Royaume du Maroc
Ministère de l'Agriculture et
de la Réforme Agraire

USAID/Rabat

PROJET DE RéFORME DE LA
COMMERCIALISATION DES CéRéALES
(PRCC -- Phase II)

AGRICULTURAL TRADE MODELING: REPORT ON TRAINING COURSE AND CURRENT MODELING EFFORTS

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CMR REPORT ET 60

Agricultural Trade Modeling

Introductory Note: This report has two purposes. The first is to report on a training course given to personnel from the Ministry of Agriculture in Rabat over the period May 11-29, 1992. The second is to provide a preliminary description of agricultural trade impact modeling efforts that will be undertaken by the CMR project over the next six months as part of the project's Phase II program.

Part I: Report on Trade Modeling Course

Summary

The course was presented to personnel of Ministere de l'Agriculture et de la Reforme Agraire (MARA)from the following Directorates:

- Direction de la Planification et des Affaires Economiques (DPAE);
- Office Nationale Interprofessionnel des Céreales et des Legumineuses (ONICL); and
- Direction de la Production Vegetale (DPV).

Objectives and Contents

The objective of this course was to familiarize staff at the above parts of MARA with methods and techniques of international trade modeling. Emphasis was placed on how trade opportunities influence outcomes from domestic agricultural policies, trade policies and marketing reform measures. A primary objective was to see how domestic policy models must be modified to accommodate trade policies and institutions. We also looked at how international market models are constructed, and the relation between those models and the national models presented.

Course participants learned to create and use simple trade models on personal computers, based on Quattro spreadsheets. They also used some existing computer simulation models to gain experience with more complex model structures.

Trade theory appropriate to course objectives and economic analysis of cereals trade issues was presented. Problems of establishing based data and behavioral parameters (e.g. supply and demand elasticities) were also examined. Consequences of modeling assumptions and limitations to modeling were discussed. Application to problems of the Moroccan cereals sector were used as classroom examples and served to foster discussion on trade theory and its application, modeling issues, and model limitations.

Text and References

Economie Internationale by Peter Lindert served as a textbook for this course. It

is a French translation of the 8th edition of International Economics, published in French by Economica/ Nouveaux Horizons in 1989. (The English edition was published by Irwin in 1986). Only a limited number of chapters were utilized in the course, but future work on international trade by course participants would be enhanced by reading chapters not considered in this course. The CMR project purchased and distributed 19 copies of the text to participants at the beginning of the course.

Numerous handouts and computer modules supplemented the textbook. References on trade models, including USDAs SWOPSIM model and the OECDs RUNS model, were contributed to the DPAE library for future use.

Topics Covered

Some changes in the originally planned course outline were pursued, based largely on the prior training of course participants. While a few participants held U.S. Masters or PhDs in Economics, most had much less training in Economics. Hence, more time was spent on basics of trade theory and on computer simulation techniques than was originally expected. In spite of the training limitation, we were able to cover the critical topics, and indeed expose course participants to a wide range of approaches to agricultural trade modeling and modeling of economic equilibrium in general.

A list of topics covered in this course, in order of presentation, follows:

Issues in International Agricultural Trade Modeling
- Introduction and Basic Assumptions

Supply/Demand Equilibrium in Open versus Closed Economies
- Net Trade and the Two Panel Diagram
- Small versus Large Countries in Trade: Three Panel Diagrams
- Algebraic Representation and Computer Simulation of Market Equilibria
- Data Issues: Benchmarking, Base Data and Behavioral Parameters
  - Institutional Reform and Modeling Limitations

General Equilibrium and Traditional Trade Theory

- Comparative Advantage (Riccardo, Heckscher-Ohlin)
  - Assumptions and Theory
  - Simple Computer Simulations (Optimization Methods)
- Leontief Paradox, Strategic Trade Theory and Explanations of Observed Trade Patterns
- Production Possibility Frontiers and Trade Equilibria
- Derivation of Supply/Demand Curves
  - Supply and Increasing Costs
  - Opportunity Costs in Production, Consumption and Trade
- General versus Partial Equilibrium
- Welfare Impacts: Consumer and Producer Surplus, Revenues and Expenditures
- Consumer Welfare Simulation using a Linear Expenditure System

Tariffs, Quotas, and Exchange Rates: Policy in an Open Economy Equilibrium

Theory: Market and Welfare Impacts
Computer Simulations of Tariffs and Quotas
Theory of Second Best

Domestic Policy and Trade

Consumer and Producer Subsidies and Taxes
Marketing Boards, Effective Quotas, and Domestic Price Targets

Abbott-Imrani Model of the Moroccan Cereals Sector

Structure and Assumptions
Simulations of Policy Alternatives

International Market Modeling

Price Transmission, Net Trade and Domestic Trade Models
Net Trade and International Equilibrium - Non-Spatial Models

Participants

Nineteen governments officials from DPAE, ONICL and DPV participated regularly in the course. A list of those participants follows:

Participant		**Office**
AZZOUZI	Essaid	DPAE
BENYASSINE	Abderrahim	DPV
BERRI	Youssef	ONICL
BOUCHTA	Mohamed	DPAE
BRAHIM	El Bakkouchi	DPV
BRITEL	Amal	DPAE
CHAKRI	Ahmed	ONICL
CHARI	Mostafa	ONICL
CHIMI	Salah	ONICL
EL AMRANI	Mohamed El Amine	DPAE
EL BOUZIRI	Mohammed	ONICL
EL MAZOR	Abdelkader	DPAE
EL MEZROUI	Rachid	ONICL
ESSLIMI	Lahsen	DPAE
EZZOUINI	Rachid	DPAE
HOUMY	Abderrahim	DPAE
KAMILI	Mohhamed	DPAE
KEBBARA	Youssef	ONICL
ZIDAN	Alaoui-Soulimani	DPV

In addition, a few additional individuals attended parts of the course. Those who

did not attend regularly were prevented from doing so due to job requirements. Most who attended regularly were at all course sessions. Only a couple of the regular participants were called away from the course from time to time.

Course Schedule

This course began on Tuesday, May 11, 1992 at 9:00am. Class was held each day at 9:00am until Friday, May 29, 1992. Class would generally end at 11:30am, with a break at about 10:15. The ending time varied somewhat from day to day, depending on the needs of the course, and lasted until noon on several days.

Participants were given homework assignments, generally involving computer simulations using Quattro spreadsheets, each day at the end of a class. The instructor would be available in the afternoon at ONICL until 4:00-4:30pm, and at DPAE afterwards, to answer questions on the homework and on course material.

Problems of cereals market reform were also discussed with course participants during the afternoons. Meetings with other contacts concerning future modeling efforts were also in the afternoons.

Course Problems and Solutions

Relatively few problems were encountered in presenting this course. The greatest difficulty encountered was coping with the widely varying backgrounds of course participants. More time was spent on trade theory and modeling basics than was originally planned. All participants learned quickly, however. Each day, groups of students worked together on the homework assignments. Assistance was provided to the groups when needed. This group support system helped most course participants keep up with the relatively fast pace of the course.

A Datashow was used in the course daily to offer "live" demonstrations of the computer simulations. Some logistical problems were encountered at the beginning in finding a computer compatible with the Datashow and set it up in the classroom. One of the students had a portable computer compatible with the datashow which was used throughout the course. Future courses could benefit with a unit compatible with the CMR project's portable computers. Given the practical nature of this course, in class computer demonstrations were invaluable.

Homework on the computer helped participants to gain some experience with simulation methods, although simple model structures were used throughout. Most of the techniques used in actual trade modeling were presented, but none of the models presented are as complex (combine as many parts) as trade models found in the literature.

PART II: CMR PHASE II Modeling Efforts

One objective of this course was to prepare DPAE, ONICL and DPV staff in trade modeling so that they could participate in future modeling efforts. Abbott met with Moroccan officials and other project counterparts as well as CMR staff to discuss and consider future modeling efforts which these agencies and other project participants might pursue to further project objectives and Moroccan cereals market reforms. Those meetings led to three recommended modeling efforts to assist in understanding the consequences of cereals market reform. These recommendations follow from the project's phase I identification of key concerns for the future of the Moroccan cereals sector. Each of the key issues identified and relevant modeling approaches is discussed below.

Model No. 1: Stocks Subsidies and Monthly Price Variability

As part of the cereals market reform, it is likely that the subsidy given to mills to hold stocks of Blé tendre (bread wheat) by ONICL will be eliminated. Now there is little incentive for farmers or other marketing agents to hold stocks, and prices are stable and close to the reference price throughout the year. If stocks are not subsidized, it is likely that monthly price variations similar to those found now for the other cereals will occur. That is, prices will reach their highest level just before harvest, and will fall rapidly as the harvest comes in, reaching their lowest level shortly after harvest.

This generally observed price cycle is desirable in that it provides the incentive for farmers and traders to hold stocks. If a reference price is used to set border prices at which imports will arrive, for domestic consumption to be sold, the price of domestic production will fall below the reference price. This price decline also smoothes the seasonal consumption pattern, rationing supplies over time. As the market price rises after harvest, it eventually reaches the reference price level and imports substitute for domestic production.

The above price patterns are likely to arise if price stockholders without subsidies replace the current stockholders, who are subsidized. It is also likely that price declines will occur at harvest time, and that decline will be related to incentives to hold stocks. Price must decline enough to encourage private agents to hold wheat until higher prices are realized later in the year.

The principal questions which arise in this situation include: By how much will the market price fall below the reference price if subsidies are eliminated? Are the stocks held by private agents in this situation adequate for food security needs? Is it desirable to adjust the reference price monthly to offer greater (or lesser) incentives to stockholding by private agents? If reference prices are replaced by fixed tariffs, so that the border price is uncertain, how will that policy change affect stocking and monthly price variability? Specifically, will food security stocks be adequate? Will larger or smaller price declines at harvest occur?

Two approaches may be followed to seek answers to these questions concerning the stock subsidy and monthly price variability. The first is to examine what is now happening for the cereals where there are no stocks subsidies and private agents hold stocks. This is now the case for Blé dur (durum wheat), barley and corn. Statistical analysis of monthly trends in these cereals' prices, and their relationship to stocking costs, interest rates, production and demand levels, and other factors would be instructive. Creative use of regression analysis and time series models, looking at ways of predicting the monthly price pattern and testing hypotheses concerning which factors influence the evolution of prices would be useful.

A second approach would be to construct structural behavioral models of stockholding decisions by farmers and traders (separately). These models would project stocks levels by these agents according to stocking costs (by method), interest costs (the opportunity cost of holding a good rather than selling it), and market conditions. A monthly stocks model would aggregate agents, and would relate the difference between monthly carry-in and carry-out stocks to market conditions. This monthly model would be used in conjunction with monthly supply/demand equilibrium models, including import supply given by an exogenous world price and trade policy linking domestic (import) and world prices. Such a model could project the stocks held and prices by agents, following the annual variations in production and the level of demand. Supply and demand equations would follow traditional approaches, but would represent monthly decisions. Hence, since production arrives annually, the most important factor influencing availability of a good is market surplus, or stocks release by private agents. If public stocks are also to be held, the equilibrium accounts would need to take them into account, and consider the effect they might have on stocking decisions.

An important complication to this model concerns the trade policy assumptions invoked. The above description assumes that import prices are fixed and hence certain, due to the policy set reference price. A fixed tariff regime would add uncertainty to the decision of stockholders. Hence, future price would become a stochastic factor in the model. Risk aversion would likely induce stockholders to hold greater stocks. Uncertainty could also affect production decisions. The introduction of variability in world prices changes this problem from a static, deterministic problem to a stochastic problem, where the decision model must reflect uncertainty and risk aversion. These issue are treated in the literature on stockholding and probably in the literature on futures market behavior, as well.

The first approach, time series analysis of the freely traded cereals, should be completed first to gain insight into the factors critical to current stocking decisions by Moroccan farmers and traders, and to give an idea of likely results which should be expected from the second approach. Work on the second approach will first require a review of literature on the economics of stockholding. Work by Bruce Gardiner, Joseph Stiglitz, David Newberry and Brian Wright will be useful in this regard. Following this review, theoretical models would be constructed to verify the reasoning suggested above. Then these models should be estimated econometrically for the freely trade cereals, and those results used to set parameters for the Blé tendre model. Once the model is constructed, simulations using various policy alternative and market conditions would provide answers to the questions posed above. The model could project the consequences

of elimination of the stocks subsidy on monthly prices, import patterns and stocks.

It would be useful to enlist the help of experts familiar with the literature on stockholding to implement the recommended approaches. One individual familiar with price analysis and time series methods could examine both the existing trends in monthly prices and the patterns of world cereals prices which Morocco faces. An expert in the stocks literature could work with Moroccan counterparts on model development and estimation. Data and information collection on stocks costs by method of stocking, interest rates, monthly supply and demand (if available) and on other factors affecting stocking will need to be collected. Data on monthly cereals prices is already available. To construct models for the other cereals, data on existing stocking levels, where available, would also be useful.

Model No. 2: Transportation Subsidies and Flour Mill Profitability

Subsidies given to the transportation of cereals in Morocco are also likely to be eliminated as cereals markets are liberalized. Currently, Morocco uses subsidies and the use of ONT (Office National de Transports) to maintain the same official subsidized price throughout the country for flour (pan-territorial pricing of Farine National de Blé Tendre - FNBT). In a free market, the spatial location of a firm or consumer is critical to the price seen and depends on transportation costs and marketing margins. With pan-territorial pricing, distortions in the location of production, processing and consumption may arise.

Distortions in the location of wheat processing (flour milling) in Morocco may be quite significant. The location of flour mills in the past twenty years has often been determined by the government, and may not correspond to market demands or efficiencies in transportation. As subsidies are removed, the spatial pattern of milling will likely move toward a competitive equilibrium. Those mills which are located far from markets or supplies will likely see reduced capacity utilization, and the more disadvantageously located mills may well fail. The more advantageously located mills will move toward full capacity utilization and may collect rents due to their efficient location (low transportation costs). The success or failure of mills will depend on their costs of production in addition to the prices they will realize due to their location.

In anticipation of this change and consequent effect on the market, several questions may be posed, which a classic transportation/linear programming model could answer. One could determine which mills are likely to operate at capacity and which mills would operate below capacity. What prices would be seen at mills, based on border prices (trade policy) and supply conditions? How would profitability of individual mills be affected? Market conditions (production, imports and consumption) could be varied to see if outcomes are sensitive to the fraction of supplies imported (i.e. does a drought year make a large difference for some mills?).

Variables in a transportation model include the flows of cereals from supply points to processing points and then to demand points. In this case, supply points include the 5 ports and the major producing regions. Demand points would be defined to identify the major areas of consumption and to represent the spatial location of consumption. These

flows would approximate the shipment of grain to mills and subsequently the shipments of flour to consumers. Milling is an intermediate process with a transformation cost and location.

The model is solved by minimizing transportation and marketing costs subject to milling capacity, transformation costs, and the requirement that flows to and from locations are equal and the national supply equals national demand. Constraints on transportation capacity and on decisions by millers (e.g. the quotas on FNBT) should also be included in the model.

The cost minimizing solution of this model approximates a competitive market in spatial equilibrium. Hence, it would give an idea of the changes in pricing patterns which would occur under market reform - elimination of transportation subsidies. The dual prices for constraints give an idea of their importance, as well. For example, mill capacity constraints indicate the rents which accrue to an advantageous location. For those mills which will have excess capacity, rents will equal zero (and fixed costs will not be covered).

In initial versions of such models, national supplies and demands are exogenous, although they could subsequently be made to depend on prices, though more sophisticated modeling techniques would be required. Information would need to be collected on regional supply and demand patterns and on the receipts of cereals by port. These would serve as exogenous factors in the model, and could be varied to simulate alternative market conditions (surplus or drought years). The more sophisticated approach would also require supply and demand elasticities by region.

Critical information for a model of this sort would include the production costs of each mill represented in the model; and transportation costs and marketing margins between ports and mills, supply regions and mills, and mills and demand centers. This collection of the fundamental price linkages of a competitive cereals market would be invaluable information, not only in this effort, but also for other work of the Cereals Market Reform project. Marketing costs and their changes under market liberalization will depend strongly on these costs. Any model which attempts to regionalize the Moroccan cereals economy could benefit from this information. Reporting the price linkages these would give would be useful information for both researchers and the interprofession.

Collection of transportation cost and marketing margin data is probably the most important need for this model, and also the most difficult step. This data collection should begin first, followed by a review of studies on the milling industry to establish production costs and capacity constraints. If good data on these are available, assumptions on regional supply and demand patterns can be made in order to complete this model. (Modeling the current situation may require information on the extent and cost of private sector transportation, and how those costs are affected by regulations on transportation.)

Agro-Concept and ONICL have both expressed strong interest in this particular issue and the construction of this model. They should begin data collection to ascertain

the feasibility of this effort.

Upon completion of the data collection and construction of the model, spatial price patterns should be reported and the outcomes (profitability) by flour mill under varying market conditions should be projected using the model to address the questions concerning the impact of the elimination of the transportation subsidy.

Model No. 3: Trade Policies and Food Security

The third and broadest change in the Morocco cereals market is the liberalization of border measures which in the past protected the Moroccan agricultural sector from import competition. Imports of cereals are now subject to a variable levy, which is calculated based on a reference price. Import licenses are still granted by ONICL, who also organizes the tender offers for imports and hence controls the quantity of grain imported. The use of a parastatal such as ONICL to regulate imports and exports, holding monopoly control over trade, influenced the CMR Phase I Foreign Trade Study Group (Group C) to emphasize the quantitative regulation of the cereals market through trade. The movement toward reference prices and a variable levy reflects the desire to maintain an stable domestic market in the face of fluctuating world prices, even if price regulation is to replace quantity regulation. If the GATT succeeds or reforms proceed further independently, Morocco may move to fixed rather than variable levies, which would result in domestic prices following fluctuations in world prices.

The influence of world market conditions on the Moroccan cereals market, and the role played by alternative trade policy regimes (e.g. fixed versus variable levies) is of critical importance to the evolution of the Moroccan cereals sector. As seen above, the impact of other reforms depends on the trade regime in place and the stability of domestic prices. Trade policy will also determine the extent of protection of Moroccan farmers and/or subsidization of cereals consumption. Currently Morocco seeks to subsidize producers through import limits to insure realization of high reference prices, along with subsidies to consumers to compensate them for the cost of the producer policy. Such programs can be quite expensive, depending on world market conditions. Another benefit of a trade model would be to estimate in advance the costs and benefits of policy alternatives.

Assessing the impact of alternative trade polices on the Moroccan cereals sector should involve the use of one or several domestic policy models set in an open economy context. Such a model would portray supply and demand conditions in Morocco along with import supply (or export demand) according to assumed trade linkages. Several static models of this sort already exist and have been used to investigate average impacts of policy alternatives. The World Bank's multi-market model simulates supply/demand/trade equilibrium for cereals, livestock and other agricultural goods. It was criticized by Abbott, however, for its lack of flexibility in representing trade policy alternatives, and for poor information available to implement the multi-product linkages of that model. He created a much simpler but more flexible model with Imrani to permit both quantitative and price regulation of trade, and limited the model to the cereals sector. A number of criticisms could also be leveled against that model as an accurate

representation of the Moroccan cereals sector, as well. At a minimum, it is now dated. More importantly, it is static, like the multi-market model. Differences between fixed and variable levies will appear only in a dynamic market simulation. More information on welfare impacts could also be taken from simulation results.

Dynamic simulation and market adjustments given trade policy choices are critical to evaluation of the food security offered by a policy regime. The government is concerned with the frequency of abnormally low prices for farmers and excessively high prices, and hence low consumption, for consumers. It needs to know how liberalized markets will react to varying production and international market conditions, and what actions, if any, might be required to insure the food security of the population. Outcome measures would include the traditional farmer revenue and welfare, and consumer expenditure and welfare. Added information would include price and consumption stability measures and the frequency of very low or high prices and low consumption.

To accomplish such a dynamic assessment, existing models would need to be converted to a Monte Carlo simulation framework. In such a framework, exogenous but stochastic (uncertain) factors such as regional production and world prices would be varied, and the distribution of resulting market outcomes would be mapped out. Such a model would resemble the model developed for FAO by Abbott, but could be kept simpler and would be re-designed to reflect Moroccan conditions. The software package "@ Risk" could be used with the Abbott-Imrani model to capture such a stochastic structure in the easily changeable spreadsheet solution framework.

A number of other revisions to the existing models could also be pursued. Most models now use aggregate national production and demand. If data were available to estimate regional supply and demand functions, this could increase the useful information from the model, describing the differences in regional impacts from alternative trade policies. Income effects from the subsidies should be endogenous in the model, and it might be useful to consider impacts on vulnerable groups by separating demand functions according to income. More attention must also be paid to public and private stockholding behavior. A more detailed study should also link such a model to events in the livestock sector.

Implementation of such a model will require additional data collection and equation estimation beyond what is now available in existing models. Supply behavior should be re-estimated using regional data to see if reasonable models are obtainable. The Living Standards Survey may serve as a source of data for re-estimation of demand functions, especially by income level. The stocks model described above may help to set stocking behavior, although annual stockholding equation estimation should also be attempted. The Transportation model will also make necessary regional price linkage information available.

When a simulation model is constructed, Monte Carlo simulations of alternative policy regimes can be conducted. Those simulations at a minimum should examine various levels for fixed and variable levies on imports. Sensitivity analysis on alternative modeling assumptions should also be explored. Results for these simulations will include the costs and benefits to producers, consumers, traders and the government under

alternative trade regimes and market conditions.

DPAE should serve as the lead Moroccan counterpart for this modeling activity, which would also include participation of Abbott, Tyner, the Moroccan students at Purdue, and colleagues at AIRD (Salinger and Stryker). It is expected that the Master's thesis by Imrani will contribute to this effort. Re-estimation of supply and demand on a regional/income group basis might also involve the participation of interested Moroccan academics.

Conclusion

The review of future modeling issues indicated that there are important questions arising as a consequence of cereal's market reforms. Both the modeling class instructor and participants learned about problems with and prospects for cereals market reform in class discussions of the relevance of these models to actual policy issues The CMR project, DPAE, DPV and ONICL are in a position to take advantage of the training given to course participants to address these and other issues. The participants worked hard on course material and performed well. They now need practical experience to solidify the benefits of their training. The CMR project can provide guidance and feedback to course participants as they pursue such efforts to enhance the practical experience of the students. Future work on the above modelling and trade issues will be of benefit to both the CMR project and the Moroccan counterparts collaborating in those studies.