

**Food Security Research Project (FSRP) and
Division of Agricultural Statistics (DSA)**

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Research Report

**Rwandan Smallholder Coffee Tree Maintenance and Cherry
Processing Techniques**

Results of a National Farm-level Survey, 2002

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EXECUTIVE SUMMARY

This study is the third of a series of three reports on Rwanda's coffee sector. The focus of the study is an assessment of the current status of farmer practices in coffee tree maintenance and farm-level post-harvest coffee processing. The data come from a national survey of households growing coffee. The interview questions replicate a 1991 study addressing the same topics, so frequently it is possible to make ten-year comparisons of changes in farmer practices. The analysis also compares growers according to the number of trees the household manages. In general, differences are greater between the 1991 and 2001 country-wide averages than among various categories of 2001 growers—a highly unusual finding in African agriculture. The results indicate that some very basic steps might help improve productivity of Rwanda's coffee sector. Very few growers are planting new trees. The proportion of growers pruning their coffee has declined. Use of both inorganic and organic soil fertility-enhancing measures increased since 1991, but large numbers of farmers still do not use organic fertilizers, and less than 10% of growers use chemical fertilizers. The proportion of growers who use pesticides has declined from 96% to 57% since 1991. The proportion of growers who depulp the same day as the harvest has increased since 1991, but is still only 44% of growers. The percent of growers who use locally made depulping machines has increased since 1991, but some growers are still using rocks to depulp their coffee. Only 22% of growers ferment their depulped coffee in rust-free containers. Coffee drying techniques remain extremely crude, with by far the most common method being a mat spread on the ground. While larger growers are more likely to employ improved growing and processing techniques, overall, production practices of the average farmer have lost substantial ground over the past ten years. Large quantities of high quality coffee are “lost” to Rwanda because growers fail to employ “best” practices at nearly every stage of production and post-harvest processing. If steps are not taken to reward growers who produce superior coffee through price incentives for higher quality, Rwanda's coffee sector will likely decline even further from its current substantially reduced state.

I. INTRODUCTION

This paper is the third in a series of three reports by Rwanda's Food Security Research Project (FSRP) relating to Rwanda's coffee sector. The first (Loveridge et al. 2001) placed Rwanda's coffee in the context of the global market systems in which it must compete. The report documented the serious challenges in reversing the long term decline of Rwanda's coffee sector. The second (Loveridge et al. 2003) created comparisons with a study of 1991 coffee producers (Rwalinda et al., 1992). Loveridge et al. (2003) found, among other things, that the decline in coffee production is primarily due to reduced numbers of growers, and that production is more geographically concentrated than in pre-war years. The Loveridge et al. (2003) study also focused on prices farmers currently receive and potential grower responses to price changes that might occur in the future. While the first two FSRP coffee studies provide information for a broad range of policy-makers, this study's focus is on techniques growers use to enhance productivity of their trees and how the coffee is prepared for market after the harvest. As such, the study's primary intended audience is government or donor-funded groups who are actively involved in stimulating Rwanda's coffee marketing and production systems or private sector enterprises trying to identify ways to become more profitable in Rwanda.

The rest of this report is organized as follows. Section II provides a brief description of the method used to assemble the data. Section III focuses on grower cultural practices. Section IV reports on grower methods of preparing the harvest for sale. Section V provides some brief conclusions.

II. METHODS

The primary source of information in this report is data collected from a stratified random sample of agricultural households. The households are part of the national sample FSRP used to collect information on agricultural production in Rwanda. In January and February 2002, the FSRP enumerator team visited each household in the sample to complete a slightly modified version of a questionnaire developed for the Rwalinda et al. (1992) study. By repeating for the 2001 coffee season questions asked for the 1991 study, we have two nationally representative data points for many of the survey results, allowing some insights into how things have changed in the past decade. Some of the results have already been reported in Loveridge et al. (2003). This report focuses on the tree maintenance and post-harvest processing questions that were not fully explored in the earlier report. A full copy of the interview schedule is provided in Loveridge et al. (2003) so it is not reproduced here.

As with many of FSRP's studies, this report takes advantage of the fact that the sample of households is nationally representative. Our sampling process produces weights for each household, so that when responses are aggregated using the weights, the responses represent a statistically valid estimate for rural agricultural households by province or for the country as a whole. Readers desiring more complete information on the sampling and weighting procedure are referred to FSRP publication number 5e (FSRP, 2002).

Our basic method of analysis is to compare responses to the various questions at the national and provincial levels. To elucidate differences among small and larger growers, we established a "grower category" variable in Loveridge et al. (2003). Our key variable for "grower category" is the number of trees found on the plantation. Many of the tables that follow use the "number of trees" categories because it helps show major differences in how different types growers behave. Table 1 provides a breakdown of the number of growers in each province. Some growers weren't able to recall the number of trees they manage—

recorded in Table 1 as “don’t know”. In many of the tables that follow, the “don’t know” category is suppressed to improve readability of the report; the totals for Rwanda also include those growers in the “don’t know” category.

Table 1
Number of Growers
By Province and Grower Category

	Grower Category (Number of Trees)				
	5 to 49	50 to 97	100 to 198	200 to 1350	Don't Know
BUTARE	18561	12654	14819	19974	4656
BYUMBA	7508	8454	12369	9213	
CYANGUGU	4947	7630	4212	9832	7125
GIKONGORO	3264	4087	3425	8287	1334
GISENYI	8090	12619	13174	8001	3389
GITARAMA	5498	8235	10637	15443	5945
KIBUNGO	2093	3462	3539	7183	10283
KIBUYE		527	805	2644	1860
KIGALI RURAL	7315	7688	15178	8791	649
RUHENGERI	1450				
UMUTARA	3903	3394	1161	575	
RWANDA	62629	68750	79320	89941	35241

III. CULTURAL PRACTICES

New Plantings. New fields of coffee and routine replacement of old stands are obviously ways to increase production. The survey asked whether any new trees had been planted over the past six years (Table 2). Growers with the highest number of trees were more likely to have planted new trees than growers in the other categories—this seems quite logical. Overall, the proportion of growers who had planted new trees was quite small at just over 14%—a substantial reduction from the 45% reported by Rwalinda et al.

Table 2
Percentage of Growers Planting New Trees in 1995 – 2001
By Province and Grower Category

	Grower Category (Number of Trees)				Rwanda 2001**	Rwanda 1991
	5 to 49	50 to 97	100 to 198	200 to 1350		
BUTARE			6.8%	12.0%	5.2%	33%
BYUMBA	11.6%	13.6%	18.5%	33.1%	19.6%	*
CYANGUGU	47.0%	9.3%	18.4%	54.7%	34.5%	51%
GIKONGORO				17.0%	7.4%	63%
GISENYI		13.4%	13.5%	21.2%	12.3%	47%
GITARAMA			11.2%	22.7%	11.8%	32%
KIBUNGO	42.9%		76.2%	50.1%	44.2%	*
KIBUYE				50.0%	33.2%	71%
KIGALI RURAL				16.7%	3.8%	47%
RUHENGERI						26%
UMUTARA	15.0%	25.3%			16.0%	*
RWANDA	7.5%	6.4%	12.3%	26.5%	14.2%	45%

*Rwanda 1991 not reported here for Byumba, Kibungo, and Umutara because the borders of the provinces are not the same as in 1991. **The Rwanda 2001 column includes those households that did not know the number of trees they manage; in some cases this makes the provincial average outside the range of the categories.

Trimming. A basic activity associated with any tree-based crop is trimming the trees to increase their productivity. In Rwanda, two basic types of trimming are practiced on coffee trees: pruning or “gukata” in which trees are trained by cutting off branches from less productive parts of the tree and a less labor intensive activity known in French as “egourmandage” in which errant buds and dead branches are removed. Table 3 shows the proportion of growers who practice pruning by grower category and province. Overall, national participation in even this very basic yield-increasing activity is down from the 92% reported by Rwalinda et al. Larger growers are much more likely to engage in pruning than small growers. The survey asked those who do not prune why they do not prune. The most frequent response to this question in 1991 was “plants too young—78%” (Rwalinda et al., p. 17). By 2001 only 13% gave this as a reason, with increases in the proportion of growers citing lack of labor or simply not giving a reason. In 1991, Rwalinda et al. reported 94% of growers who pruned did so once or twice per year. In 2001, the comparable figure is 59% (Table 3). In contrast, the bud and dead branch removal pattern shown in Table 4 is quite similar to the 1991 figures.

Table 3
Percent of Growers who Prune their Trees
By Province and Grower Category, 2001

	Grower Category (Number of Trees)				Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	
BUTARE	78.5%	70.0%	77.2%	94.0%	82.5%
BYUMBA	45.8%	86.6%	93.8%	75.2%	78.0%
CYANGUGU	45.7%	60.4%	100.0%	100.0%	79.9%
GIKONGORO	59.3%	67.8%	80.9%	100.0%	83.8%
GISENYI	100.0%	95.9%	100.0%	100.0%	98.8%
GITARAMA	58.8%	85.3%	89.4%	95.3%	84.3%
KIBUNGO	57.1%	76.1%	74.6%	100.0%	76.3%
KIBUYE			100.0%	100.0%	81.9%
KIGALI RURAL	91.7%	92.1%	100.0%	100.0%	95.3%
RUHENGERI	100.0%				100.0%
UMUTARA	82.4%	82.8%	100.0%	100.0%	85.9%
RWANDA	73.6%	80.3%	91.4%	95.3%	85.4%

Table 4
Frequency of Tree Trimming Activities
By Grower Category, 2001

Activity	Frequency (per year)	Grower Category (Number of Trees)				Rwanda
		5 to 49	50 to 97	100 to 198	200 to 1350	
Pruning	1	39.1%	38.3%	41.7%	49.1%	43.6%
	2	23.0%	15.2%	16.9%	8.8%	14.3%
	3				2.2%	.6%
	5			1.2%	1.1%	.6%
	Less than once per year	30.5%	42.6%	35.0%	31.7%	34.5%
	When I pass through the fields	4.9%	1.4%	5.3%	6.3%	5.2%
Bud & dead branch removal	1	26.9%	18.4%	24.5%	20.5%	23.2%
	2	13.8%	16.8%	12.5%	8.3%	12.0%
	3		4.8%		4.8%	2.7%
	4			1.2%	.6%	.7%
	5			1.2%	1.0%	.6%
	Less than once per year	5.0%	7.2%	3.7%	9.2%	6.1%
When I pass through the fields	54.3%	52.8%	57.0%	55.6%	54.5%	

Weeding. More growers weed their entire coffee plantation now than in 1991 (88% versus 76%), with the largest growers most likely to weed (Table 5). Among those who weed, the distribution of the frequency of weeding is quite different than figures reported for 1991 (Table 5). Much of the difference may arise from reporting differences--the 2001 data include those households that did not know how many times they weeded—not reported in 1991. Some categories of growers weed less than the average 1991 grower, while others seem to be weed more.

Table 5
Percent of Growers Who Weed and Frequency of Weeding by Growers who Weed
By Grower Category

	Grower Category (Number of Trees)				Rwanda	Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	2001	1991
Percent Who Weed	80.4%	92.1%	85.5%	93.2%	88.3%	76%
Weedings per Year Among those Who Weed						
1	4.3%	3.8%	5.7%	5.7%	5.1%	
2	35.2%	25.4%	29.3%	25.1%	29.7%	58%
3	24.3%	22.6%	19.8%	24.5%	24.3%	33%
4	12.8%	16.4%	14.5%	4.9%	10.3%	9%
5	5.8%	2.8%	3.2%	4.2%	3.5%	
6		1.8%	4.8%	2.4%	2.9%	
7			2.5%	.6%	.6%	
8		3.6%		2.1%	1.1%	
10	5.2%	3.1%		.7%	1.4%	
12	1.0%	2.5%	.8%	2.7%	1.4%	
Don't Know	11.3%	17.8%	19.4%	27.0%	19.6%	
	100.0%	100.0%	100.0%	100.0%	100.0%	100%

Mulching. Mulching of coffee fields maintains soil fertility by enhancing organic material in the soil and by reducing the soil's exposure to erosion. Another benefit of mulching is retention of moisture (Coste, 1992). The practice of mulching has declined dramatically since 1991, when Rwalinda et al. reported 96% of growers employing the technique. In the 2001 season, only 65% of growers mulched (Table 6). As was the case in 1991, banana material is the most frequently mentioned form of mulch, but the frequency of the second most popular mulch—maize or sorghum stalks—is substantially reduced from 1991 (Table 6). The shift away from maize or sorghum stalks is likely due to reduced farmer interest in sorghum since the 1990s (Donovan et al.). Growers rely primarily on their own fields as sources of mulch, although there is clearly a market for mulching material. The grow-group with the least number of trees is more likely to have paid for all the mulch applied, while the largest growers combine purchased and own mulch (Table 7); smaller growers are more likely to have to purchase all of their mulch (Table 7).

Table 6
Percent of Growers Who Mulch; Types of Mulch by Grower Category—Percent of Growers Mentioning, and Comparison to 1991

	Grower Category (Number of Trees)				Rwanda 2001	Rwanda 1991
	5 to 49	50 to 97	100 to 198	200 to 1350		
Percent Who Mulch	46.7%	77.8%	72.4%	76.6%	65.4%	96%
Type of Mulch*						
Banana Leaves or Trunks	56.7	69.1	64.9	61.0	62.8	60%
Maize or sorghum stalks	33.4	33.3	35.7	24.3	29.9	52%
Pennisetum	34.8	16.6	26.5	20.7	21.4	22%
Ishinge (Erogrotis)	24.8	24.7	24.0	39.3	30.8	20%
Forest debris	10.8	11.8	12.7	25.5	16.8	15%
Grass grown for mulching	13.5	9.6	15.0	7.7	10.3	13%
Other	5.9	27.7	35.9	17.8	23.9	

*Multiple responses per household allowed.

Table 7
Sources of Mulch by Grower Category—Percent of Growers Mentioning (Multiple Responses per Household Allowed)

Sources of Mulch	Grower Category (Number of Trees)				Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	
Gather from Own Fields	74.2	76.3	81.7	79.7	77.5
Gather from Other Fields without Payment	14.5	12.3	13.2	22.2	16.1
Gather from Own and Others Fields without Payment	14.1	8.7	23.3	8.3	13.5
Purchase all of the Mulch	22.7	6.5	3.2	2.3	6.1
Gather Part and Pay for Part	7.9	15.6	20.3	39.4	22.3
Other		.8		1.2	.5

Manure or Compost. Rwalinda et al. did not report the exact percentage of growers using organic fertilizers on their trees at planting, saying only that “the majority” of households planting new trees used this fertility enhancing technique. As shown in Table 8, the comparable national figure for the 2001 season is 55%, which still accounts for a majority.

Composting on mature trees increased slightly to just under 13%, or about 3% higher than Rwalinda et al. reported for 1991. In 2001, more farmers listed lack of animals or that coffee was simply not a priority as reasons for not composting (Table 9).

Table 8
Growers' Use of Compost or Manure on Trees
By Grower Category

Timing of Composting		Grower Category (Number of Trees)				Rwanda
		5 to 49	50 to 97	100 to 198	200 to 1350	
Compost at planting?	Yes	45.2%	43.9%	58.1%	70.0%	55.1%
	No	50.9%	50.9%	39.6%	28.1%	41.8%
	Don't Know	3.9%	5.2%	2.3%	1.9%	3.1%
Total		100.0%	100.0%	100.0%	100.0%	100.0%
Compost on trees in place?	Yes	14.1%	9.8%	11.5%	15.4%	12.9%
	No	85.9%	90.2%	88.5%	84.6%	87.1%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%

Table 9
Grower Reasons for Not Composting
By Grower Category

	Number of Trees				Rwanda	Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	2001	1991
Grass is good enough as compost	31.1%	37.6%	41.1%	43.2%	37.8%	65%
Lack of animals or dung	33.3%	17.8%	27.4%	26.0%	26.0%	13%
Coffee is not a priority crop	16.8%	17.4%	15.1%	14.5%	16.6%	8%
Did not know about it/never saw it*	5.7%	12.0%	8.4%	5.3%	7.9%	*
Encourages pests/empty fruit	2.7%	4.1%	1.7%	4.4%	3.1%	2%
Soil is fertile enough	1.6%		1.8%	1.4%	1.7%	4%
Encourage excess leaves/pests	0%	0%	0%	0%	0%	4%
Other	8.8%	11.1%	4.7%	5.2%	6.9%	4%
Rwanda	100.0%	100.0%	100.0%	100.0%	100.0%	100%

*This response combined with "other" in the 1991 study.

Chemical Fertilizer. Rwanda's small growers are much less likely to use chemical fertilizer than other categories of growers. Overall the proportion of growers using chemical fertilizer has increased nearly fivefold from 1991. Even so, the proportion of growers using chemical fertilizer is still very low at just under 10% (Table 10). Reasons for not using chemical fertilizer have changed considerably since 1991 (Table 10). Growers are much more aware of fertilizer, but lack money to purchase fertilizer.

Table 10
Percent of Growers Using Chemical Fertilizer
and
Reasons for Not Using Chemical Fertilizer
By Grower Category

	Number of Trees				Rwanda 2001	Rwanda 1991
	5 to 49	50 to 97	100 to 198	200 to 1350		
Percent Using Fertilizer	6.9%	12.3%	9.7%	10.4%	9.9%	2%
Reasons for Not Using Fertilizer						
No money	53.5%	50.2%	58.7%	50.4%	52.5%	15%
Fertilizer not available	17.4%	22.3%	16.6%	27.4%	21.8%	40%
Don't know its usefulness/never saw	17.3%	14.2%	13.1%	13.4%	13.6%	38%
Soil is fertile enough			2.1%		.5%	4%
Grass works as fertilizer*	1.3%	7.7%	1.6%	3.1%	4.3%	*
Not profitable on coffee*	4.2%			2.4%	1.4%	*
Creates excess production followed by low yield*	.7%	1.2%	1.4%		.7%	*
Other	5.6%	4.4%	6.5%	3.3%	5.1%	2%
Total	100.0%	100.0%		100.0%	100.0%	100.0%

*These responses were combined with "other" in the 1991 study.

Pesticides. Pesticide use has declined dramatically since 1991, with only 57% of growers now using it. The largest growers are the most faithful to pesticides, with 72% of that group applying it to their coffee (Table 11). Because pesticide use was so high in 1991, with 96% of growers using it, Rwalinda et al. did not report reasons for not using pesticide in their report. In 2001, the top reason for not using pesticide is simply that it is not available (Table 11), and only 40% say it is always available when needed (Table 12). Among those who did find pesticides, distance to the source of the pesticide did not seem to present a large barrier, as the average time to the source was less than half an hour (Table 13). Only 45% thought that sufficient quantities of pesticide were available (Table 14). Fully 85% of growers who apply pesticides use a sprayer. Those who do apply pesticides are divided among those who apply it once (55%) and twice (45%); Table 15 indicates there is not much regional or grower-category variability in number of applications among users. When asked whether pesticides are effective, the majority of users stated they are effective or generally effective. While this response in isolation would not sound alarm bells, when compared to the 1991 responses, it represents a substantial decline in grower perception of pesticide effectiveness (Table 16). Thirty-six percent of pesticide users felt they could use more pesticide on their trees (Table 17). When asked whether they would increase the number of pesticide treatments for a 2 Frw charge per tree, 31% of growers using pesticide were ready to make this additional investment if they had to pay cash (Table 18), and 69% would do it if credit were available (Table 19). Growers with more trees appear less interested in making additional pesticide investments than growers with fewer trees (Tables 18 and 19), despite evidence from Table 17 that a larger proportion of large growers state they'd like to use more pesticide.

Table 11
Percent of Growers Using Pesticides and Reasons for Not Using Pesticides
By Grower Category

	Number of Trees				Rwanda	Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	2001	1991
Percent Using Pesticides	38.5%	50.8%	60.1%	72.2%	57.4%	96%
Reasons for Not Using Pesticides						
Not available	61.8%	49.5%	47.5%	54.8%	54.0%	*
Not enough money	2.9%	14.2%	3.9%	3.9%	7.4%	*
Don't know if it is useful		4.1%			2.3%	*
Other	35.3%	32.2%	48.6%	41.3%	36.3%	*
Rwanda	100.0%	100.0%	100.0%	100.0%	100.0%	*

*Rwalinda et al. did not report reasons for not using pesticides—at that time only 4% of growers did not use pesticides, so it was not an important issue.

Table 12
Are Pesticides Available When Needed? 2001
By Grower Category

	Grower Category (Number of Trees)				Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	
Yes	45.1%	38.8%	43.9%	39.7%	39.5%
Never		10.1%	5.6%	13.3%	8.7%
Not Always	54.9%	51.1%	46.8%	45.9%	50.5%
Don't Know			3.7%	1.0%	1.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Table 13
Average Walking Time in Minutes to Source of Pesticides, 2001
By Province and Grower Category

	Grower Category (Number of Trees)				Mean
	5 to 49	50 to 97	100 to 198	200 to 1350	
BUTARE	14	8	23	16	17
BYUMBA	20	35	59	10	35
CYANGUGU	12	13	15	16	16
GIKONGORO	.	87	28	67	61
GISENYI	21	34	14	27	22
GITARAMA	10	77	11	17	23
KIBUNGO	5	14	5	10	13
KIBUYE	.	.	30	30	32
KIGALI RURAL	14	19	45	22	31
RUHENGERI	.	.	.	.	.
UMUTARA	30	.	.	.	30
ALL	16	29	26	24	24

Table 14
Sufficient Quantities of Pesticide Available? 2001
By Grower Category

	Number of Trees				Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	
Yes	43.2%	38.7%	50.3%	47.5%	44.9%
Never		11.9%	7.5%	12.1%	9.7%
Not always	56.8%	49.4%	41.1%	39.3%	44.4%
Don't know			1.1%	1.0%	1.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Table 15
Average Number of Pesticide Applications
By Grower Category and Province, 2001

	Number of Trees				All
	5 to 49	50 to 97	100 to 198	200 to 1350	
BUTARE	1.3	1.4	1.4	1.3	1.3
BYUMBA	1.0	1.5	1.2	1.5	1.3
CYANGUGU	1.2	1.4	1.7	1.3	1.4
GIKONGORO	2.0	2.0	1.0	1.5	1.5
GISENYI	1.3	1.4	1.7	1.9	1.5
GITARAMA	1.4	1.5	1.3	1.2	1.3
KIBUNGO	2.0	1.5	1.0	1.3	1.4
KIBUYE	.	.	1.0	1.7	1.5
KIGALI RURAL	1.8	1.8	1.6	2.0	1.8
RUHENGERI	.	.	.	.	.
UMUTARA	2.0	.	.	.	2.0
ALL PROVINCES	1.4	1.5	1.5	1.5	1.5

Table 16
Grower Perspectives on Effectiveness of Pesticides
By Grower Category

	Number of Trees				Rwanda 2001	Rwanda 1991
	5 to 49	50 to 97	100 to 198	200 to 1350		
Very Effective	48.7%	31.6%	37.5%	33.4%	37.6%	74%
Generally Effective	21.5%	46.6%	48.3%	41.3%	40.4%	16%
Acceptable	11.5%	10.3%	7.3%	14.8%	11.8%	4%
Ineffective—insects are resistant	3.0%	3.8%	1.1%	1.9%	2.6%	
Ineffective—method or timing of application	12.9%	4.9%	2.3%	5.7%	5.0%	6%*
Other	2.5%	2.9%	3.4%	2.9%	2.7%	
	100.0%	100.0%	100.0%	100.0%	100.0%	100%

* Responses in these two “ineffective” categories were combined in the report from the 1991 study.

Table 17
Grower Desire to Use More Pesticides on Their Trees
By Grower Category

	Number of Trees				Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	
Yes	32.9%	40.8%	32.0%	41.8%	36.1%
No	38.3%	45.7%	47.1%	37.0%	42.0%
No, but improve current treatments	28.8%	13.5%	20.9%	21.2%	21.9%
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 18
Pesticide User Willingness to Pay 2 Frw/Tree Cash for an Additional Treatment
By Grower Category

	Number of Trees				Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	
Yes	65.8%	57.9%	29.3%	19.6%	30.8%
No	34.2%	37.1%	60.0%	63.5%	56.5%
Maybe		5.0%	10.6%	16.9%	12.6%
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 19
Pesticide User Willingness to Pay 2 Frw/Tree on Credit for an Additional Treatment
By Grower Category

	Number of Trees				Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	
Yes	80.8%	87.0%	56.2%	64.6%	68.8%
No	19.2%		29.4%	14.9%	11.7%
Maybe		13.0%	14.5%	20.5%	19.5%
	100.0%	100.0%	100.0%	100.0%	100.0%

IV. POST-HARVEST COFFEE PROCESSING TECHNIQUES

Depulping. Tables 20 and 21 provide insights into the distribution of grower depulping activities. Depulping the coffee quickly after harvest results in higher quality. Overall, Rwanda has improved in this measure since 1991, but growers who employ same-day depulping are still in the minority, and large growers (as one might expect) tend to have a harder time reaching the goal of same-day depulping than growers with fewer trees. Table 21 shows that Cyangugu has the lowest ability to depulp the day of harvest—this is critical since Loveridge et al. (2003) found that Cyangugu has a concentration of big coffee producers. Nationally, the most common way to depulp is to take the cherries to a large washing station operated by OCIR, MINAGRI, or the Commune. Still, only 44% of growers employ this technique (Table 25). Use of these large operations varies substantially from one province to the next; in Umutara the most common form of depulping is rocks. Cyangugu apparently lacks access to large-scale depulping operations. Nationally, the largest growers are more likely to use OCIR, MINAGRI, or the Commune than are other categories of growers (Table 23). The proportion of growers using locally made depulping machines has increased since 1991 (Table 24). It would be worthwhile investigating the quality of the output of these local machines.

Table 20
Timing of Depulping Operation (Days After Harvest)
By Grower Category

	Number of Trees				Rwanda	Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	2001	1991
Same Day	61.3%	45.0%	41.7%	42.3%	43.8%	31%
Day After	26.1%	38.4%	35.3%	38.4%	37.9%	51%
Part Same Day, Part Day After		1.7%	4.7%	3.4%	2.5%	9%
Part Day After, Part Two Days After		2.4%	6.3%	4.1%	3.3%	5%
Other	12.6%	12.6%	12.1%	11.8%	12.5%	3%
	100.0%	100.0%	100.0%	100.0%	100.0%	100%

Table 21
Timing of Depulping Operation (Days After Harvest)
By Province

	Same Day	Day After	Part Same Day, Part Day After	Part Day After, Part Two Days After	Other	Total
BUTARE	52.6%	35.8%		3.9%	7.7%	100.0%
BYUMBA	55.6%	27.0%		2.9%	14.4%	100.0%
CYANGUGU	13.0%	70.5%		3.7%	12.8%	100.0%
GIKONGORO	17.1%	69.1%		3.6%	10.3%	100.0%
GISENYI	62.4%	32.7%		3.7%	1.2%	100.0%
GITARAMA	63.4%	26.2%		2.2%	8.1%	100.0%
KIBUNGO	30.6%	40.3%	11.4%		17.7%	100.0%
KIBUYE	43.7%	23.2%	4.8%		28.3%	100.0%
KIGALI RURAL	22.7%	23.8%	14.5%	7.7%	31.4%	100.0%
RUHENGERI		100.0%				100.0%
UMUTARA	70.3%	29.7%				100.0%
RWANDA	43.8%	37.9%	2.5%	3.3%	12.5%	100.0%

Table 22
Depulping Methods
By Province

	Rocks	Sell Cherries to Large Washing Station	Use Own Machine on Farm	Use People who Move from Farm to Farm Depulping	Depulp at OCIR, MINAGRI, or Commune	Depulp with Machine Elsewhere	Other	Total
BUTARE	21.0%			3.6%	54.1%	20.3%	1.0%	100.0%
BYUMBA	42.6%			7.8%	32.5%	5.8%	11.3%	100.0%
CYANGUGU	3.2%		4.6%	73.2%	14.5%	3.7%	.9%	100.0%
GIKONGORO	22.4%				74.3%		3.3%	100.0%
GISENYI	5.0%	19.9%	27.7%	5.0%	33.5%	8.9%		100.0%
GITARAMA	3.1%		.9%	44.8%	51.1%			100.0%
KIBUNGO	38.8%			28.8%	28.1%	4.3%		100.0%
KIBUYE	41.9%			3.0%	52.1%		3.0%	100.0%
KIGALI RURAL	9.6%			6.0%	74.6%	8.4%	1.4%	100.0%
RUHENGERI	100.0%							100.0%
UMUTARA	54.7%				6.1%	39.2%		100.0%
RWANDA	16.8%	2.2%	4.0%	24.1%	43.6%	7.4%	1.9%	100.0%

Table 23
Depulping Methods
By Grower Category

	Number of Trees				Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	
Rock	37.8%	24.2%	14.3%	5.9%	16.8%
Sell Cherries to Large Washing Station	3.5%	5.5%	4.7%		2.2%
Use Own Machine on Farm	3.5%	5.5%	2.4%	5.7%	4.0%
Use People who Move from Farm to Farm Depulping	6.1%	8.4%	15.5%	26.4%	24.1%
Depulp at OCIR, MINAGRI, or Commune	34.1%	48.4%	47.7%	54.5%	43.6%
Depulp with Machine Elsewhere	11.5%	6.9%	15.3%	4.9%	7.4%
Other	3.5%	1.0%		2.6%	1.9%
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 24
Type of Depulping Machine
By Grower Category

	Number of Trees				Rwanda 2001	Rwanda 1991
	5 to 49	50 to 97	100 to 198	200 to 1350		
Locally Made	30.0%	17.7%	24.9%	33.2%	34.2%	4%
Industrially Made	70.0%	80.8%	73.1%	66.8%	64.5%	95%
Other		1.4%	2.0%		1.3%	1%
	100.0%	100.0%	100.0%	100.0%	100.0%	

Removal of Mucilage After Depulping. Growers were asked how they process the coffee after it is depulped. Normal coffee processing procedures call for removal of the bean's mucilage coating. Removing the mucilage helps the bean dry properly. Removal can be accomplished through fermentation (in water), or chemical and mechanical methods (Coste).

Fermentation in water is probably the most appropriate method for Rwanda, given lack of access to other types of inputs. The survey results show that very little of Rwanda's coffee is properly fermented. After depulping, 46% of growers put their coffee into a container (Table 25); of those 60% said the container was not rusty (Table 26) and 79% said the container also contained water (Table 27). Multiplying the three figures in the previous sentence provides the proportion of growers who soak their depulped coffee in rust-free water: 22%.

Table 25
Treatment After Depulping
By Grower Category

	Number of Trees				Rwanda 2001	Rwanda 1991
	5 to 49	50 to 97	100 to 198	200 to 1350		
Dry Immediately	8.6%	4.0%	7.6%	4.9%	8.2%	9%
Leave in a Container	60.2%	54.5%	48.4%	45.7%	46.8%	67%
Leave in a Bag or Basket	28.1%	40.4%	39.1%	46.2%	42.0%	24%
Other	3.2%	1.1%	4.9%	3.1%	3.0%	1%
	100.0%	100.0%	100.0%	100.0%	100.0%	100%

Table 26
Is the Container Rusty?
By Grower Category

	Number of Trees				Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	
Yes	32.5%	51.5%	43.1%	39.9%	39.1%
No	67.5%	48.5%	56.9%	60.1%	60.4%
Other					.5%
	100.0%	100.0%	100.0%	100.0%	100.0%

Table 27
Does the Container Have Water in It?
By Grower Category

	Number of Trees				Rwanda
	5 to 49	50 to 97	100 to 198	200 to 1350	
Yes	89.4%	72.7%	86.5%	67.7%	78.6%
No	10.6%	26.3%	11.2%	32.3%	19.9%
Other		1.0%	2.3%		1.6%
	100.0%	100.0%	100.0%	100.0%	100.0%

Drying. A greater proportion of growers use intermittent drying techniques than was the case in 1991 (Table 28). The most commonly used drying surface for coffee is the drying mat, although a smaller proportion of growers in 2001 reserve mats exclusively for coffee than was the case in 1991 (Table 29). The proportion of growers elevating their coffee for drying remains unfortunately at extremely low levels (Table 30), with 93% of growers drying coffee at ground level. A few of the largest growers (13.8%) do elevate at least some of their coffee for drying.

Table 28
Drying Interval by Grower Category

Drying Technique	Number of Trees				Rwanda 2001	Rwanda 1991
	5 to 49	50 to 97	100 to 198	200 to 1350		
Leave in sun--intermittently at beginning	27.1%	19.4%	13.2%	26.8%	21.9%	36%
Leave in sun intermittently after a day or more in the sun	50.2%	51.9%	63.2%	55.4%	51.9%	58%
Leave in sun until dry	21.3%	24.0%	21.7%	17.0%	24.8%	6%
Other		4.7%	2.0%	.8%	1.5%	
	100.0%	100.0%	100.0%	100.0%	100.0%	100%

Table 29
Drying Surface by Grower Category
(up to two responses per grower)

Drying Surface	Number of Trees				Rwanda 2001	Rwanda 1991
	5 to 49	50 to 97	100 to 198	200 to 1350		
Drying Trays	7.5	8.3	.8	9.1	6.2	2%
Cement Surface	1.2		.8		.6	*
Ikidasesa or coffee mat	28.3	34.8	29.9	48.6	36.2	66%
Other ikidasesa or mat	66.1	69.3	71.9	73.1	71.2	30%
Tin Roofing Material	1.2		1.0		.4	*
Ground	2.3	3.4		.7	1.3	*
Sack	6.3				1.1	*
Other	19.5	15.6	24.3	15.7	19.3	2%
Total	100.0	100.0	100.0	100.0	100.0	

*These categories were present in the 1991 survey instrument, but not reported by Rwalinda et al. It is possible these were combined into "other" in their report.

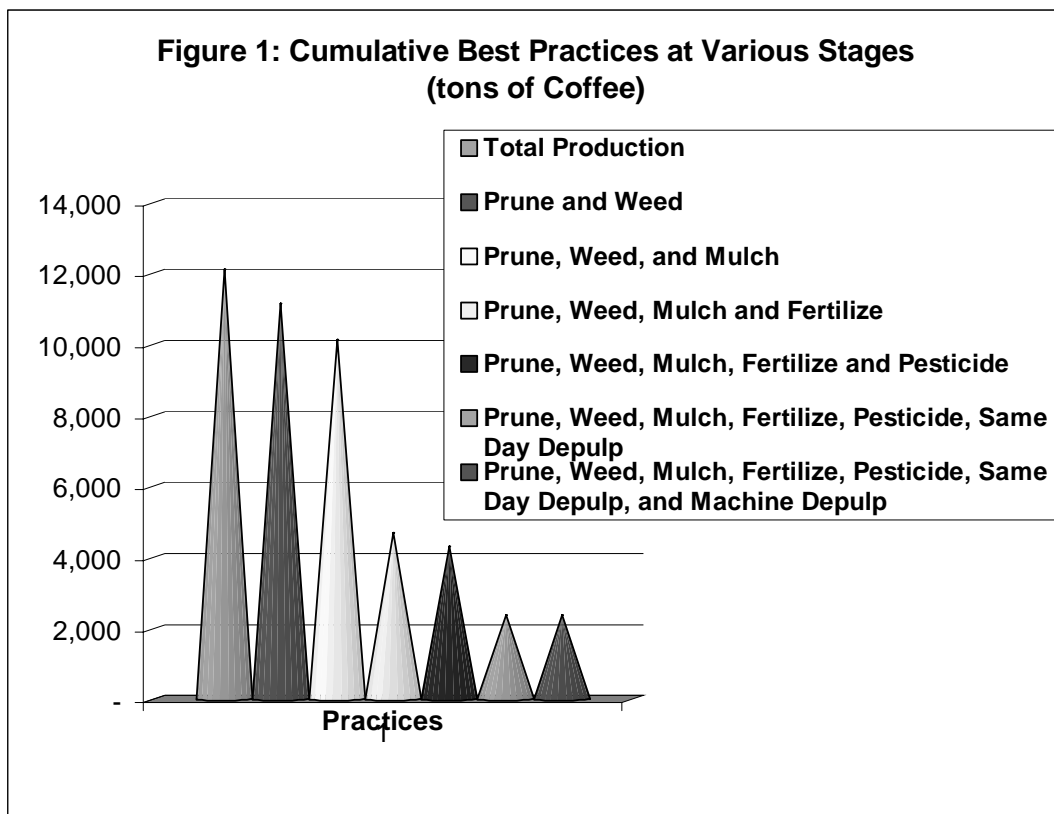
Table 30
Elevate Coffee for Drying?
By Grower Category

	Number of Trees				Rwanda 2001	Rwanda 1991
	5 to 49	50 to 97	100 to 198	200 to 1350		
Elevated	1.8%	5.3%	5.7%	9.7%	5.4%	6%
Ground Level	95.7%	93.0%	94.3%	86.2%	93.0%	93%
Both Elevated and Ground Level	2.5%	1.7%		4.1%	1.7%	1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100%

V. CUMULATIVE "BEST" PRACTICES

Previous sections of this document have focused on each practice separately. From an overall quality perspective, it is a series of "best" practices that ultimately lead to a superior bean. In this section, we attempt to portray how much coffee may "survive" quality challenges at various points under the grower's control. Figure 1 (drawn from Table A1 in the Appendix) captures the assessment by showing how much of Rwanda's coffee production enjoys multiple dimensions of quality-enhancing activities. Bean size is a dimension of

quality. Pruning, weeding, mulching, and fertilizing lead to bigger bean size. The second cone in Figure 1 indicates that about 10% of Rwanda's is not pruned and/or not weeded. The third cone indicates that of the pruned and weeded coffee, 10% is not mulched. About five thousand tons of the pruned, weeded, and mulched coffee does not receive organic or chemical fertilizer treatment. Pesticides reduce damage to beans, enhancing overall quality. There is considerable overlap between fertilizer use and pesticide use because the drop between the fourth and fifth cones is small. Same-day depulping of coffee cherries helps retain flavor (Coste). About half of the pruned, weeded, mulched, fertilized, and pesticide-protected coffee is then not depulped on the day of harvest. Machine depulping appears to be essential for same-day depulping as there is 100% overlap between machine use and same day depulping (cones 6 and 7 of Figure 1). Fermenting is the next critical step in the treatment of coffee. About 418 tons of coffee (all practices) is sold as cherries and our grower survey cannot track how it is then treated, so we can't say whether it is fermented. Of the remaining 2 thousand tons of "best practice" coffee not sold as cherries, only seven tons is fermented in containers free of rust. Elevated and constant drying are also recommended to retain flavor and to reduce foreign matter and insect infestation. Unfortunately, none of the seven tons of fermented best practice coffee is also dried in the recommended way. In summary, large quantities of high quality coffee are "lost" at nearly every step in the coffee production and post-harvest treatment process.



VI. CONCLUSIONS

The picture of change presented by comparing the 2001 and 1991 survey results is grim. In many respects, Rwanda's coffee sector is less technically advanced than it was ten years earlier, with only slight improvements fertilizer use and depulping. Growers are likely behaving rationally—lower international prices make it likely that intensification using technologies they know is not worth the effort. This conclusion mirrors that of a European Union study (Agrisystems Limited, 2002), which found that returns to labor were a principle barrier to improving the coffee sector. Given Rwanda's continually increasing land pressures, it is somewhat surprising that so many growers dedicate land to coffee without making basic investments to enhance productivity of their coffee trees. As shown in this study, those who have the greatest investments in terms of number of trees do tend their coffee plants and treat the harvested coffee better than other categories of growers, but even among the largest growers, there is much room for improvement. A return to the command and control agronomic policies of the past is not a recommended course of action for improving how growers treat coffee. Instead, incentives for growers to produce higher quality coffee should be reflected in the prices they receive. As long as Rwanda's internal marketing structures fail to strongly differentiate between various qualities of coffee, the sector will continue to decline. These marketing reforms should be matched with Extension programs to help farmers learn or relearn the practices that lead to high quality coffee, and with programs to help create sustainable systems for high quality post-harvest coffee processing.

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Table A1
Cumulative Best Coffee Production and Post-Harvest Practices
By Province, Rwanda, 2001
(Kilos of Coffee “Surviving” Each Stage)

	1. Prune and Weed	2. Prune, Weed, and Mulch	3. Prune, Weed, Mulch and Fertilize (organic or inorganic)	4. Prune, Weed, Mulch, Fertilize and Pesticide	5. Prune, Weed, Mulch, Fertilize, Pesticide, Same Day Depulp	6. Prune, Weed, Mulch, Fertilize, Pesticide, Same Day Depulp, and Machine Depulp	7. Sold as Cherries	8. Grower Kept Depulped Cherries	9. Best Cultural Practice and Ferment in Water w/o Rusty Container
BUT	921013	650013	.	.	.	.	.	.
BYU	1132036	924742	306264	136027	.	.	.	.
CYA	3496941	3347175	1793187	1750565	550637	550637	550637	.	
GIK	607844	563688	56838	56838	7061	7061	7061	7061	
GIS	3016073	3002516	2228925	2228925	1750905	1750905	417982	1396658	
GIT	552607	421632	65831	65831	59442	59442	.	59442	
KGO	586393	521708	160865	59158	.	.	.	.
KBY	307885	271291	10337	10337	.	.	.	.
KIG-R	361894	299398	.	.	.	.	.	.
RUH	.	.	.	.	.	.	.	.
UMU	155237	119920	66128	.	.	.	.	.
RWA	11137923	10122084	4688375	4307682	2368045	2368045	417982	2013798	
								7061	

Notes. Cumulative tests through column 6. Column 8 represents column 6 minus the coffee in column 7 that had all the characteristics mentioned in column 6. Column 9 is the coffee from column 8 that was also fermented in rust-free containers.