FSRP/DSA Publication No. 3E

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

Ministry of Agriculture, Animal Resources, and Forestry

MINAGRI

Agricultural Intensification in Rwanda: An Elusive Goal

Fertilizer Use and Conservation Investments

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FSRP/DSA Policy Brief

January 2001

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.

Funding for FSRP is provided by the Food Security II Cooperative Agreement between the Department of Agricultural Economics of Michigan State University (MSU) and the United States Agency for International Development (USAID) through the Office of Agriculture and Food Security, Economic Growth Centre, Global Bureau (AFS/EG/G), and the USAID Rwanda Mission.

This report presents descriptive statistics and summary analysis on the *production practices* section 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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1. BACKGROUND

Prior to the 1994 war, Rwanda had one of the best agricultural data bases on the African continent with a consistent time series on production, area, and yield data spanning the period from 1984 through 1992. This data base, drawn from annual surveys of a nationally representative random sample of approximately 1,240 farm households, was supplemented with a variety of specialized surveys conducted intermittently on topics such as input use, livestock production, natural resource management practices, non-farm income, etc. A key finding of these pre-war studies was that yields of most crops declined from 1984 through1991.

There have been a few rapid appraisals of agricultural production and food availability in Rwanda since 1994 (regular seasonal rapid crop assessment exercises began 1994); however, the Ministry of Agriculture, Animal Resources, and Forestry (MINAGRI) in Rwanda did not reinstate an annual agricultural census based on a nationally representative random sample of farmers until the beginning of the 2000A season. Although the survey focused on the collection of basic production and land use data, a number of complementary themes were also examined. Given the MINAGRI's interest in promoting greater agricultural productivity through the development of a commercial agricultural sector where private traders and/or farmers' organizations market inputs such as fertilizers and pesticides to individual farmers and offer a reliable output market for their surplus production, one of the complementary survey themes dealt with production practices (use of organic and inorganic fertilizers, pesticides, anti-erosion techniques, etc.). The questions on practices included both the 2000A season and an overview of practices used during the early post-war period (1995-1999).

Objectives. The objectives of this policy brief are to (1) describe the post-war situation concerning production practices, comparing the post-war situation (when possible) to the pre-war situation, and (2) discuss the implications of the findings for the design of programs and policies to promote agricultural intensification through the use of improved inputs and conservation practices.

2. OVERVIEW OF PRODUCTION PRACTICES DURING THE 2000A SEASON

Because the choice of production practices is influenced by factors such as farm size, land tenure, and other land characteristics (Clay et al. 2000); we begin with a brief overview of the pre- and post-war land situation before getting into the details of recent production practices.

Table 1 shows that average farm size has declined since 1991 (currently estimated at 0.71 ha vs. 1.06 previously)[1]. This suggests that there *may be* growing pressure on the land and the ability of a farm family to feed itself. Growing pressure on the land is not necessarily a bad thing. Pre-war data and analyses indicate that smaller Rwandan farms are often cultivated more intensively (more inputs, labor, and conservation investments per hectare) than larger farms. This increased production intensity on smaller farms has been associated with higher yields per hectare in the past (Clay et al. 1995). In other words, smaller farm size can stimulate intensification providing that available technologies are profitable and farmers have the necessary human and financial capital to adopt more intensive practices. Just how small a Rwandan farm can get before the process of intensification no longer compensates for the shrinking farm size is not clear and warrants further study.

Land tenure status is reflected by the percent of farm land owned (vs. rented, leased, borrowed, etc.). The survey results show that the percent of farmland owned has remained relatively stable with a small change from 92 to 94%. There is, however, some evidence of a reduction in land rented (down from 8% to only 2%). This implies that there has been an increase in the use of other mechanisms for temporarily acquiring land (borrowing, leasing, etc.).

TABLE 1. FARM SIZE AND LAND TENURE: 1991A AND 2000A

	1991A	2000A
Farm Size	(hectares)	
Average size*	1.06	0,71
Land Tenure	(% of cropped area)	
Owned	92	94
Rented	8	2
Other	0	4

Source: Estimated from MINAGRI (FSRP/DSA) survey data.

* Includes crops, pasture, fallow, and woodland.

Use of Anti-Erosion Barriers and Manure Has Declined from 1991 to 2000. Table 2 shows that Rwandan farmers have yet to regain prewar levels of **conservation investments** such as terraces, grass strips, and diversionary ditches used to prevent erosion on fields with steep slopes. During the 2000A season, these types of anti-erosion techniques were used by only 65% of farms representing only 65% of cultivated area. Before the war the comparable figures were 93% and 76%.

[1]Because of differences in the methods used to measure fields and farmers' unwillingness in some cases to fully cooperate with interviewers during the 2000A survey (e.g. suspicion that the information could be used to expropriate some of their land) we believe that the 2000A figure underestimates the actual farm size. Nevertheless, the large difference between 1991and 2000 suggests that something more than measurement error may be involved. Increased cooperation of farmers during the 2000B season and improved measurement methods should result in more accurate estimates.

The post-war figures for use of **organic matter** (primarily manure) show a similar decline with current use reported by only 69% of farms on 59% of cultivated area (versus 95% and 70% before the war).

TABLE 2. INPUT USE AND CONSERVATION INVESTMENTS ON CULTIVATED LAND: 1991A VS. 2000A

	% of farms using specified input		% cultivated area covered*	
Type of Input/Investment	1991 A	2000 A	1991 A	2000 A
Chemical fertilizers or lime	7	5	5	3
Pesticides	N.A.	9	N.A.	5
Organic inputs	95	69	70	59
Conservation investments	93	65	76	65

Source: Estimated from MINAGRI (FSRP/DSA) survey data.

*In order to make the comparisons with 1991 data, we counted the entire area of a block if an input was used on any parcel within the block; this results in some over-estimation of area actually covered.

Little Change in the Use of Inorganic Fertilizers, which Are Less Popular than Pesticides. Nine percent of farmers used pesticides on five percent of cultivated land during the 2000A season. The comparable numbers for **fertilizers and lime** show that 5% of farms applied fertilizers to 3% of the cultivated area. These numbers are slightly lower than those for 1991 (7% of farms and 5% of area), however, the standard deviations for both the pre- and post-war data sets are very large and there is no statistically significant difference in fertilizer use between the two periods.

It is not surprising that fertilizer use did not attain its pre-war levels in 2000A. Although the Government of Rwanda (GOR) has made agricultural intensification through increased use of inorganic fertilizers one of its key objectives, it has been following a judicious policy of trying to do this while simultaneously building a strong private sector input distribution system. The GOR initiated two fundamental policies to address this objective. In November 1999, the MINAGRI passed a *Ministerial Decree* banning the distribution of free or subsidized farm inputs (except in the case of emergency re-integration and emergency poverty alleviation programs). In April 2000, parliament passed two laws regulating the importation of agricultural inputs (mainly fertilizers). Law No. 05/2000 of April 19, 2000 eliminated import duty on agricultural inputs for a period of 3 years (which may be extended for another 2 years by presidential decree). Law No. 06/2000 of April 19, 2000 exempted all imported agricultural inputs from sales tax for a period of 3 years as well. Thus, the last two years have represented a transition from the donor-led (European Union) fertilizer import program (where fertilizer was subsidized by 50% in 1995 and the subsidy gradually reduced to 20% in 1998) to one run entirely by the private sector (1999-2000). This transition resulted in a temporary decline in fertilizer imports and use during the period that the private sector was learning about the market and how to benefit from the line of import credit supplied in 2000 through the World Bank funded Agricultural and Rural Markets Development Project (ARMDP). This project offers credit at 9% interest rate for the importation

of agricultural inputs as opposed to the commercial rate of 16-18% interest rate. Although these are favorable terms, importers continue to be timid concerning the importation of fertilizers. A few firms have entered the market and several more have shown interest and appear committed to moving ahead. Although quantities initially imported have been in small lots they are moving rapidly (e.g. one firm imported 800 tons and sold it within one and a half months, ARMDP personal communication). Despite some deterioration in the exchange rate during the last several years, retail prices charged during the 2000A season (220 to 250 RwF/kg, depending on fertilizer type and location of sale) are comparable to unsubsidized 1997 and 1998 prices reported in EU/PASAR documents (202-237 RwF/kg, depending on fertilizer type and location of sale).

Impacts of Prevailing Production Practices. In 1991 farmers estimated that approximately half their land exhibited declining soil fertility. By 2000A, the estimate was at 61%, with 72% of farmers reporting a decline in soil fertility. The declining use of soil conservation techniques and organic supplements and the small quantities of inorganic fertilizers applied are undoubtedly the key contributing factors explaining the decline of soil fertility perceived by farmers.

The disparity between pre- and post-war levels of conservation investments and use of organic fertilizers could prove to be more problematic than the low levels of inorganic fertilizer currently used. First of all, there is some evidence from the survey that a larger share of cultivated area may now be located on slopes >20 degrees than was the case before the war (42% now vs. 33% previously).[2] If this is true, the need for anti-erosion techniques has increased. Furthermore, inorganic fertilizers are not effective on soils that do not contain a minimum level of organic matter, nor can they be effectively used on fields that are not protected against erosion because the nutrients will be washed away with the first heavy rains. Also, all of the findings upon which current fertilizer recommendations are based are predicated on an application of manure to the field receiving inorganic fertilizers.

3. FERTILIZER[3] USE FROM 1995 THROUGH 1999

The 2000A survey asked farmers some retrospective questions about their fertilizer use during the 1995-1999 period. Over the five-year period a total of 12% of farm households had used inorganic fertilizer at least once (versus only 5% in the single 2000A season), indicating that it is not the same set of farmers using fertilizer each year. Farmers having used fertilizer in 1998 and 1999 were asked a series of questions about how they obtained the fertilizer (suppliers and means of financing) and how fertilizer use affected their yields, incomes, and food security. The results are summarized in Table 3 and discussed below.

Fertilizer Acquisition 1998-1999. Total fertilizer purchases averaged 3,504 tons per year for a total of 7,008 tons during the 1998-1999 period. More than half of these purchases were reported by farmers in Gisenyi where a substantial amount of fertilizer is applied to potatoes. The most

[2]These numbers are subject to change if the 2000B survey shows that there is substantially more land being cultivated in the relatively flat marshes and lowlands (see footnote 1).

[3]Use of the word *Fertilizer* in this section refers to inorganic fertilizer.

important supplier category was private traders (approximately 4000 tons) and the most important means of financing was cash payment at time of purchase (almost 5800 tons); 56% of all purchases during the two year period were made via cash payment to private traders. The second most important combination of financing and distributor was cash purchases made through cooperatives (13% of total quantities purchased) followed by credit purchases through cooperatives (9%). As anticipated, given the government policy of disengagement from the input sector, DRSAs[4] accounted for only 8% of the total market (primarily sales to farmer associations).

TABLE 3. FERTILIZER PURCHASED BY TYPE OF FINANCING AND SUPPLIER: 1998-99

Financing ⬇	Unit	Suppliers ➜ NGO	Assoc/Coop	Trader	DRSA	Other	Total
Gifts/aid	tons	399	43		70	22	534
	%	(6)	(1)		(1)	(<1)	(8)
Credit	tons		643	61	3		707
	%		(9)	(1)	(<1)		(10)
Cash	tons		937	3955	539	323	5754
	%		(13)	(56)	(8)	(5)	(82)
Other	tons					13	13
	%					(<1)	(<1)
Total	tons	399	1623	4016	612	358	7008
	%	(6)	(23)	(57)	(9)	(5)	(100)

Source: MINAGRI (FSRP/DSA) survey data, 2000.
Note: Numbers in parentheses are percent of total purchases.

Farmers' Perceptions of Fertilizer Impacts. Because fertilizer response differs depending on the crop and the type of fertilizer used, this analysis is disaggregated into the 16 different fertilizer/crop categories reported in Table 4. Given the small number of farmers who used fertilizer in 1998 and 1999, the relatively low response rate to survey questions about fertilizer impacts, and the need to disaggregate the results by crop and fertilizer type, there are very few observations for most of the 16 categories. The limited number of responses means it is not possible to draw broad generalizations about farm-level impacts, hence, the results are presented to stimulate reflection and develop hypotheses for future research.

[4]Direction Regionale de Services Agricoles (MINAGRI regional agricultural offices located in each prefecture). Sale of fertilizer in this case is by projects that are associated with DRSA offices through which the sale is effected.

Table 4 shows that there was general agreement across most crops (>80% of respondents) that all types of fertilizers increased yields. Support for the yield increasing capacity of fertilizer was slightly weaker for urea used on rice (only 75% saw a yield increase) and for NPK applied to sorghum (only 58% saw a yield increase).

Questions about the impact of fertilizer use on income elicited a wider range of responses. Both urea and NPK used on coffee and other industrial crops (e.g., tobacco, tea, pyrethrum) was considered to increase income by close to 100% of respondents. NPK used on rice and DAP applied to vegetables received similar ratings. Potatoes–a crop considered to respond well to fertilizer–received favorable ratings from only 60-80% of farmers, depending on the type of fertilizer being discussed. The potato results are probably more reliable than those for other crops as the number of respondents is substantially higher (46 farmers versus only 23 for vegetables and fewer than 10 for each of the other crops). The combination of a favorable yield response for potatoes and a substantially less favorable income impact suggests that there may be output marketing problems that need to be addressed (e.g., prices might have fallen at the moment some farmers marketed their crop and net incomes after paying for fertilizers were less than expected). Fewer than half of the respondents reported positive income impacts on beans and sorghum–a much lower share than had reported a positive yield impact. As in the case of potatoes, these results suggest that output markets and prices may be a constraint to the expansion of fertilizer demand.

TABLE 4. FERTILIZER IMPACTS REPORTED BY FARMERS WHO USED FERTILIZER IN 1998 AND 1999 (BY CROP AND TYPE OF FERTILIZER)

		Estimated Users		Percent of Users Reporting a Positive Impact on...		
Crop/Fertilizer Type	No. of Observations	No. of Rural hh	Percent of Rural hh	Yield	Income	Food Security
Coffee						
Urea	9	14683	1	100	100	100
NPK	6	9456	0.7	100	93	75
Vegetables						
Urea	9	9422	0.7	100	86	80
DAP	4	5777	0.4	100	100	100
NPK	23	24619	1.7	95	76	91
Potatoes						
Urea	6	4793	0.3	100	60	100
DAP	2	1777	0.1	100	78	78
NPK	46	48229	3.3	96	80	64
Beans						
Urea	5	4334	0.3	85	39	85
DAP	4	2974	0.2	87	29	58
NPK	5	5267	0.4	84	48	84
Other Industrial Crops						
Urea	3	3567	0.2	100	100	62
DAP	8	5901	0.4	100	100	47
Rice						
Urea	6	3398	0.2	75	75	75
NPK	6	5810	0.4	100	100	77
Sorghum						
NPK	5	5645	0.4	58	37	37

Source: MINAGRI (FSRP/DSA) survey data, 2000.

Responses concerning impacts on food security differed from those concerning impacts on income in several cases. For example, only two of the five farmers using urea on beans thought fertilizer had a positive impact on income, but four reported a positive impact on food security. Conversely, all six farmers using NPK on rice reported increased incomes but only 77% reported increased food security. These results probably reflect the fact that rice has a stronger market demand than beans. When rice production increases through fertilizer use more rice is sold and this contributes to income but some farmers may not readily view this as food security; when fertilizer contributes to more bean production most of this production is probably consumed by the household and therefore viewed as making a strong contribution to food security.

Reasons for Not Using Fertilizer From 1995-1999. As noted above, only 12% of farmers have used inorganic fertilizers in the recent past. This leaves 88% of farmers who did not use the input from 1995 through 1999. These farmers were asked to explain their reasons for not using the input. The results are summarized in Table 5 which shows the breakdown of responses by Prefecture.

TABLE 5. REASONS WHY FARMERS DID NOT USE FERTILIZER FROM 1995 THROUGH 1999

	Butare	Byumba	Cyangugu	Gikongoro	Gisenyi	Gitarama	Kibungo	Kibuye	Kigali Rural	Ruhengeri	Umutara	Rwanda
						(percent of non-users)						
Don't know	41	22	78	50	56	84	76	39	27	60	41	53
High price	44	38	13	24	24	9	10	52	70	24	2	30
No credit	1	3	7	0	4	0	0	1	1	12	1	3
Not available	10	40	11	21	19	10	4	0	3	3	45	13
Other	5	31	2	6	2	1	10	8	0	1	18	7

Source: MINAGRI (FSRP/DSA) survey data, 2000.
Notes: Percents are based on responses made by the 88% of farmers not using fertilizer from 1995-1999.
Some columns total to more than 100% because multiple responses were permitted.

Lack of Knowledge Inhibits Fertilizer Use. The most common explanation for non-use (53% of the 88% who were non-users, which represents 47% of all farm households) was that they did not "know" fertilizer. We interpret this response to mean that although they have heard about inorganic fertilizers, their knowledge of the benefits and of how to use the fertilizers was not strong enough to stimulate use.

Farmers were also asked if they thought that inorganic fertilizers needed to be used with complementary inputs to be effective–another way of assessing farmers' knowledge about fertilizers. The replies indicate that knowledge concerning the complementarity of organic and inorganic fertilizers is fairly strong (68% of respondents indicated that these inputs needed to be used together), followed by knowledge about pesticide use (46% reporting complementarities) and improved seeds (mentioned by 35% of respondents). Complementarities involving fungicides (27%) and compost (22%) were also mentioned. There were differences in the level of response

across prefectures that suggest not only differences in the level of knowledge but also differences in needs due to soil characteristics. For example, more than 90% of respondents in Gisenyi and Gitarama recognized the need to combine inorganic and organic fertilizers while the highest mention of the need for lime (31%) came from farmers in Gikongoro, a zone of unusually acid soils. These results suggest that farmers are not as poorly informed about fertilizer use as the results reported in the previous paragraph suggest. Nevertheless, if the goal is to rapidly expand fertilizer use, all potential users need to understand the importance of using fertilizers in combination with key complementary inputs to ensure profitable results.

High Fertilizer Prices Are A Constraint. The next most common explanation for non-use from 1995-1999 was that fertilizer prices were too high (30% of the non-users or 25% of all farms). Typical unsubsidized fertilizer prices for the 1995-1999 period were in the 200-260 RwF/kg range, with prices varying by type of fertilizer and transportation costs.

The 2000A survey asked farmers to provide an estimate of the maximum fertilizer price they would be willing to pay per kilogram for use on selected crops. The responses were quite varied, but the results suggest that current prices (220-250 RwF/kg in 2000A) will need to decline substantially to stimulate growth in effective demand. Table 6 shows that average willingness to pay varied from 131 RwF/kg for sorghum (a crop rated relatively low by farmers with respect to fertilizer yield response) to 161 RwF/kg for coffee and vegetables (crops thought to exhibit strong yield responses); these prices are all substantially below those prevailing during the 2000A season.

TABLE 6. PRICES FARMERS ARE WILLING TO PAY FOR FERTILIZERS

Crop	Prices Farmers are Willing to pay for Fertilizer (RwF/kg)	
	National Average	Standard Deviation
Beans	141	77
Potatoes	144	71
Vegetables	161	78
Coffee	161	66
Sorghum	131	77

Source: MINAGRI (FSRP/DSA) survey data, 2000.

In most cases, the price of fertilizer alone is a poor indicator of the financial incentive to use the product because fertilizer profitability varies with changes in both the price of fertilizer and changes in the value of the supplemental production attributable to fertilizer use. Input/output (i/o) price ratios are often used as a means of evaluating changes in fertilizer price incentives for a given technology package; they reflect the number of kilograms of output a farmer must use to purchase one kilogram of fertilizer (as the ratio increases fertilizer becomes less profitable).

Because such a large percent of Rwanda's farmers market very little of their production, it is understandable that many currently look at the price of fertilizer in isolation rather than in conjunction with output prices. Nevertheless, as farmers begin the transition from semi-subsistence production to commercial agriculture, they will begin to pay more attention to the i/o ratio. This ratio needs to become more favorable if fertilizer demand is to grow. It is more

desirable to accomplish this through reductions in the price of fertilizer than through increases in the output price, particularly when the output is a food product in high demand by food-insecure households. Reductions in fertilizer prices tend to come about through increases in the quantity of fertilizer demanded (which permits suppliers to realize economies of scale) and when fertilizer markets become more competitive (as this drives down the margins of various actors in the input supply chain).

Inadequate Fertilizer Supply Reduces Access for a Small Group of Farmers. Poor fertilizer supply was mentioned as a constraint by 13% of non-users (11% of all farms). The problem of supply was noted more frequently in Byumba (40% of non-users) and Umutara (45% of non-users). Supply seems to be less of a problem in Kibuye, Kigali Rural, Ruhengeri, and Kibungo where it was cited as a constraint by <5% of non-users (lack of knowledge and prices being more important).

Credit Constraints Seldom Mentioned. Lack of credit was mentioned by a small group of non-users (3%, equivalent to 2.6% of all farms), but it represents a minor factor in the aggregate picture where lack of knowledge, high prices, and supply factors predominate.

4. IMPLICATIONS OF FINDINGS ON CONSTRAINTS TO FERTILIZER USE

The results reported above provide valuable insights for both extension services and the private sector as they move forward in building fertilizer demand and input markets.

The large share of farmers claiming that they do not know enough about fertilizer to use it provides firm evidence that there is a need for improvements in extension services. The issue of developing effective extension services in Rwanda is too broad and too controversial to be adequately addressed in this brief note,[5] but it is clear that the extremely limited MINAGRI budget (approximately 2% of the national budget in 99) during the past several years has made it very difficult for extension personnel to interact directly with a large number of farmers. The farmer training program pursued by the MINAGRI during the past two years has informed model farmers about fertilizers as well as other techniques of agricultural intensification. Thus far the program has provided approximately 4500 farmers (30 per commune) with classroom training. The second phase of the training program is a series of on-farm fertilizer demonstration plots (to begin in the 2000B season) that will permit farmers who have received the classroom training to practice what they have learned about fertilizers and demonstrate the results to others in their communities. The effectiveness of these training programs and demonstration plots needs to be carefully monitored (and adjusted, if necessary) to ensure that farmers are getting increased yields and incomes from the use of fertilizer and that after participation in the training and demonstration plot programs farmers' demand for improved techniques and inputs, particularly inorganic fertilizers, grows.

[5]For example, the issue of which institutions (e.g., fertilizer distributors, government, NGOs, primary and secondary school programs, etc.) should provide what types of extension services (e.g.theoretical training, on-farm demonstrations, monitoring and evaluation, etc.) needs to be resolved, taking into account the strengths and weakness of all potential participants (e.g., human resources, financial resources, willingness to collaborate in a joint effort with others, etc.).

Although complaints of inadequate supply were not very common, the results presented above provide the private sector with evidence that demand is greater than supply among a small group of farmers located primarily in Byumba and Umutara. This information can be used by importers as they develop mechanisms to distribute fertilizers throughout the country.

A key objective of the ARMD project currently getting underway with World Bank financing is to develop a competitive private sector input supply system that will ensure adequate supplies of fertilizer at prices that will stimulate increased demand. As the program was getting underway in September 2000, retail prices were higher (ranging from 220 to 250 RwF/kg) than the average willingness to pay expressed by farmers taking part in the DSA/FSRP 2000A survey (131-161 RwF/kg). It is anticipated that as traders realize there is an unmet demand for fertilizers they will increase the size of their imports (realizing economies of scale) and more traders will enter the market (increasing competition); both of these events should drive prices down in the near future.

5. CONCLUSIONS

Agricultural investments and input use have not yet attained their pre-war levels. Without major increases in anti-erosion investments and use of fertilizers (both organic and inorganic), soil erosion and decline in soil fertility will continue to be major problems. The consequences are clear–low agricultural productivity, low rural incomes, and increased food insecurity throughout Rwanda. Results from the 2000A agricultural survey suggest that post-war policies and investments have not yet resulted in measurable progress from a subsistence-based to a commercially oriented agricultural sector.

This is not a surprising result given the relatively short time since the war and the magnitude of the changes necessary to move Rwandan farmers from the extremely low level of agricultural modernization and commercialization (low even by African standards) attained before the war to a modern agricultural sector. Nevertheless, the results reported above suggest that current levels of investment in and output of basic agricultural services (e.g., research, extension, market development and information systems, roads and communications infrastructure, replenishment of livestock loss during the war, etc.) may not be adequate to promote the type of agricultural transformation described in current Government of Rwanda (GOR) agricultural policy statements. The importance of agriculture in Rwanda should be reflected in the GOR policies and long term strategies adopted to achieve a modern sustainable agricultural sector.

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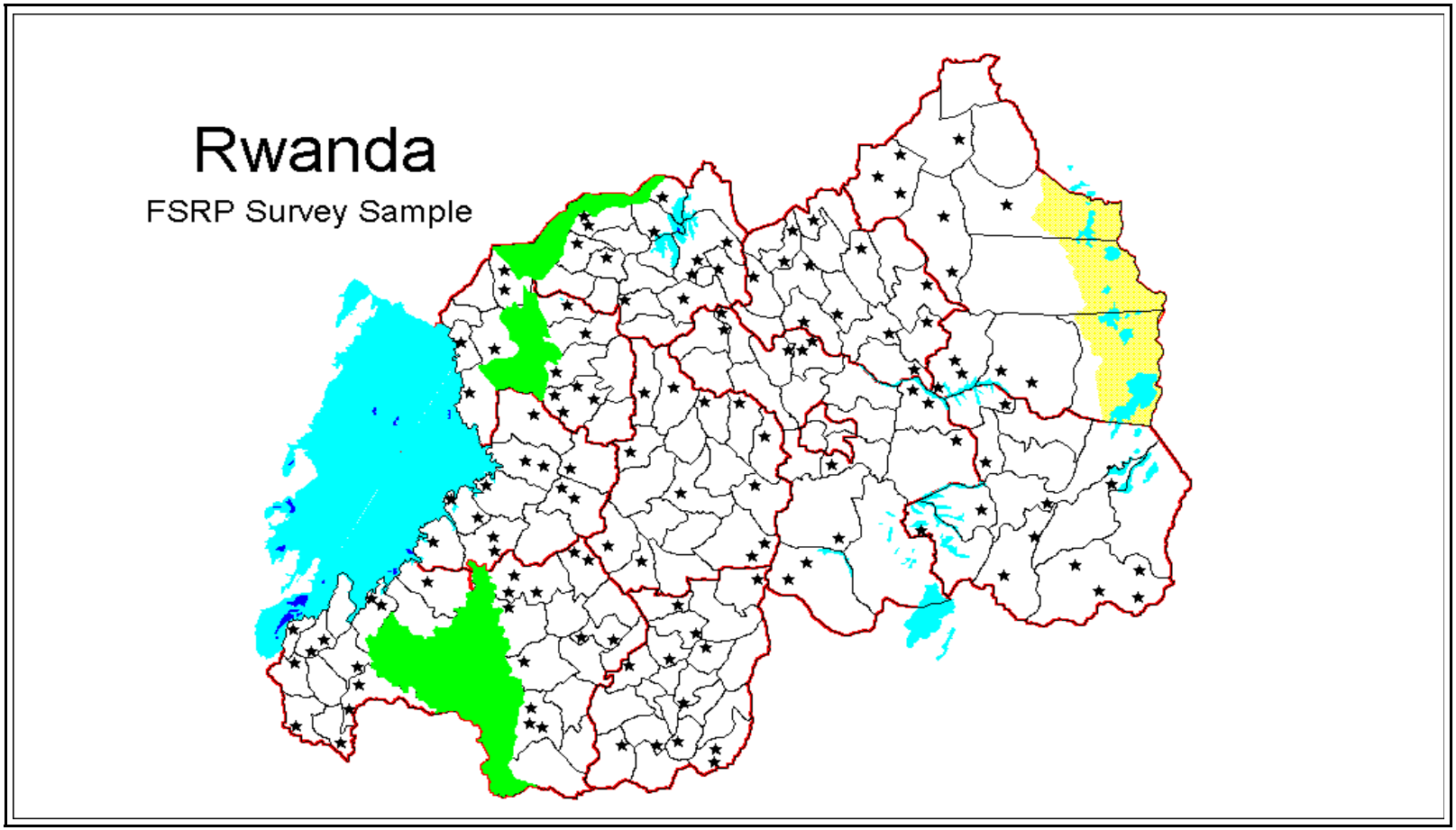
APPENDIX 1.

FSRP/DSA Sample Survey Distribution



Each star represents 12 households within a cellule. FSRP/DSA used 132 cellules, resulting therefore in a national sample of 1584 households.