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Research Report

Learning from Doing:

Using Analysis of Fertilizer Demonstration Plots to Improve Programs for Stimulating Fertilizer Demand in Rwanda

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ACRONYMS

ARMDP	Agricultural and Rural Markets Development Project
BNR	Banque Nationale de Rwanda
DAP	Diamonium phosphate fertilizer (18-46-00)
DVC	Department de la vulgarization et de la commercialization, MINAGRI
FAO	Food and Agriculture Organization of the United Nations
FSRP	Food Security Research Project
GRCS	Génie Rurale et Conservations des Sols
ISAR	Institut des Sciences Agronomiques de Rwanda
MINAGRI	Ministry of Agriculture, Animal Resources, and Forestry
NGO	Non-Governmental Organization

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1. CONTEXT

Since the second half of the 1990s the Government of Rwanda (GOR) has been promoting agricultural commercialization and productivity growth as one of the key means of raising rural incomes and improving aggregate economic growth. A major component in this strategy is the expansion of the use of modern inputs, particularly fertilizers.[1] Many analysts view the promotion of some combination of organic and inorganic fertilizers as the most promising means of achieving rapid increases in the productivity of land, which is one of the most limiting resources in Rwanda. Since 1997 the GOR has made important strides in implementing policy reforms designed to stimulate the growth of private sector fertilizer markets and projects designed to increase fertilizer demand. Particular attention has been given to promoting fertilizers on non-beverage food crops (potatoes, maize, beans, rice, and sorghum). This represents a change from past policies where fertilizers were used almost exclusively on tea and coffee. Recent growth in both fertilizer demand and supply for these non-beverage crops has been encouraging, but there is now concern that the growth is beginning to stall. It appears that fertilizer suppliers have responded more strongly to government incentives than farmers, making the need to stimulate farmers' demand the critical challenge at present.

2. OBJECTIVES

The objective of this paper is to stimulate discussion that will lead to the identification of a feasible, cost-effective strategy for increasing farmers' demand for fertilizer on non-beverage food crops in Rwanda.[2] We begin with a summary of accomplishments to date in developing fertilizer demand and supply to underscore the importance now given to the demand side. This is followed by a discussion of Rwanda's recent demonstration plot programs the principle technique used at present to stimulate fertilizer demand. The paper concludes with recommendations for moving forward and a discussion of institutional issues that need attention.

3. EVOLUTION OF FERTILIZER POLICY

Annex 1 provides a time line of Rwandan fertilizer policy and projects, with a focus on developments since 1995. The turning point in fertilizer policy was the GOR decision in 2000

[1] Some analysts have expressed an interest in assessing Rwanda's potential for entering the organic produce market and therefore question the wisdom of the current emphasis on inorganic fertilizers. The authors of this report consider the organic market an unlikely option in the short- to medium-run given the very high quality standards that must be met to supply these markets.

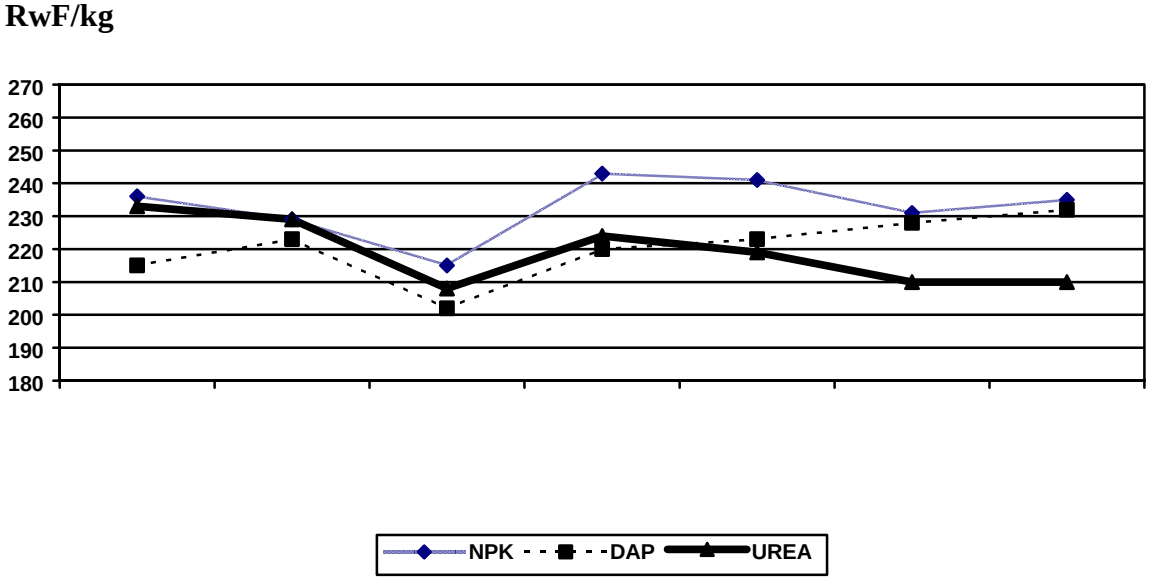
[2] There is also a need to improve fertilizer demand and supply for the tea and coffee sectors and to integrate these vertically coordinated market systems with those for non-beverage crops. We focus here on the non-beverage crops because they represent the sectors where fertilizer market development activities are currently focused.

to (1) remove taxes on fertilizer imports and, (2) to limit free or subsidized distribution of fertilizer to officially sanctioned fertilizer demonstrations and emergency programs (a response to complaints by the private sector that uncontrolled distribution of free and subsidized fertilizer by donors and NGOs was making it difficult to sell at remunerative prices). Shortly after the implementation of these reforms, the Ministry of Agriculture, Animal Resources, and Forestry (MINAGRI) and the Agricultural and Rural Market Development Project (ARMDP) launched their fertilizer demonstration programs in an effort to increase fertilizer demand.

The positive impact of these reforms and programs is seen in the increase in fertilizer dealers, the relative stability of fertilizer prices, survey evidence showing an increase in fertilizer use by farmers benefiting from ARMDP advisory services, and growth of fertilizer imports for non-beverage food crops. In 2001 there were 22 private fertilizer dealers, up from 5 in 1998. The increased number of dealers provided enough competition in the market to keep fertilizer prices in a relatively stable range (Figure 1). Average prices for each type of fertilizer ranged from a low of 217 RwF/kg for DAP to 229 and 230 RwF/kg for urea and NPK, respectively. The standard deviations around the means ranged from 6 RwF/kg for DAP to 8 RwF/kg for NPK and 10 RwF/kg for urea.[3] DAP stands out as the fertilizer with the lowest absolute price and the lowest price variability per kilogram of fertilizer and per kilogram of fertilizing nutrient.[4]

Figure 1. Stability in fertilizer prices from October 2000 through June 2002

	Oct-Dec 00	Jan-March 01	Apr-June 01	July-Sept 01	Oct-Dec 01	Jan-March 02	Apr-June 02
NPK	233	241	234	224	238	224	219
DAP	211	220	213	222	223	223	210
UREA	231	243	226	226	239	222	215



Source: Compiled by ARMDP from PASAR market price data.

[3] The lower the standard deviation the less variability in the prices across time.
[4] Average cost per kilogram of nutrient is 339 RwF for DAP, 451 RwF for NPK, and 498 RwF for urea.

Farmers participating in the ARMDP program in Gitarama (the only province for which ARMDP input use data are currently available) are responding well to the combination of good supply, stable prices, and advisory services. The percent of farmers using modern inputs (particularly fertilizers) increased from 10 to 15 fold in some districts between the 2001A and the 2002A season (Table 1).

Table 1. Evidence of increases in fertilizer demand in Gitarama

Location	Number of households	% HH using inputs in 2001A	% HH using inputs in 2002A	Type of input
Ntongwe	902	2	21	Fertilizer
Ndiza	1040	11 4	74 62	Fertilizer Pesticides
Taba	1117	17	42	Fertilizer

Source: ARMDP data.

Fertilizer imports for non-beverage food crops grew at a rate of 186% from 1999 through the end of 2000 and at 196% the following year (Table 2). Because planting and fertilizer application for the 2002A season took place during September and October of 2001, the increase in 2000A fertilizer demand suggested by data presented in Table 1 would have contributed to an increase in imports during 2001. The rapid growth of imports documented for 1999 through 2001disappears, however, in the first half of 2002. Import statistics through June of 2002 suggest that a slowdown in the rate of growth is now taking place: 2017 tons imported this year versus 2357 tons for the same period in 2001.[5] Because the private sector has responded so well during the past three years and there were some carry over stocks at the end of 2001, most analysts believe the apparent stagnation in fertilizer imports is due to slow growth in effective demand. Although there is evidence from ARMDP surveys that their package of advisory services is having a positive impact on farmer demand for inputs (Table 1) the aggregate growth in fertilizer demand is not being sustained. This raises concerns (1) that the demonstration programs put in place are not convincing the targeted farmers that fertilizer use is profitable and/or (2) that there may be a need for supplementary efforts to improve farmers' ability to access fertilizer once they are convinced of the potential profitability (e.g., credit or assistance with storage and output marketing, and market information services to reduce price risks). As a variety of reports on Rwanda's recent demonstration programs have recently become available,[6] it is now possible to consider the strengths and weaknesses of the programs and assess how well they are serving as a vehicle for rapidly increasing agricultural productivity and crop incomes.

Table 2. Fertilizer import trends for non-beverage crops

Year	Imports (tons)	Comments
1998	3780	Last year of EU import/subsidy program
1999	731	Pre-reforms
2000	2094	Early post-reform period
2001	6126	Moving ahead (demonstrations begin)
2002 (to June 30th only)	2017	Slowing down (June 2001 = 2357 tons)

Source: BNR data and ARMDP information on imports at Cyanika.

[5] The two principle sources of fertilizer import data are the Banque National de Rwanda and the Customs Office. Although they both compile import statistics from the same basic forms completed by importers and presented to the customs service at the time of importation, there are often differences in the quantities of fertilizer imports reported. The differences appear to be due to less capacity at the Customs Office to rapidly enter the data and different procedures for compiling information from form 126 *bis*, which is used to report small quantities of imports passing through customs post such as Cyanika (personal communication Abt/USAID Agricultural Policy Development Project). Numbers in Table 2 are based on official BNR statistics adjusted using data on imports through Cyanika.

[6] Desai 2002, Kelly et al. 2002, ARMDP April and July 2002.

4. 2001B MINAGRI FERTILIZER DEMONSTRATIONS

In 2000 an updated FSRP/FAO analysis of fertilizer response and profitability in Rwanda became available providing decision makers, NGOs, fertilizer dealers, and extension service personnel with guidelines on the crops and zones where fertilizer use was most likely to be profitable and recommendations on the types and quantities of fertilizer to apply (Kelly and Murekezi).[7] These analyses showed that by switching from earlier recommendations using NPK (primarily 17-17-17 supplied through bilateral aid agreements) to a combination of DAP and urea, it was possible to reduce fertilizer costs and increase profitability. At a workshop where these recommendations were presented, there was strong support among the technical scientists and policy analysts for moving in this direction so long as the switch was accompanied by monitoring of changes in soil quality (particularly evidence of potassium depletion, soil acidification or loss of soil organic matter). The recommendations of the report were that (1) fertilizer promotion programs should introduce DAP and urea fertilization techniques to farmers and (2) both fertilizer suppliers and those involved in programs to stimulate demand should focus their activities on crops and zones where fertilizer use was most likely to be profitable (zones labeled with a "green light" in the FSRP/FAO report).

Although there was no official announcement changing fertilizer recommendations from NPK to DAP and urea, MINAGRI launch a series of demonstrations for the 2001B season to introduce these DAP/urea recommendations to farmers and evaluate the results. The demonstration sites (shown in Figure 2) were selected to represent the most profitable outcomes reported in FSRP/FAO analyses for each of the five MINAGRI focus crops: Irish potatoes, maize, sorghum, climbing beans, and soybeans. DVC/FSRP/GRCS worked together in the design of the program while DVC took major responsibility for implementation (training, placing inputs, monitoring progress and collecting data to evaluate the demonstrations) and FSRP took major responsibility for the analysis of data collected.[8]

Kelly et al. 2002 describe the demonstration protocol, report the results of the demonstrations (yield response and profitability) and review some of the implementation problems encountered. Table 3 summarizes the yield and profitability results for the 278 demonstrations (of 480 placed) for which data were collected. The results of the 2001B demonstration plots contain unequivocal evidence that use of fertilizers on Irish potatoes can increase the profitability of potato production and farm income—two important goals of both agricultural policy and the Rwandan government's poverty reduction program. Surprisingly, the average value/cost (v/c) ratio for Gikongoro (6.06) was higher than that for the traditional potato zones in Ruhengeri.

7 Tea and coffee were not covered in this report due to lack of fertilizer response data.

8 Representatives of other MINAGRI projects working on fertilizer issues (the Abt/USAID Agricultural Policy Development Project and the ARMDP) also assisted in the design phase of the program.

Figure 2. Location of MINAGRI 2001B Demonstration Plots (Note: prints correctly in color only)

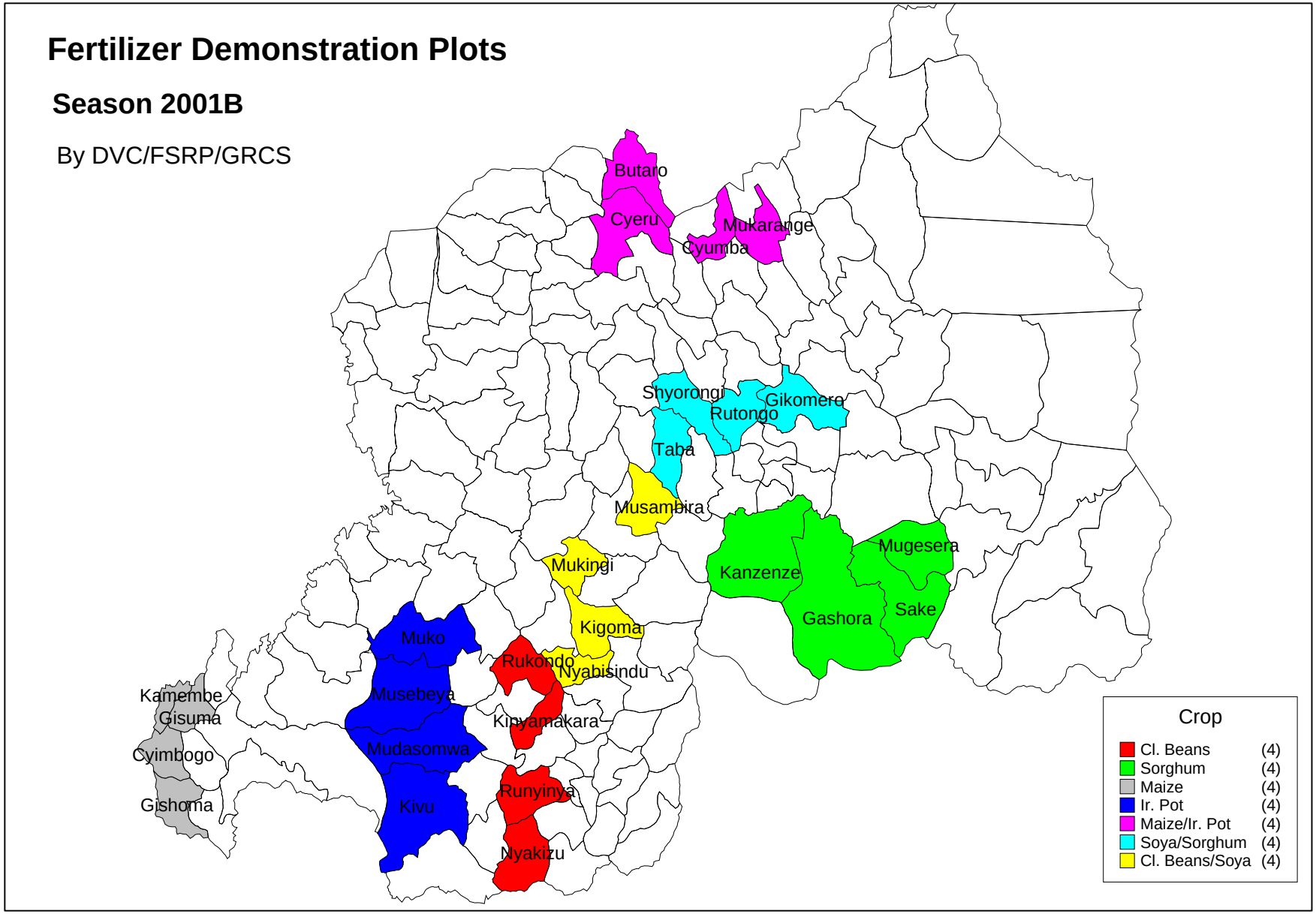


Table 3. Yield Response and Profitability of MINAGRI 2001B demonstrations to promote profitable utilization of DAP and urea fertilizers

Crops/ Provinces (*districts*)	Zone	No. of Cases	Response (kg/are)	V/C ratio	Comments
Potatoes : Overall results >>>		**73**	**33**	**4.3**	Aver. v/c for all districts >2; v/c for four districts >4 (one of four >8).
Ruhengeri (*Butaro, Cyeru*)	5B	23	33	3.45	
Byumba (*Cyumba, Mukarange*)	5B	21	25	2.95	
Gikongoro (*Kivu, Mudasomwa, Muko/Musebeya*)	5A	29	40	6.06	
Climbing Beans : Overall results >>>		**56**	**4**	**1.9**	
Gitarama (*Tambwe/Kigoma, Musambira, Mukingi*)	4C	24	5	1.98	V/C for Mukingi was 2.26.
Gikongoro (*Kinyamakara, Rukondo/Karaba*)	4B	16	3	1.37	
Butaré (*Nyasibindu*)	4C	6	2	0.89	
(*Nyakiza/Runyinya*)	4B	13	5	2.37	
Maize : Overall results >>>		**68**	**12**	**1.8**	V/C for Cyimbogo was 2.33 but other results in zone 2A/B were poor.
Cyangugu (*Cyimbogo, Gishoma, Gisuma*)	2A/B	23	9	1.62	
Ruhengeri (*Cyeru, Butaro*)	5B	23	8	1.21	
Byumba (*Cyumba, Mukarange*)	5B	21	19	2.71	
Sorghum : Overall results >>>		**34**	**9**	**1.5**	Aver v/c >4 in Taba (8 cases) but <2 in all other districts.
Kibungo (*Sake, Mugersera*) and Kigali Rural (*Kanzenze*)	6A	17	5	0.64	
Gitarama (*Taba*)	4D	8	24	4.17	
Kigali Rural (*Rutongo/Shyorongi*)	4D	9	4	0.82	
Soybeans : Overall results >>>		**47**	**3**	**1.60**	Aver v/c >3 in Taba (10 cases) but <2 in all other districts.
Gitarama (*Musambira, Taba, Tambwe/Kigoma, Mukingi*)	4C	32	4	1.92	
Kigali Rural (*Rutongo/Shyorongi*)	4D	7	1	1.22	
Butaré (*Nyasibindu*)	4C	8	1	0.61	

Source: Synthesized from Kelly et al. 2002.
Notes: All demonstrations used fertilizer doses recommended in Kelly and Murekezi 2000.

(3.45) and Byumba (2.95). The v/c ratio is the value of additional production due to fertilizer use divided by the cost of the fertilizer. A v/c ratio ≥2 is considered the minimum level of profitability necessary to stimulate fertilizer demand among small farmers in SSA.

Overall results for other crops do not yet provide strong evidence that all farmers, given their current capacity to use fertilizer, will increase incomes through fertilizer use. Nevertheless, there is a sufficient number of farmers meeting or exceeding the fertilizer responses and v/c ratios reported for previous trials and demonstrations that continued efforts to train farmers in the use of fertilizers appears warranted. This is particularly true for maize where 21 farmers in Byumba did very well. For sorghum and soybeans, the performance of farmers in Taba provides some

evidence that the fertilizers promoted by the demonstrations can produce good results. Unfortunately, the number of observations in Taba is limited (eight for sorghum and ten for soybeans). The very poor performance by farmers in other districts suggests the need for careful analysis of the reasons behind this poor performance. Follow-up interviews are also recommended for farmers in Taba to confirm that their perceptions of the good results conform to the data received.

Results for climbing beans were generally poor. Although two of the six districts with climbing beans had v/c ratios greater than two, many farmers in these districts planted their demonstrations on smaller than recommended plots. This resulted in the use of higher than recommended rates of fertilizer per unit area. When the v/c ratios were corrected for these higher doses of fertilizer, average v/c results for all districts were below two. Also the average yield response across all districts (ranging from 2 to 5 kg/are) was generally less than half the anticipated response (12 kg/are) reported in the FSRP/FAO analysis.

These poor results are due, at least in part, to the fact that the breadth of coverage attempted by the 2001B demonstration program clearly exceeded MINAGRI financial and human resources. The principle problems encountered were (1) late distribution of inputs to some farmers, (2) inadequate training of most participant farmers that resulted in incorrect application of inputs by many, and (3) poor supervision of data collection that resulted in 42% of demonstrations having no data available for analysis.

Following this experience, DVC recommended that future demonstration programs be limited to one province per season and then rotated into new provinces each season; but in 2002A resources were not available for even a very limited program in one province. During the 2002A season, the ARMDP was the only official program involved in fertilizer demonstrations.

5. 2002A ARMDP FERTILIZER DEMONSTRATIONS

The ARMDP is not a fertilizer demonstration program *per se* but a broader program with multiple components aimed at stimulating agricultural productivity growth and improving agricultural input and output markets in Rwanda. One means employed by the project to achieve its objectives is the provision of advisory services offering technical and management training to "lead" farmers, representatives of farmers' organizations, and traders. Training of the "lead" farmers began in late 2000 and in late 2001 these farmers had put in place about 2000 demonstration plots for the 2002A season.

Unlike the MINAGRI fertilizer demonstration program, which selected districts strictly on the basis of potential fertilizer profitability, the ARMDP used a broader range of selection criteria. The criteria included (1) the presence of agricultural projects, NGOs, and farmers' associations able to assist with project implementation, (2) the availability of ARMDP baseline survey data (an important pre-requisite for evaluating project impact), and (3) evidence of fertilizer profitability reported in the FSRP/FAO report. Because the first two criteria often received more weight than the third one, ARMDP found itself conducting some fertilizer demonstrations for

crop/zone combinations where there were no FSRP/FAO "green lights" for profitable fertilizer use.

Desai (2002) reviewed ARMDP demonstration plot reports and noted that only 28% of the 40 individual crop/district/treatment situations covered resulted in average v/c ratios >2. Compounding the problem of low profitability was a high rate (45% of 40 situations) of v/c ratios <0, which means that farmers would have lost money had they paid for their inputs. Part of the poor yields is thought to be due to late input delivery and planting—a consequence of late project implementation. However, the possibility of inappropriate fertilizer doses cannot be eliminated because there were many demonstrations conducted for crop/zone combinations where the underlying profitability analysis did not exist and numerous other demonstrations that did not follow the profitability-based recommendations reported by FSRP/FAO. Table 4 summarizes the results of a subset (243 of about 2000) of the ARMDP demonstrations that (1) concerned crop/zone combinations with a "green light" for profitability from FSRP/FAO and (2) for which ARMDP farmers used DAP and urea instead of NPK.[9] Overall v/c results across the four crops (potatoes, climbing beans, maize, and soybeans) are all >2 except for climbing beans (v/c 1.2). These overall results for DAP/urea treatments are better than the MINAGRI results (Table 3) where only potatoes exhibited an average v/c>2, and among the better results across the other demonstrations conducted by ARMDP and described in the previous paragraph. These results suggest that profitability is more likely when DAP and urea are used for crop/zone combinations given the "green light" for profitability in the FSRP/FAO report.

A technical issue that requires attention is the level of DAP/urea applied in demonstrations targeted at zones covered by the FSRP/FAO recommendations. For example, doses of DAP and urea applied to ARMDP climbing beans and maize demonstrations far exceeded those recommended by FSRP/FAO. Furthermore, the ratio of DAP to urea is reversed for maize in Bugarama (i.e., more DAP than urea rather than more urea than DAP). Although there is a benefit in training farmers to apply different rates and compare results, at this point in the process of developing fertilizer demand it would appear more prudent to focus on demonstrations that call for well tested application rates that have passed the "profitability" test. When this is not possible, a limited number of well controlled and implemented trials would be more appropriate than a large number of diverse demonstrations that risk discouraging fertilizer use among the many participating farmers who are likely to have poor results.

In summing up its demonstration plot results, the ARMDP report states: "Apart for the Irish potato, the profitability due to the fertilizer application is not obvious."

The report then goes on to plan for a doubling of demonstrations for the 2002B season whereby the lead farmers will again conduct their own demonstrations but also assist three other farmers to implement them. There is no discussion in the report of the need to evaluate the causes of the low response and profitability or to re-examine some of the fertilizer doses applied during the 2002A season. ARMDP is currently using the number of demonstrations conducted as a performance indicator. This indicator could be pushing the project to rapidly expand demonstrations rather than taking the time to evaluate the causes of the many unprofitable

[9] We do not attempt to interpret the other demonstrations conducted by ARMDP as we have no information available for evaluating the appropriateness of the doses recommended and no benchmark against which to compare the results.

outcomes. Incorporating a slightly different or additional evaluation criteria such as the number of demonstrations obtaining v/c ratios >2 might be a way of improving the demonstrations as well as fertilizer uptake by farmers.

Table 4. Yield Response and Profitability of ARMDP (2002A) demonstrations using DAP/urea for crops and zones identified as profitable by FSRP/FAO

Crops/ Provinces (*district*)	Zone	No. of Cases	Average response (kg/are)	V/C ratio	Comments
Potatoes : crop average>>		**111**	**44**	**4.3**	Urea applied was conform with K/M.
Gikongoro					
(*Mudasomwa*)	5A	52	26	2.5	DAP applied was less than recommendations in K/M (90 vs. 110 kg/ha recommended). Note that other demos with NPK (not shown) performed less well than DAP/urea.
(*Musebeya*)	5A	40	60	5.8	
(*Nshili*)	5A	19	60.	5.8	
Climbing Beans : crop average >>		**79**	**11**	**1.2**	Fertilizer doses exceeded recommendations in K/M .
Cyangugu (*Bugarama*)	1	16	6	1.1	Zone 1 : 150 DAP + 50 urea vs. 80 + 30 kg/ha recommended;
Kig.Rur. (*Bicumbi*)	4D	63	12	1.2	Zone 4D : 150 DAP + 50 urea vs. 100 kg/ha DAP recommended
Maize : crop average >>		**53**	**10**	**2.6**	Fertilizer not conform with K/M.
Cyangugu (*Bugarama*)	2B	19	6	1.1	Zone 2B : 100 DAP + 60 urea vs. 90 +120 kg/ha recommended.
Gitarama (*Ntongwe*)	4C	34	12	3.5	Zone 4C : 100 DAP + 100 urea vs. 60 + 60 kg/ha recommended.
Soybeans : crop average >>		**34**	**4**	**2.2**	DAP slightly higher than K/M.
Gitarama (*Ntongwe*)	4C	34	4	2.2	100 DAP vs. 90 kg/ha DAP recommended

Source : Compiled from ARMDP quarterly reports and Desai 2002.
Notes : K/M refers to fertilizer recommendations made in Kelly and Murekezi 2000.

6. KEY CONCLUSIONS FROM BOTH SETS OF DEMONSTRATIONS

This review illustrates the important contribution that a relatively small effort to collect demonstration plot data can make to the analysis of the strengths and weaknesses in demonstration program design and implementation; both MINAGRI and ARMDP should be commended for their efforts to add research and monitoring components to their demonstrations.

Although the principle goal of the MINAGRI program was to rapidly increase fertilizer uptake by focusing on the crops and zones with the highest profit potential, the program was too ambitious and suffered from poor implementation. A large number of demonstrations were not profitable due to incorrect use of inputs, late planting, and so forth. An even larger number were monitored so poorly that no data were collected or those that were could not be evaluated. No survey was conducted after the demonstrations to evaluate the impact of the program on farmers'

decisions to use fertilizer during the 2002A season, but the generally poor program implementation suggests that few farmers would have been convinced that fertilizer use was profitable and worth adopting.

The ARMDP did not focus as much as MINAGRI did on selecting the zones, crops and fertilizer doses likely to be the most profitable. Although this lack of focus on profitability limited ARMDP's ability to rapidly increase farmers' confidence in fertilizer profitability and thereby stimulate fertilizer demand, the ARMDP program was much better implemented and monitored than the MINAGRI program (e.g., data collected on 1284 of the 2000 demonstrations placed and results for DAP/urea applications better than those of MINAGRI). Both the MINAGRI and ARMDP programs were pilot projects, so it is appropriate for us to take stock of lessons learned from these two experiences at this time and make recommendations for improved demonstration plot programs in the future.

7. MOVING FORWARD WITH FERTILIZER DEMONSTRATIONS

In moving forward, we take as given the estimate that potential demand for fertilizer in Rwanda is a minimum of 23,000 tons per year (Kelly et al. 2001, Desai 2001). We also take as given the idea that demand is currently a more important problem than supply. Desai (2002) notes that in the early stages of fertilizer market development two processes for increasing fertilizer demand predominate: Increasing the number of farmers adopting fertilizer and increasing the number of crops a farmer fertilizers.

Farmers' perceptions of fertilizer profitability are generally considered the most important determinants of these processes, hence, options for rapidly increasing fertilizer demand from the current level of approximately 8,000 tons to its 23,000-ton potential need to focus on improving farmers' understanding of fertilizer profitability.

To accomplish this, Desai has proposed a public sector National Fertilizer Demonstration Program that (1) focuses on zones and crops with the greatest promise of fertilizer profitability (i.e., the "green light" zones in the FSRP/FAO report) and (2) conducts the demonstrations in a manner that focuses farmers' attention on the increased profits they can realize if they use fertilizers correctly. He argues that demonstration programs promoting fertilizers have traditionally been the responsibility of the public sector (e.g. ministries of agriculture and government extension services in many developing countries, land-grant universities attached to state governments in the United States). He also notes that it is inappropriate at the initial stages of input market development to expect fertilizer dealers to invest resources in demonstrations because of the important investments they need to make in warehousing, building stocks, and managing transportation. Desai further argues that permitting fertilizer demonstrations on crop/zone combinations for which there is not adequate documentation of profitability dilutes the demonstration program and prevents it from increasing fertilizer demand as rapidly as it could be increased if all resources were first invested in the profitable "green light" crop/zone combinations.

Despite the evidence from other countries in favor of publicly funded and managed fertilizer promotion programs, the MINAGRI 2001B experience suggests that there would need to be major changes in human resources and budget if the MINAGRI were to take on the responsibility for conducting a wide scale fertilizer demonstration program. Key issues that would need to be addressed in designing such a program are:

- What would such a program cost in terms of personnel, annual budget, and capital investments?
- From where would the human and financial resources to implement such a program come?
- To what extent should/could the private sector (fertilizer distributors, NGOs, crop exporters or processors) contribute?
- What types of policies would be needed to ensure that private sector participants were objectively promoting input use that was in the farmers' interest rather than that which might increase upstream or downstream profits at the expense of farm profits?
- How would this program relate to the recently launched Rural Sector Support Project being funded through a World Bank loan?
- What type of research or extension activities should be carried out for zones where adequate information for making fertilizer recommendations is not available?
- Should these zones be entirely ignored in the early stages of fertilizer promotion or should there be an active research/extension program carried out as a preliminary step leading up to fertilizer promotion programs?

We concur with Desai concerning the importance of a demonstration plot component in any Rwandan effort to promote more rapid expansion of fertilizer use. We believe that expansion of the demonstration program should be targeted at crop/zone combinations where farmers' knowledge remains the principal constraint. However, when knowledge is no longer the principle constraint, other activities will be needed. For a crop/zone combination where the majority of farmers are convinced of fertilizer profitability and have mastered fertilizer techniques (potato growers in zone 5B of Gisenyi and Ruhengeri may be close to this), the demonstration programs should be scaled down and supplemented by activities designed to improve access and reduce risk (e.g., credit, management training for farmers' associations).

Having carefully examined the recent evidence on fertilizer import growth, demonstration plot results, and the Desai proposal for a concerted MINAGRI fertilizer demonstration program, we have developed the following set of specific recommendations for consideration by MINAGRI as it moves forward with its fertilizer promotion activities.

(1) Change official publication of fertilizer recommendations in the *Agenda Agricole* to include DAP/urea combinations recommended in the FSRP/FAO report and confirmed by the MINAGRI and ARMDP demonstration programs.
(2) Supplement the recommendations published in the *Agenda Agricole* with information on factors influencing profitability (yield response potential and input/output price ratios used in the analysis).
(3) To ensure a multi-disciplinary approach to fertilizer recommendations that takes into account crop productivity, farm-level profitability, and environmental impacts, a

multidisciplinary team (economist, agronomist, and soil scientist at a minimum) should be assigned the task of drafting the Agenda Agricole recommendations and updating them each year to incorporate price changes and lessons learned from new research or analysis of demonstration plot data.

(4) The MINAGRI should promote a program of soil monitoring in zones of highest fertilizer consumption to ascertain the continued appropriateness of recommendations (e.g., changes in soil acidity, potassium levels, soil organic matter, or increased erosion).

(5) The MINAGRI should encourage better use of the media for disseminating information on fertilizer recommendations, profitability and prices (perhaps in conjunction with weekly reports on market prices); this information should be targeted at farmers as well as traders and NGOs assisting farmers.

(6) The MINAGRI should advocate fertilizer promotion policies and programs (a) that are first targeted to crop/zone combinations with the highest potential for fertilizer profitability, then gradually expanded to less profitable crop/zone combinations and (b) that take into account non-knowledge constraints such as access or output market development problems when they emerge in zones where improved knowledge has stimulated interest in fertilizer use but effective demand remains a constraint.

(7) In targeted zones, local field days and competitions among farmers should be considered as means of increasing interest in the demonstration plots.

(8) All institutions involved in fertilizer demonstrations should cooperate in designing and using the same monitoring and evaluation methods so that a standard set of data is collected for each demonstration plot (area, yield, fertilizer dose, v/c ratio, accompanying practices such as manure, lime, etc.) and made available for use in an annual report that synthesizes results for the entire country.

(9) A workshop of key actors concerned with fertilizer demand and supply should be convened annually to discuss the results of the fertilizer demonstration analyses, trends in fertilizer imports and distribution, etc. with the goal of identifying bottlenecks and designing improvements to be implemented for the following year.

Those implementing the sixth recommendation should select only districts with at least one crop that has already been shown to respond profitably to fertilizer ("green lights" in FSRP/FAO report) and then determine the relative importance of the knowledge versus the access constraints (methods for doing this in a cost-effective manner need to be developed). Limited funds should then be allocated across knowledge-building and access-enhancing programs in a manner that takes into account the relative importance of these two constraints. For example, where the principal constraint is farmers' knowledge (e.g., maize producers in Umutara), demonstration programs using the most profitable fertilizer recommendations should be the focus. For crop/zone combinations where the principal constraint is no longer farmers' knowledge, resources should be transferred to activities that reduce risk or improve access (e.g., strengthening farmers' associations and their ability to obtain and manage credit, encouraging traders and banks to offer input credit, or strengthening output demand and market performance). It will also be important to develop transition plans for switching the emphasis from demonstration programs to access promotion programs at the appropriate time. The ultimate success of the program will then depend on the development of plans for exiting the access promotion programs at the appropriate time and moving on to new districts.

In addition to providing insights about what should be done to promote rapid growth in efficient, profitable use of fertilizers, the recent demonstration programs provide some lessons on pitfalls to avoid. We summarize the key lessons below:

(1) Don't do fertilizer demonstrations for crop/zone combinations where there is not well-established evidence of profitability. For example, if working in Ntongwe, where there is a "green light" for fertilizer profitability on climbing beans, maize, and soybeans but not for potatoes and rice, demonstrations should not be conducted on potatoes and rice. This does not mean potatoes (with a yellow light signaling proceed with caution) and rice (no data available) should be ignored in this district if they are crops being grown by farmers; it means that extension and research should work with a limited number of farmers using on-farm trials to identify the appropriate doses and deal with the plant disease problems that led to the yellow light recommendation for potatoes (see Kelly and Murekezi 2000 for details).
(2) Don't do fertilizer demonstrations on crop/zone combinations with a red light indicating that fertilizer use is not profitable (unless subsequent price changes or the introduction of new crop varieties render fertilizer profitable in these crops/zones)
(3) Don't do fertilizer demonstrations for crop/zone combinations where no prior data are available (white districts on the maps in the FSRP/FAO study), but develop on-farm trials that (1) are supervised more closely than demonstrations by both research and extension personnel, and (2) test a variety of levels (minimum of 3 different levels each) of N, P, and K fertilizers permitting the estimation of production functions, (3) analyze the results and identify doses with v/c ratios ≥ 2[10], (4) once satisfied that a profitable dose has been identified move to demonstrations comparing farmers current practices with the recommended fertilizer treatment.
(4) Don't do more fertilizer demonstrations than necessary to establish and maintain general agreement among farmers that fertilizer use is profitable and desirable.

8. MOVING FORWARD ON INSTITUTIONAL ISSUES

We think that the experiences of the past few years have taught us a lot about fertilizer potential for non-beverage food crops and stimulating fertilizer supply in Rwanda. Because of sound public sector facilitating and regulatory policies, private sector firms have significantly increased fertilizer supplies. We have also gained some important insights about how to proceed with making improvements in fertilizer demonstrations and other fertilizer promotion activities. Moving forward with fertilizer promotion programs is unlikely to happen, however, if a number of very important institutional issues are not resolved. During the past three years the MINAGRI has relied on project personnel and resources for much of the fertilizer policy analysis and demonstration program implementation. Consequently, there is not yet an obvious "institutional home" in MINAGRI with the human and financial capacity to carry out the many tasks that will be required to push forward with the design of an expanded fertilizer promotion program much less with the coordination, implementation, and monitoring. A similar problem of capacity and financial resources exists at the *Institut des Sciences Agronomiques du Rwanda* (ISAR), the

10 A fertilizer recommendation with a v/c$\geq$2 is not a profit maximizing fertilizer dose but rather a more conservative recommendation that takes into account the risks involved in fertilizer use.

logical home for fertilizer research. As three of the projects that have been providing support to fertilizer policy analysis and project implementation are rapidly drawing to a close,[11] the GOR should be thinking about how to find appropriate and sustainable institutional homes for the coordination and conduct of fertilizer policy, research, and promotion activities. Some of the questions that need resolution at the central level are:

- Who should coordinate the design and implementation of Rwanda's fertilizer promotion and research program?
    - An existing or new institution or department of government
    - A special project or committee composed of both foreign and national consultants representing a wide range of stakeholders (farmers, government, fertilizer distributors, NGOs)
    - Something else?
- Who should participate in the design and implementation activities?
    - Which departments of MINAGRI
    - What research institutions
        - National
        - Regional
        - International
    - What other ministries or government services
    - What non-governmental institutions
    - What businesses (e.g., banks, input distributors, agricultural exporters)
- Who should do the monitoring and evaluation of programs once implemented?
- What will be the cost of design, implementation, and evaluation?
- From where will the funding come in the short-run? In the long run?
- Will there be resources to maintain a fertilizer research and promotion program that is capable of providing farmers services as their fertilizer needs evolve or special problems are encountered?

Additional questions concerning local implementation of fertilizer demonstrations and research also need to be addressed:

- What institution or institutions should be responsible for local management, implementation, and monitoring of results?
    - Government extension services
    - NGOs, special projects or consultants
    - A combination of the above?
- To what extent will decentralization affect the ability of local governments to design, fund, and implement their own programs?

Although the preceding list of questions concern what needs to be done to develop a successful fertilizer promotion program, one cannot separate the issue of what needs to be done in fertilizer from what needs to be done for agricultural policy analysis, research and extension in general. If Rwanda already had a well-functioning system in place to conduct agricultural policy analysis,

11 The FSRP, the Abt/USAID Agricultural Policy Development Project, and the ARMDP.

research, and extension, we would not be asking the above questions. Our recommendation is that the GOR use the design of a priority program to promote fertilizer as an opportunity to develop a more coherent and better-articulated institutional framework for conducting all of its agricultural policy, research, and extension activities.

As there is no single one-size-fits-all solution to developing a successful fertilizer promotion program, the GOR needs to answer the questions on the previous page by examining the strengths and weaknesses of alternative programs. The GOR has experimented with a variety of approaches to extension services that could be used to implement a fertilizer promotion program. In this paper we have briefly discussed the strengths and weaknesses of two public sector programs that have focused on fertilizer promotion using different approaches:

- The MINAGRI program carried out primarily by DVC and DSA staff at the national level (with some financial and technical assistance from the FSRP project) and district agronomists at the local level; the program relied on "model" farmers who had participated in MINAGRI technical training programs in the recent past but had not yet benefited from any practical experience with fertilizer applications.
- The ARMDP program that was carried out by project-funded staff housed in the MINAGRI collaborating with district-level agronomists and NGOs who were contracted by the project to provide a variety of farmer advisory services; the extension model used was one of "lead" farmers who would be trained and then assisted with their demonstration plots the first year. The following year the lead farmer is expected to assist three additional farmers conduct demonstration plots.

In addition to these two recent government sponsored efforts, there are a variety of past and current projects that have been funded by multilateral or bilateral donors working in collaboration with the government. For example:

- The PEARL project, which is promoting a U.S. style extension service built on promoting strong university, research, and extension links that are largely funded and implemented at the provincial or district level.
- The Rural Sector Support project, which is just getting underway, anticipates using an extension model similar to the one tested by ARMDP with both NGOs and district agronomists involved. A slight modification of the ARMDP experience that has been discussed is a stronger focus on district agronomists12 as the direct link to farmers with NGOs being used more for training district agronomists than for direct training of farmers.
- The *Projet de Gestion des Espaces Ruraux de Buberuka* (PGERB) a program funded by IFAD and implemented by the DSRA in Ruhengeri; the project conducted agricultural demonstrations in all districts of Ruhengeri in 2001B and 2002A, many of which were fertilizer demonstrations.

12 It is anticipated that over time districts and/or farmers' associations will be able to hire their own extension agents from among the individuals currently being trained, thereby increasing the ability of local communities and farmers to ensure that they get good quality services.

- Private sector and parastatal efforts where exporters or processors of high value crops provide inputs and extension services to farmers (for example, tomatoes grown for the local tomato processor, sorghum grown for industrial breweries, OCIR tea and coffee).

Each of these examples represents a different combination of government and private sector actors and funding and a different set of outcomes. To the extent that written documentation exists, a careful review of the strengths and weaknesses of each program should provide additional input that could be used to answer the list of questions posed on the previous page about who should do what and with what type of funding.

Finally, it may also be useful to consult with experts knowledgeable about programs developed elsewhere in SSA that exhibit similarities to the Rwandan situation and assess the extent to which these experiences may contribute to the design of an appropriate fertilizer promotion program for Rwanda.

Since there is no on-size-fits-all solution, the most likely outcome would be a heterogeneous extension and fertilizer promotion program in Rwanda that takes into account the special characteristics of different crops and types of production systems. In cases where there is potential for private sector extension and credit, the government role may be one of facilitator rather than implementer. Facilitation in such cases often takes the form of providing market information that brings farmers and exporters or processors together, training that enhances the capacity of individual farmers or farmers' organizations to negotiate fair terms, and improvements in the judicial system ensuring that contracts can be enforced and penalties imposed for non-compliance.

Although there may be some situations where the private sector is willing to shoulder a large share of input promotion activities, experience in Rwanda and elsewhere suggests that there are many crops for which it will be difficult to get the private sector involved. These crops tend to be local food crops for which there is no export market or industrial processing demand. In these cases, it is likely that the GOR will need to play the role of coordinator, facilitator and, in some cases, implementer of fertilizer promotion programs and demonstration plots.

Rwanda has made amazing progress in moving from a government and donor controlled fertilizer distribution system to a private sector system in a very short period of time, yet much remains to be done if Rwanda is to realize the full potential that fertilizer offers for increasing crop productivity, rural incomes, and aggregate GDP. Resolving these institutional issues with the appropriate balance of GOR/donor funding, public/private implementation, and central/local participation is the next important step in moving toward a effective fertilizer promotion program and realizing this potential.

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Annex: Time-line of fertilizer policy and projects in Rwanda

Date	Important benchmarks affecting fertilizer demand and supply
1970s/80s	Strong emphasis on organic farming methods; use of inorganic fertilizers discouraged.
Late 1980s to early 1990s	FAO and bilateral donors assist GOR/ISAR with fertilizer research (trials to determine appropriate doses, demonstrations to familiarize farmers with fertilizer); research continued to emphasize importance of combining organic and inorganic fertilizers and appropriate use of lime on acid soils.
1995-98	EU imported fertilizers that were sold at subsidized prices to NGOs and input dealers as part of post-war recovery program; sales volume was low (<3000 tons/yr) and credit repayment was a problem; private sector complained of unfair competition from NGOs distributing fertilizers free or below cost.
1997	National workshop on fertilizer united Rwandan and international experts in crop production and soil fertility issues; general consensus that Rwanda needed to increase use of inorganic fertilizers but little concrete action taken following workshop.
1999	FSRP/FAO/MINAGRI hold workshop and publish report, which updates profitability analysis of fertilizer use by crop and agrobioclimatic zone; report shows strong potential for profitable use of fertilizers in many (but not all) parts of Rwanda.
2000	GOR implements two major policy changes and ARMDP project begins; policy changes included (1) no free or subsidized fertilizer distribution without written MINAGRI permission and (2) temporary removal of fertilizer ICHA (15%) and customs duties (5%) for three years, followed by possible renew for two additional years.
2000-2002	Fertilizer imports for non-beverage crops increase from 731 to 2094 and then to 6126 tons from 1999 to 2001; aggregate imports do not increase in first half of 2002. Number of fertilizer importers increases from 5 in 1998 to 22 in 2001 and the diversity of import sources/routes increases. Line of Credit for importers provided by ARMDP project contributes to increases but remains under-utilized because banks and traders were able to mobilize their own funds for 90% of the imports. ARMDP program of input credit facility to farmers offered through Banques Populaires began in October 2001 and appears to be working well.
2001	(a) MINAGRI/USAID policy workshop on fertilizer use and marketing results in proposed action plan to increase fertilizer consumption from 2000 levels of 8000* tons to 23000 tons over a period of 3 years (5000 tons per year). (b) MINAGRI conducts a series of fertilizer demonstrations during 2001B season focused on the zones identified in FSRP/FAO profitability analysis as the most likely to realize high returns for the five crops targeted by MINAGRI programs: potatoes, maize, sorghum, soybeans, climbing beans. (c) ARMDP begins their program of advisory services for the adoption of modern farm inputs and access to credit; 18 districts are selected for the pilot program, with preference given to districts with farmers associations and NGOs having the competence to implement program. Fertilizer demonstrations are conducted as a part of the program but, unlike MINAGRI demonstration program, FSRP/FAO recommendations on fertilizer profitability are not the key criteria used in selecting districts and fertilizer recommendations.
2002	(a) Fertilizer Policy Committee created: revises draft action plan from 2001 workshop and develops terms of reference for a consultant to further develop an action plan for fertilizer sector. (b) Analysis of MINAGRI and ARMDP 2001B fertilizer demonstrations completed**; yield response and profitability acceptable for potatoes but results for other crops are highly variable suggesting a need to improve both focus and implementation of fertilizer demonstration programs.

* There was some confusion concerning quantities imported in 2000 at the time of the February 2001 workshop and the action plan was based on the assumption of 8000 tons rather than the 6126 tons used in subsequent reports.
**Results and analysis of demonstrations are reported in ARMDP quarterly reports Nos. 01/02 and 03/02, Desai 2002, and Kelly et al. 2002.