatoes, the table refers to both types of crop.

Whilst the table provides no information on how producers apply chemicals or fertiliser, it does confirm that producers see application of chemicals and fertiliser as critical to meeting perceived consumer priorities.

Table 11: Measures Taken to Obtain Desired Produce Quality

MEASURE	NO. of RESPONDENTS
Timely spraying and/or sufficient number of sprays	161
Adequate inorganic fertiliser use	159
Adequate watering	117
Adequate organic[10] fertiliser use	96
Timely and/or adequate weeding	39
Scouting for pests	8
Grading	6
Minimise inorganic fertiliser use	4
Sell on same day as harvest	3
Use clean water	2

6. Production Practices

Fertiliser Application

Table 12 shows the types of inorganic fertiliser that respondents reported using on leafy vegetables and tomatoes. (Information was not gathered on onions and carrots). The table shows that by far the most popular fertiliser application for leafy vegetables was so-called compound X, a home mix of compound D and ammonium nitrate. Where producers can afford it, this is applied after each harvesting of leaves. Both compound D and ammonium nitrate are relatively cheap (in per bag terms, though not in nutrient equivalent terms) in comparison with other fertiliser products[11]. By contrast, the recommended fertiliser application regime for the four leafy vegetable crops covered here (as given in the Agritex Farm Management Handbook) is a basal dressing of 700-800kg/ha of compound L, followed by 100kg/ha of ammonium nitrate at monthly intervals during picking. Only two respondents

[10] Where specified, this was primarily manure. However, a few respondents also noted that they apply anthill soil.

[11] Their prices continued to be fixed by the government until 1995, when other prices were deregulated in 1993, due to their popularity with smallholder farmers.

claimed to apply compound L fertiliser, which is more expensive than compound D or ammonium nitrate.

Table 12: Types of Inorganic Fertiliser Applied to Leafy Vegetables and Tomatoes

TYPE	Number of Respondents Applying to:				
	RAPE	COVO	VISCOSE	TSUNGA	TOMATOES
Compound X	131	82	112	24	17
Compound D	9	11	16	6	14
Compound X + AN	8	7	12	4	2
Ammonium Nitrate (AN)	3	2			1
Compound L + AN	1		2	2	
Compound M	1	1	1		1
Compound S		1	1	1	25
Compound C					2
Other Combinations[12]	4	2	5	1	7
No Application Recorded	18	13	4	5	12
TOTAL	175	119	153	43	81

Roughly 10% of producers of rape, covo and tsunga (fewer in the case of viscose) reported no application of inorganic fertiliser. Whilst in some cases, this means that they did not apply any[13], in other cases this may simply reflect the fact that the information was not sought or noted down. These figures suggest that, despite difficult economic conditions, producers still made an effort to obtain inorganic fertiliser for their leafy vegetables and that production of these crops remained profitable enough to warrant this (at least in areas close to Harare).

For tomatoes, the Agritex Farm Management Handbook recommends a basal dressing of 1000-1500kg/ha of compound S, followed by applications of ammonium nitrate and potassium sulphate once when fruits are marble sized and every three weeks during picking. A more substantial minority of respondents did report using the recommended basal fertiliser than was the case for leafy vegetables. As with leafy vegetables, the proportion of producers recording no application of inorganic fertiliser is not that high.

Only a subset of those respondents claiming to apply inorganic fertiliser provided information that would permit the calculation of per hectare equivalent application rates[14]. Table 13 quotes application figures for compound X for leafy vegetables and compound S for tomatoes, as these were the most common fertilisers applied in each case.

The figures in Table 13 are calculated by multiplying the reported quantity applied per application by the number of applications per season, multiplying by 10000, then dividing by

[12] Combinations here refers to the use of two or more fertilisers during the course of the season (either at different times or together). Recorded combinations, in addition to those shown in the table, were: (for leafy vegetables) compounds X and D, X and S, S and D, M and D; (for tomatoes) compounds X and D, X and S, S and D, M and S, S and C and L, and compound S with ammonium nitrate.

[13] Enumerators noted comments such as "fertiliser is very expensive" on the relevant questionnaires.

[14] For example, where respondents reported applying fertiliser at the base of every plant, it was not always possible to estimate a per hectare application rate.

the area over which an application was made (quoted in sq.m.)[15]. Where number of applications was quoted per month, rather than per season, a harvesting season of three months is assumed for rape and tsunga, and twelve months for covo and viscose (hence the higher average application rates for the latter).

Table 13: Application Rates for Common Fertiliser Types (kg/ha)

CROP	FERTILISER TYPE	N =	MEAN	MEDIAN	MAXIMUM	STANDARD DEVIATION
Rape	Compound X	119	10700	6000	177778	18505
Covo	Compound X	75	28808	13333	384000	53064
Viscose	Compound X	95	29625	17600	384000	48766
Tsunga	Compound X	18	6084	3000	16667	5209
Tomatoes	Compound S	19	5029	1500	60000	13445

In Table 14, the figures on fertiliser application rates (calculated on a per season basis in Table 13) are translated into annual nitrogen application rates[16]. The calculations assume that compound D and ammonium nitrate were mixed equally in the preparation of compound X. To obtain application rates per year, it was assumed that three crops of rape, tsunga and tomatoes could be grown on a given piece of land in the course of a year, whereas a single crop of covo or viscose is commonly harvested for a year or more.

Table 14: Nitrogen Application Rates (kg/ha/year)

CROP	FERTILISER TYPE	N =	MEAN	MEDIAN	MAXIMUM	STANDARD DEVIATION
Rape	Compound X	119	6821	3825	113333	11797
Covo	Compound X	75	6122	2833	81600	11276
Viscose	Compound X	95	6295	3740	81600	10363
Tsunga	Compound X	18	3878	1913	10625	3321
Tomatoes	Compound S	19	1056	315	12600	2824

Table 15: Incidence of High Nitrogen Application Rates

CROP	FERTILISER TYPE	N =	Incidence of Rates in Excess of	
			5000 kg/ha/yr	10000 kg/ha/yr
Rape	Compound X	119	48	20
Covo	Compound X	75	27	13
Viscose	Compound X	95	39	18
Tsunga	Compound X	18	7	1
Tomatoes	Compound S	19	1	1

[15] Note that this does not imply broadcasting of fertiliser. Rather, a respondent might indicate that a certain quantity was sufficient for a given number of beds, each of a certain area.
[16] Compound D contains 8% nitrogen; ammonium nitrate 34.5%; compound S, 7%.

These fertiliser application rates generate a large number of extremely high nitrogen application rates, calculated on a kg per ha per year basis (Table 15). 5000 kg/ha/yr is over ten times the recommended nitrogen application for a hectare of leafy vegetables in a single year. The mean nitrogen application rates for rape, covo and viscose recorded in Table 14 are 14-15 times the recommended rates[17].

Verification of Fertiliser Application Rates

To check these rates, questions about fertiliser application were again asked during the follow-up survey in October 2003. All the interviews for the follow-up survey were conducted in farmers' fields (whereas some of the original interviews were conducted at homesteads), so that enumerators could verify the crop areas described by respondents. Water was scarce at the time of the survey, so only viscose and tomatoes were observed in the ground. Producers were using the water that was available to keep their viscose alive, so were not planting rape or other leafy vegetables at the time. The follow-up survey indicated a modification of fertiliser application practices (an increase in the use of AN) since the original survey, but still very high application rates, despite the even more difficult economic climate.

Half the respondents (50%) said they do not apply any fertiliser or manure when they plant viscose. Some said the crop dies if you apply fertiliser at planting. Almost all sampled households that did use fertiliser at planting time used kraal manure. Only one household said they used compost at planting. One household used a mixture of manure and anthill. The rate of manure use ranged from 50 tons/ha to 350 tons/ha.

After crop establishment all farmers applied fertiliser at least once. The time of fertiliser application ranged from one week to four weeks after transplanting. A significant proportion of sampled households (45%) applied compound D. The rest applied manure, ammonium nitrate, compound X or compost. Estimates given by farmers suggest that those who applied compound D applied rates ranging from 200 to 2860kg/ha with a mean of 1550kg/ha. A second, similar application is then made before harvesting. (As noted above, recommendations from research and extension suggest that farmers should apply 7-800kg/ha compound L at planting time).

Farmers indicated that they harvested viscose six to eight weeks after transplanting. The majority of sampled households (55%) applied AN at this stage, with the rest applying manure, compound D, compound X, compost or nothing (2 respondents). Fertiliser is applied by farmers every time they harvest leaves, which is every two weeks in summer and every three weeks in winter. Estimates given by farmers suggest that those who applied AN applied rates ranging from 250 to 2850kg/ha *per application* with a mean of 1660kg/ha. Therefore, for AN the mean application rate per year was 24,930kg/ha – close to the mean recorded for compound X in Table 13[18].

Eleven producers were growing tomatoes at the time of the follow-up survey. As in the original survey, claimed rates of fertiliser application were lower than for leafy vegetables.

[17] 800kg of Compound L at 12.5% nitrogen, plus ten applications each of 100kg AN at 34.5% nitrogen gives a total nitrogen application rate of 445 kg / ha / year.

[18] This represents a higher application rate in terms of nitrogen per hectare, as AN contains a higher percentage of nitrogen than compound D.

Whilst rates varied quite considerably, the mean application rate was close to official recommendations.

Inorganic Fertiliser Use

Information on organic fertiliser applications from the original survey is shown in Table 16. This is likely to understate the full extent of organic fertiliser usage (i.e. it is thought that the number of questionnaires where no application was recorded considerably exceeds the number of farms where no application was made).

Table 16: Types of Organic Fertiliser Applied to Leafy Vegetables and Tomatoes

TYPE	Number of Respondents Applying to:				
	RAPE	COVO	VISCOSE	TSUNGA	TOMATOES
Animal Manure	67	46	72	16	20
Compost	6	3	5	2	1
Manure + Compost	13	4	12	2	
Anthill Soil	3	1	3		
Manure + Anthill Soil	12	9	8	1	
Compost + Anthill Soil	1	1			1
All Three	1		2	1	
No Application Recorded	72	55	51	21	59
TOTAL	175	119	153	43	81

As expected, the main source of organic fertiliser is animal manure. The significance of anthill soil as a source of organic fertiliser in Zimbabwe has been raised by Cavendish (2000).

Pesticides Applied[19]

Respondents were asked firstly to provide general information on their pesticide application practices for tomatoes and leafy vegetables.

A total of 86 growers provided information on pesticide application practices for **tomatoes**. The answers indicate that some of the growers (11) use up to three different pesticides, whilst only three growers did not use pesticides at all.

The most commonly used pesticide was Dithane, which was used by 49 growers. However, it was only used for its intended use - control of fungal diseases - by 8 growers. The other growers mainly quoted it as being used for the control of red spider mite, which is an incorrect usage.

There were similar findings for other pesticides. Karate was used by 29 growers, but none of these claimed to use it for its correct use on tomatoes, which is the control of cutworm. Copper oxychloride was used by 19 growers, but only two growers quoted the correct use, which is control of diseases. Rogor was used by 17 growers, of whom eight growers quoted it

[19] The authors are grateful to Dr.Irene Koomen for the analysis of the pesticide application data.

for the correct usage, which is control of aphids. Carbaryl was used by four growers, whilst only one grower indicated the use of Kelthane, which (s)he used correctly to control red spider mite in tomato.

Overall, only 17% of respondents had chosen the correct pesticide for the tomato pest and/or disease to be controlled. Red spider mite was often controlled with a pesticide not intended for the control of red spider mite, while a chemical specifically for the control of red spider mite (Kelthane) was only used by one grower. In addition, the use of fungicides is often not correct; they are used for the control of insect pests rather than for the control of diseases.

The full set of responses provided for tomatoes is given in Appendix Table 1. An explanation of the registered use of pesticides is given in Appendix Table 3.

Meanwhile, a total of 272 growers provided information on pesticide application practices for **leafy vegetables**. The answers indicate that up to 130 growers use two pesticides on leafy vegetables, whilst only five growers used no pesticides. In contrast to tomatoes, the choice of pesticide on leafy vegetables often reflects the target pest/disease.

Rogor was the dominant pesticide used - by 250 growers (92%). Of these, 234 growers indicated that they used it for the control of aphids, which is the correct usage, sometimes in combination for the control of other pests as well.

Karate was used by 68 growers, of whom 32 indicated that they used it for the control of cutworm. Karate is registered for use against cutworm on other crops, such as tomatoes, but has no registration for use on brassicas. Moto was used by 20 growers. This pesticide is not listed in the Zimbabwe Crop Chemical Handbook. Carbaryl was used by 16 growers, of whom 11 quoted it for its correct usage, which is control of cutworm and other pests. Dithane was used by 14 growers. Dithane is registered for use against downy mildew on brassicas, but none of the growers quoted this. Copper oxychloride was used by six growers. This chemical is, however, not registered for use on brassicas. Tameron was used by 5 growers, of whom two used it correctly for the control of aphids. Finally, Malathion was correctly used for control of 'other pests' by one grower.

Overall, 69% of growers quoted the correct target organism. For Rogor alone the correct usage (for the control of aphids) was 94%. However, two pesticides - Karate and Copper oxychloride - are used on Brassicas, but have no registration for use on this crop.

The full set of responses provided for leafy vegetables is given in Appendix Table 2.

Most Recent Pesticide Application

Respondents were then asked to give more detailed information on their most recent pesticide application, either on tomatoes and/or leafy vegetables. The aim here was to gain an insight into the application rates for different pesticides and crops. Table 17 shows the pesticides most recently on tomatoes for which detailed data were collected. 79% of respondents (43/57) used a knapsack sprayer to apply pesticides on tomatoes, the remainder using either a broom (*mutsvairo*) or both knapsack sprayer and broom.

Table 17: Pesticides Most Recently Applied on Tomatoes

Pesticide	No. of respondents
Copper-oxychloride	5
Dithane M45	35
Karate	10
Rogor	5
Rogor + Carbaryl mix	1
Other	1
TOTAL	57

Pesticide application rates can be divided into two components: the concentration of the pesticide in the tank mix and the volume of liquid (tank mix) applied per unit area of crop.

As can be seen from Table 18, the concentration of the tank mix that farmers made varied enormously[20]. One grower claimed to use a concentration ten times the desired concentration. However, a difference is observed between chemicals that come in powder and in liquid form. According to Table 18, the average tank mix concentrations were below the recommended concentrations for Copper oxychloride and Dithane M45, both of which come in powder form. However, at 204 ml per litre, the average concentration for Karate was double that of the recommended concentration, whilst the average concentration of Rogor was 70% above the recommended concentration. Both of these products come in liquid form.

Table 18: Concentration of Pesticides in Tank Mix and Spray Volumes: Tomatoes

Pesticide	Reg.	Recommended concentration ($100l^{-1}$)	Range applied by respondents ($100l^{-1}$)		
			min	average	max
Copper-oxychloride	√	500 g		352 g	
Dithane M45	√	200-300 g	17 g	156 g (200 g)[1]	533 g (3333 g)[1]
Karate	√	100 ml	53 ml	204 ml	240 ml
Rogor	√	100 ml	107 ml	171 ml	320 ml
Spray volume	100 – 200 litres / ha		75 l/ha	1269 l/ha	7500 l/ha

[1] One grower used a very high concentration. Figures without brackets exclude this grower, figures within brackets include this grower.
N.B. Tank mixes for chemical combinations (e.g. Rogor + Carbaryl) cannot be calculated.

[20] To be able to calculate the tank concentration, the volume of the bottle cap used to measure the chemical into the tank needed to be known. Some enumerators actually recorded the size of bottle that the grower would use. Appendix Table 4 gives the actual volume of the caps used. In most cases, however, the size of the bottle was not recorded. In these cases it was assumed that a small bottle size was used by the grower and the smaller cap sizes were used for the calculations. In some cases this could lead to underestimation of the tank concentrations.

Even if the concentration of the tank mix is not correct, the correct amount of chemical can still be applied to a given area depending on the spray volume. Table 18 also, therefore, gives an overview of the spray volumes applied[21]. These varied from 75 l/ha to 7500 l/ha, while the recommended volume using a knapsack sprayer is 100-200 l/ha. In most cases growers applied excessive volumes per unit area, with an average of 1269 l/ha.

Table 19 shows the pesticides most recently on leafy vegetables for which detailed data were collected. In the case of leafy vegetables, 55% of growers (146/272) used a knapsack sprayer, a lower percentage than for tomato growers. The remainder used either a broom (*mutsvairo*) or both knapsack sprayer and broom.

Table 19: Pesticide Most Recently Applied on Leafy Vegetables

Pesticide	No. of respondents
Carbaryl	1
Dithane M45	5
Karate	17
Moto	3
Rogor	236
Rogor + Carbaryl mix	3
Rogor + Karate mix	1
Tameron	3
Other	4
TOTAL	272

Again concentrations of the tank mix varied enormously (Table 20). The pesticides in powder form - Carbaryl and Dithane M45 - had an average tank concentration below the recommended rate, whereas the liquid pesticides - Karate, Rogor and Tameron - had an average tank concentration two – three times the recommended concentration.

The spray volume by which the pesticides were applied on leafy vegetables varied from 10 l/ha to 12,500 l/ha, with an average spray volume of 1582 l/ha – again many times the recommended application rate.

[21] The spray volumes were calculated using the volume of the bucket or spray tank as indicated by the growers and the area to which the spray was applied. This cannot be correct in all cases. For example, the most extreme spray volumes, 10 l/ha and 12500 l/ha result from one grower applying 10 liter of spray over an area of 1 ha while on the other extreme a grower applied 2 litres of spray over an area of 16 m^2. Without actually observing the growers applying a spray it has to be assumed that the information provided is correct.

Table 20: Concentration of Pesticides in Tank Mix and Spray Volumes: Leafy Vegetables

Pesticide	Reg.	Recommended concentration ($100l^{-1}$)	Range applied by respondents ($100l^{-1}$)		
			min	average	max
Carbaryl	√	200 g		67 g	
Dithane M45	√	200 g	25 g	90 g	150 g
Karate	no		80 ml	175 ml (270 ml)[1]	600 ml (1800 ml)[1]
Moto	?		107 ml	142 ml	160 ml
Rogor	√	75 ml	40 ml	198 ml	1143 ml
Tameron	√	100 ml	107 ml	171 ml	320 ml
Spray volume	100 – 200 litres / ha		10 l/ha	1582 l/ha	12500 l/ha

[1] One grower used a very high concentration. Figures without brackets exclude this grower, figures within brackets include this grower.

N.B. Tank mixes for chemical combinations (e.g. Rogor + Carbaryl) cannot be calculated.

Verification of Pesticide Application Rates

Given the high pesticide application rates recorded in the 2001 survey, the follow-up survey conducted in October 2003 also collected information on pesticide application, so as to either confirm or refute the earlier findings. Ideally, enumerators would have observed producers applying pesticides to their tomatoes and leafy vegetables, but this proved difficult to arrange. Therefore, discussions on pesticide applications were held in the plots concerned, so that at least the areas covered could be verified by the enumerators. As noted in relation to fertiliser application, respondents were only growing viscose and tomatoes at the time of the follow-up survey.

The majority of respondents (18/20) said that they apply pesticides on viscose. Of these, fifteen applied Dimethoate (Rogor). Other pesticides applied on viscose were Tamaron, Vege-dust, Orthene, Mitac, Karate, Disyston and traditional remedies. Tamaron was applied by four respondents; the remainder by one each. Traditional remedies included use of ashes, tobacco waste, some leaf extracts as well as use of repellants (weeds) such as Mexican Marigold and Black Jack (*bidens pilosa*) to control pests. Some farmers mentioned using up to three chemicals (Dimethoate, Tamaron and diverse others) on viscose, depending on what was available at the time.

The majority of respondents (55%) used a knapsack sprayer to apply the chemical. Most of these farmers owned the knapsack sprayers. Only one of these farmers mentioned using a hired knapsack sprayer. Other methods of applying chemicals mentioned by respondents included grass broom *(mutsvairo)*, hand sprayer, tree branches (*muzeze*) and dusting using Vege-dust. Some farmers used a grass broom to apply Dimethoate as well as using traditional remedies. Dimethoate was also applied using tree branches. A hand sprayer was always used to apply Tamaron.

Application rates for Dimethoate (Rogor) were similar to those recorded in Table 20. Table 21 shows the results for ten respondents who applied Dimethoate using a knapsack. The

average tank mix concentration is somewhat lower than that recorded in Table 20, although nine of the ten respondents reported a concentration above the recommended level. The mean spray volume per hectare of viscose was almost identical to that recorded by the original survey. All ten respondents reported application rates of the active ingredient (Rogor) above the recommended level, with the mean figure being more than twelve times the recommended level[22].

Table 21: Application of Dimethoate (Rogor) on Viscose

N=10	Recommended Rate	Actual Application Rate ($100l^{-1}$)		
		minimum	average	maximum
Tank Mix	75 ml / 100 litres	53	119.33	180
Spray Volume	100 – 200 litres / ha	100	1620.42	3750

Meanwhile, the majority of respondents (70%) said that they applied chemicals every two weeks on viscose with the pesticide being applied just after harvesting. Only three said they applied chemicals less often – three or four times a year. This frequency of application is too high, given that produce should not be harvested for two weeks after the application of Dimethoate. The fact that farmers feel they have to spray so regularly may indicate that persistent high application rates have induced a degree of resistance in pests[23].

In the case of tomatoes, nine out of the ten tomato growers said they apply pesticides. The majority of these applied Dithane M45 (for the control of early and late blight). Other pesticides applied on tomatoes were Copper oxychloride, Tamaron, Bravo, Malathion, Karate, Dimethoate and traditional remedies. Traditional remedies included use of ashes, tobacco waste, some leaf extracts and Black jack to control pests. Four farmers mentioned using two or more chemicals on tomatoes depending on what was available. A combination of Dithane M45 and Copper oxychloride was used by three of these.

The majority of tomato growers (7/10) used a knapsack sprayer to apply chemicals. Most of these farmers owned the knapsack sprayers. Only one of these farmers mentioned using a hired knapsack sprayer. Other methods of applying chemicals were by grass broom *(mutsvairo)* and hand sprayer. A grass broom was used to apply Karate, Malathion and traditional remedies. A hand sprayer was used to apply Tamaron.

The majority of pesticide users (80%) said they applied chemicals on tomatoes between once a week and twice a month. Only 20% (2) said they applied chemicals less often –three or four times a year.

Reported application rates for Dithane M45 and Copper oxychloride are shown in Table 22. As in Table 18, where tank mix concentrations for powder chemicals were lower than recommended levels, the tank mix concentrations are low. However, also as in Table 18, the application rate (spray volume) per hectare of crop was well in excess of the recommended

[22] If 75ml of Rogor were mixed in 100 litres of water, then 200 litres of the mixture applied to one hectare, the application rate would be 150 ml per ha. The mean figure reported by these ten respondents was 1896 ml per ha.
[23] During the follow-up survey, some respondents said that they had reduced or stopped use of Dimethoate since the original survey, as "the strength of the chemical has decreased. It is no longer effective in pest control". An alternative explanation for their observation is that there is some resistance to Dimethoate developing in aphids.

rate. Overall, therefore, the application rate of active ingredient per hectare was generally in excess of the recommended level[24].

Table 22: Application of Dithane M45 and Copper Oxychloride on Tomatoes

N=7	Recommended Rate	Actual Application Rate ($100l^{-1}$)		
		minimum	average	maximum
Tank Mix	200-500g / 100 litres	33	61.9	100
Spray Volume	100 – 200 litres / ha	625	1797.35	5000

Taking the follow-up sample as a whole, 14 respondents (70%) said they scout for pest incidence before applying chemicals. The study did not establish the threshold at which the farmers sprayed and it is not clear how this squares with their reported practice of spraying every fortnight. Five said that they follow a calendar spraying routine.

Respondents were asked whether their chemical application varies across wet and dry seasons. 95% of respondents (19) said that it does. The majority of these (14) said they spray more regularly during the wet season particularly for tomatoes. Some of the explanations given for spraying more regularly during the wet season were that

- there are more diseases such as early blight
- rain washes off the chemical therefore there is need to spray after every shower.

By contrast, 25% (5) of respondents said that they spray leafy vegetables more frequently during the dry season. The major reason given for spraying more regularly in the dry season was high pest infestation, particularly aphids on viscose. Only three said that they apply more chemicals per spray on leafy vegetables during the wet period to make up for washing-off by the rains.

A Final Note on Methodology

Both the initial 2001 producer survey and the follow-up survey in 2003 recorded extremely high application rates of fertiliser (Compound X or AN) and chemicals (principally Rogor) on leafy vegetables. Are these figures credible?

One way to cross-check them is to assess the net returns to leafy vegetable production if these quantities of fertiliser and chemicals were indeed applied. We do this in Table 23. The calculations in this table use the following data and/or assumptions:

- the mean plot size in our sample was .56ha, the median was .4ha
- an average of 70% of total plot area is under cultivation of leafy vegetables throughout the year (assumption)
- the mean gross income from leafy vegetable production in 2001 was Z$500,000, the median was Z$200,000

[24] If 300g of Dithane were mixed in 100 litres of water, then 200 litres of the mixture applied to one hectare, the application rate would be 600 g per ha. The mean figure reported by these seven respondents was 1110 g per ha. However, this mean figure is heavily influenced by one high quoted rate. The remaining six quoted rates were either below 600 g per ha (three) or within 50% of it (three).

- the mean application of Compound X on viscose was 29,265 kg/ha during the course of a year, the median application was 17,600 kg/ha
- the price of Compound X was Z$26.25 per kg (during 2001 AN was sold at a controlled price of Z$7.5 per kg, Compound D at Z$45 per kg)
- Rogor was applied at the rate of 198ml per 100 litres of spray and at the rate of 1582 litres of spray per hectare
- Rogor was applied 20 times during the course of the year
- The price of Rogor was Z$200 per litre in 2001.

Table 23: Net Income for "Mean" and "Median" Leafy Vegetable Producers 2001

	"Mean" Producer		"Median" Producer	
	Calculation	Total (Z$)	Calculation	Total (Z$)
Gross Income		500000		200000
Fertiliser Costs	29625*26.25*0.39	303286	17600*26.25*0.28	129360
Chemical Costs	0.198*15.82*200 *20*0.39	4886	0.198*15.82*200 *20*0.28	3508
Net Income		191828		67132

The calculations in Table 23 suggest that the quoted input application rates are not impossible. However, they do/would seriously compromise the profitability of leafy vegetable production for growers. Moreover, it is the fertilizer application rates that do the most damage to profitability.

The initial 2001 producer survey and the follow-up survey in 2003 used essentially the same methodology in collecting data on fertilizer application. In neither case were actual applications observed. Thus, the data collected could possibly be subject to one of the possible flaws:

- Quantities applied per application could be overstated
- The area over which such applications were made could be overstated (although an attempt was made to cross-check this during the follow-up survey)
- The number of applications per month or year could be overstated.

Of these, the latter should be easiest for respondents to recall reliably - and application twice per month was a common response both times. It is, of course, possible that respondents believed that this was an application frequency that we wanted to hear. However, there is no obvious reason why this should be so. Quantities applied per application remain as yet unchecked. Field observation of fertilizer (and chemical) application would, therefore, still be worthwhile.

However, even if the figures cited in this report are over-estimates, the extent to which reported application rates exceed recommended levels suggest that there is a real phenomenon here. The *Conclusions and Recommendations*, therefore, proceed on this basis.

Conclusions and Recommendations

The survey work reported here found that, despite highly adverse economic conditions, smallholder horticultural producers in peri-urban areas are applying high levels of both fertilizer and pesticides, particularly on leafy vegetables. Application rates on tomatoes are also at or above recommended rates, but not at the excessive levels found for leafy vegetables.

These findings highlight a clear need for enhanced extension advice to producers of tomatoes and leafy vegetables, to show them that good quality produce can be obtained using lower levels of fertilizer and pesticides. This should be in their economic interest, as excessive input usage reduces the returns to production. However, if they are to change their production practices, they will have to be persuaded that they can still produce tomatoes and leafy vegetables that are acceptable to consumers without applying such high quantities of inputs. In turn, consumers may also need some education that deep green leaves and deep red tomatoes are not always the best. The need for enhanced extension advice also raises the need for greater attention to be given to horticulture within AREX, including in the training that its staff receive.

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Appendix Table 1: Pesticides Applied, plus rationale for application: Tomatoes

Pesticide	Rationale for application																							
	Aphids			Red spider mite			Other pests			Fungal/leaf diseases			Strengthen leaves			Encourage flowering			Routine spray			Other + no reason		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Carbaryl				1			**1**[1]							1					1					
Copper	1			8		1	1	1				**2**			1						1		3	
Dithane				28	4	2	1	1		**5**	**3**		2			1			1					1
Karate	1			16	6		2	1		1													2	
Kelthane					**1**																			
Rogor	**6**	**2**		4				2						1									2	
Other				3	1				1													1		1
None																							**1**	**1**
Answer 11?					1																			
Answer 12?					1						1											1		

[1] Entries bold and underlined indicate where the pesticide has been used for the correct reason. See also Appendix Table 3.

Appendix Table 2: Pesticides Applied, plus rationale for application: Leafy Vegetables

Pesticide	Rationale for application																	
	Aphids		Cutworm		Other pests		Aphids + cutworm		Aphids + other pests		Prevent colour loss		Only known pesticide		Cheap		Other + no reason	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Carbaryl	1		**2**[1]	**6**	**1**	**2**	**1**[2]	**1**										2
Copper	2	1		1		1						1						
Dithane	3	2	1	2					2									1
Karate	3	6	6	26	2	8		3	3	3								8
Malathion					**1**													
Moto	1	3	2	4		6		3										1
Rogor	**180**	**11**	4	2	1	1	**17**	**1**	**21**	**4**			4		1		3	
Tameron	**1**		2			**1**												
None	1			1		1											1	1
Other	1			3	1	1												
Answer 12?	3	6		1				1		1								

[1] Entries in bold and underlined indicate where the pesticide has been used for the correct reason.
[2] Entries in bold only indicate a partly correct usage of the chemical. See also Appendix Table 3.

Appendix Table 3: Pesticides, their Recommended Use and Rates on Brassicas and Tomatoes

Trade name	Active ingredient	Brassicas		Tomatoes	
		Rate ($100l^{-1}$)	For use against	Rate ($100l^{-1}$)	For use against
Carbaryl 85WP	carbaryl	75 ml	aphids red spider mite	100 ml	aphids
Copper Oxychloride 85WP	copper-oxychloride		no registration	500 g	early blight late blight leaf spot
Dithane M45	mancozeb	200 g	downy mildew	200-300 g	early blight late blight leaf spot
Karate	lambda-cyhalothrin		no registration	100 ml /ha	cutworm
Kelthane	dicofol		no registration	220 ml	red spider mite
Malathion	malathion	Varies with grade	aphids diamond back moth cabbage moth red spider mite	Varies with grade	aphids leaf hoppers red spider mite
Moto					
Tamaron 600SL	methamidophos	100 ml	aphids diamond back moth	100 ml	Heliothis bollworm leafminer semi-loopers
Rogor (or Dimethoate 40EC)	dimethoate	75 ml	aphids red spider mite	100 ml	aphids

Source: The Zimbabwe Crop Chemical Handbook, 1998.

Appendix Table 4: Volume of Bottle Caps according to Bottle Volume

	Volume of bottle							
Pesticide	50 ml	100 ml	200 ml	450 ml	500 ml	750 ml	1 l	5 l
Copper	-	-	-	-	-	6 g	-	-
Dithane	5 g	5 g	5 g	-	-	6 g	-	8 g
Karate	-	-	8 ml	-	8 ml	10 ml	-	-
Rogor	8 ml	8 ml	8 ml	not available	8 ml	not available	10 ml	13 ml
Tameron	8 ml	-	-	-	-	-	-	-