

CHAPTER 4:

SUMMARY, CONCLUSIONS, LIMITATIONS AND IMPLICATIONS FOR FUTURE RESEARCH

4.1 Summary

The main objective of this study was to develop a procedure for agricultural research evaluation in Senegal. This procedure is developed within the Senegalese peanut sector and applied to the evaluation of a new peanut variety, La Fleur 11.

In addition to performing an ex-ante evaluation of research investments on La Fleur 11 by evaluating the magnitude of research benefits, this study attempted to address several issues. It disaggregated the Senegalese peanut sector vertically and computed the benefits from research on La Fleur 11 for the main peanut commodities: unshelled peanuts consumed on farm, unshelled peanuts sold on the unofficial market, peanut seeds, peanut oil and peanut cakes. For each commodity and each market, this study determined the distribution of the benefits among consumers, producers and the government; and evaluated the effect of the corresponding pricing policy on the benefits from research.

This procedure consisted of three steps. In the first chapter, a description of the current peanut sector in Senegal, the history of agricultural policies and current peanut policies provided background information for the construction of an adequate model. In the second chapter, a conceptual research evaluation model was built on the basis of the methods described in Alston et al (1995) and past research evaluation studies. This model was developed to take into account the characteristics of the Senegalese peanut sector described in the first chapter. In the third chapter, data collected from different sources were presented, adapted to the model outlined in the second chapter and analyzed using a spreadsheet program. From this exercise, results were derived and discussed. Further comments were made after a sensitivity analysis tested some key parameters.

The peanut sector is one of the most important agricultural activities in Senegal representing 37 percent of the total cultivated area and earning 52 percent of agricultural exports in 1997-98. Several markets constitute the peanut sector in Senegal. In general farmers use 24 percent of their supply of unshelled peanuts for their own consumption. The rest is sold either on the unofficial market in the form of unshelled peanuts (10 percent of the total supply of unshelled peanuts), or on the official market to SONACOS (65 percent of the total supply of unshelled peanuts). SONACOS utilizes its purchases of unshelled peanuts in two ways. Fifteen percent of the total supply of unshelled peanuts are seeds that are stored, treated with chemicals and sold to farmers the following season. The remaining 50 percent are transformed into oil and cakes. The confectionery industry is not considered in this analysis since La Fleur 11 produces oil seeds. All the peanut products are consumed domestically except oil and cakes that are exported: 54 percent and 41 percent respectively. While the unofficial market is free, the official market is subject to a price intervention. Farm sales of unshelled peanuts to SONACOS are subject to a producer base price.

Because of its economic importance, the peanut sector has been subject to several governmental interventions since the French occupation and independence. These interventions have been motivated more by political than economic factors. As a consequence, the productivity of the peanut production system and the efficiency of the peanut marketing system have been adversely affected. The decrease in peanut productivity has been sustained by two factors. In Senegal, the increasing incidence of drought and soil degradation contributed to decreases in peanut yields. The implementation of structural adjustment programs ended government intervention in

input distribution. Consequently, peanut farmers reduced or ended their input use and peanut productivity and revenues fell. At the international level, world economic shocks such as the rise in petroleum prices in the 1970's and 1980's, the fall in world phosphate (another important export product of Senegal) prices in the 1970's and the loss of preferential trade relations with France weakened the Senegalese economy and the peanut sector. Also the increasing competitiveness in the world peanut oil market and the resulting decrease in world price reduced Senegal's share of the peanut oil world market.

In order to address this situation, the Senegalese government has been investing in agricultural research with the technical and financial support of international research institutions, CIRAD, ICRISAT, and the peanut CRSP. Improved peanut varieties have been developed such as La Fleur 11, which is expected to increase peanut productivity. Its yield is expected to be 30 percent higher than that of the most similar traditional variety 55-437. The purpose of this study is to evaluate the economic impact of La Fleur 11 on the Senegalese economy, only from the perspective of the Senegalese government's investment in it. Information on CIRAD, ICRISAT and Peanut CRSP expenditures on La Fleur 11 were not available.

In order to achieve the objectives of the study, the evaluation of research benefits uses the concept of economic surplus in a partial equilibrium framework. When a new technology is adopted, the supply curve shifts to the right due to cost savings or increase in output and the difference in economic surpluses between the without-research equilibrium and the with-research equilibrium represents the benefits from research.

This framework is applied to the Senegalese peanut sector. Two scenarios are considered: an aggregated market scenario and a disaggregated market scenario. In the

aggregated market scenario, it is assumed that farmers sell their entire supply of unshelled peanuts to SONACOS at the producer base price and the evaluation is conducted at the farm level using a closed economy model. In the disaggregated market scenario, the peanut sector is vertically disaggregated and the evaluation is conducted separately for each La Fleur 11 market in the peanut sector. With the disaggregated markets, a farm level evaluation is conducted for farm household consumption of unshelled peanuts at the unofficial market price using a closed economy model where demand is assumed to be perfectly inelastic. A farm level evaluation is also conducted for farm sales of unshelled peanuts on the unofficial market at the unofficial market price using a basic closed economy model. Another farm-level evaluation is conducted for farm sales of peanut seeds on the official market at a producer base price using a closed economy model with a price support. Because SONACOS transforms a part of its purchases of unshelled peanuts from farmers into oil and cakes, two evaluations are conducted at the SONACOS-level for peanut oil and cakes at the world price using an open economy model. To obtain total research benefits in the disaggregated market scenario, the benefits computed in each market are summed. Each model is refined by considering both a parallel and pivotal shift of the supply curve, and a parallel rightward shift of the demand curve due to changes in population and income.

Data were collected from different sources: literature, international databases and the Senegalese government. The data needed were either used as they were found (elasticities), or averaged for several years (prices and quantities), or derived using economic theory and/or simple calculations, or approximated using some qualitative and/or quantitative information. Two pieces of information were approximated: the

adoption profile and research costs. Based on the information collected in Senegal about La Fleur 11 characteristics and farmers' use of this variety, two adoption profiles were approximated, a pessimistic adoption profile and an optimistic adoption profile. The pessimistic adoption profile has a long second lag (20 years) and a low maximum adoption rate (15 percent). The optimistic adoption profile has a short second lag (10 years) and a medium maximum adoption rate (25 percent). All the calculations of research benefits were made for each type of adoption profile. Annual research costs were approximated on the basis of annual researcher salaries. Researcher salaries were evaluated using the number of researchers, the number of years where they were employed and salaries found in an IMF database.

These data are used in the models of the aggregated market and disaggregated market scenarios presented above, for each type of the adoption profile and each type of supply shift. Research benefits are calculated for consumers and producers. When a subsidy applies, the research-induced changes in the government cost of the subsidy and in the net social welfare are calculated as well. Total research benefits are summed. Net research benefits are derived by subtracting research costs. In order to account for the stream of future benefits and costs from research, annual benefits and costs are discounted and the present value of net research benefits is calculated for each scenario, each market, each adoption profile, and in each case of the supply shift.

Results show that research on La Fleur 11 increases the net social welfare in Senegal. The distribution of the benefits among consumers, producers and the government is determined by the level of evaluation, level of aggregation, pricing policy, type of adoption profile and type of supply shift.

In the aggregated market scenario, benefits (to consumers and producers) and costs (to the government) are 2.6 times higher with the optimistic adoption profile than with the pessimistic adoption profile. Consumers (SONACOS) are the main beneficiaries from research. Their benefits are 4.2 times producers' (farmers) with a parallel supply shift and 8.4 times producers' with a pivotal supply shift. With a parallel supply shift, the research-induced increase in the government cost of the subsidy represents 80 percent of consumers' and producers' benefits; the research-induced increase in net social welfare represents 20 percent of consumers' and producers' benefits. These figures are 88 percent and 12 percent with a pivotal supply shift. The IRR vary between 40 and 60 percent depending on the adoption profile and the type of supply shift. They are more likely to be 47 percent with a parallel shift or 40 percent with a pivotal shift assuming that the most likely adoption profile is the pessimistic adoption profile.

In the disaggregated market scenario, at the farm level, research benefits consumers (SONACOS) more than producers (farmers) by 1.8 times more with a parallel supply shift and 4.4 times more with a pivotal supply shift. Most of producers' benefits come from farm household consumption (47 percent of total farm-level benefits). At the SONACOS-level, research benefits producers (SONACOS) only, consumers (rest of the world) do not benefit from research at this level. The IRR vary between 38 and 60 depending on the market, the adoption profile, and the type of supply shift. They are more likely to be between 38 and 47 percent.

Sensitivity analyses are conducted in order to test the stability of the results when some parameters vary. The parameters tested are the percentage of increase of research salaries to obtain research costs, the elasticities, the exchange rate and the discount rate.

When research costs, the exchange rate and the discount rate are varied, research benefits change in size but not in distribution. Increasing research salaries by 50 percent instead of 20 percent to estimate research costs only affects research benefits at or by less than 0.4 percent. Decreasing the exchange rate by 9 percent and the discount rate by 10 percent increases research benefits by 9.9 percent and by 15-16 percent respectively. The use of long-run elasticities instead of short-run elasticities changes research benefits in size and distribution. With long-run elasticities, consumers' and producers' research benefits decrease by 91 percent and 33 percent on average respectively, the cost of the subsidy decreases by 92 percent, and the net social welfare decreases by 40 percent on average. Also, producers receive more benefits than consumers in most evaluations with long-run elasticities while they were receiving fewer benefits than consumers with short-run elasticities. These results are due to the use of more elastic supply and demand curves and a more elastic demand elasticity relatively to the supply elasticity.

4.2 Working hypotheses revisited

The following working hypotheses were formulated in chapter 2 for subsequent confirmation by the study:

- Research on La Fleur 11 has positive net benefits.
- Consumers benefit from research on La Fleur 11 more than producers in a closed economy, but only producers benefit from research on La Fleur 11 in an open economy.
- The implementation of peanut pricing policies affects the size and the distribution of the benefits among consumers, producers, and the government

and among markets. Producers' share of the benefits from research is greater than consumers' in the context of a producer base price.

The first hypothesis has proven right. Table 3.21 shows that total research benefits net of research costs are positive for all evaluations of the study.

Regarding the second hypothesis as shown in tables 3.22 and 3.23, consumers are the main beneficiaries from research in all closed economy models but farm household consumption. Producers are the only beneficiaries from research in the farm household consumption model and in the open economy models.

Regarding the third hypothesis, it is incorrect to state that producers' share of the benefits from research is greater than consumers' in the context of a producer base price. Producers benefit less than consumers from research when a producer base price is applied. However, the implementation of a producer base price affects the impact of research on the economy by decreasing the net social welfare through the increase of the government cost of the subsidy.

4.3 Conclusions

On the basis of this study, it can be concluded that research on La Fleur 11 was a good investment. The Senegalese society benefits from research and at each market level, each economic agent either benefits from or is not affected by the research but never loses except producers when a pivotal supply shift is considered in the unofficial market of unshelled peanuts.

However, on the basis of the information obtained in Senegal and from previous studies on La Fleur 11 (Bravo-Ureta et al, 1997 and 1998), the impact of La Fleur 11 could be enhanced if other actions were undertaken. First, the distribution of La Fleur 11

seeds should be improved in order to allow more farmers to have access to this variety and hence possibly increase La Fleur 11 adoption rates. Second, the use of a peanut variety with such a high potential yield requires the use of inputs in adequate quantities and the use of recommended agricultural practices. In the irrigated areas where more effort is made regarding extension and farmers' input use, La Fleur 11 yields exceed 1.5 tons per hectare (Senegal, Republic of, Ministry of Agriculture, 1998 b) while they are about 0.7-0.8 tons per hectare in other areas of Senegal (Sow, 1998). For larger economic impacts of La Fleur 11, its adoption should be accompanied by an extension program that facilitates farmers' access to factors of production (credit, seeds, pesticides, fertilizers) and informs the adopters about the agricultural practices that most efficiently take advantage of the yield potential of La Fleur 11. If a better use of La Fleur 11 agronomic practices provides an incentive to adopt this variety, the impact on the magnitude of research benefits may be much greater than indicated in this study. As shown in the analysis, research benefits are higher with higher adoption rates (optimistic adoption profile).

Nevertheless some problems related to La Fleur 11, such as its susceptibility to aflatoxins, cannot be corrected unless a new variety is developed. At some point, the adoption of La Fleur 11 will probably be affected by the lack of resistance of this variety to some diseases and aflatoxins.

4.4 Contribution and policy implications of the study

The usefulness of this study resides primarily in the fact that it provides a guide for the completion of similar agricultural research evaluations in Senegal. To this end, the model was described in detail and two procedures were considered. The first procedure

(aggregated market scenario) calculated research benefits at the farm level, for one commodity taking into consideration the pricing policy that commodity is subject to. The second procedure computed research benefits both at the farm level and at the SONACOS level for several commodities, which face different types of markets and pricing policies. This second procedure was interesting theoretically because it led to more sophisticated modeling. Empirically it was more realistic because it considered the major markets constituting the peanut sector in Senegal and the pricing and trade policies implemented in the peanut sector.

This study is also useful because it presents a framework for decision-making about agricultural research in Senegal. There are several parties involved in agricultural research in Senegal. They are the Senegalese government and international agricultural research institutions such as CIRAD and ICRISAT or programs such as the peanut CRSP, which provide funds and/or expertise. The purpose of such a study is to provide information to these institutions and programs and to the Senegalese government about whether funds were used efficiently, that is whether research increased the country's net social welfare. Depending on the impact of research on the economy, funding sources and expertise providers will make decisions about future research investments in agriculture and the peanut sector in Senegal, in order to improve the nation's social welfare.

4.5 Limitations of the study and implications for future research

There are two ways in which this study can be extended. One way is by relaxing some assumptions or extending the objectives of the study. Another way is by modifying

the methods used in the study, considering more sophisticated techniques for a more accurate estimation of research benefits.

Depending on the objectives of a study, there are many ways to conduct a research evaluation. The present research evaluation was conducted for the entire country assuming homogeneity. However, Senegal contains enough heterogeneity due to climatic, soil and agricultural differences that evaluating research benefits for each relatively homogeneous agro-climatic region and measuring spillovers among these regions would be an appropriate next step to take. Also, this research evaluation has been conducted within the limits of the Senegalese boundaries ignoring spillovers outside the country. This evaluation could be expanded by introducing West Africa or the rest of the world into the model and measuring research benefits at this level. La Fleur 11 is a drought-resistant variety. Thus, it exhibits a potential decrease in the production-related risk due to drought. By not considering this potential risk reduction, this study may have underestimated the research benefits. Finally, this research has been conducted from the Senegalese government perspective: only the Senegalese government expenditures were considered for the estimation of research costs. An extension to this study may be to estimate the returns from all research investments, including those made by foreign institutions (CIRAD, ICRISAT, and Peanut CRSP).

A number of assumptions were made about the functional form of the supply and demand functions, about the homogeneity of the country and about the constancy of some parameters. As a consequence of these assumptions, the estimation of research benefits is a more or less accurate approximation of the actual research benefits. In order to improve the estimation of research benefits, these assumptions may be relaxed to allow for non-

linear supply and demand functions, some heterogeneity of the country regarding the market prices, the adoption profile, on farm consumption ratio and so on. Variability of some key parameters such as the discount rate, the ratios used to assign the equilibrium quantities and so forth can be examined.

Another extension of this study might be to use different techniques. This evaluation has been done on the basis of linear supply and demand curves defined using elasticities and equilibrium prices and quantities. A more precise evaluation can be completed later in the adoption process by the econometric estimation of the supply and demand functions if the model were based on a supply shift or the econometric estimation of a production function if the model were based on the shift of a production function. To avoid any assumption about the functional form of the production function a non-parametric method could be applied for production analysis and research evaluation.

According to Alston et al (1995), the choice of the research evaluation method is determined by the following factors: the objective of the research evaluation, the availability of operational and financial resources, the skills of the analyst and the appropriateness of the techniques used regarding economic theory. Although they don't recommend any of the many methods of research evaluation that they present, they suggest that research evaluation be conducted on the basis of an economic surplus analysis within a partial equilibrium framework. They explain that "each procedure has its advantages and disadvantages and no one approach is best for every situation (p. 504)."