IMPACT OF THE FERTILIZER SUB-SECTOR REFORM PROGRAM ON FARMERS: THE RESULTS OF THREE FARM-LEVEL SURVEYS

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IMPACT OF THE FERTILIZER SUB-SECTOR REFORM PROGRAM ON FARMERS: THE RESULTS OF THREE FARM-LEVEL SURVEYS

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and

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by

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THE AGRICULTURAL MARKETING IMPROVEMENT STRATEGIES PROJECT

Abt Associates, Washington, D.C.
and
The University of Idaho/Postharvest Institute

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GLOSSARY

AMIS	-	Agricultural Market Improvement Strategies Project
DEAPA	-	Directorate of Agro-economic Surveys and Agriculture Planning, Ministry of Agriculture
FONADER	-	Fond National pour le Developpement Rural
FSSRP	-	Fertilizer Sub-Sector Reform Program
IFDC	-	International Fertilizer Development Center
IRA	-	Institutes de Recherche Agricole
MIDENO	-	Mission de Developpement du Nord Ouest
Minagri	-	Ministry of Agriculture
OLS	-	ordinary least squares
UCD	-	University Center at Dschang
USAID	-	United States Agency for International Development

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The document was written by Nicholas Minot, Survey Specialist, during a trip to Cameroon from February 14 to March 14, 1991. Mr Minot was part of a three-person team, including Richard Abbott, Marketing Specialist, and David Lloyd, Banking and Credit Specialist. The latter two consultants prepared a separate report entitled Privatization of Fertilizer Marketing in Cameroon: A Third-year Assessment of the FSSRP.

The present study is a synthesis of the results of three farm-level surveys, with additional analysis of one of the three. The surveys were originally recommended in a 1989 AMIS report (Minot, 1989). The questionnaire and survey methods were developed as part of a separate AMIS report later that year (Minot and Johnson, 1989). With funding from the FSSRP, the surveys were conducted in 1990 and the results analyzed by three local institutions: the Directorate of Agro-economic Surveys and Agricultural Planning (DEAPA) of the Ministry of Agriculture, the University Centre at Dschang (UCD), and the Mission de Developpment du Nord Ouest (MIDENO).

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EXECUTIVE SUMMARY

This report summarizes the results of three farm-level surveys carried out in 1990 with the goal of evaluating the impact of the Fertilizer Sub-Sector Reform Program (FSSRP) on farmers and improving our understanding of fertilizer use. One survey was based on a sample of 426 farmers in the seven southern provinces, another used a sample of 100 farmers in the North West Province, and the third interviewed 172 coffee growers in the West Province.

By the time of the survey (after the second year of FSSRP), the subsidy had been cut from 66% of delivered cost to about 30%, thus more than doubling the share of delivered cost paid by farmers. However, privatization has sharply reduced costs, so that farm-level fertilizer prices rose by "only" 28%. All the same, combined with a 50% drop in coffee prices and late payment for coffee, these events have led to a substantial drop in fertilizer demand. This takes the form of fewer users (around 22% in 1990 compared to 25-30% in the mid-1980s) and smaller quantities bought by users.

In the context of these events, it is surprising to find that farmers in the seven southern provinces are evenly split between those believing the distribution system has improved and those seeing a deterioration. Statistical analysis reveals that the level of satisfaction is associated with farm size and region. Specifically, small farmers and those living in the West and North West Provinces are significantly more positive about the new distribution system than others. This is encouraging because participation in the FSSRP has been particularly active in these two provinces. (Section 2 describes these results).

Those farmers seeing improvements in fertilizer distribution point to greater availability, more prompt delivery, and better quality, while those perceiving a deterioration complain of higher prices and lack of credit. Problems of limited availability were reported by only 11% of fertilizer users (the rate was even lower in the West and North West where demand is concentrated). Less than 10% of fertilizer users mentioned problems with fertilizer quality. Complaints about the choice of fertilizers available were cited by 13% of the users, although this is partly due to deliberate cooperative policies to discourage the use of ammonium sulfate. Late delivery of fertilizer was the most commonly cited distribution problem, mentioned by 22% of the fertilizer users. (Sections 2 and 3 review these findings.)

Pesticides and herbicides are imported and distributed by the government at highly subsidized rates, much as fertilizer was before the FSSRP. As a basis of comparison, users of these chemicals were asked to evaluate aspects of their distribution. Frequent shortages and late delivery were each reported by 35% of users. Unavailability of the preferred types was mentioned by 29% of them. These results indicate that the privatized

fertilizer distribution system performs better, as perceived by farmers, on these dimensions than the administered distribution of pesticides and herbicides. (More detailed results can be found in section 8).

How do fertilizer users differ from non-users? In order to answer this question, fertilizer use was modeled using logit multiple regression. The results indicate that fertilizer use is positively associated with having arabica coffee trees, having robusta coffee trees, and being a commercial maize producer, while being negatively related to distance from a point of sale. The model, using these four variables, correctly "predicts" whether or not a farm will use fertilizer in 89% of the cases in the sample. On the other hand, the likelihood of fertilizer use is not related to farm size, ownership of animals and other assets, cooperative membership, and production of other crops such as cocoa and root crops. (The model and related findings are presented in section 4).

The survey also explored the way fertilizer users purchase and apply fertilizer. Two thirds of all fertilizer purchases occur in the period from January to April. Around 80% of the fertilizer users apply it to coffee, half of them put it on maize, a quarter fertilize vegetables, and half apply it to other crops. Two thirds of all fertilizer users apply it to more than one crop. The average quantity purchased is 6 bags, although most farmers buy four bags or less. There are some regional differences. In the West and North West Provinces, small farmers purchase relatively small quantities from cooperatives and apply it to coffee and to maize, and sometimes to vegetables and other crops. In the other provinces, fertilizer users tend to be larger farmers buying greater quantities from coffee processors and merchants located at some distance from the farm. No one crop is fertilized by the majority of these users. Multiple regression analysis reveals that the quantity of fertilizer purchased by users is positively related to the number of coffee trees and to commercial maize production, while being negatively associated with late payment for the coffee harvest. (Section 5 describes fertilizer use patterns in more detail).

Although fertilizer users in Cameroon have well-defined preferences in terms of the types of fertilizer, the survey results show that they lack basic information about fertilizer. Farmers were asked three questions of practical importance for choosing and applying fertilizer. Even among fertilizer users, only 9-13% were able to answer correctly. (These results are presented in section 6).

Finally, since most farmers in Cameroon do not use fertilizer, one section of the survey was devoted to examining the reasons for non-use. A large majority of non-users (82%) accept the idea that fertilizers have a positive impact on crop yields. A smaller majority (62%) declare that fertilizer is "worth the cost and risk." The predominant reasons given for not using fertilizer is "lack of money", although relatively few mention lack of credit as a constraint. Only a quarter of non-users outside the West and North West Provinces even know where to obtain fertilizer. Those that do, cite distances fifteen times as far on average, as those reported by users. Interpretation of these results is complicated by the fact that points of sale and knowledge of them both respond to demand and affect demand. Late

delivery does not appear to be a significant factor in the non-use of fertilizer. (These results are described in section 7).

In light of these findings, the following recommendations are made to improve the Fertilizer Sub-Sector Reform Program as it affects farmers:

Take measures to expand participation in FSSRP, particularly in provinces where the program has not been active.

Explore ways of improving linkages between potential users in thin-demand areas and transporters who could arrange fertilizer deliveries.

Monitor the development of the fertilizer sub-sector with a general survey to be collected every two years.

Conduct a province-level fertilizer survey in the Littoral.

Seek ways to support cooperatives and government agencies in disseminating information about fertilizers to farmers.

Encourage compilation of existing fertilizer response research and reconsider support of new fertilizer response trials.

Support efforts to improve the marketing of coffee and the prompt payment of arrears.

In consultation with appropriate policy makers, study the possibility of reforms in the pesticide/herbicide sub-sector along the lines of the FSSRP.

These recommendations, along with some approaches for implementing them, are discussed in more detail in section 9 of this report.

1. INTRODUCTION

This report summarizes the results of three surveys of farmers in Cameroon regarding the use of fertilizer and examines the implications for the Fertilizer Sub-Sector Reform Program (FSSRP). The surveys were paid for out of the FSSRP local currency fund, managed jointly by the Government of Cameroon and the United States Agency for International Development (USAID). The three surveys used quite similar questionnaires, and all three were carried out between July and September 1990, thus allowing a degree of comparability among them.

One survey, carried out by the University Center at Dschang (UCD), collected information on 172 coffee growers in the West Province. Another survey, conducted by the Mission de Developpement du Nord Ouest (MIDENO), was based on a random sample of 100 farmers in the North West Province. And the third survey was implemented by the Directorate of Agro-economic Surveys and Agricultural Planning (DEAPA) of the Ministry of Agriculture and used a random sample of 426 farmers in the seven southern provinces. Except where noted, the results presented in this report refer to percentages and averages of the sample data. A small bias may be introduced by not using expansion factors to extrapolate from the sample data to the farm population, as discussed in Appendix A.

The results of these surveys must be interpreted in the context of two important events. The first is the Fertilizer Sub-Sector Reform Program, involving the privatization of fertilizer distribution in Cameroon and the phased removal of fertilizer subsidies. Starting during the 1988-89 season, private firms began importing and distributing fertilizer independently, no longer relying on public tenders issued by the Ministry of Agriculture and financed by FONADER, the rural development bank. The level of subsidization (as a percentage of the farm-level price) has declined from 66% in 1987-88 under the old system of public-sector monopoly, to 43% in 1988-89, 36% in 1989-90, and around 30% in 1990-91[1].

At the same time, privatization has led to a sharp decrease in the delivered cost of fertilizer, thus dampening the impact on prices at the farm level. For example, without any reduction in cost, farm-level prices would have doubled over the first two years of the program. Instead, average farm-level fertilizer prices rose "only" 28% over this period (Abbott, 1989 and 1990). From the point of view of the farmer, of course, this is still a significant increase.

Second, the economic crisis facing Cameroon has affected both the incentives facing farmers and their purchasing power. World coffee prices

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1. These figures are calculated by taking the average per unit subsidy as a percentage of the sum of the subsidy and the average retail price (see Abbott, 1990, Exhibits 3 and 4).

peaked in the mid-1980s and have fallen by almost 50% since that time. The drop in world prices was passed on to farmers starting with the 1989-90 agricultural year. Since coffee is one of the main crops receiving fertilizer in Cameroon, coffee prices directly affect the profitability of, and hence demand for, fertilizer. In addition, low coffee prices and late payment for delivered coffee have imposed cash flow constraints on many farmers. Given imperfect credit markets, these farmers may not be able to purchase fertilizer even if it would be profitable to do so.

The net result of these events is that fertilizer use has declined. Fertilizer imports in the first and second year of the program (1988-89 and 1989-90) were around 63,000 mt, virtually unchanged from the last year under the old system. Although fertilizer use matched imports in the first year of the program, farmers sharply reduced their purchases in the second year of the program, leaving large unsold stocks. This was the situation at the time the surveys were undertaken. (In the third year, fertilizer purchases by farmers partially rebounded, reducing the stocks. See Abbott and Lloyd, 1991).

The report is organized as follows. Section 2 provides the results of several questions concerning the evaluation by farmers of the current fertilizer distribution system compared to the system existing before 1988. Section 3 focuses on the degree to which fertilizer supply in the new system is responsive to effective demand. This is measured along several dimensions: fertilizer quality, its availability in sufficient quantities, the timing of its availability, and the choice of types of fertilizer. In section 4, the factors associated with fertilizer use are explored using cross-tabulation and a logit regression model. Section 5 concentrates on fertilizer users and describes the ways fertilizers are bought and used. Multiple regression is used to estimate the quantity of fertilizer purchased among users. Section 6 considers the level of fertilizer knowledge of farmers, as well as actual and potential sources of information. In section 7, we focus on farmers who do not use fertilizer in order to determine the reasons for non-use and perceived constraints faced by these farmers. Section 8 describes the results of a short section of the questionnaire which examines the pesticide and herbicide distribution system. And finally, section 9 discusses some ways that the fertilizer distribution system might be improved in light of the results presented in this report.

2. FARMER EVALUATION OF FERTILIZER DISTRIBUTION: COMPARING OLD AND NEW SYSTEMS

The Fertilizer Sub-Sector Reform Program was developed to address some specific problems associated with the old system of subsidies and public-sector monopoly. First, the fiscal cost of the fertilizer subsidies had become substantial, reaching around 6 billion CFA francs per year in 1987 (about $ 23 million at current exchange rates). In addition, the system was characterized by late delivery of fertilizer, quantitative restrictions (rationing), costly importation and distribution procedures, and lack of responsiveness to changes in demand. These problems were documented in reports by Elliot Berg and Associates (1983) and the International Fertilizer Development Center (1986).

In this section, farmer perceptions of the fertilizer distribution system, as revealed in the surveys, are considered. Included are several questions to determine the extent to which the problems cited above still exist. Most of the results presented in this section refer to "recent fertilizer users," defined as those having purchased fertilizer at least once in the previous five years. The questions were directed at recent users, rather than current users, to avoid biasing the results by excluding those so dissatisfied that they no longer use fertilizer. The sub-sample of recent users included 114 farmers (27% of the sample) in the DEAPA seven-province survey, 46 farmers (46%) in the MIDENO survey in the North West, and 142 of the coffee growers (83%) in the UCD survey of the West Province.

2.1 Overall Evaluation of Fertilizer Distribution

The questionnaire included a question as to how farmers perceive the current fertilizer distribution system compared to that existing before 1988. According to the DEAPA survey of the seven southern provinces, farmers are more or less evenly split in their evaluation of the program. As shown in Exhibit 1, the proportion declaring the system to be better or significantly better (40.4%) was slightly lower than the percentage reporting it to be worse or significantly worse (41.9%)[2]. On the other hand, the positive assessments were somewhat stronger than the negative ones so that the "average" was slightly positive. In other words, if the five possible responses are converted to a scale from 0 for "significantly worse" to 10 for "significantly better," the average score is 5.1.

How does the level of satisfaction vary among different types of farmers? Statistical analysis was used to determine what household and agricultural characteristics were associated with the level of satisfaction

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2. These figures are calculated using province-level expansion factors. Thus, they differ somewhat from those published by Minagri/DEAPA. See Annex A for further details.

in the fertilizer distribution system[3]. Nineteen variables were tested, but only two were found to be statistically significant (Appendix B provides the regression results).

Exhibit 1: Perceptions by recent fertilizer users of the fertilizer distribution system now compared to before 1988

Perception	Pct of users
Much better	18.6 %
Better	21.8 %
About the same	17.8 %
Worse	27.1 %
Much worse	14.8 %
Total	100.0 %

Source: Calculated from Minagri/DEAPA survey data using province-level weights. Number of observations = 92.

As shown in Exhibit 2, there are several differences in perception. First, the level of satisfaction varies across provinces. More specifically, farmers in the North West and West Provinces evaluate fertilizer distribution more positively (average scores of 5.8 and 5.4, respectively) than those in the other five provinces (average score 3.3). These two provinces have the highest proportions of fertilizer users among the seven southern provinces (see section 4.1) and currently account for two-thirds to three-quarters of the demand for subsidized fertilizer. They are also distinguished for being arabica coffee growing areas and having strong agricultural cooperatives. These cooperatives served as channels for fertilizer distribution even before privatization under the FSSRP. By contrast, in the other provinces fertilizer was distributed primarily through government channels such as FONADER and the Provincial Delegations of Agriculture. The institutional gap left by privatization is only beginning to be filled by cooperatives and private distributors in these provinces.

It is worth noting that the Littoral is also an important fertilizer user, both in terms of total volume (second after the West Province) and proportion of farmers using fertilizer (third according to the 1990 DEAPA fertilizer survey and second according to the 1984 DEAPA Agricultural

3. Multiple regression analysis was used, with the farmer evaluations (on a scale from 1 to 5) as the dependent variable and various household characteristics as independent variables.

Census). Unfortunately, the DEAPA fertilizer survey sample in the Littoral is too small (37 farms, of which six used fertilizer) to evaluate the level of satisfaction in this province.

Exhibit 2: Perceptions by recent fertilizer users of the fertilizer distribution system by province

Province	Much better	Better	About same	Worse	Much worse
North West	29.6 %	25.9 %	7.4 %	22.2 %	14.8 %
West	21.1 %	21.1 %	26.3 %	18.4 %	13.2 %
Others	0.0 %	17.7 %	15.5 %	49.1 %	17.7 %
Average	18.6 %	21.8 %	17.8 %	27.1 %	14.8 %

Source: Calculated from Minagri/DEAPA survey data. Averages are calculated using province-level weights. Number of observations = 92.

Second, the evaluation of the fertilizer distribution system varies with farm size (Exhibit 3). Small farmers are more likely to evaluate the program positively than larger farmers (the average scores are 6.0 and 3.4, respectively). It is important to note that this relationship is not simply the by-product of the fact that the North West and West Provinces have relatively small farms on average: farm size and region have separate, statistically significant, effects.

Exhibit 3: Perceptions by recent fertilizer users of the fertilizer distribution system by farm size (cultivated area)

Farm size	Much better	Better	About same	Worse	Much worse
2 ha or less	25.9 %	25.9 %	20.4 %	18.5 %	9.3 %
More than 2 ha	5.3 %	15.8 %	13.2 %	42.1 %	23.7 %
Average	18.6 %	21.8 %	17.8 %	27.1 %	14.8 %

Source: Calculated from Minagri/DEAPA survey data. Averages are calculated using province-level weights. Number of observations = 92.

One hypothesis is that when distribution was organized as a public monopoly, fertilizer allocation was determined administratively, thus favoring larger and more well-connected farmers. In contrast, small farmers are now able to purchase as much as they want and can afford. As discussed in section 2.2, the data provide modest support for this hypothesis.

It is worth noting some of the factors which were not found to be associated with the level of satisfaction with the new fertilizer distribution system: 1) the level of education, 2) the number of radios, bicycles, or animals (indicators of household wealth), 3) the crops grown (arabica, robusta, cocoa, maize, and potatoes were tried), 4) late payment for coffee harvest, and 5) the amount of fertilizer purchased in 1990.

The MIDENO survey in the North West Province confirms the results of the seven-province survey with regard to the generally positive assessment of the fertilizer distribution system in that province: 54% of the respondents in this survey evaluated the new system as somewhat better or much better, while only 13% perceived it as worse or much worse than before (the remainder saw no change or had no opinion).

The results of the UCD survey in the West Province, on the other hand, indicate a generally negative opinion of the distribution system: 42% declared it was "worse" or "somewhat worse" and 28% reported no change. However, it is difficult to interpret these results because the survey in the West Province covered only coffee growers. In addition, the sample was not selected randomly, and there appears to be a bias toward large farmers. As was noted above, larger farmers are, on average, somewhat less satisfied with the new distribution system than small farmers.

2.2 Reasons for Positive or Negative Evaluation

Farmers were asked in what way(s) fertilizer distribution has worsened and in what way(s) it has improved. In the seven-province survey conducted by DEAPA, the most common complaint was higher fertilizer prices, cited by slightly more than half the respondents (54%), while the lack of credit was also commonly mentioned (37%). While the first is attributable to the FSSRP, the second is the result of international events and the consequent liquidity crisis. In discussing ways in which the distribution system has improved, the most common response was that the fertilizer is now available on time (32%). Other improvements commonly mentioned were the ability to buy larger amounts (28%) and the higher quality of fertilizer (25%). All of these appear to be due to the FSSRP, reflecting more efficient delivery, the elimination of fertilizer rationing, and shorter periods of outdoor storage in transit.

Given the significant difference between the level of satisfaction of small farmers and that of large farmers, it is interesting to ask whether the reasons differ. Farmers with less than one hectare of cultivated area were somewhat more likely to mention improved availability (33% did so) than were farmers with more than three hectares (23%). This provides modest support for the hypothesis suggested in section 2.1.

The results of the MIDENO survey in the North West Province were similar to those of the DEAPA survey. The improvements most often cited were more prompt arrival of fertilizer (41%) and the elimination of rationing (15%), while the most frequent complaints were the high price and the lack of credit (26% and 17%, respectively). The UCD results from the West Province also follow this pattern, although timeliness does not appear, having been omitted from the questionnaire as a possible response.

2.3 Reasons for Increasing or Decreasing Fertilizer Use

The previous section concerned farmers' subjective evaluation of the new fertilizer distribution system. This section focuses on a similar question: what are the most important factors affecting farmer decisions to increase or decrease fertilizer use. As noted in the introduction, fertilizer use had fallen sharply at the time the surveys were undertaken (1990). Thus, the relevant question is what are the factors behind farmers' decisions to reduce fertilizer use.

First, farmers were asked whether they had increased or decreased their purchases of fertilizer since 1989, the first full year of the program. Both the MIDENO survey in the North West and the UCD survey of coffee growers showed downward trends (the results from the seven-province survey are not considered reliable[4]). In the North West, 44% reported decreasing fertilizer use while only 17% reported increasing it (the remainder reported no change). The trend was even more striking among coffee growers in the West, where 78% of the respondents reported using less fertilizer than before. These results demonstrate at the household level the same trends observed in aggregate data on deliveries.

Next, farmers were asked the reasons for increased or decreased fertilizer use, depending on the case. The results can only be considered suggestive given the small sample sizes, but there is a close correspondence between the results of the seven-province survey and that of the MIDENO survey (the UCD questionnaire changed this to an open-ended question, making processing difficult). In the seven-province survey, the most common explanations for reduced purchases were lack of credit, lower crop prices, and higher fertilizer prices. These three reasons were also the most frequent responses in the MIDENO survey in the North West. The survey data indicate that both the removal of subsidies and the economic crisis have caused reductions in fertilizer use, but they do not reveal the relative

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4. In this survey, there was no clear trend upward or downward. However, these results are suspect because the question was asked only of farmers having used fertilizer this year and before 1989. This procedure excluded those who have recently stopped using fertilizer and made the sample relatively small. By contrast, the other two survey asked this question of all recent users.

importance of each factor[5]. However, it is worth noting that calculations in Appendix C, based on plausible assumptions about the response of demand to price changes, indicate that crop prices and late payment may be a more important factor than subsidy removal.

Given that fertilizer imports under the FSSRP have been dominated by the West, Littoral, and North West Provinces, three implications can be drawn. First, the program is generally appreciated in two of the three provinces in which it is most active, in spite of the price increases. Second, all three major improvements in fertilizer distribution perceived by users appear to be attributable to the FSSRP, whereas of the various complaints, only one (albeit the most important one: prices) is the result of the FSSRP. Third, efforts must be made to strengthen its performance in the Littoral and to expand its coverage to new regions in order for the benefits of the program to be perceived on a wider scale.

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5. The reasons given for increasing the amount of fertilizer used were not very helpful. By far the most common response was "in order to increase yields."

3. FARMER EVALUATION OF FERTILIZER DISTRIBUTION: MATCHING SUPPLY AND DEMAND

The previous section focused on the evaluation of the new fertilizer distribution system relative to the old, as perceived by farmers who had used fertilizer recently (i.e. at least once in the previous five years). It is also worth asking how the new system compares to some absolute standards of performance. This section concentrates on how well supply matches demand in terms of quantity, quality, type of fertilizer, and time of availability. In the seven-province survey conducted by Minagri/DEAPA, the questions were addressed to current fertilizer users (i.e. those using fertilizer in 1989-1990), which represent 19% of the sample. In the MIDENO survey, these questions were asked of all 46 recent users (46% of the sample). In the case of the UCD survey, it is not clear which sub-sample was used for these questions.

3.1 Timing of Fertilizer Availability

One of the principal complaints under the system of public monopoly was that deliveries consistently arrived too late to be of use. Thus, the survey asked current users whether late delivery was a problem that year. According to the seven-province DEAPA survey, 78% of the fertilizer users indicated that the fertilizer had arrived on time. This implies that the timing of fertilizer availability is still a problem, but not one that affects everyone. According to the DEAPA survey, the proportion of farmers satisfied with the timing did not vary much between the West, North West, and other provinces. In the MIDENO survey of North West farmers, the proportion satisfied with the timing of fertilizer delivery was lower (63%). The UCD survey in the West Province did not yield useful results since no response was recorded in 85% of the cases.

3.2 Availability of Sufficient Quantities of Fertilizer

To examine the issue of quantitative restrictions, farmers were asked whether they were able to buy as much fertilizer as they wanted. In the seven-province survey, one third of all current fertilizer users responded negatively. However, this overstates the degree of quantitative restrictions, as indicated by the responses to the follow-up question "Why not?" Only 11% of current fertilizer users declared having been constrained by the amount of fertilizer available to buy. The remainder cited other reasons such as insufficient income and credit constraints.

These averages, however, mask important regional differences. In the West and North West Provinces, the proportion of farmers reporting quantity limits was even lower (5% and 8%, respectively). The sample size of current fertilizer users from the other five provinces is too low to offer a firm percentage, but 6 out of 20 fertilizer users in these provinces reported quantity limits.

The MIDENO survey in the North West found a larger, but still modest, proportion of farmers declaring actual availability constraints (17%). The UCD survey of coffee growers in the West Province used slightly different wording, asking if fertilizer users were able to buy as much as they "needed" (rather than "wanted"). Fully 67% responded negatively, but the follow-up question revealed that only 5% of the fertilizer users declared limited availability to be a problem. Instead, they were prevented from buying the amount they "needed" by insufficient income, late coffee payments, and so on.

3.3 Fertilizer Quality

Another problem under the old system was that fertilizer arrived in poor condition, often as a result of exposure to rain during delays in distribution. In the seven-province survey, 91.5% percent of current fertilizer users responded positively when asked if the fertilizer was "of good quality." Of the seven respondents who reported problems, five were in the West Province, probably referring to the same damaged shipment (the other two were in the East Province). The problems mentioned were ripped bags and caked fertilizer.

The MIDENO survey in the North West found only 57% of the fertilizer users found the quality good. This percentage is surprisingly low compared to the results of other surveys, but unfortunately, it is difficult to further examine this result because the quality problems were not specified. On the other hand, 83% of the coffee growers interviewed for the UCD survey declared that the fertilizer was of good quality, a percentage very close to the West Province figure in the seven-province survey.

3.4 Availability of Desired Types of Fertilizer

One of the anticipated advantages of the privatized fertilizer distribution system was that the types of fertilizer imported would correspond more closely to the types desired by farmers. The eventual elimination of the subsidy will remove the artificial incentives to use one of the five types of fertilizer eligible for subsidies. However, at the time of these surveys, the subsidy was still 30% of the delivered cost of the fertilizer, offering strong inducement to choose one of the five. The relevant question for the moment is, therefore, whether the proportions of these five fertilizers fit the proportions demanded by farmers.

The seven-province survey carried out by Minagri/DEAPA found that 87% of current fertilizer users responded positively when asked whether the types of fertilizer they needed were available. The proportion was somewhat higher in the West and North West Provinces, although the difference is probably not significant. The MIDENO survey in the North West found 72% were satisfied with the choice of fertilizers, while the UCD survey of coffee growers in the West reported 70% satisfaction.

Those who were dissatisfied with the choice available were asked what type of fertilizer they wanted but could not obtain. The most common answer

in both the seven-province survey and the UCD survey in the West was ammonium sulfate (the MIDENO report does not provide this information). Interviews conducted in 1989 as part of the survey design work revealed that cooperative leaders and agronomists were trying to discourage the use of ammonium sulfate because 1) it is a relatively expensive source of nitrogen and 2) it contributes to soil acidification. Thus, the "shortage" of ammonium sulfate reported by farmers was probably the consequence of deliberate cooperative policy rather than the result of an unresponsive marketing system.

As will be discussed in section 6.1, farmer knowledge of the differences between fertilizers is fairly limited. Thus, their preferences are likely to be based solely on habit or on the advice of someone, rather than being based on knowledge of fertilizer characteristics, local soil conditions, and crop requirements. This may be partly the result of years of administrative control over fertilizer distribution. Once the subsidies are eliminated, there will be greater incentive for farmers to take an active interest in the cost effectiveness of different types of fertilizer under local conditions.

In summary, among the various dimensions examined, farmers are least satisfied with the timing of fertilizer delivery, although less than a quarter of them report this problem. Quantitative limits or actual unavailability is not a problem in the West and North West Provinces, but is mentioned by about a third of farmers in the other provinces, where fertilizer demand is more sparse. Only one in eight farmers is dissatisfied with the types of fertilizer available, and this is partly due to effort to discourage the use of ammonium sulfate. The proportion of farmers reporting quality problems was low in the seven-province and West Province surveys, but quite high in the North West Province survey. In short, the distribution system is doing a fairly good job matching supply and demand, but there is still room for improvement.

4. DETERMINANTS OF FERTILIZER USE

In this section, the results of the three surveys are used to address the question of who uses fertilizer. In other words, what characteristics of the farm household affect the likelihood that it will use fertilizer. First, simple cross-tabulations are used to examine the rate of fertilizer use as a function of various characteristics, each considered separately. Later, multiple regression is used to examine a number of variables jointly, determining the impact of each while statistically controlling for the effect of the other variables.

As mentioned above, 19% of the 426 farmers in the seven-province Minagri/DEAPA survey sample used fertilizer in the twelve months prior to the survey, while 27% of the sample had used fertilizer at least once over the previous five years. As mentioned in section 1, sample percentages may be biased estimates of the true population percentage if the sample is not representative of the population. Since the West and North West Provinces have high proportion of fertilizer users and these two provinces were under-represented in the sample, the above percentages are biased downward. Using province-level weighting factors, the estimated proportion of farmers using fertilizer in the year of the survey becomes 22% (instead of 19%), while the proportion using it in the previous five years is 30% (instead of 27%). These issues are discussed further in Appendix A.

When these figures are compared to estimates from the agricultural survey carried out annually by Minagri/DEAPA, it is clear that the proportion of farmers using fertilizer has declined since the mid-1980s. The 1984 Agricultural Census of close to 5000 farm households found 30% of the farmers in the seven southern provinces used fertilizer (Ministère de l'Agriculture, 1987). Data from this survey for the following three years (1985-1987) yield estimates ranging from 23 to 29%. Again, it is difficult to separate the effect of higher fertilizer prices and that of lower coffee prices.

4.1 Fertilizer Use by Province

According to the seven-province survey, the proportion of farmers using fertilizer varies widely from one province to another. Exhibit 4 shows that the 1990 fertilizer use rates are relatively high in the West and North West (48% and 37%, respectively), lower in the Littoral and the South West, and below 6% in the East, Center, and South Provinces. The provinces follow almost the same order when ranked by the percentage of farmers using fertilizer over the previous five years. It should be noted that this provincial pattern of fertilizer use is not new: the West, North West, and Littoral Provinces have traditionally had the highest proportions of fertilizer users (see Minot and Johnson, 1989).

The two provincial surveys contracted by the Fertilizer Sub-Sector Reform Program yielded similar results. The MIDENO survey in the North West estimated that 30% of the farmers used fertilizer that year, while 46% had

used it in the previous five years. The UCD survey of coffee growers in the West Province indicates that 48% of them used fertilizer that year and 83% had used it at least once in the previous five years.

Exhibit 4: Percentage of farmers using fertilizer in 1990 by province

Province	Total number in sample	Percentage using fertilizer in 1990	Percentage using fertilizer in previous 5 years
East	58	5.2 %	10.3 %
Center	114	5.3 %	7.9 %
Littoral	37	16.2 %	37.8 %
South West	29	10.3 %	13.8 %
North West	65	36.9 %	46.2 %
West	79	48.1 %	60.8 %
South	44	4.5 %	6.8 %
Total	426	22.3 %	30.5 %

Source: Calculated from Minagri/DEAPA survey data. Seven-province averages are calculated using province-level weights.

By way of comparison, the 1984 Agricultural Census found fertilizer being used by 75% of the farmers in the West Province, 37% of those in the Littoral, and 37% of those in the North West. Around 10% of the farmers in the South West and the East used fertilizer, while less than 2% of those in the East and Center Provinces did so (Ministère de l'Agriculture, 1987).

4.2 Fertilizer Use by Crop

The seven-province survey carried out by Minagri/DEAPA indicates that fertilizer use is closely tied to the crops cultivated by the farm. One set of questions asked which crops were grown by the household, while another sought information on which crops were fertilized. By comparing the two figures, we can estimate the proportion of the sample fertilizing each of several crops. As shown in Exhibit 5, arabica coffee was fertilized by two thirds of those growing it. By contrast, robusta coffee was fertilized by less than one fifth of its growers. And only one in nine maize farmers in the sample fertilized this crop. It is also worth mentioning that among farmers that were not growing coffee, only 7% used fertilizer on any crop in the year of the survey.

Exhibit 5: Percentage of growers fertilizing arabica, robusta, maize, and other crops

Crop	Number of growers in sample	Percentage fertilizing this crop
Arabica coffee	59	67.8 %
Robusta coffee	115	17.3 %
Maize	378	11.6 %
Other crops	426	10.3 %

Source: Calculated from Minagri/DEAPA survey data.

To put these figures in context, in 1984 when coffee prices were at their peak and fertilizer was still heavily subsidized, 53% of the coffee growers in the seven southern provinces used fertilizer and 14% of the food crop farmers applied fertilizer (Ministère de l'Agriculture, 1987). The 1990 DEAPA survey indicates that the rate for all coffee growers (arabica and robusta) was around 34%. With regard to food crops, the figures are not exactly comparable, but the rate implied by the 1990 figures presented in Exhibit 5 would probably be similar to the 1984 rate[6].

4.3 Fertilizer Use by Farm Size

Are large farmers more or less likely to use fertilizer than small farmers? It is often supposed that large farmers have greater resources, better access to credit, and perhaps a greater appreciation of the importance of using modern inputs in agricultural production. On the other hand, evidence from many countries indicates that small farmers cultivate their land more intensively, obtaining higher yields on average than larger farms. The seven-province survey conducted by Minagri/DEAPA indicates that the rate of fertilizer use does not vary according to farm size as measured by cultivated area (Exhibit 6).

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6. The 1984 figures include a small number of farmers using organic fertilizer, while the 1990 figures refer only to the use of chemical fertilizers. In addition, the 1990 figures for coffee (arabica and robusta combined) and for maize are biased downward by the under-representation of the West and North West Provinces in the sample. The differences between 1984 and 1990 are thus somewhat overstated by these figures.

Exhibit 6: Percentage of farmers using fertilizer in 1990 by farm size (cultivated area)

Farm size	Farms in sample	Percent using fertilizer in 1990
Less than 1 ha.	152	18 %
1 - 3 hectares	145	19 %
More than 3 ha.	129	19 %

Source: Calculated from Minagri/DEAPA survey data.

4.4 Fertilizer Use by Distance from Point of Sale

The cost of using fertilizer is not just the cost of the fertilizer itself, but also the cost (in money and/or time) of getting the fertilizer from the point of sale to the farm. Thus, we would expect a negative relationship between the proportion of farmers using fertilizer and the distance from the farm to the point of sale. As shown in the Exhibit 7 below, this is indeed the case.

Exhibit 7: Percentage of farmers using fertilizer in 1990 according to distance from point of sale

Distance	Farms in sample	Percent using fertilizer in 1990
Less than 10 km	86	60 %
11 - 50 kilometers	50	44 %
More than 50 km	74	7 %

Source: Calculated from Minagri/DEAPA survey data.

This table should be interpreted with caution for several reasons. First, many non-users did not know of a point of sale and thus could not estimate the distance; these observations were excluded from the table. Second, of those who said they did know a point of sale, some gave estimates that were impossibly high; all guesses over 500 kilometers were truncated at that level. Third, there is a problem of causality, since there may be no nearby point of sale because the demand is weak in that area, rather than farmers not using fertilizer because of the distance.

4.5 A Model of Fertilizer Use

In this section, the agricultural and socio-economic characteristics related to fertilizer use are examined more rigorously. This is done by applying multiple regression analysis[7] to the seven-province survey data collected by Minagri/DEAPA. The following household characteristics were tested statistically for significant association with fertilizer use:

size of household
education of the head of household
area cultivated by the household
number of animals owned by the household
whether or not they are a member of a cooperative
whether or not they were paid late for coffee
whether or not the household has non-agricultural income
whether or not they own a radio
whether or not they own a bicycle
distance to fertilizer sales point
number of arabica trees
number of robusta trees

In addition, the agricultural characteristics of households were explored using variables to represent whether or not the household grows and sells each of the following crops: arabica coffee, robusta coffee, cocoa, maize, groundnuts, potatoes or sweet potatoes, yams, plantains or bananas, cassava, oil palm, sugar cane, egussi (squash), beans, macabo, and taro root.

Of all the variables tested, only four were consistently found to have a statistically significant association with fertilizer use. Those variables are 1) whether or not the household grows arabica coffee, 2) whether or not it grows robusta coffee, 3) whether or not it is a commercial maize producer (defined as one selling over half the harvest), and 4) the distance to a place where fertilizer is sold. The relationship was, as expected, positive in the case of the three crops and negative in the case of distance. The regression equation (provided in Appendix B) yields the estimated probabilities presented in Exhibit 8.

Roughly 13% of the sample fits into the first category: those growing arabica but who are neither robusta growers nor commercial maize producers. The second category (robusta only) represents 27% of the households, while the third group (commercial maize growers with no coffee production) accounts for 6% of the sample[8]. About half of the households (51% in the sample) fall into the last category, not harvesting coffee and not being a "commercial"

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7. The model used was a generalized least squares logit model. The procedure and the results are explained in more detail in Annex B.

8. Although 89% of the sample households grew maize, less than half of these (40% of the sample) sold any maize. Of those that sold maize, only a small portion (6% of the sample) sold more than half of the harvest, as required under the definition of "commercial maize grower" used here.

maize grower. The remainder (just 3%) reflects those few farms that combine two or three of these activities.

Exhibit 8: Estimated probabilities of fertilizer use as a function of crops and distance to point of sale

Type of grower	Distance to point of sale 10 km	50 km	100 km
Arabica grower (no maize or robusta)	70 %	59 %	44 %
Robusta grower (no maize or arabica)	40 %	29 %	18 %
Commercial maize grower (no coffee)	49 %	37 %	24 %
None of the above	24 %	16 %	10 %

Source: Multiple regression model based on the Minagri/DEAPA survey data. Number of observations = 426. See Appendix B for more detail.

The regression equation explains about 40% of the variation in the dependent variable (R^2=0.41). A more intuitive index of the degree of explanatory power of the equation is the proportion of households for which the equation correctly "predicts" whether or not fertilizers are used[9]. This logit model with just four explanatory variables yield correct "predictions" in 89% of the 426 cases.

Some variables were only occasionally significant (that is, they were significant only in certain combinations of other explanatory variables). Thus, there is some evidence that the probability of fertilizer use is greater 1) for households that grow and sell beans, 2) for households that grow and sell sugarcane, and 3) for households in the West and North West Provinces.

It is at least as interesting to examine the variables that show no statistically significant relationship with fertilizer use. For example, the probability of fertilizer use does appear to be affected by 1) the area under cultivation, 2) whether or not the household has non-agricultural income, 3) the number of animals it owns, and 4) whether or not it owns certain durable goods (radio and bicycle). These variables are often considered to be indicators of income or wealth. To the extent that this is true in the

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9. The estimated probability is a fraction, but can be converted to a "prediction" by rounding to the nearest unit. Thus, the prediction is that a household <u>will</u> use fertilizer if its estimated probability is greater than 0.5 and that it <u>will not</u> use fertilizer if the probability is less than 0.5.

context of Cameroon, the results imply that the fertilizer use is not related to income or wealth.

Furthermore, the likelihood of fertilizer use shows no significant association with either the level of education of the head of household or cooperative membership. No relationship was found with the non-commercial production of maize and beans, nor with production of cocoa and root crops. Although Irish potatoes are said to be fertilized by many growers, this could not be tested because Irish potatoes and sweet potatoes were combined in the questionnaire.

In summary, whether or not a household uses fertilizer is most strongly influenced by its proximity to a point of sale and by the crops grown by the household. Coffee growers and commercial maize producers are much more likely to use fertilizer than others, while bean producer/sellers show a weaker tendency to use fertilizer. On the other hand, farms that are larger, more educated, or wealthier (as indicated by animal, radio, and bicycle ownership) are no more likely to use fertilizers than others.

5. PATTERNS IN FERTILIZER USE

In the previous section, we explored the factors which influence whether or not a household uses fertilizer. In this section, we limit our attention to current users and examine the patterns in the purchase and use of fertilizer. Topics covered include the frequency of fertilizer purchases, the source of fertilizer, the mode of payment, the seasonal pattern of purchases, the crops fertilized, and the types and amounts of fertilizer used. The sub-sample of current users includes 79 households from the DEAPA seven-province survey, 46 from the MIDENO survey in the North West, and 91 coffee growers from the UCD survey in the West Province. Due to sample size constraints, the DEAPA results can only be broken down by province for the West and North West Provinces. The lack of province-level figures on fertilizer users in the other five provinces, particularly the Littoral, is a significant weakness of this data set.

5.1 Frequency of Fertilizer Purchases

As described in section 4.1, about 22% of the farmers in the seven southern provinces had bought fertilizer the year of the survey. Given farm population estimates, this represents about 150,000 farmers. The question arises whether there are 150,000 households which use fertilizer every year or whether there are, say, 300,000 households which purchase fertilizer every two years. To answer this question, current users were asked how often they buy fertilizer. Exhibit 9 shows that in the seven-province Minagri/DEAPA survey, the majority (60%) of current users declared buying fertilizer every year, but a significant minority reported making purchases every two years (15%) or occasionally (25%). There were no obvious differences among the provinces.

Exhibit 9: Frequency of fertilizer purchases

Frequency	Among buyers in a given year (1990)	Among the farm population
Every year	59.6 %	36 %
Every two years	14.9 %	18 %
Occasionally	25.4 %	46 %
Total	100.0 %	100 %

Source: **First column calculated from Minagri/DEAPA data. Second column derived from first, assuming half the "every-two-year" buyers and one third of the "occasional" buyers were included in the sample of 1990 buyers.**

The distribution among buyers in a given year is different than that of the general population, since the former contains a disproportionate number of annual buyers. However, under certain assumptions (described in the footnote of the table), we can obtain the latter distribution from the sample of 1990 buyers. The results indicate that, in the general population, annual fertilizer buyers are in the minority.

The MIDENO survey in the North West yielded very similar results, with 54% of the current users reporting annual purchases, 9% reporting purchases every other year, and 33% calling themselves occasional buyers. The UCD survey omitted this question from the questionnaire.

5.2 Sources of Fertilizer

With regard to the source of the fertilizer, most farmers obtain fertilizer from a cooperative. The Minagri/DEAPA seven-province survey found 68% of the fertilizer users in the sample relied on this source. The proportion was highest in the West (87%), lower in the North West (63%), and below half in the other provinces. Merchants and agricultural projects were a more common source of fertilizer in the other five provinces, but more detail is not possible because of the small sample of current fertilizer users (20 farms) in these provinces.

The MIDENO survey in the North West found that half the fertilizer purchases were from cooperatives, 13% from other farmers, 4% from projects, and 34% from other sources. Some of the "other" responses may reflect the activity of merchants who reportedly bought fertilizer from cooperatives in the West Province for resale in the North West. If this were the case, then the estimate that one half the fertilizer comes from cooperatives would be understated. The UCD survey confirms the importance of cooperatives as a source of fertilizer in the West Province, 72% of the sample of coffee farmers buying fertilizer from that source.

5.3 Mode of Payment for Fertilizer

The mode of payment was generally cash, rather than credit. Over 85% of the users in the DEAPA study paid cash, whereas only 7% were able to buy on credit. The remainder was "other," presumably representing combinations of cash, credit, and barter. Fertilizer is frequently obtained from the coffee cooperative at harvest time, the cost of the fertilizer being deducted from the farmer's coffee payment. This was not a separate option in the questionnaire, but it appears that most farmers considered this exchange to be a cash transaction.

The proportion of farmers paying cash was particularly high in the West Province (95% according to DEAPA and 96% according to the UCD survey of coffee growers). The MIDENO survey reported that only 52% of users paid cash for fertilizer, although 31% reported an unspecified "other" mode, perhaps barter exchange with coffee.

5.4 Seasonal Pattern of Fertilizer Purchases

What is the pattern of fertilizer demand by season? One question, which asked the preferred month(s) for fertilizer purchases, did not yield useful results in any of the three surveys (in the DEAPA survey, the enumerators misunderstood the question; the MIDENO and UCD surveys did not report any results for this question). However, results are available for the actual pattern of fertilizer purchases. By excluding households reporting late arrival of fertilizer, we can draw a picture of the seasonal distribution of demand when unhampered by supply constraints.

These figures, presented in Exhibit 10, indicate that the largest number of fertilizer purchases occurred in April, with the first four months together accounting for almost 70% of the total number of purchases. There was a much smaller increase in the number of purchases recorded in September. It should be noted that these figures may be affected by recall biases since some months were recent at the time of the survey, while others were long before the interview date. .

Exhibit 10: Seasonal distribution of fertilizer purchases among households reporting purchases on time

Month	Percentage of all purchases	Cumulative percentage
January	10.5 %	10.5 %
February	11.4 %	21.9 %
March	19.0 %	40.9 %
April	28.6 %	69.5 %
May	7.6 %	77.1 %
June	9.5 %	86.6 %
July	1.0 %	87.6 %
August	1.9 %	89.5 %
September	7.6 %	97.1 %
October	1.0 %	98.1 %
November	1.9 %	100.0 %
December	0.0 %	100.0 %

Source: Calculated from Minagri/DEAPA seven-province survey data. Number of observations = 105.

In the MIDENO survey of the North West, the bulk of the fertilizer purchases were made from March to June, although it should be recalled that 37% of the fertilizer users in that survey felt that the fertilizer arrived late.

5.5 Crops to Which Fertilizer is Applied

In section 4.2, we looked at the number of farmers fertilizing different crops as a proportion of the number growing that crop. In this section, we concentrate instead on the number of farmers fertilizing each crop as a proportion of the number using fertilizer. The Minagri/DEAPA survey of the seven southern provinces provides the results presented in Exhibit 11.

Exhibit 11: Proportion of fertilizer users applying it to each crop

Crop	Pct. of fertilizer users applying it to this crop
Arabica coffee	49.4 %
Robusta coffee	29.6 %
Maize	54.3 %
Vegetables	25.9 %
Other	50.6 %

Source: Calculated from Minagri/DEAPA seven-province survey data. Number of observations = 81.

There are two interesting aspects of this table. First, the number of farmers fertilizing maize is greater than the number fertilizing arabica coffee. In section 4.2, it was observed that two thirds of the arabica growers fertilize this crop, whereas only 12% of maize growers do so. However, because there are over six times as many maize growers as arabica growers, the absolute number of farmers fertilizing maize is somewhat larger.

The second notable aspect is that the sum of the percentages is around 210%. This means that the fertilizer user applies it, not just to one crop, but to an average of 2.1 of the crops listed above (with "other" counting as one crop). In fact, almost two thirds of all users apply fertilizer to more than one crop. The regression analysis of section 4.5 indicated that fertilizer use is significantly associated with only a few crops (arabica, robusta, commercial maize production, and possibly commercial bean and sugarcane production). The results here, however, suggest that once a farmer decides to buy fertilizer for one of these crops, he or she will often apply it to other crops as well.

The pattern presented in Exhibit 11 varies somewhat according to region. In the West and North West Provinces, almost all users apply fertilizer to coffee (mainly arabica but sometimes robusta), a majority fertilize maize, and smaller numbers apply it to vegetables and other crops.

In the other five provinces, no one crop is fertilized by a majority of the users, although this result must be considered tentative because of the small sample size.

5.6 Method of Application

Farmers were asked how they applied fertilizer to their crops: broadcast, along the lines, around the plant, between the plants, or covered with soil. In all three surveys, the most common method by far was to place the fertilizer around the plant. In the seven-province survey, 71% of the responses were "around the plant." Because multiple responses were allowed, the proportion of farmers having applied fertilizer this way (among others) was higher: roughly nine out of ten.

In the MIDENO survey in the North West, 61% of the farmers reported applying fertilizer around the plant, while 26% of them mixed it into the soil and 11% scattered it on the field (multiple responses were not allowed in this case). In the UCD survey of coffee growers in the West Province, 80 to 90% of the farmers declared placing fertilizer around the plant.

5.7 Types of Fertilizer

In this section, we examine the types of fertilizer farmers prefer and the types they actually use. The questions about preferences were addressed to recent fertilizer users, whereas the questions concerning actual usage were directed only at current users. When asked their first and second choices, recent users generally chose NPK 20-10-10 first and ammonium sulfate second. In the Minagri/DEAPA survey, 57% of those asked cited NPK 20-10-10 as their first choice, while 15% preferred ammonium sulfate. Only 15% of recent users had no preference. With regard to their second choice, the most frequently mentioned type was ammonium sulfate (cited by 28%), although 35% of the users had no second choice.

The MIDENO survey in the North West Province found very similar results: 54% preferred NPK 20-10-10, with ammonium sulfate in second place with 11%, and 26% having no opinion. Again, ammonium sulfate was the most common second choice, though 59% had no opinion with regard to a second choice. The UCD survey of coffee farmers omitted this question from the questionnaire.

What types of fertilizer are actually used and in what quantities? Exhibit 12 summarizes the results of the Minagri/DEAPA survey with regard to this question. NPK 20-10-10 was bought by 71% of the farmers who used fertilizer in 1990, while ammonium sulfate was purchased by 44% of them. These figures also indicate that NPK 20-10-10 accounted for about half of the fertilizer used by farmers in the year of the survey in the seven southern provinces (these figures refer to the survey population of family farms, thus excluding plantations). Ammonium sulfate, in turn, represents almost a third of the total quantity. These figures correspond roughly to aggregate data on subsidized fertilizer imports in recent years (Abbott, 1990).

Exhibit 12: Percentage of farmers buying each type of fertilizer and average amount bought in 1990

Fertilizer type	Pct of users buying this type	Number of bags per fert. user
NPK 20-10-10	71 %	3.06
Ammonium sulfate	44 %	1.97
Urea	27 %	0.75
NPK 12-6-20	11 %	0.44
Other	1 %	0.03
Total		6.25

Source: Calculated from Minagri/DEAPA seven-province survey data.

5.8 Quantity of Fertilizer Used

Among users of fertilizer, what are the quantities used and what factors are associated with the volume used? According to the seven-province Minagri/DEAPA study, the average amount used during the year of the survey was 6.25 bags or 312 kilograms (this is the average among users, not the general population). Given the average area cultivated among fertilizer users, this implies an average application rate of 114 kg/ha. This rate is the farm-wide average among fertilizer users; application rates for fields actually fertilized would presumably be higher.

Exhibit 13 shows the frequency distribution of the quantity of fertilizer purchased in the twelve months prior to the survey. It shows, for example, that about 60% of all fertilizer users in 1990 bought four bags of fertilizer or less. On the other hand, almost a quarter of them bought seven bags or more. The average quantity of fertilizer bought by farms in this latter group is 16.3 bags.

These figures appear to indicate that the quantities of fertilizer purchased by users has declined since the mid-1980s. The agricultural surveys conducted by the Ministry of Agriculture found an average of over 450 kg/user in 1985 and between 350 and 400 kg/user for the following two years.

5.8.1 Quantity of Fertilizer Used by Province

How does the quantity of fertilizer used vary by province? Exhibit 14 provides the average quantities of fertilizer used over all farms (first column) and the average among users (second column). The table shows that users in the West and North West Provinces buy relatively small amounts on average, whereas users in the other five southern provinces purchase two or

Exhibit 13: Frequency distribution of fertilizer use in 1990

Quantity (bags)	No. of farms in sample	Pct. of all farms	Pct. of those using fertilizer
0	347	81.4 %	--
1	12	2.8 %	15.2 %
2	18	4.2 %	22.8 %
3-4	18	4.2 %	22.8 %
5-6	12	2.8 %	15.2 %
7 or more	19	4.5 %	24.1 %
Total	426	100.0 %	100.0 %

Source: Calculated from Minagri/DEAPA seven-province survey data.

three times as much on average. At the same time, the average fertilizer use among all farmers is higher in the North West and West. In other words, in these two provinces a large number of farmers purchase small amounts of fertilizer, whereas in the other five provinces a small proportion of the growers buy large quantities.

This may be the effect of the smaller average farm size in the West and North West. In addition, perhaps the longer distances to points of sale in the other five provinces discourage small farmers from using fertilizer, whereas the points of sale tend to be closer in the West and North West Provinces (see section 5.8).

Exhibit 14: Average quantity of fertilizer used by province

Province	Number of users	Average no. bags (overall)	Average no. bags among users
North West	24	1.31	3.54
West	37	2.41	5.14
Other five	19	0.78	12.17
Total	80	1.16	6.25

Source: Calculated from Minagri/DEAPA seven-province survey data.

5.8.2 Quantity of Fertilizer Used by Farm size

In section 4.3, it was shown that small farmers are just as likely to use fertilizer as large farmers. At this point, we examine the relationship between the quantity of fertilizer used and farm size. Exhibit 15 demonstrates clearly that large farmers (not surprisingly) use greater quantities of fertilizer than small ones. What is interesting is that the quantity of fertilizer used per hectare decreases as cultivated area increases. This is an example of the general pattern by which small farmers cultivate their land more intensively.

Exhibit 15: Average quantity of fertilizer used by farm size

Cultivated area	Users in sample	Average number of bags	Average number of bags/ha
Up to 1 ha.	33	2.85	5.23
1-3 hectares	26	5.54	2.62
More than 3 ha.	20	12.80	2.30
Total	79	1.16	6.25

Source: Calculated from Minagri/DEAPA seven-province survey data.

5.8.3 Model of the Quantity of Fertilizer Used

Multiple regression analysis was used to estimate the quantity of fertilizer used as a function of a series of socio-economic and agricultural characteristics of the household (see Appendix B for more information). The following statistically significant associations were identified: the volume of fertilizer use is positively related to the number of people in the family, the number of robusta trees, commercial maize production, and distance to a point of sale and negatively related to payment for the coffee harvest. The price of fertilizer was statistically significant in a number of regressions but not in the final version. In spite of the lack of statistical significance, the price variable was left in the model because of its policy relevance and the strong theoretical justification for including it.

Other things equal, each additional member of the household is associated with an additional third of a bag of fertilizer. The number of people in the family may reflect the availability of labor to help in agricultural task and/or the food and income requirements of the farm household. In either case, a large family would thus be more likely to cultivate a given plot of land more intensively, including greater use of fertilizer. It should be noted that the UCD survey in the West Province

found a significant relationship between the quantity of fertilizer used and the number of wives. Since the number of wives is presumably correlated with family size, this may be part of the same pattern.

The regression equation indicates that the quantity of fertilizer used increases with the number of robusta trees. More specifically, the use of fertilizer increases by 2.1 bags for every 1000 robusta trees. Thus, if a robusta farm used fertilizer and had 2,553 trees (the average in the sample), it could be expected to use about 5.4 bags of fertilizer more than it would have without the robusta coffee. The quantity of fertilizer is not related to the number of arabica trees, although the reasons are unclear. Perhaps the fact that arabica growers often fertilize other crops blurs the relationship. Alternatively, it may be difficult to identify a significant relationship because of the low variability in the number of arabica trees across farms[10].

The equation also implies that a commercial maize producer will use 6 bags more than an otherwise similar farmer who is not a commercial maize producer. As mentioned above, a commercial maize producer is defined here as one selling more than half the output. Only about 6% of the households in the sample fit this description.

Late payment was represented by a binary variable, with the value of 1 if a coffee grower was not paid in full at the time of delivery, 0 if a coffee grower was paid in full or if the farmer did not grow coffee. Defined this way, late payment reduced the quantity of fertilizer purchased by about five bags. This is quite a significant impact, given the average purchase of 6.2 bags/farm.

The most counter-intuitive result was the positive relationship between the distance to a point of sale and the quantity of fertilizer used. The key to understanding this finding is to recall that the analysis concerns only those who used fertilizer. The positive association follows from the plausible hypothesis that only a farmer who needs a large quantity of fertilizer is willing to travel a long distance to obtain it. Those needing small amounts will only buy it if it is available nearby. In sum, if the point of sale is a long distance away, a farmer is less likely to buy fertilizer (see section 4.5), but if fertilizer <u>is</u> bought, the quantity will probably be relatively large.

Although the coefficient on the price variable is not statistically significant in the final version of the regression, it is worth commenting on the magnitude. It implies that a 100 franc CFA increase in the price per bag will reduce the quantity used by one tenth of a bag. Given the average price of about 3000 francs CFA/bag and the average quantity of 6.2 bags/farm, the price elasticity of demand would be 0.6, a very plausible value. This elasticity means that a 1% increase in price results in a 0.6% decrease in quantity demanded. However, this figure should be considered highly

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10. The coefficient of variation of the number of arabica trees is one half that of the number of robusta trees.

speculative at best.[11] Price elasticity estimates are useful for determining the impact of subsidy reduction on demand. The implications of alternative price elasticities are explored in Appendix C.

Alternative models show that when the number of robusta trees is not included as a variable, area under cultivation becomes a statistically significant variable. One example (reported in Appendix B, Exhibit B-4) implies that each additional hectare of cultivated land is associated with an additional 1.1 bags of fertilizer.

At the risk of over-simplification, the above results can be summarized by identifying two types of fertilizer users. One type is a small farmer growing arabica coffee in the West or North West Provinces who purchases six bags or less from a cooperative relatively near by. This farmer uses fertilizer on coffee, maize, and sometimes vegetables or another crop. The other type of fertilizer user is a larger farmer living in one of the other five provinces and purchasing a relatively large quantity of fertilizer from a merchant or coffee processor at some distance from the farm. These farmers fertilize either robusta, maize, vegetables, or another crop, no one crop being fertilized by a majority of the farmers.

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11. The 95% confidence interval for the price elasticity of demand is 0.55 ± 0.96. Thus, we cannot be 95% sure that the true value is different than zero.

6. FARMER KNOWLEDGE OF FERTILIZER

The rationale for fertilizer privatization rests on the assumption that independent importers, distributors, and farmers have greater incentive and more complete information to allocate resources efficiently. The sharp decline in the cost of delivering fertilizer to the farm since privatization confirms this assumption as it relates to importers and distributors. To gain maximum advantage from the privatized system, however, farmers must be able to guide the marketing system with well-informed preferences. Thus, an understanding of the level of fertilizer knowledge is important in guiding the FSSRP and related efforts.

6.1 Existing Fertilizer Knowledge

As mentioned in section 5.7, fertilizer users are generally aware of the different types of fertilizers and have distinct preferences among them. The question is whether or not these are informed preferences, based on knowledge of the characteristics of different fertilizers and the requirements of their crops and soils. Interviews with researchers and cooperative officials reveal a common belief that the fertilizer preferences of farmers are based on habit or whichever fertilizer is the least expensive.

In order to address this issue, three questions were included in the original survey to measure the level of fertilizer knowledge. The questions were chosen to have practical importance for farmers and to be questions of fact. These questions were administered to the entire sample, that is to both fertilizer users and non-users.

The results shown in Exhibit 16 are unambiguous: virtually none of the farmers knew any of the answers. In the seven-province survey, only 4% of the sample knew that urea has the most nitrogen among the four options given. Most farmers (80%) said they didn't know, but among those that made a choice, ammonium sulfate and NPK 20-10-10 were more frequent responses than urea. Only 3% knew that it is ammonium sulfate that tends to acidify the soil. And only 4% knew that it is urea that works best if covered by soil. Among users there is a core 10% or so that appears to have basic knowledge of fertilizer characteristics, but the bulk of fertilizer users do not have the information necessary to make informed choices and to use fertilizer effectively.

The proportion of farmers declaring they did not know was consistently lower in the West and North West Provinces. However, in spite of their greater confidence, the farmers in these provinces were no more likely to know the correct answer than those in the other provinces. The MIDENO survey also found very few farmers who knew the correct answers (1-2%). The UCD survey of coffee growers included only one question, finding that only 4% answered it correctly.

Exhibit 16: Farmer knowledge of certain characteristics of fertilizer

Question	Percentage answering correctly among users	among non-users	overall
Which fertilizer has the most nitrogen (urea)	9 %	3 %	4 %
Which fertilizer tends to acidify the soil (ammonium sulfate)	13 %	1 %	3 %
Which fertilizer should be covered for best results (urea)	10 %	2 %	4 %
Number of observations	79	347	426

Source: Calculated from Minagri/DEAPA seven-province survey data.

It may be argued that the questions were too difficult, involving concepts like nitrogen and acidification that are not easily translated into local languages. But the fact that these concepts are not in farmers' vocabulary (in any language) is a sign that their knowledge is deficient. This is not "theoretical" knowledge but rather practical information which would allow them to choose and apply fertilizer more effectively. For example, if farmers knew that urea is a cheap source of nitrogen (being twice as concentrated as ammonium sulfate), it might be more widely used. If they knew that ammonium sulfate has a much stronger tendency to acidify the soil than other fertilizers, they might be more reluctant to use it.

6.2 Sources of Fertilizer Information

If farmers need more information about fertilizers, how can this information be delivered? One solution is to improve the effectiveness of existing channels. The seven-province survey found that most respondents (56%) declare the extension agent to be the most important source of information about fertilizer. Other farmers are the second most commonly cited source of information (10%). This general pattern is repeated in most of the individual provinces with some variation: cooperatives are significant in the West, South West, and North West (11-14%) and television is important in the East (12%).

Another approach is to use existing fertilizer marketing channels. These channels are discussed in more detail in section 6.3, but it is worth

noting here that cooperatives play a dominant role in the West and North West, whereas merchants and other outlets are more important in the other provinces. One disadvantage of using existing fertilizer marketing channels to disseminate information is that those currently not using fertilizers are less likely to be reached.

Another approach would be to provide information via the coffee marketing channels. According to the seven-province survey, cooperatives are the most important coffee marketing channel in the West and North West, whereas the other provinces rely more on coffee processors and licensed buying agents. This distinction corresponds roughly to the arabica and robusta growing areas of Cameroon.

In many countries, fertilizer is available from merchants specializing in agricultural inputs. Thus, one question in the survey asked where farmers obtain their maize seed. However, 90% of all maize farmers interviewed for the seven-province survey obtained maize seed from their own harvest or that of another farmer. The use of private merchants as a source of seed was only common in the Littoral and the South West (46% and 40%, respectively). The MIDENO and UCD surveys confirmed these general patterns, although the Ministry of Agriculture and the Institutes de Recherche Agricole (IRA) stations were cited with some frequency (18% in the North West and 24% in the West).

7. REASONS FOR NOT USING FERTILIZER

The original questionnaire contained a set of questions to explore the reasons that most farmers in Cameroon do not use fertilizer. This section of the survey was administered to farmers who had not used fertilizer in the past five years. This sub-sample included 312 households (73%) in the DEAPA survey of the seven southern provinces and 54 households (54%) in the MIDENO survey carried out in the North West Province. Although 29 farmers (7%) in the UCD survey had not used fertilizer in the past five years, the questions addressed to these farmers were dropped from the questionnaire.

There are various issues to explore in determining why a farmer does not use fertilizer. The first questions concern whether the farmer believes that fertilizers are effective in increasing crop yields. If so, the next issue is whether farmers believe the improved yields are worth the cost and risk associated with fertilizer purchases. Finally, if fertilizer is perceived to be profitable, what other constraints prevent the farmer from using it.

The surveys indicate that there is little doubt among farmers that fertilizer increases yields. The DEAPA survey covering the seven southern provinces found 82% of the non-users interviewed responded positively, with little variation among the provinces. Similarly, the MIDENO survey found that 89% of non-users in the North West Province believed fertilizer has a positive impact on yields.

If fertilizer increases yield, then does this increase justify the cost and risk of purchasing fertilizer? Again, a majority of non-users responded positively (62% in the seven-province survey and 85% in the North West Province survey). At the same time, by far the most common reason given for not using fertilizer was "lack of money." In the seven-province survey, 60% of those farmers declaring that fertilizer was worth the cost and risk also declared lack of money to be the main constraint.

If farmers really believe fertilizer is worth the cost but do not buy it for "lack of money," one would have to conclude that credit is the principal constraint. However, only 15% agreed that "lack of credit" was a factor in their decision not to use fertilizer (respondents were free to choose multiple reasons, e.g. lack of money <u>and</u> lack of credit). For this reason, it seems likely that most of those who cited "lack of money" would not borrow money even if they could. Perhaps farmers believe fertilizers are worth the cost in some general sense, but given current prices and economic conditions the rewards do not justify the risk.

Another possible constraint to fertilizer use is knowledge of points of sale. According to the Minagri/DEAPA survey, only 31% of non-users know where to purchase fertilizers. The proportion, however, varies considerably by province. Barely one quarter or less of the non-users in the East, South, Center, and Littoral Provinces know where to purchase fertilizers. By contrast, the proportions are much higher in the West (65%), the North West (60%), and the South West (44%). The MIDENO survey finds an even higher

proportion of non-users in the North West who know where to buy fertilizer (80%). These figures should be interpreted with caution since not knowing a point of sale may not be the cause of non-use; it may instead be the effect of not wanting fertilizer enough to find out where it can be purchased. It would seem that the latter must often be the case.

Even if farmers know where to purchase fertilizers, the distance may prevent them from doing so. In the seven-province survey, distance was cited as a constraint by 21% of the non-users who believed fertilizer is worth the cost and risk, making it the second most common reason after lack of money. Among those who claimed to know where to buy fertilizer, the average distance was almost 200 kilometers[12], about 15 times the average distance reported by fertilizer users. As noted in section 4.5, the negative relationship between distance to a point of sale and the likelihood of fertilizer use is statistically significant.

Again, there is an issue of causality: are farmers discouraged from buying fertilizer because of the distance, or are points of sale only established where fertilizer demand exists. It is safe to say that both factors are at work. Many farmers for whom distance is a constraint probably live in areas where the demand is too sparse to support a distribution outlet. At the same time, since fertilizer distribution was administratively controlled until recently, it seems likely that the system has not fully adapted to the geographic pattern of demand. This implies that there is probably scope for expanding the distribution network to relieve the distance constraint, particularly after coffee prices recover.

Finally, the timing of fertilizer delivery does not appear to be an important constraint as perceived by non-users, defined as farmers not having used fertilizer in the past five years. Only 2% of the non-users in the seven-province survey reported late arrival of fertilizer as a factor, and the percentage was only 4% in the MIDENO survey in the North West.

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12. In calculating this average, eighteen responses over 500 kilometers were truncated at that level. Even if they knew a point of sale, many farmers apparently did not know how to estimate the distance in kilometers.

8. PESTICIDE AND HERBICIDE DISTRIBUTION

Before 1988, the pesticide/herbicide and fertilizer sub-sectors were organized along very similar lines: the government imported the chemicals and closely controlled their distribution at highly subsidized prices. The FSSRP has resulted in the privatization of fertilizer distribution and the phased removal of subsidies, while the system for distributing pesticides and herbicides remains the same. Thus, it is interesting to compare farmer perceptions of the two distribution systems. For this purpose, several questions in the questionnaire addressed farmer perceptions of the herbicide and pesticide distribution system.

According to the seven-province survey carried out by Minagri/DEAPA, slightly less than half (47%) of the sample declared using pesticides and/or herbicides. Exhibit 17 presents the proportions of farmers in each province using these chemicals. As can be seen, chemical use is the most common in the South and West and the least common in the North West.

Exhibit 17: Proportion of farms using herbicides or pesticides by province

Province	No. of farms in the sample	Percentage using herbicides or pesticides
East	58	40 %
Center	114	53 %
Littoral	37	38 %
South West	29	45 %
North West	65	25 %
West	79	58 %
South	44	64 %
Total	426	64 %

Source: Minagri/DEAPA (1990). Section VIII, Table 1.

The MIDENO survey in the North West Province also found a relatively low rate of pesticide/herbicide use in that province (23%). In the UCD survey of coffee growers in the West, a large majority of respondents declared using insecticides (77%), and fungicides (65%), while a smaller number reported using herbicides (28%). The high rate of use in the UCD survey compared to the DEAPA results in the West Province may be due to the fact that the former survey was limited to coffee growers and had more large-scale coffee growers than the DEAPA sample.

Users of pesticides and herbicides were asked what problems, if any, they perceived in the distribution of these chemicals. The results shown in Exhibit 18 indicate that scarcity and late delivery are experienced by a significant minority of users. It is useful to compare these figures with corresponding ones for the fertilizer distribution system, described in section 3 (all comparisons are among users of the respective products in the seven southern provinces as recorded by the Minagri/DEAPA survey). Only 11% of current fertilizer users faced quantitative restrictions (including unavailability), whereas 35% of the pesticide/herbicide users report "frequent shortages." Around 22% of the fertilizer users complained of late deliveries, while 35.5% of pesticide/herbicide users did so. Just 13% of the fertilizer users were not able to find the type of fertilizer they preferred, but 29% of the pesticide/herbicide users reported this problem. Complaints about the distance to a point of sale and the lack of credit were also more common in the pesticide/herbicide sub-sector than in the fertilizer sub-sector, although it is less likely that this is attributable to the FSSRP.

Exhibit 18: Problems perceived by users of pesticides and herbicides

Problem	Percentage of users perceiving problem
Limited stock	26.0 %
Late delivery	35.5 %
Frequent shortages	35.0 %
Types desired unavailable	29.0 %
Lack of credit	33.5 %
Distant point of sale	29.5 %
Other problems	31.5 %

Source: Minagri/DEAPA (1990). Section VIII, Table 2.

The MIDENO survey in the North West Province only identified 23 users of herbicides so the results must be interpreted with caution, but "unavailability" was mentioned by over half of these users, while late delivery and "wrong type available" were reported by over a quarter of them. The UCD questionnaire omitted the questions concerning specific problems users face, but it did asked if the respondent "had problems" obtaining these chemicals: almost 60% responded that they did.

Those farmers that did not use pesticides or herbicides were asked to explain why they chose not to purchase or were not able to purchase these chemicals. The most common responses in the Minagri/DEAPA seven-province survey were scarcity (33% of non-users), lack of necessity (28%), and lack of credit (10%). In the North West, according to the MIDENO survey, 90% of the non-users claimed pesticides and herbicides were not necessary on their farms, but 68% said they were rarely available anyway. Among the 45 non-

users in the UCD sample of West Province coffee growers, the most common explanation given was that they didn't know where to buy these chemicals (44% of non-users).

To summarize, the predominant problem in the pesticide/herbicide sub-sector is scarcity, followed by late delivery and the wrong types being available. On all of these dimensions, a larger share of farmers perceive problems in the pesticide/herbicide sub-sector than do so in the fertilizer sub-sector. Because these chemicals are consumed by a larger share of the agricultural population and because they have a higher value/bulk ratio, one might expect the chemicals to be more widely available than fertilizer. The fact that this is not the case is probably due to the system of price subsidies and the administratively controlled distribution that characterizes the pesticides/herbicides sub-sector.

9. RECOMMENDATIONS

Take measures to expand participation in FSSRP, particularly in provinces where the program has not been active. The results presented in section 2.1 show that the fertilizer distribution system is, on average, viewed positively in the West and North West Provinces where it has been very active. However, in the areas of traditionally sparse demand for fertilizer, fertilizer distribution is perceived to have deteriorated. The measures should focus on providing information to potential importers, distributors, and end-users about the program. This effort could take the form of seminars in provincial capitals, brochures, or even demand studies. Demand studies, if done, should respond directly to information needs of importers and distributors. These studies could take the form of localized surveys focusing on recent users or rapid marketing assessment techniques involving interviews with key informants. In either case, the studies should focus on areas of actual or potential demand where the existing information base is weak. The East Province, particularly the Haut Nyong Division, is one such area.

Explore ways of improving linkages between potential users in thin-demand areas and transporters who could arrange fertilizer deliveries. The survey results demonstrate that distance to a point of sale is a strong disincentive to fertilizer use. In areas where fertilizer demand is sparse, it may not be economically justifiable to establish a network of distributors willing to keep fertilizer in stock. In these areas, fertilizer delivery might take the form of groups of farmers contracting a trucker to deliver fertilizer. Although it is not possible to avoid the transport costs of delivery to remote areas, it may be possible for the program to reduce the information costs of such arrangements. To the extent that information about fertilizer suppliers, availability, prices, and transport possibilities are a constraint, the FSSRP may be able to reduce the transactions costs. This might be done by connecting farmer groups, as identified by local extension personnel, with importer/retailers, distributors, and truckers. Information about prices, availability, and suppliers could be distributed via extension agents and even radio and newspaper.

Monitor the development of the fertilizer sub-sector with a general survey to be collected every two years. Such a survey would serve to measure progress and identify problems in the fertilizer sub-sector. Since many of the variables collected in the 1990 surveys are not likely to change much from year to year, the questionnaire could be streamlined to reduce the data collection and processing burden. For example, the sections on coffee and maize production patterns and the reasons for non-use of fertilizer could be shortened or eliminated. The fertilizer knowledge section would be repeated only if an information campaign was conducted prior to the survey. Similarly, the section on pesticide/herbicide distribution would be included only if reforms had been introduced. Minagri/DEAPA would be the obvious candidate to undertake such a survey. In order to get more information on fertilizer use in areas of thin demand, the sample could be stratified so as

to include, say, 30 users and 30 non-users in each province. This would, however, increase the data processing burden since expansion factors would have to be used to compensate for the sampling method. Alternatively, as noted in Appendix A, if expansion factors are not used, the distribution of the sample should mirror that of the farm population.

Conduct a province-level fertilizer survey in the Littoral. The Littoral is second only to the West Province in fertilizer consumption, accounting for one quarter to one third of the fertilizer demand under the FSSRP. Yet there is little information on fertilizer use in this province. As mentioned above, the sample for the Minagri/DEAPA seven-province survey included 37 farms in the Littoral, of which only six were fertilizer users. A province-level survey would help determine the level of satisfaction with fertilizer distribution, the types of problems experienced, and the patterns of fertilizer use in the Littoral. In the absence of a university, research center, or development authority in this province, the survey would probably be conducted by Minagri/DEAPA. One option would be to collect this information as part of the general fertilizer survey, but the over-representation of the Littoral in the sample would require the use of expansion factors, thus increasing the computational burden.

Seek ways to support cooperatives and government agencies in disseminating information about fertilizers to farmers. The surveys indicate that farmers have distinct preferences among types of fertilizer, but that these preferences are not founded on even a basic knowledge of the characteristics of different types of fertilizer. FSSRP should attempt to complement or support rather than duplicate existing efforts. For example, FSSRP could pay for the design and printing of brochures with basic facts about the different types of fertilizer and recommendations for different crops and soil types. These could be distributed to extension agents, cooperative officials, farmer group leaders, and private distributors. Pamphlets for farmers themselves are not out of the question, but issues of language, literacy, and volume[13] need to be addressed.

Encourage compilation of existing fertilizer response research and reconsider support of new fertilizer response trials. There is some question as to whether the fertilizer information that farmers need currently exists among agronomists in the country. A national fertilizer response database was proposed by consultant Jerry Johnson (Minot and Johnson, 1989). Even if such a task is not undertaken, a compilation and synthesis of existing research would be a valuable exercise. Fertilizer response trials should be reconsidered, given the need for better information on alternative nutrient combinations, on soil type interactions, and on the requirements of food crops.

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13. There are over 150,000 farms in the seven southern provinces which use fertilizer.

Support efforts to improve the marketing of coffee and the prompt payment of arrears. The survey found that in early 1990, late payment for coffee was significantly associated with reduced fertilizer purchases. The demand for fertilizer depends strongly on the coffee sector and will continue to do so for the foreseeable future. Although the world price of coffee must be taken as given, coffee marketing reform should be aimed at increasing the portion of the world price received by farmers and ensuring prompt payment.

In consultation with appropriate policy makers, study the possibility of reforms in the pesticide/herbicide sub-sector along the lines of the FSSRP. The fertilizer survey results confirm impressionistic evidence that the pesticide/herbicide sub-sector suffers from shortages, late delivery, and an unresponsive supply system. These problems still exist in the fertilizer distribution system, but to a much lesser degree. It is suspected that the difference is due to the reforms introduced by the FSSRP. For this reason, privatization and subsidy reduction in the pesticide/herbicide sub-sector should be seriously considered. Issues which need to be addressed include the possible "public good" nature of pesticides and concerns about safe handling of toxic chemicals.

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APPENDIX A

EXTRAPOLATION FROM SURVEY DATA

The tabulation of all three surveys was done using unweighted sample averages. Strictly speaking, this is only appropriate when the sample is collected in such a way that each household has an equal probability of being selected. This is generally not the case for surveys such as these that use stratified samples. In practice, however, the computational burden of applying weights (also called expansion factors) makes the use of unweighted sample averages a common practice for small, special purpose surveys. The size of the bias introduced by this practice is a function of 1) the degree to which the sample is unrepresentative of the population and 2) the correlation between the variable in question and the (unused) weighting factor.

Exhibit A-1 compares the distribution of the DEAPA fertilizer survey sample with the estimated distribution of farm households in the seven southern provinces. The table shows that the sample over-represents the East, Center, and, South, while under-representing the West, North West, and South West. This is unfortunate because the rates of fertilizer use are highest in the West and North West. As a result, the percentage of the sample using fertilizer (19%) under-estimates the proportion of the population using fertilizer.

Exhibit A-1: Comparison of the geographic distribution of the sample and the agricultural population

Province	Percentage of DEAPA sample	Percentage of ag. households in southern 7 prov.
East	13.6 %	9.4 %
Center	26.8 %	22.8 %
Littoral	8.7 %	9.0 %
South West	6.8 %	10.3 %
North West	15.3 %	18.5 %
West	18.5 %	22.3 %
South	10.3 %	7.7 %
Total	100.0 %	100.0 %

Source: Ministère de l'Agriculture (1991) and estimates of the number of agricultural households from the Minagri/DEAPA agricultural survey of 1989.

The most "correct" solution would have been to use household-level weights, as is done for the DEAPA agricultural surveys. A less accurate but computationally simpler alternative would be to use province-level weights. Weighted averages of this type were calculated for a few important tables for this report (see sections 2.1 and 4.1). For example, the proportion of households using fertilizer, as calculated this way, was 22%.

If additional surveys are to be conducted, the simplest solution would be to ensure that the sample is generally representative of the population. At the least, the proportion of the sample in each province (or division, for the province-level surveys) should correspond roughly to the proportion of households in each province (division). This would minimize the bias resulting from the use of unweighted sample averages.

It should be noted, however, that the use of weighted averages would not change appreciably most of the figures provided in the DEAPA report. The difference in the fertilizer use rates (19% vs. 22%) probably represents the upper limit of correction that weights would introduce. It is useful to keep in mind the fact that the West and North West Provinces are under-represented in the seven-province averages, but the basic conclusions of the survey are not in question.

APPENDIX B

REGRESSION ANALYSIS

Multiple regression is a statistical procedure to estimate the effect of each of a number of explanatory (or independent) variables on a single variable of interest (the dependent variable). It also generates estimates of the statistical significance of each explanatory variable, defined with reference to the probability of such a relationship occurring by chance. In the social sciences, a probability less than 5% (or sometimes 1%) is generally considered "statistically significant."

In this report, regression analysis is used on three occasions: to analyze the factors associated with the level of satisfaction with the fertilizer distribution system (section 2.1), to analyze the factors associated with fertilizer use (section 4.5), and to analyze the factors associated with the quantity of fertilizer used (section 5.8.3). In all cases, the analysis was based on the results of the seven-province survey conducted by DEAPA using the household as the unit of analysis.

1. Estimation of the Level of Satisfaction

In the regression analysis of section 2;1, the dependent variable was the level of satisfaction with 1 representing "much better," 2 "better," 3 "about the same," 3 "worse," and 4 "much worse." Various independent variables were tested, but only two were found to be significant: a continuous variable representing cultivated farm area (expressed in hectares) and a binary variable with 1 representing the West and North West Provinces and 0 representing the other five southern provinces. A linear functional form was estimated using ordinary least squares (OLS). The results are presented in Exhibit B-1.

Exhibit B-1: Results of regression analysis estimating the level of satisfaction with fertilizer distribution

variable (X)	coefficient (ß)	T statistic
constant	3.12	
cultivated area	0.10	3.05
West/North West	-0.55	-2.26
N = 114	R^2 = 0.15	

2. Estimation of the Probability of Fertilizer Use

For the regression analysis reported in section 4.5, the dependent variable was 1 if the farmer used fertilizer the year of the survey and 0 if not. Because the dependent variable is limited to the range 0-1, a linear model is not appropriate. A generalized least squares logit model was estimated in three stages (this procedure is explained more fully in Fomby, Hill, and Johnson, 1984, p. 340-348).

In the first stage, ordinary least squares (OLS) was applied to a linear model. The estimated values of the dependent variable (P) were then transformed into "log odds ratios," that is ln(P/(1-P)), which is used as the dependent variable in the second stage. This generates an OLS logit model. The third step uses generalized least squares to correct for heteroskedasticity. The inverse of the estimated standard deviation (P/(1-P)) is used to "weight" each observation, resulting in a generalized least squares logit model. The model is as follows:

$$P = \frac{\exp(\Sigma X\beta)}{1 + \exp(\Sigma X\beta)} \quad \text{or} \quad \ln(P/(1-P)) = \Sigma X\beta$$

where P is the probability of the household using fertilizer, the X's represent the explanatory variables, and the ß's are the estimated coefficients. The estimated coefficients and their T statistics are presented in Exhibit B-2. Distance is expressed in kilometers, while arabica, robusta, and commercial maize production are represented by binary variables (1 if yes, 0 if no). The data for the dependent variable take the value 1 if the household uses fertilizer and 0 if not. The estimated value of the dependent variable is a fraction between 0 and 1 and is interpreted as the probability that the household will use fertilizer.

Exhibit B-2: Results of regression analysis estimating the probability of fertilizer use

variable (X)	coefficient (ß)	T statistic
constant	-1.01551	
distance	-0.01224	-8.73
arabica grower	1.99177	9.82
robusta grower	0.72763	2.43
com maize producer	1.08674	2.10
N = 426	R^2 = 0.41	

Note: **The T statistics were those obtained in the first stage of the estimation (the linear OLS model) due to software limitations.**

3. Estimation of Quantity of Fertilizer Purchases

In section 5.8.3, regression was used to estimate the quantity of fertilizer purchased among fertilizer users. The regression was based on the sample of 79 households using fertilizer. Because the dependent variable is "censored" (it cannot be negative), the Heckman two-stage procedure was used (see Fomby, Hill, and Johnson, 1984, p. 358-360). The first stage involves deriving a new variable from the logit estimation described above. The second stage is to add this term to the estimation of quantity used. The results are presented in Exhibit B-3. Late payment and commercial maize production are represented by binary variables (1 for yes and 0 for no). Distance is measured in kilometers, robusta in number of trees, and the dependent variable, fertilizer, in number of bags.

Exhibit B-3: Results of regression analysis of the quantity of fertilizer used among users (version 1)

variable (X)	coefficient (ß)	T statistic
constant	0.27	
persons	0.38	2.26
late payment	-5.18	-2.03
fertilizer price	-0.0012	-1.20
distance	0.16	4.11
robusta trees	0.0021	5.51
com maize producer	6.00	2.63
Heckman term	-1.31	-0.38
N = 79	R^2 = 0.54	

Alternative models were used to explore the relationship between the quantity of fertilizer used and the area under cultivation. For example, the model presented in Exhibit B-4 estimates quantity as a function of the number of persons in the household and the area under cultivation. This shows that each additional hectare of cultivation is associated with 1.1 additional bags of fertilizer.

Exhibit B-4: Results of regression analysis of the quantity of fertilizer used among users (version 2)

variable (X)	coefficient (ß)	T statistic
constant	-0.47	
persons	0.55	2.81
area	1.11	3.36
N = 79	R^2 = 0.25	

APPENDIX C

ESTIMATED IMPACT OF SUBSIDY REDUCTION

As noted in section 5.8.3, the regression analysis indicates that price has only a weak negative relationship to the quantity of fertilizer purchased by users. The price coefficient in the model implies that the price elasticity is -0.6, but the confidence interval is quite wide: +0.4 to -1.5. In addition, it is important to recall that this elasticity refers only to the impact of price on quantities consumed by fertilizer users. It does not include the effect of price on the decision whether to purchase fertilizer or not. With these caveats in mind, we now examine the implications of alternative elasticities of demand.

What would be the impact of the removal of price subsidies in the absence of other changes affecting fertilizer demand? In order to address this question, we must adopt 1) a functional form for the demand equation, 2) a price elasticity, and 3) a base period with which to make comparisons. In this exercise, we will use the double logarithmic functional form, a standard form characterized by constant elasticities. This can be expressed as follows:

$$\ln Q = \beta_0 + \beta_1 \ln(P) + \Sigma \beta_i \ln(X_i)$$

where the β's are the coefficients, Q is the quantity of fertilizer demanded, P is the price, X's are other variables affecting demand such as the price of coffee, the price of maize, timeliness of availability, and so on. The coefficient β_1 is the price elasticity of demand. If all variables other than price are held constant, then the summation term becomes part of the constant. Three elasticities will be tried: the estimated value of -0.6, a higher value of -1.0, and a lower one of -0.2. And the base period will be the 1987-88 season, the last year before the FSSRP. Using the fact that the price was 45,000 francs CFA and the volume was 64,000 metric tons, we calculate the following equations:

elasticity = -0.2:	$\ln Q = 4.99 - 0.2 \ln(P)$
elasticity = -0.6:	$\ln Q = 6.44 - 0.6 \ln(P)$
elasticity = -1.0:	$\ln Q = 7.97 - 1.0 \ln(P)$

where Q is expressed in thousands of metric tons and P is expressed in thousands of francs CFA per metric ton. With these equations, the effect of fertilizer price increases on demand can be estimated, assuming that all other factors (crop prices, availability, etc.) remained unchanged from their 1987-88 levels. The effect of two price increases are presented in

Exhibit C-1 below: an increase to 57,776 francs CFA/ton, the average level of 1989-90, and an increase to 85,000 francs CFA/ton, an estimate of the average price of fertilizer in the absence of subsidies[14].

Exhibit C-1: Impact of price increases on fertilizer demand under alternative assumptions about the price elasticity of demand

	price elasticity assumption		
	- 0.2	- 0.6	- 1.0
1987-88 price (f/ton)	45,000	45,000	45,000
1987-88 demand (tons)	64,000	64,000	64,000
1989-90 price (f/ton)	57,776	57,776	57,776
% change in price	+ 28 %	+ 28 %	+ 28
estimated demand (tons)	60,865	55,070	49,848
% change in demand	- 5 %	- 14 %	- 22 %
unsubsidized price (f/ton)	85,000	85,000	85,000
% change in price	+ 89 %	+ 89 %	+ 89 %
estimated demand (tons)	56,343	43,683	33,882
% change in demand	- 12 %	- 32 %	- 47 %

Note: The percent changes are relative to the 1987-88 figures.

These figures indicate that the price increase from 1987-88 to 1989-90 would account for a reduction in demand of from 5% to 22%, depending on the price elasticity of demand[15]. In fact, the demand for fertilizer fell by around 50% in 1989-90 (it has partially rebounded since then). If a double-logarithmic equation is a reasonable approximation of the true demand function and if the price elasticity of demand is less than or equal to one, then the price increase over 1987-88 to 1989-90 would account for less than half of the observed decline in demand over this period. The remainder would presumably be due to other changes since 1987-88 such as the worsening liquidity crisis, the lower coffee prices, late payments, and so on.

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14. According to Abbott (1990, p. 12), the sum of the retail price and the per unit subsidy was 86,939 f/ton in 1988-89 and 82,699 f/ton in 1989-90.

15. An elasticity of -1.0 means that a one percent increase in price results in a one percent decrease in demand. However, this ratio does not hold for "large" changes in price, such as those presented here.

At 85,000 francs CFA/ton, the estimated unsubsidized price, the demand for fertilizer would be 12 to 47% lower than the 1987-88 level, assuming the above price elasticities and that other factors remained unchanged from 1987-88. The actual level of demand once subsidies are eliminated will, of course, differ from these figures depending on non-price factors. Demand may be higher than shown here if the effects of improvements in fertilizer availability dominate or lower if the effect of lower crop prices and late payments dominate.