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

Food Security Survey: Phase I

Agricultural Production and Land Use Season 2000A

PREFACE

This report* is published by the Food Security Research Project (FSRP) and the Division of Agricultural Statistics (DSA) of the Ministry of Agriculture, Animal Resources, and Forestry (MINAGRI). The FSRP/DSA unit collects and publishes agricultural statistics and conducts agricultural policy studies on key food security issues.

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This report presents descriptive statistics and summary analysis of the Food Security Survey: Phase I, which was conducted during season 2000A on a national sample of 1,584 rural households and extrapolated over the total population. The results are interpreted on a national and where possible prefecture level.

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Food Security Survey: Phase I
Agricultural Production and Land Use
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1. INTRODUCTION

Rwanda is currently in transition from a period of emergency to one of development following the 1994 war and genocide. Before the tragic events of 1994, the Agricultural Statistics Division (DSA) of the Ministry of Agriculture, Animal Resources and Forestry (MINAGRI) maintained a comprehensive database of agricultural statistics. The DSA was responsible for providing information on agricultural policy based on annual surveys of rural households.

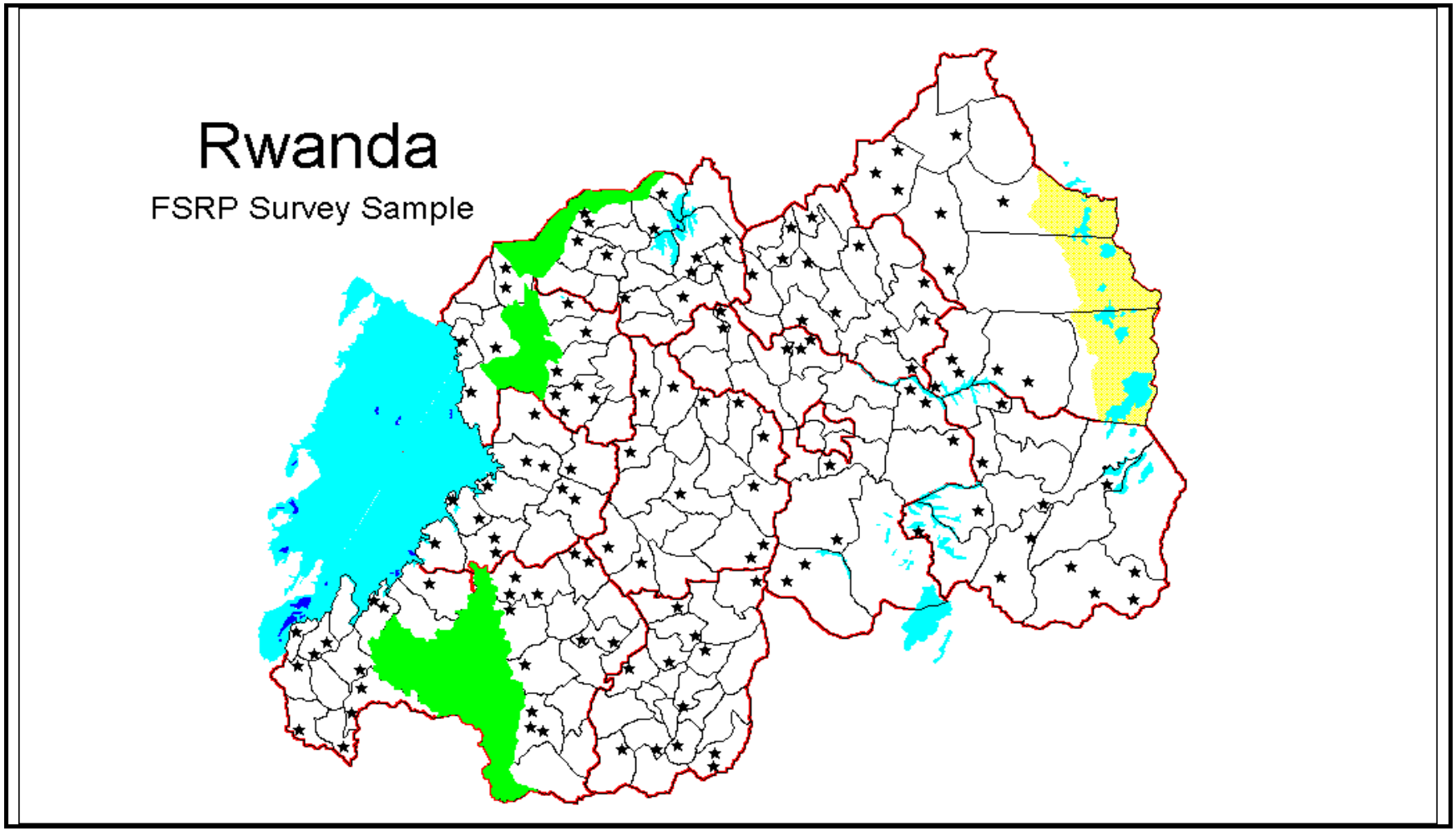
This database consisted of two parts: (1) an annual agricultural survey (crop production, land use, cultivated area, livestock, income and expenditure, etc.) and (2) a series of focused surveys/studies on selected topics such as crop sub-sectors (beans, sorghum, sweet potatoes, coffee), agroforestry, non-farm income strategies, farm inputs use, nutritional status, etc.

These surveys, which were interrupted in 1994 were resumed in 1999 by the Food Security Research Project (FSRP) and the Agricultural Statistics Division (DSA) of MINAGRI. The resumption of these activities were aimed at updating the agricultural statistics database and improving the internal capacity of MINAGRI to collect, process, and analyse data on key food security issues and to better inform the policy-making process in ways that will contribute to the promotion of food security in Rwanda.

The Food Security Survey: Phase I was conducted on a national sample of 1,584 randomly selected households[1] during season 2000A (see sample distribution map on page 2).

[1] Detailed comments on sample selection methodology are presented in Annex II.

Figure 1: FSRP/DSA Survey Sample Distribution.



Each star represents 12 households within a cellule. FSRP/DSA used 132 cellules, resulting therefore in a national sample of 1,584 households.

2. CROP PRODUCTION (Season 2000A)

Production (of principal food crops) in season 2000A resulted in 517,284,209 cereal equivalents, whereas it was 609,967,774 cereal equivalents in season 1990A. This is a production decrease of 15% (see table 1). The rural population of Rwanda, which was estimated at 6.8 million at the end of 1990 had increased to 7.7 million by 1999, a 13% increase. The production per capita has therefore decreased by 25% from 90 cereal equivalents in season 1990A to 67 cereal equivalents in season 2000A. In terms of calories, food crop production in season 2000A was equivalent to 1,190 kcal/person/day as compared to 1,591 kcal/person/day in season 1990A, a decrease of 25% as well. This suggests that domestic agricultural production is becoming less capable of adequately feeding a rapidly growing population[2].

In general, Rwandese farmers are continuing to cultivate traditional food crops such as cassava, Irish potatoes, sweet potatoes, bananas, beans, peas, maize, and sorghum. Table 2 shows that tuber production is most prominent followed by bananas, pulses, and finally cereals.

Cassava: Table 3 shows that 42% of cassava production in Rwanda is produced in the prefectures of Kibungo (26%) and Gitarama (16%), and 35% in the prefectures of Cyangugu (13%), Kibuye, and Kigali Rural (11% each). Comparing seasons 1990A and 2000A, cassava production at the national level has almost doubled and more than tripled in the prefectures of Cyangugu, Gikongoro, Gisenyi, Kibungo, and Kibuye; and decreased by 5% and 18% in Butare and Kigali Rural respectively.

Irish potatoes: Most of the Irish potatoes are produced in the prefectures of Gisenyi, Byumba, and Ruhengeri. Production in these prefectures represents 82% of national production for season 2000A. There was a slight increase of 2% in Irish potato production between seasons 1990A and 2000A.

Sweet potatoes: Production of sweet potatoes at the national level has increased by 37% between seasons 1990A and 2000A. Production almost doubled in the prefectures of Byumba and Gikongoro and increased by between 39% and 88% in Kigali Rural, Kibungo, and Kibuye. A slight increase of about 10% is noted for Butare and Cyangugu whereas production decreased by 72% in the prefecture of Gitarama and by 58% in Ruhengeri.

Bananas: Nationally, banana production decreased by 62% between season 1990A and season 2000A. A strong decrease is noted in Kigali Rural (84%), Kibungo (79%) and Gitarama (66%). Production decreased by between 37% and 57% in Byumba, Gisenyi, Butare, Cyangugu, Gikongoro and Ruhengeri. The high decrease in banana production may be due to several factors some of which are: a high incidence of fusarium (a fungal disease) in Rwanda during this period; abandoned and untended banana plantations since 1994; the villagisation resettlement policy resulting in fields being far from the home; and the insufficient rainfall that has characterised the past two years.

Beans: Bean production is highest in the prefectures of Kibungo (19% of national production) and Byumba (18%). The next highest production is found in the prefectures of Kigali Rural and Ruhengeri (about 11% of national production each). At the lower end of the

[2] The recommended caloric intake for Rwanda is 2,100 kcal/person/day.

production scale are the prefectures of Gikongoro, Gitarama, Kibuye, and Cyangugu where production is between 3% and 5% of national production. In season 1990A, national bean production was 135,809 tonnes (see table 13) but fell to 99,613 tonnes in season 2000A, a reduction of 27%. Between season 1990A and 2000A, bean production decreased considerably in Kigali Rural (71%), Gitarama (66%) and Butare (30%). But there has been an increase in production in the prefectures of Gisenyi (54%) and Kibungo (13%).

Maize: Maize production is most important in the prefectures of Gisenyi, Byumba, and Ruhengeri. In fact, 58% of maize production in Rwanda is found in these three prefectures. Comparing season 1990A to season 2000A it is noted that maize production in Rwanda decreased by 51%. The largest decline was noted in Kibuye (91%), Gisenyi (65%), and Ruhengeri (62%).

Crop production per household: Table 4 shows the quantities (kg) of crops produced per household. Compared with season 1990A, we note that average production per household has declined for almost all the food crops. Only cassava and sweet potato production (per household) has increased. This situation may be attributed to some of the following factors: population growth, non-use of improved inputs, and insufficient rains over the past two years.

Table 1: Production (cereal equivalents) and kilocalories per person per day for seasons 1990A and 2000A[3].

	Cereal Equivalents		
Crop	**Season 1990A**	**Season 2000A**	**Variation in %**
Beans	127,629,267	93,613,341	-27%
Peas	6,012,374	4,339,205	-28%
Peanuts	3,172,604	3,070,902	-3%
Soya Beans	8,742,214	4,584,998	-48%
Sorghum	26,286,794	18,130,448	-31%
Maize	81,196,000	39,634,000	-51%
Wheat	2,403,605	2,099,404	-13%
Millet	433,334	1,380,393	219%
Rice	1,386,375	2,462,099	78%
Cassava	43,440,793	89,837,569	107%
Irish potatoes	26,281,224	26,894,391	2%
Sweet potatoes	122,120,942	167,117,118	37%
Arrow root	4,882,423	4,604,826	-6%
Yams	72,541	206,198	184%
Bananas	155,907,284	59,309,319	-62%
Total	**609,967,774**	**517,284,209**	**-15%**
Rural Population	6,793,208	7,703,911	13%
Cereal eq. per capita	90	67	-25%
kcal/person/day	**1,591**	**1,190**	**-25%**

[3] One cereal equivalent equals 3,225.32 kilo calories.

Table 2: Production (in tonnes) by group of crops and by prefecture, season 2000A.

	Butare	Byumba	Cyangugu	Gikongoro	Gisenyi	Gitarama	Kibungo	Kibuye	Kigali Rural	Ruhengeri	Umutara	Rwanda
Pulses	9,531	20,112	5,181	3,802	10,956	5,327	20,312	5,366	11,271	11,366	8,466	111,690
Cereals*	2,851	9,432	3,965	2,133	13,035	1,869	6,275	1,674	3,576	8,131	9,871	62,812
Tubers	88,426	134,916	57,981	76,932	158,452	65,401	116,898	97,904	81,326	44,596	29,773	952,605
Bananas	61,118	100,812	33,881	10,454	38,105	70,852	69,148	38,121	46,877	38,115	24,579	532,061

(*) Sorghum, maize, wheat, and millet (rice is not included).

Table 3: Production of selected crops (in tonnes) by prefecture, season 2000A.

	Butare	Byumba	Cyangugu	Gikongoro	Gisenyi	Gitarama	Kibungo	Kibuye	Kigali Rural	Ruhengeri	Umutara	Rwanda
Beans	7,456	18,114	4,817	3,045	9,647	4,529	18,942	4,634	10,901	10,712	6,816	99,613
Maize	1,604	6,882	2,836	872	10,449	*	4,461	1,630	1,409	5,587	3,760	39,634
Cassava	21,356	9,331	37,973	8,027	10,087	45,283	72,709	31,720	31,631	*	14,292	283,221
Irish potatoes	3,590	31,582	*	4,435	69,019	*	2,168	10,644	*	23,981	3,353	151,015
Sweet potatoes	62,015	92,907	17,356	64,074	78,206	17,307	37,580	48,594	49,289	19,804	11,703	498,835
Bananas	61,118	100,812	33,881	10,454	38,105	70,852	69,148	38,121	46,877	38,115	24,579	532,061

(*) Observations not sufficient to make estimation at prefecture level.

Table 4: Production of selected crops (in kg) per household and by prefecture, seasons 1990A and 2000A.

		Butare	Byumba	Cyangugu	Gikongoro	Gisenyi	Gitarama	Kibungo	Kibuye	Kigali Rural	Ruhengeri	Umutara	Rwanda
Beans	1990	68	177	40	26	50	80	173	57	230	104		107
	2000	53	124	47	32	60	29	138	51	63	63	106	69
Maize	1990	7	34	50	21	239	12	22	192	15	104		64
	2000	11	47	27	9	65	*	32	18	8	33	58	27
Cassava	1990	144	62	92	18	17	189	180	36	233	24		108
	2000	151	64	368	84	63	285	529	348	182	*	222	196
Irish potatoes	1990	26	42	28	54	285	23	25	70	24	551		116
	2000	25	216	*	46	432	*	16	117	*	141	52	105
Sweet potatoes	1990	366	305	175	309	189	376	238	283	215	339		287
	2000	437	636	168	667	489	109	274	532	283	117	182	346
Bananas	1990	747	1,136	837	238	577	1,263	3,380	281	1,826	630		1,100
	2000	431	690	328	109	238	447	503	418	269	225	381	369

(*) Observations not sufficient to make estimation at prefecture level.

3. LAND USE (Season 2000A)[4]

Table 5 shows that on average 79% of all households in Rwanda have 1 hectare (ha) of land or less. In the prefectures of Cyangugu and Butare, 79% and 69% of households have 50 ares[5] (0.5 ha) or less. Table 5 also shows that in some prefectures more than 35% of households have more than 1 ha (44% in Kibungo, 40% in Gikongoro, and 36% in Gitarama).

Total farmland in Rwanda is 1,031,250 ha (see table 6). Total cultivated farmland is 839,874 ha (see table 11), which represents 81% of total farmland. Pasture and woodlot occupy 10% and 6% respectively of the total farmland (see table 9).

Table 7 shows that the average household farm in Rwanda has an area of 71 ares. The prefectures whose farms have more than 1 ha on average are Gikongoro (1.26 ha), Gitarama (1.06 ha), and Kibungo (1.04 ha). The prefectures that have average farm areas below the national average are Byumba (61 ares), Umutara (59 ares), Ruhengeri (52 ares), Gisenyi (51 ares), Butare (48 ares), and Cyangugu (37 ares).

3.1 Cultivated Area

Tables 8 and 9 show the area occupied by each crop (or group of crops). At the national level, 25% of farmland is cultivated with tubers, followed by pulses and bananas (21% each).

Ranking crops by the cultivated area they occupy yields the following (see table 10): bananas (25%), beans (22%), cassava (13%), sweet potatoes (11%), and maize (8%). As shown by table 10, the distribution in each prefecture is slightly different from the national distribution. As in season 1990A, bananas occupied 25% of the cultivated crop area followed by beans which occupied 22%.

The cultivated area occupied by tubers increased significantly as opposed to the other crops: 65% for cassava and 28% for sweet potatoes. For each particular crop, the change in cultivated area varies from prefecture to prefecture. For example, the area occupied by beans increased by 68% in Cyangugu, by 42% in Kibungo, by 22% in Kigali Rural, by 20% in Gikongoro, and by 9% in Gisenyi. There was a decrease of 27% in Ruhengeri, 20% in Gitarama, and 13% in Butare. In comparison with season 1990A, the total cultivated area in season 2000A increased by 7%.

[4] After reviewing preliminary land use figures for season 2000B, we believe that the season 2000A figures are underestimated for the following reasons: (i) As this was the first time the enumerators were measuring farmers' fields, farmers were suspicious that the information could be used to expropriate some of their land and hence did not show all their fields to the enumerators; (ii) enumerators had not yet mastered land measurement techniques, especially in Umutara, Kibungo, and Kigali Rural. Improved cooperation of farmers during season 2000B and improved measurement methods should result in more accurate estimates.

[5] 1 are = 0.01 hectares.

Table 5: Households (in %) by farmsize and by prefecture, season 2000A.

	Farmsize (ha)							Total
	0 .00- 0.25 ha	0.25 - 0.50 ha	0.50 - 0.75 ha	0.75 - 1.00 ha	1 - 2 ha	2 - 3 ha	3 ha & +	
Butare	42	27	14	7	8	2	1	100
Byumba	33	25	14	9	16	1	1	100
Cyangugu	53	26	9	8	4		0	100
Gikongoro	10	25	14	11	21	10	9	100
Gisenyi	34	29	19	7	9	0	2	100
Gitarama	13	27	18	7	23	7	6	100
Kibungo	14	10	18	13	34	9	2	100
Kibuye	30	32	10	7	11	5	4	100
Kigali Rural	31	27	19	4	12	5	2	100
Ruhengeri	34	30	15	10	9	0	1	100
Umutara	32	19	16	11	21	1		100
RWANDA	29	26	16	8	15	4	2	100

Table 6: Total farm area (in %) by farmsize and by prefecture, season 2000A.

	Farmsize (ha)							Total (Ha)
	0 .00- 0.25 ha	0.25 - 0.50 ha	0.50 - 0.75 ha	0.75 - 1.00 ha	1 - 2 ha	2 - 3 ha	3 ha & +	
Butare	12	19	17	12	24	9	6	**68,184**
Byumba	8	15	14	13	38	5	6	**88,666**
Cyangugu	17	26	15	17	14	,	11	**37,740**
Gikongoro	1	7	7	8	23	19	35	**120,757**
Gisenyi	9	20	22	12	23	2	13	**81,760**
Gitarama	2	9	10	6	29	16	27	**168,529**
Kibungo	1	4	12	11	46	20	7	**142,972**
Kibuye	7	15	9	8	22	16	23	**66,729**
Kigali Rural	5	12	16	5	22	18	23	**130,569**
Ruhengeri	11	22	18	17	23	2	7	**87,489**
Umutara	8	12	16	16	45	3	,	**37,854**
RWANDA	6	13	13	10	29	12	17	**1,031,250**

Table 7: Average household farmsize (in ares) by prefecture, season 2000A.

	Farmsize (ha)							**Total**
	0 .00- 0.25 ha	0.25 - 0.50 ha	0.50 - 0.75 ha	0.75 – 1.00 ha	1 - 2 ha	2 - 3 ha	3 ha & +	
Butare	14	35	60	85	142	219	393	**48**
Byumba	15	36	60	86	142	235	497	**61**
Cyangugu	12	37	59	81	125	,	949	**37**
Gikongoro	15	35	61	86	142	245	469	**126**
Gisenyi	14	35	61	85	125	235	402	**51**
Gitarama	18	36	63	85	139	241	508	**106**
Kibungo	7	40	66	88	142	233	418	**104**
Kibuye	16	35	61	85	144	240	443	**73**
Kigali Rural	12	35	61	88	135	242	916	**75**
Ruhengeri	16	37	62	86	137	217	366	**52**
Umutara	14	36	59	87	128	243	,	**59**
RWANDA	14	36	62	86	138	238	511	**71**

Table 8: Land use (in ha) by group of crops and by prefecture, season 2000A

	Butare	Byumba	Cyangugu	Gikongoro	Gisenyi	Gitarama	Kibungo	Kibuye	Kigali Rural	Ruhengeri	Umutara	Rwanda
Pulses	13,014	24,931	10,579	12,237	11,600	15,752	42,912	12,879	35,043	19,412	8,009	206,368
Cereals	6,866	5,331	6,219	20,957	17,621	4,720	8,652	8,887	12,176	29,243	9,732	130,403
Tubers	13,558	14,474	5,792	33,616	19,708	63,131	35,803	14,290	26,829	15,658	7,560	250,420
Bananas	13,973	20,205	6,716	15,662	13,063	44,640	31,188	10,657	33,845	12,610	7,479	210,038
Vegetables and other food crops	1,492	*	560	574	*	1,309	1,474	*	*	*	*	7,088
Coffee and other industrial crops	2,539	2,513	3,848	1,764	7,046	10,370	2,045	1,667	3,497	*	*	35,558
Fallow and pasture	7,550	17,586	718	13,883	9,518	9,292	12,778	7,640	6,589	8,135	7,139	100,829
Forest	4,204	2,071	845	18,727	1,741	16,674	*	10,452	6,663	1,252	*	63,045
Total	63,196	87,382	35,277	117,419	80,824	165,889	135,083	66,590	125,204	86,331	40,552	1,003,748

(*) Observations not sufficient to make estimation at the prefecture level.

Table 9: Land use (in %) by group of crops and by prefecture, season 2000A.

	Butare	Byumba	Cyangugu	Gikongoro	Gisenyi	Gitarama	Kibungo	Kibuye	Kigali Rural	Ruhengeri	Umutara	Rwanda
Pulses	21	29	30	10	14	9	32	19	28	22	20	21
Cereals	11	6	18	18	22	3	6	13	10	34	24	13
Tubers	21	17	16	29	24	38	27	21	21	18	19	25
Bananas	22	23	19	13	16	27	23	16	27	15	18	21
Vegetables and other food crops	2	*	2	0	*	1	1	*	*	*	*	1
Coffee and other industrial crops	4	3	11	2	9	6	2	3	3	*	*	4
Fallow and pasture	12	20	2	12	12	6	9	11	5	9	18	10
Forest	7	2	2	16	2	10	*	16	5	1	*	6
Total	100	100	100	100	100	100	100	100	100	100	100	100

(*) Observations not sufficient to make estimation at the prefecture level.

Table 10: Cultivated area of selected crops (in %) by prefecture, season 2000A.

	Butare	Byumba	Cyangugu	Gikongoro	Gisenyi	Gitarama	Kibungo	Kibuye	Kigali Rural	Ruhengeri	Umutara	Rwanda
Beans	23	33	30	11	14	10	31	23	31	21	23	22
Maize	2	4	12	11	20	1	4	18	3	17	11	8
Cassava	15	5	9	12	2	33	14	8	13	*	15	13
Irish potatoes	*	6	*	2	13	*	1	6	1	15	1	4
Sweet potatoes	9	10	7	25	13	9	13	13	10	5	7	11
Bananas	27	30	20	18	19	32	26	22	30	16	23	25

(*) Observations not sufficient to make estimation at the prefecture level.

Table 11: Cultivated area (in ha) by crop and by prefecture, season 2000A.

	Butare	Byumba	Cyangugu	Gikongoro	Gisenyi	Gitarama	Kibungo	Kibuye	Kigali Rural	Ruhengeri	Umutara	Rwanda
Beans	12,062	22,495	10,025	8,959	9,937	14,326	38,337	11,205	35,033	16,344	7,556	186,279
Peas	*	1,136	*	2,495	1,261	*	535	1,105	*	2,995	*	9,746
Groundnuts and soya	948	1,300	437	783	*	1,339	4,040	569	*	*	441	10,343
Sorghum	5,883	2,014	344	11,099	3,039	2,946	4,229	*	8,629	10,931	5,793	54,908
Maize	983	3,036	3,880	9,531	13,669	1,773	4,307	8,691	3,538	13,371	3,678	66,455
Other cereals (wheat, millet, rice)	*	*	1,994	326	913	*	*	*	*	4,942	261	9,040
Cassava	7,713	3,082	3,110	10,035	1,146	46,524	17,273	3,659	14,606	*	4,986	112,235
Irish potatoes	*	4,390	*	1,502	8,794	*	1,791	3,150	932	11,456	340	32,909
Sweet potatoes	4,620	6,482	2,416	20,959	9,347	12,880	15,528	6,477	10,660	4,002	2,165	95,537
Other tubers (yams , etc.)	798	520	*	1,120	420	3,656	1,210	1,005	*	*	*	9,738
Vegetables and other food crops	1,492	*	560	574	*	1,309	1,474	*	*	*	*	7,088
Bananas	13,973	20,205	6,716	15,662	13,063	44,640	31,188	10,657	33,845	12,610	7,479	210,038
Coffee	2,448	2,090	3,436	1,150	3,977	10,370	2,045	1,030	3,015	*	*	29,828
Other industrial crops	*	*	412	615	3,070	*	*	638	*	*	*	5,730
Total	51,442	67,725	33,713	84,810	69,564	139,923	122,075	48,498	111,952	76,945	33,227	839,874

(*) Observations not sufficient to make estimation at the prefecture level.

Table 12: Farmsize (in ares) per household, by crop and by prefecture, season 2000A.

	Butare	Byumba	Cyangugu	Gikongoro	Gisenyi	Gitarama	Kibungo	Kibuye	Kigali Rural	Ruhengeri	Umutara	Rwanda
Beans	8	15	10	9	7	9	29	12	19	9	12	13
Peas	*	1	*	3	1	*	*	1	*	1	*	1
Groundnuts and soya	1	1	*	1	*	1	3	1	*	*	1	1
Sorghum	5	1	*	12	2	2	3	*	5	7	9	6
Maize	1	2	4	10	9	1	3	9	2	8	6	6
Other cereals (wheat, millet, rice)	*	*	3	*	1	*	*	*	*	2	1	1
Cassava	5	2	3	11	1	31	12	4	9	*	9	11
Irish potatoes	*	3	*	2	5	*	1	3	1	6	1	4
Sweet potatoes	3	4	2	22	7	8	10	7	6	2	4	8
Other tubers (yams, etc.)	1	*	*	1	*	2	1	1	*	*	*	1
Bananas	10	13	8	16	9	27	20	12	22	8	11	15
Other food crops	1	*	*	1	*	1	1	*	*	*	*	1
Coffee and other industrial crops	2	2	4	2	3	8	2	2	2	*	*	4
Fallow, pasture	5	12	1	9	9	5	8	7	4	4	11	8
Forests	3	2	1	19	1	9	*	11	3	1	*	8
Other usage	*	*	*	6	*	1	*	1	*	*	1	4
Mean area per household	45	60	34	122	51	105	98	73	72	51	63	69

(*) Observations not sufficient to make estimation at the prefecture level.

ANNEX I: CROP PRODUCTION (Season A, 1984-2000)

Table 13: Production of particular crops by prefecture for seasons A, 1984 - 2000.

Crop	Year	Butare	Byumba	Cyangugu	Gikongoro	Gisenyi	Gitarama	Kibungo	Kibuye	Kigali	Ruhengeri	Umutara	Rwanda
Bananas	1984	*	*	*	*	*	*	*	*	*	*		*
	1986	89,798	125,704	73,939	23,041	107,254	139,012	261,925	32,649	171,875	74,701		1,099,897
	1987	97,220	121,014	73,231	26,081	95,214	150,806	281,828	26,742	192,856	78,573		1,143,566
	1988	104,462	139,511	85,013	33,472	110,014	200,584	277,011	31,053	242,689	95,172		1,318,981
	1989	111,731	148,888	77,027	24,545	85,227	195,201	296,034	24,554	287,764	98,443		1,349,415
	1990	116,733	160,628	75,584	23,983	71,898	207,772	362,655	25,728	301,108	88,544		1,398,634
	2000	61,118	100,812	33,881	10,454	38,105	70,852	69,148	38,121	46,877	38,115	24,579	532,061
Beans	1984	30,618	27,206	10,065	10,785	10,125	21,299	19,552	12,408	34,509	15,564		192,131
	1986	29,817	21,777	7,430	10,109	16,044	25,244	19,946	10,214	38,963	14,401		193,945
	1987	26,057	17,482	3,990	6,146	11,197	17,174	14,331	5,520	27,146	11,602		140,645
	1988	18,228	22,880	4,173	6,861	12,763	18,573	16,664	5,998	32,579	12,844		151,563
	1989	12,979	20,827	4,181	3,799	8,872	18,211	20,420	5,734	29,396	15,168		139,587
	1990	10,648	24,998	3,597	2,626	6,254	13,228	16,750	5,228	37,923	14,557		135,809
	2000	7,456	18,114	4,817	3,045	9,647	4,529	18,942	4,634	10,901	10,712	6,816	99,613
Maize	1984	2,440	6,871	6,842	2,484	25,858	1,952	1,798	23,564	5,500	18,993		96,302
	1986	2,265	5,849	8,508	4,051	19,521	4,120	3,679	43,210	9,692	17,077		117,972
	1987	2,220	5,963	8,165	4,220	15,528	2,920	3,005	27,055	4,419	15,332		88,827
	1988	1,577	4,603	7,060	5,169	22,381	3,315	1,749	36,388	6,061	23,543		111,846
	1989	1,344	3,648	5,285	3,060	27,055	1,444	2,012	18,795	4,239	15,726		82,608
	1990	1,145	4,814	4,478	2,149	29,791	1,980	2,129	17,604	2,440	14,666		81,198
	2000	1,604	6,882	2,836	872	10,449	*	4,461	1,630	1,409	5,587	3,760	39,634
Cassava	1984	23,782	7,985	14,085	8,567	10,681	32,581	21,548	8,704	40,989	3,692		172,614
	1986	42,304	3,114	8,855	9,170	7,643	50,765	14,135	5,165	34,079	2,334		177,564
	1987	47,916	5,355	8,534	11,915	6,557	53,576	18,132	6,127	45,027	2,639		205,778
	1988	40,099	9,380	6,363	7,484	6,579	45,567	15,783	4,972	52,170	2,356		190,753
	1989	29,379	8,789	9,651	6,421	3,067	38,240	6,412	7,307	43,155	3,346		155,767
	1990	22,500	8,787	8,276	1,835	2,121	31,026	17,357	3,301	38,379	3,369		136,952
	2000	21,356	9,331	37,973	8,027	10,087	45,283	72,709	31,720	31,631	*	14,292	283,221

Table 13 (cont'd): Production of particular crops by prefecture for seasons A, 1984 – 2000.

Crop	Year	Butare	Byumba	Cyangugu	Gikongoro	Gisenyi	Gitarama	Kibungo	Kibuye	Kigali	Ruhengeri	Umutara	Rwanda
Irish potatoes	1984	6,430	7,465	2,712	1,716	40,072	5,997	3,448	5,535	3,645	52,951		129,971
	1986	3,857	8,202	4,068	3,204	29,141	5,318	968	13,375	2,125	61,638		131,896
	1987	4,460	8,470	2,707	2,562	22,561	4,708	853	8,357	4,028	45,011		103,717
	1988	4,037	7,857	2,044	2,763	16,375	4,769	1,217	5,904	3,805	44,122		92,893
	1989	3,788	3,428	2,489	1,676	24,465	6,109	2,670	4,083	4,923	70,351		123,981
	1990	4,118	5,997	2,563	5,400	35,590	3,797	2,374	6,440	3,932	77,361		147,572
	2000	3,590	31,582	*	4,435	69,019	*	2,168	10,644	*	23,981	3,353	151,015
Sweet Potatoes	1984	60,880	50,016	9,742	48,237	28,441	44,796	15,717	44,333	42,652	38,079		382,893
	1986	75,306	43,905	17,685	46,785	29,540	47,270	26,374	33,271	42,123	45,873		408,132
	1987	67,911	39,471	13,003	46,762	27,131	43,459	16,025	27,343	34,039	66,409		381,553
	1988	52,984	52,061	20,250	57,326	31,923	45,891	17,158	38,304	43,614	60,207		419,718
	1989	54,163	62,513	15,921	47,849	27,363	40,787	19,276	33,792	36,175	56,946		394,785
	1990	57,119	43,114	15,754	31,235	23,547	61,844	23,000	25,916	35,429	47,566		364,525
	2000	62,015	92,907	17,356	64,074	78,206	17,307	37,580	48,594	49,289	19,804	11,703	498,835

Source : FSRP/DSA, MINAGRI.

* Observations not sufficient to make estimations at prefecture level.

ANNEX II: METHODOLOGY

1. COMMENTS ON METHODOLOGY

Because the financial resources available to conduct this first post-war household level survey of the agricultural sector were much less than those available for the pre-war agricultural surveys, it was necessary to introduce a number of methodological changes. Table 14 summarizes some of the key differences between the pre- and post-war surveys, noting in the last column of the table our hypotheses concerning the impact of these changes on the accuracy of the current survey and its comparability to pre-war results. The key differences between the two surveys fall into two categories: sampling differences and measurement differences.

The pre-war surveys for which the database has been reestablished (1984-1990) used a sampling frame based on the 1978 Rwandan general census of population and housing – RGPH (with annual updates of household lists in the census districts selected for each agricultural survey). In 1991, a new RGPH was conducted providing the sampling frame that was used for the 1992 agricultural survey (unfortunately, the data for the 1992 agricultural survey did not survive the war).

In an effort to economize on survey costs and render the post-war agricultural data complementary to other survey efforts being planned in Rwanda, FSRP/DSA decided to use a sub-sample of the *Enquête Integrée sur les Conditions de Vie des Ménages au Rwanda* (EICV) being conducted by the Direction de la Statistique (MINECOFIN).

An analysis conducted prior to launching the FSRP/DSA survey predicted that the accuracy of estimates for key parameters would not be strongly influenced by the change from the pre- to the post-war sampling design (Megill 1999). For example, estimated coefficients of variation for *national* statistics (production by crop, kcal/person/day, and area cultivated) using the post-war sampling methods were expected to be similar to those obtained before the war; in some cases the design effect in the post-war sample was smaller than it had been before the war. For the prefecture-level estimates, some were predicted to be more, and others less accurate than pre-war estimates, but there was no general tendency in one direction or the other.

The second section of table 14 suggests, however, that the post-war changes made in data collection methods probably introduced a substantial amount of non-sampling error in several areas. In the interest of creating an agricultural statistical system that would be manageable in terms of cost and sustainable in the future, simplified data collection methodologies were developed for measuring agricultural production and land use. While these new methodologies have proven to be far less costly and easier to implement than the former system, it is believed that the precision of the estimates from these data has been reduced.

Post-war production was obtained by asking households to recall amounts harvested during the entire season (almost 6 months) while pre-war production data was collected weekly and objectively measured using standardized buckets. The post-war method is subject to potential inaccuracies due to poor recall when a crop is harvested in small amounts every day, crops that were not completely harvested at the time of the interview (e.g., potatoes in some parts of

Ruhengeri), and a ‘food aid’ mentality that encourages households to underestimate production so the food aid continues to flow.

We believe that the net effect of these measurement errors has been a downward bias on estimates of total production and kcal/person/day. Given these changes in measurement methods, care must be taken in interpreting the results from this first post-war survey. Although we do present some comparisons of post- and pre-war statistics, the extent to which these differences are due to real changes or to measurement errors is not clear.

We are in the process of looking into low-cost ways of improving the measurement methods for further surveys and are hopeful that as households become accustomed to regular agricultural surveys and the food aid mentality fades, we will be able to reduce the measurement biases that appear to be in the current survey data.

Table 14: Pre and post war methodologies: Impact on results.

FACTOR	PRE-WAR	POST-WAR	IMPACT ON RESULTS
Sampling Procedures			
Size	2,100 rural households in 1984; 1,092 in 1986-88; 2,496 in 1990-91 (of which only 1,248 participated in all surveys; demographic characteristics and livestock covered 2,496 sample).	1,584 rural households	None, sample size for production estimates approximately the same.
Frame	Based on 1978 census, but household lists up-dated annually in selected sample districts. New sampling frame designed and used in 1992, based on the 1991 census of population and housing. Data were lost during the war.	Uses 1991 census, updated in 1997 with count of hh in each cellule.	Weighting of survey observations to extrapolate to prefecture and national level may not be accurate if 1991 census and 1997 update do not adequately reflect population change since the war.
Methods	Random selection of sectors followed by random selection of census districts (primary sampling units) w/i sectors. 150 PSUs selected in 1984 but reduced to 78 in 1985 due to costs. Probability of selection proportional to number of rural households in the PSU.	Random selection of 12 cellules (Primary Sampling Unit) within stratum (11 rural prefectures) for 132 PSUs nationally. Probability of selection proportional to number of rural households in the PSU.	
Stratification	21 strata based on 10 prefectures and 5 geographic zones. Data not representative at the commune level.	11 rural strata based on prefectures; no allowance for geographic strata. Data not representative at the commune level.	Cannot get representative results by geographic region.

FACTOR	PRE-WAR	POST-WAR	IMPACT ON RESULTS
Measurement Procedures			
Production	Weekly measurement of quantities harvested by farmers for all crops on a field. Standardized buckets used for measuring.	Recall for entire season 2000A (about 6 months). No physical measurement, just farmers' estimates reported in kg or local units that were then converted to kg.	Recall will be less accurate than objective measurement. Errors should be randomly distributed, but estimates for some crops may be more difficult (i.e., less accurate) than others. Interviewers suspected that there was consistent under-reporting of production by households not wanting to jeopardize continued flows of food aid.
Area	All fields measured using compass, tape measures, etc. Programming calculators were used to calculate the area**.** For inter-cropped fields, interviewers' estimate of crop density on the inter-cropped field compared to that of the crop grown as a single culture. The density is not standardized and recorded for all crops in intercropped field**.**	Distances estimated by pacing off lengths of sides of blocks. The enumerator's pace is converted to meters**.** Each block is adjusted to a rectangle by enumerator using his eyes. Knowing that there is a unique and relatively stable relationship between a given field's perimeter squared and its area, we apply this method to estimate the block area**.** Within the bloc, the field area is estimated in percentage of block area. For inter-cropped fields, interviewers' estimate of crop density on the inter-cropped field compared to that of the crop grown as a single culture. The density is standardized and recorded for two principal crops in the field.	Area measurements likely to be less accurate than before the war and more subject to interviewer bias. If errors of measurement not randomly distributed, aggregate estimates may be biased.

2. SAMPLING METHODOLOGIES

Introduction: FSRP surveys will be carried out on a subsample of EICV (Integrated Survey on Household Living Conditions) currently underway in the Statistics Department, Ministry of Finance and Economic Planning. It will be cost-effective to use a subsample of the households selected for the EICV for such follow-on surveys, since it will be possible to match the data files from the two survey to have a comprehensive database for the analysis. The sample design for the *Enquête Integrée sur les Conditions de Vie des Ménages au Rwanda* (EICV) is described in Dr. Christopher Scott's report on "*Plan de l'Enquête et Plan de Sondage*" (July 1997).

Target Population: The target population for agricultural surveys carried out by FSRP/DSA is constituted by rural households. This population represents almost 90% of the total population according to the 1996[6] Socio-demographic survey. Urban areas are excluded in the sample.

Stratification of the primary sampling units (PSU): The sampling frame was stratified by prefecture, urban and rural. The urban strata consisted of Kigali-Ville and other urban areas, while the rural part of each prefecture was treated as a separate stratum. The sampling frame of cellules within each stratum had been ordered geographically in a serpentine manner before the segments were selected systematically with probability proportional to size (PPS). According to EICV sampling design, a stratified two-stage sample design will be used for the EICV. Within each stratum, the sample segmens/cellules were selected systematically with probability proportional to size (PPS), where the measure of size for each segment/cellule was based on the number of households from the sampling frame; sample households are selected at the second stage within each segment/cellule.

Within each stratum, 40 PSUs (Primary Sampling Units) or cellules have been selected systematically with probability proportional to size. Following the updated listing, 12 households have been selected within each rural sample segment. EICV has a total sample size of 5,280 rural households.

Estimation methodology based on the survey: The EICV sample segments within each prefecture will be divided into 10 equal subsamples assigned to the 10 cycles throughout the year. In the case of the rural stratum within each prefecture, the 40 sample segments will be divided into subsamples of 4 segments each, selected with equal probability. In this case, the subsampling rate for each cycle would be equal to 4/40, or 1/10. If two cycles are selected for the follow-on agricultural survey, the subsampling rate would be equal to 8/40, or 1/5. FSRP has considered 3 cycles consisting of 144 sample households distributed among 12 PSUs in each prefecture. The total sample of households is 1,584.

[6]ESD, Direction de la Statistique, MINECOFIN, 1996

Therefore the overall probability of selection for the sample households would be calculated as follows:

$$p_{hi} = \frac{n_h \times M_{hi}}{M_h} \times \frac{m_{hi}}{M'_{hi}} \times \frac{n'_h}{n_h} = \frac{M_{hi}}{M_h} \times \frac{m_{hi}}{M'_{hi}} \times n'_h ,$$

where:

p_{hi} = probability of selection for the sample households in the i[th] sample segment in stratum (prefecture, rural) h;

n_h = number of sample PSUs selected in stratum h; in the case of the rural stratum of each prefecture, n_h = 40 for the EICV sample;

M_h =total number of households in the EICV sampling frame for stratum h;

M_{hi} =total number of households in the EICV sampling frame for the i[th] sample PSU (*cellule*) in stratum h;

m_{hi} = number of sample households selected in the i[th] sample segment in stratum h; in the case of the rural strata for the EICV, m_{hi} = 12;

M'_{hi} = total number of households from the updated listing in the i[th] sample segment in stratum h;

n'_h = number of segments selected in the subsample for stratum h; in the case of the rural stratum of each prefecture, $\boldsymbol{n'_h}$ = 4 x c, where *c* is the number of cycles included in the subsample.

The final sampling weight, or expansion factor, is calculated as the inverse of this probability of selection, adjusted to take into account the noninterview rate for each survey. Since the weights will be calculated at the level of the sample segment, it would be advantageous to adjust the weights at this level. For the FSRP survey, the final weight can be expressed as follows:

$$W_{hi} = \frac{M_h \times M'_{hi}}{M_{hi} \times m_{hi} \times n'_h} \times \frac{m'_{hi}}{m''_{hi}} ,$$

where:

W'_{hi} = final weight for the sample households in the i[th] sample segment in stratum h;

m'_{hi} = total number of valid (occupied) sample households selected in the i[th] sample segment in stratum h (that is, the number of interviews plus the number of noninterviews in the sample segment);

m''_{hi} = total number of interviewed sample households in the i[th] sample segment in stratum h, including replacement households.

The most common survey estimates to be calculated from the household surveys are in the form of totals and ratios. The survey estimate of a total can be expressed as follows:

$$\hat{X} = \sum_{h=1}^{10} \sum_{i=1}^{n_h} \sum_{j=1}^{m''_{hi}} W'_{hi} \, x_{hij} \quad ,$$

where:

x_{hij} = value of variable y for the j-th sample household in the i^{th} sample segment in stratum h

The survey estimate of a ratio is defined as follows:

$$\hat{R} = \frac{\hat{Y}}{\hat{X}},$$

where:

$\hat{Y}$ and $\hat{X}$ are estimates of totals for the variables y and x, respectively, calculated as specified previously.