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EVALUATION, PLANNING AND TRANSFER OF TECHNOLOGY: PLASTICS USE IN MEXICO'S AGRICULTURAL SECTOR

DP/MEX/78/017/11-06/32.1 H

CONSULTANTS REPORT

Submitted to UNDP by

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As Per

PPRS/APP/No. 84-449/VAT

I. INTRODUCTION: MISSION PURPOSE

As per the job description for this project, the original duties of the Consultant were to be as follows:

1. Assist in planning organization and transfer of technology related to semi-arid zones, taking into consideration the economic requirements to strengthen the industrial and agro-industrial development of these areas;
2. Prepare models for regional and industrial development;
3. Evaluate cost-benefit and cost-efficiency analysis of proposed industrial and agro-industrial activities;
4. Construct scenarios for the evaluation of the technological impact of such projects in these areas as well as analyze development projects;
5. Conduct group meetings and workshops in which construction of scenarios and prospective evaluation of technological development are discussed.

Two major considerations resulted in changes in the shape of the Consultants tasks, wherein such changes were formed in consultation with the CIQA Project Directors Dr.s Salvadore Fernandez (CIQA) and Gregorio Pruzan (UNIDO). First, earlier work by UNIDO's Consultant Dr. Robert Anderson provides adequate progress in the structure of industrial development models (duties 2 and parts of 1, 3, 4 and 5; see Anderson 1B/02-82). Secondly, the CIQA project was, in October 1984, initiating its first, large scale agricultural experiments designed to develop the production coefficients required for analyses of the economic feasibility of "plastic-culture". Thus, it was most important that research designs for economic analyses of plastics impacts on the agricultural sector be developed in conjunction with research designs for the agricultural experiments that are to produce these coefficients.

As a result of the above, UNIDO/CIQA project managers and the Consultant focused on the following issues, which are detailed in the following sections.

Task A Design analytical framework for assessing economic returns to Mexico's agricultural sector attributable to the use of plastic mulches.

Task B Design framework for assessing alternative policies for facilitating the adoption of plastics technology in Mexico's agricultural sector.

Task C Design framework for assessing social returns to the use of plastics in Mexico's agricultural sector.

Task D Design framework for assessing "early market" effects of plastic-culture for crops sold in international markets.

Task E Design framework for determining the optional number of hectares, in various crops, which should be put under plastic mulches.

Task F Offer conclusions and recommendations concerning the timely completion of the above-described tasks.

A brief overview of the Consultants activities in his efforts to accomplish these tasks is given in Table 1. In terms of accomplishing these tasks in a timely manner, two things must be understood at the outset: (i) completion of these tasks requires a research process which must continue over the next several months (until May-June, 1985); CIQA's recent hiring of Ing. Efren Jimenez provides the on-site resource to carry out this process, and (ii) coordination of the research activities is of the utmost importance. In this regard, Ing. Jimenez is responsible for coordinating data required for Tasks A-F with the director of CIQA's agricultural experiments, Ing. Ibarra. The Consultant has been and will continue to receive monthly progress reports from Ing. Jimenez in order to assure timely progress on the economic assessment studies. In turn, the Consultant will report periodically to Dr.s Fernandez and Pruzan concerning the progress of the economic studies.

TABLE 1

BRIEF OVERVIEW OF CONSULTANT ACTIVITIES

DATE	ACTIVITY
9/23/84	Arrive Mexico City
9/24/84	Briefing with Han Steen, UNDP, Mexico City; leave for Saltillo
9/24 - 10/2	CIQA: meetings with Gregorio Purzan, Salvadore Fernandez, Ing. Ibarra and other CIQA staff. Developed Work Plan for Economics projects; established Tasks for Ing. Galo Carretiro and Efren Jimenez (see Appendix A)
10/2 - 11/17	In Albuquerque, completed preliminary analyses of the impacts of Mexican exports of fresh fruits/ vegetables on port-of-entry prices received for exports. Contacted Mexico's Central Bank (Banco de Mexico) for information on shadow prices for foreign exchange. Contacted potential candidates for Mexican national graduate students in the U.S. (agricultural economists) for employment with CIQA.
11/18/84	Returned to Mexico City
11/19/84	Brief meeting with Han Steen, UNDP. Trip to CIMMYT (El Batan) for meeting with economists specialized in technology transfer in agriculture. Meeting with Agricultural Economics faculty at the Collegio de Postgraduados, ENA, Chapingo, Mexico, to discuss possible collaborative research with CIOA's economists.
11/20/84	Meeting with economists from Banco de Mexico regarding foreign exchange studies. Leave for Monterrey.
11/21 - 23	Meetings with CIQA staff; review of progress with Dr. Fernandez and with Ing. Jimenez. Development of Work Plan for Ing. Jimenez.
11/23 - 12/2	Preparation of Final Report

II. NET BENEFITS TO MEXICAN AGRICULTURE ATTRIBUTABLE TO PLASTICS

1. The Benefit-Cost Framework. The analytical framework per se for assessing the economic feasibility of plastic-culture is reasonably straight-forward. What is needed is a detailed description of each activity (e.g., barbecho, rastreo, siembra, limpia acequias, etc.), along with costs (hours/costs for labor, machinery and purchased inputs) and yields for each crop; see example in Table 2. In collaboration with Ing. Ibarra, the Consultant and Ing. Jimenez have developed small manuals for each crop to be used by farm experiment teams in each of the experimental areas given in Table 3. Data from CIQA's experiments, which should be available during the February - April Winter harvest period, will then serve the purposes of benefit-cost, feasibility analyses.

Several alternatives exist in terms of analytical methods for conducting the b - c analyses. In the simplest terms, tables demonstrating net crop returns with and without plastics can be used. Alternatively, Dr. Anderson's (1B/02-82) "Greenhouse Model", in storage in CIQA's computer system, may be used. Our plans are to begin with Tabular presentations, after which Dr. Anderson's model may be used for some expository purposes.

2. Scope of Comparisons. Ideally, we would have data reflecting costs/yields with and without plastics for various levels of farm management -- e.g., ejidatario and pequena propritario. Unfortunately, such data, collected and published by SARH, are out-dated and unavailable for the areas wherein CIQA experiments are on-going. Thus, b - c analyses must be limited to data from CIQA's "testigo" and plastics - using experimental plots.

The implications of the above are straight forward: net benefits attributable to plastics use are those obtainable under relatively high management levels. This implication has some analytical appeal in that the adoption of plastic-culture in Mexico would most likely be initiated by pequena proprietorios with higher than average management skills.

3. Research Goals For 1985. In terms of Task A, our primary goal between now and July 1, 1985, is to complete the first round of feasibility analyses for the 9 crops, in the 11 geographic areas, given in Table 3.

TABLE 2

EXAMPLE DATA SHE

ESTADO	MICHOACAN
CULTIVO	LIMON
DISTRITO DE RIEGO	CUPATITZIO-TEPALCATEPEC
AÑO AGRICOLA	1979
CICLO	PERENNE P
CARACTERISTICA	RDF
TIPO DE TENENCIA	PRIVADA

CONCEPTO	MECANIZACION				TRACCION ANIMAL				MANO	
	N VECES REALIZO LABOR	JORNADAS HR/MA	COSTO $/HA	$/$ DE LA SUP EN QUE REAL.	N VECES REALIZO LABOR	JORNADAS	COSTO $/HA	$/$ DE LA SUP EN QUE REAL.	N VECES REALIZO LABOR	JORNAD
**LABORES DE BENEFICIO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.
APLICACION DE INSECTICIDAS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	3.
CAJETEO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.
FERTILIZACION	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1
LIMPIA DE CANAL	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
LIMPIA DE REGADERAS	2.00	1.33	222.22	100.00	0.00	0.00	0.00	0.00	0.00	0
PISTEO	1.00	.83	300.00	100.00	0.00	0.00	0.00	0.00	1.00	
PODICION DE ARBOLES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	29
RIEGO	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00		
TOTAL		3.49	744.44							
**COSECHA	10.00	0.00	415.20	100.00	0.00	0.00	0.00	0.00	0.00	0
ACARREO LOCAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	13
CORTE		0.00	4152.00		0.00	0.00	0.00	0.00		144
TOTAL										
**INSUMOS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CUOTA DE AGUA		0.00	0.00		0.00	0.00	0.00	0.00		
TOTAL										
**FERTILIZANTES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
UREA		0.00	0.00		0.00	0.00	0.00	0.00	0.00	
TOTAL										
**INSECTICIDAS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CLORDANO 140 S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
FOLIDOL 3%		0.00	0.00		0.00	0.00	0.00	0.00		
TOTAL										
**PLANTAS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
GINEQUINE		0.00	0.00		0.00	0.00	0.00	0.00		
TOTAL										
**PLANTAS (REPLANTES)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL		0.00	0.00							
**GASTOS VARIOS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
IMPUESTO PRODUCCION		0.00	0.00							
TOTAL										
TOTAL		3.49	4897.24			0.00	0.00			

TABLE 3

EXPERIMENTAL AREAS

State/Site	[illegible]	[illegible]
1. Tamaulipas		
Reynosa, Patilla	[illegible]	[illegible]
2. Nuevo Leon		
Gen. Teran	Calcaregosos, [illegible]	[illegible]
3. Coahuila		
Reg. Lagunera	Aridic, [illegible], Xerosoles y [illegible]	[illegible]
4. Chihuahua		
Ojinaga	Chile Marron	[illegible]
5. Sonora		
Cd. Obregon, Guaymas	Aridic, Calcaregosos	[illegible]
6. Baja California Sur		
La Paz, Cd. Constitucion, Loreto, Vizcaino	Yermosol, Calcaregosos, [illegible], Aridic, Xerosol	[illegible]
7. Sinaloa		
Culiacan, Mocorito	[illegible], Calcaregosos, [illegible], Aridic	[illegible]
8. [illegible]		
[illegible]	Aridic	[illegible]
9. Tamaulipas		
Villa Hidalgo	Aridic, Medio	[illegible]
10. Michoacan		
Mapababirillo, Apatzingan	Regosol, Medio, [illegible]	[illegible]
11. Vera Cruz		
Tuxpan	Aridic	[illegible]

* Temporal: todos otros son de riego

To this end, between December, 1984 and March, 1985, Ing. Jimenez at CIQA is scheduled to complete the following:

(i) prepare data manuals for use by experiment managers in the 11 experimental areas.

(ii) in January, 1985, visit sites in Sonora and Sinaloa to assure coordination between on-site data collection efforts and on-going economic analyses. Also, particularly in Sinaloa (Culiacan), collect market data and annual publications concerning authorized hectares for export crops from the Union Nacional de Productores Hortalizas (see UNPH, 1982).

(iii) complete comparison studies from data now available from CIQA experiments in:

Gen Teran	Tomatoes
	Calavacitas
Vera Cruz	Sandia

(iv) acquire monthly data from experiments and continue to up-date data sheets to be used, after the termination of harvests, for benefit-cost analyses.

Ing. Jimenez will submit monthly progress reports concerning these activities to Dr. Fernandez, with copies to the Consultant. The Consultant will monitor these activities.

Between March and July, 1985, Ing. Jimenez, in collaboration with the Consultant, will complete the benefit-cost analyses for CIQA's Winter crop experiments. The end product will be a Report which analyses the on-farm economic returns to the use of plastics in Mexican agriculture.

During the March - August, 1985 period, collaborative efforts between the economics group and Ing. Ibarra's farm experimental group will focus on appropriate research designs for CIQA's Spring crop experiments. These designs will lay out work plans for economic analyses for the balance of 1985.

III. TECHNOLOGY ADOPTION

1. Risk and Technology Adoption. Based on the Consultant's meetings with staff at CIQA, as well as well agricultural economists and other professionals at Chapingo, Centro Internacional por la Mejormiento de Maiz Y Trigo (CIMMYT) and New Mexico State University (Las Cruces), it seems clear that the major potential impediment to broad-based adoption of the plastics technology in Mexico's agricultural sector relates to risk: substantial up-front capital at risk (the cost of plastics) is basic to plastic-culture. Of course, at issue is the increased fixed costs -- lost in the case of crop failure -- implied by the use of plastics.

These risks may be ameliorated by some form of risk-pooling or risk-sharing. Alternatives include:

(i) insurance provided by private or government institutions

(ii) credit, for plastics costs, provided by a government agency (e.g., PEMEX), with or without provisions for sharing risks of losses due to crop or market failures

(iii) direct subsidies by government agencies designed to affect risk-costs.

At this point it is premature to initiate general technology adoption studies. Such studies must await the results of Task A (described above in Part II) which will identify the economic returns to risk-taking in plasti-culture. Given, however, the likely need for some form of government participation in the technology adoption process, we can anticipate the need for social benefit-cost analyses which address the question: what societal gains might be attributable to the broad adoption of plastics in Mexico's agricultural sector? This research topic is discussed below in section IV.

2. Research Goals For 1985. Following the completion of Task A's assessment of results from CIQA's Winter crop experiments (as well as Task C described below) -- mid-summer 1985 -- the economics group at CIQA will define specific technology adoption studies which appear appropriate and necessary in light of Task A's analyses. Such studies would be initiated in early Fall, 1985, with completion dates most likely in early 1986.

IV. SOCIAL B/C ANALYSES

1. Social vs. Private Benefits and Costs. The focus of Task A is on private benefits and costs: yields valued at market prices and market-determined costs. Within this framework, net benefits are essentially measures of net returns to farmers, processors, transporters, etc. -- returns to private entities involved to the production-to-market process.

It is typically the case, however. that technologies such as plasticulture involve social and economic effects that are external to the above-described market process -- their adoption results in benefits and costs that accrue to the region or nation as a whole. An agency of the government, when asked to actively participate in the technology adoption process, is then concerned with the magnitude of these external benefits and costs inasmuch as such net social benefits are relevant for assessing the net gains to the country as a whole that would result from their (financial) participation in the technology adoption process.

In any benefit-cost analysis, a social B/C measure differs from a private B/C measure in that the former employs social accounting practices. Basic to social accounting practices is the use of prices and costs that reflect the opportunity cost of factors of production, rather than market prices/costs which may be distorted by such things as market imperfections, subsidies, trade/currency regulations and exclusions of non-market goods. Thus, for purposes sought in Task B (secion III above), it will be necessary to prepare social B/C measure counterparts to the private B/C measures develop in Task A.

2. Major Components For CIQA's Social B/C Analyses. For CIQA's purposes, the social B/C analyses will focus on the following:

(1) foreign exchange. To the extent that plastics are used for export crops, higher yields (and early market effects) may substantially increase Mexico's earnings of foreign exchange. Social accounting dictates that the plasticulture-related increase in foreign exchange be weighted by the scarcity value of foreign exchange in the Mexican economy. In conjunction with economists at the Banco de Mexico, the Consultant is developing relevant scarcity values for foreign exchange to be used in CIQA's social B/C analyses.

(ii) water resources. Plastics technology can result in substantial reductions in water use in Mexico's irrigated agricultural sector. Water per se (other than pumping or distribution costs) is a non-market good -- it commands no market price (cost) included in private B/C analyses. Particularly in Northern Mexico, water per se has a social value, however, which consists of the scarcity value of water (reflecting, in the case of mined, coastal aquifers, the intrusion of sea water into fresh water aquifers). Thus, a social benefit attributable to the adoption of plastics technology is the social value of the reductions in water consumption associated with this technology. The Consultant will have obtained relevant scarcity values for water by April, 1985.

(iii) labor use. Higher yields and altered production processes associated with the plastics technology may be expected to result in increased employment in agricultural, processing, transport and petroleum-related sectors. Given pervasive unemployment in many Mexican sectors, plasticulture-related increases in the employment of otherwise unemployed, or underemployed, labor give rise to social benefits in amounts equal to wages paid to labor less their opportunity cost. These aspects of social accounting will be defined after the completion of Task 1.

3. Research Goals For 1985. The social B/C analyses will be conducted jointly with Task A's private B/C analyses. Thus, for CIQA's Winter crop experiments, social B/C measures will be included as a part of Task A's Report scheduled for July, 1985. Late 1985 - early 1986, analyses of results from Spring/Summer crop experiments will include social B/C analyses.

V. EARLY HARVEST EFFECTS

1. The Issue. As noted above, the use of plastic mulch can result in harvests that are 2 to 4 weeks earlier than those realized without such mulch (see, e.g., Anderson, 1982 and 1B/02-82, Anderson and Fernandez (no date) and Houmes (1984)). Given crop prices determined by demand and supply, crops brought to market during periods of relative scarcity will command higher prices -- thus potential benefits to plasticulture via early harvest effects. Measurement of these benefits requires estimates of the relationship between market prices and the quantity of a commodity that is available in the market. In the simplest case, this relationship has the form

$$P = a - b\,Q \qquad (1)$$

where P is the unit price in a given period of time, a is a constant, b measures the effect on prices per unit change in the quantity (Q) of the commodity available in the market during the given period of time.

2. Estimating the P - Q Relationship: Domestic Markets. Estimation of the equation (1) requires substantial time series and/or cross sectional data. Mexico's SARH collects and publishes weekly price data for several crops only for the D.F. market. Price data are published for other markets-- e.g., Monterrey, Torreon, etc. -- but, regretably, crops included in CIQA's experiments (Table 1) are not included in the crops for which prices are reported. Thus, there is some question at this point in time as to the extent to which market analyses can be accomplished for domestic markets in Mexico.

Ing. Jimenez will be searching for market data for crops included in CIQA's experiments in Monterrey, Torreon and Culiacan over the December, 1984-January, 1985 period. Conclusions as to our ability to conduct domestic price analyses must await the results of his search.

3. Estimating the P - Q Relationship: Export Markets. The U.S. Department of Agriculture publishes data concerning daily trucklots, and f.o.b. port of entry prices received for Mexican exports of fruits and vegetables at the Nogales, Texas and Florida ports of entry (Agricultural Marketing Service, 1978-83). The Consultant, during the period 10/2 - 11/17/84,

used these data for computer regression analyses wherein various expanded forms of equation (1) were estimated. Simple regression results for four crops are given in Table 4. Detailed computer outputs from these experiments are available from the Consultant upon request. As measured by the t-statistics given in Table 4, the volume (Q) of Mexican exports have significant effects on f.o.b. prices for cantaloupes, watermelons, and tomatoes, but not for squash. As measured by the F-statistic, the P - Q equations per se are significant, however. Referring to R^2 measures in Table 4, the volume of Mexican exports "explains" 64% and 92% of the variation in f.o.b. prices for cantaloupe and watermelons (Nogales port of entry), respectively, but only 22%, 34%, .3% and 17% of the variation in f.o.b. prices for watermelon (Florida ports of entry), squash, tomatoes (Nogales) and tomatoes (Florida), respectively.

Before continuing with a discussion of results from the Consultant's initial efforts to estimate the P - Q relationship for export markets, it is useful to consider how our successful estimates of these relationships might be used in our economic analyses. Assume that the following expanded versions of (1), estimated by the Consultant, represents a "good" estimate of the P - Q relationship for cantaloupes; Q is in trucklots (of 45,000 lbs.).

Week	Equation
1	.473 + .008Q
2	.523 + .0004Q
3	.548 + .0004Q
4	.473 + .0006Q
5	.348 + .0008Q
6	.048 + .002Q
7	.323 + .0006Q
8	1.073 + .001Q
9	1.25 + .001Q

Assuming that the use of plastics results in harvests that are 3 weeks earlier than non-plastic crops, but ignoring yield increases from plastic mulches, data in Table 5 demonstrate the gains from Mexican cantaloupe exports in the 1982-83 season that would have resulted from having 10% of the 18,306 ha. authorized for cantaloupe exports under plastic mulches. Actual port-of-entry

TABLE 4

SIMPLE PRICE EQUATIONS FOR FOUR CROPS

Cantaloupe

$P = 33.93 - .023Q$

$R^2 = .64$ (16 weekly dummies)
$t = -3.06$
$F = 1.954$

Watermelon

Nogales $P = 17.4 - .0046Q$

$R^2 = .917$ (little weekly effect)
$t = -2.23$
$F = 3.386$

Fla. $P = 13.01 - .0021Q$

$R^2 = .22$
$t = -2.11$
$F = 4.47$

Squash

Nogales $P = 8.11 - .0003Q$

$R^2 = .34$ (3 weekly dummies)
$t = .032$
$F = 5.48$

Tomatoes

Nogales $P = 7.75 - .0005Q$

$R^2 = .003$

$t_Q = -0.5$

$F = .3$

Fla. $P = 16.75 - .005Q$

$R^2 = .17$

$t = -4.4$

$F = 19.2$

TABLE 5

EXAMPLE OF EARLY HARVEST BENEFITS: 10% OF CANTALOUPE ACREAGE UNDER PLASTICS

	Actual: 1982-83 Season			Example: 10% Plastics**		
Week	Trucklots*	Price/lb.	Gross Revenue (millions)	Trucklots	Price/lb.	Gross Revenue (millions)
1				5	$ .84	$ .19
2				5	.84	.19
3				4	.60	.12
4	34 (.50)	$ .44 (.76)	$ .67	42	.50	.95
5	46 (.54)	.51 (1.12)	1.06	57	.55	1.41
6	45 (.57)	.56 (1.15)	1.13	59	.55	1.46
7	104 (.59)	.53 (2.76)	2.48	129	.53	3.07
8	156 (.45)	.39 (3.16)	2.74	194	.48	4.19
9	181 (.31)	.28 (2.52)	2.28	237	.39	4.16
10	346 (.56)	.24 (8.72)	3.74	311	.53	7.42
11	535 (.50)	.21 (12.04)	5.06	481	.56	12.12
12	738 (.27)	.26 (8.97)	8.63	664	.53	15.84
		($41.21)	$27.79			$51.12

Returns To Plastics (10% of authorized acreage in cantaloupes; 1,831 ha.): $10 million (Note: assumes no yield increase)

*45,000 lbs./trucklot

**Authorized Crop Plan for exported cantaloupe: 18,306 ha. Assumes

Week	Trucklots/ha.
1	.0019
2	.0025
3	.0025
4	.0057
5	.0085
6	.0099
7	.0189
8	.0292
9	.0403

revenues during this 9-week example period (March 16 - May 13, 1983) were $27.79 million -- $41.21 million when actual trucklots are valued at prices estimated by the above equations. With 10% of the cantaloupe acreage under plastic mulch, estimated revenues would have been $51.12 million. Thus, using estimated prices, plasticulture in but 10% of cantaloupe acreage would have increased Mexico's earnings of foreign exchange by some $10 million. Still another use of the P - Q relationships is demonstrated below in our discussion of optimal acreage for use in plasticulture.

Returning now to the issue of estimating P - Q relationships as shown in Table 4, the equations given in Table 4 are those that would obtain in instances wherein the demand for Mexican exports is invariant with time --- for a given number of trucklots, f.o.b. (e.g., Nogales) prices are the same in one week as in any other week. The low R^2 measures for most crops suggest (among other things) that this is not the case. The Consultant experimented with other forms of the regression equation (1) wherein the intercept (a in equation (1) and the slope b in equation (1) were allowed to differ by week (as in the cantaloupe example above). Generally, these equations "performed" better in terms of R^2 measures but, in many cases, anomalous results obtained -- most importantly, as in our cantaloupe example -- the sign of b was positive in a number of weeks (one expects price to fall when Q rises). These anamolies may reflect, among other considerations, the need for a longer time series (5 years were used above), the need to include weekly marketings of U.S. producers in our regression equation, or (for some crops and in some weeks) the relative insensitivity of f.o.b. prices to the volume of Mexican exports.

4. Research Goals For 1985. Considerably more work is required with our regression equations before conclusions can be drawn as to the P - Q relationship for crops exported by Mexico to the U.S., and, therefore, as to the "early harvest" benefits attributable to plasticulture in Mexico. The Consultant (at no cost to UNDP or CIQA -- ie., at his own expense) plans to have this work well advanced by May, 1985, and to complete the work by the end of 1985. The May, 1985, date has obvious importance given our earlier described goals of completing private and social B/C analyses for CIQA's Winter crop experiments by July, 1985 -- analyses which require for their completion defensible estimates for export prices.

VI. THE OPTIMAL SCALE (MARKET) FOR PLASTICS USE IN MEXICAN AGRICULTURE

1. The Problem. Of particular importance for the plastics-producing industrial sector is some notion as to the likely market for agricultural plastics. Thus, some basis is required for estimating that scale (number of hectares) for agricultural plastics use that is optimal in the sense of maximizing farmers profits and/or best serving the interests of Mexican society.

A relatively simple model for determining the optimal scale for plastics use in Mexican agriculture is given in Appendix B. Its use presupposes the on-farm feasibility of plastics use -- the demonstration of which is the substance of Task A. Its data requirements are fairly obvious: parameters from the price equation (1), yield increases and early-harvest timing attributable to the use of plastics and the weekly pattern of port of entry trucklots under average harvesting conditions (which might be assumed to be the same as historical patterns without plastics use). For numerical resolution, the model is amenable to the use of simple, "canned" computer algorythms such as Linear Programming or other simple algorythms for solving simultaneous sets of equations.

2. Research Goals For 1985. Following the completion of Tasks A and D-- late May or early June -- data will be available for experiments with the Optimal Scale Model. The Consultant plans to complete this work during the period May - July, 1985, in Albuquerque during the two scheduled visits to CIQA planned for late May and early August, 1985.

VII. CONSULTANTS CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions. At the present stage of CIQA's experimental work in developing on-farm production parameters for crop production with/without (testigo) plastic mulches, the progress of economic studies is reasonably in line with Dr. Pruzan's Plan of Work for the project. Dr. Anderson, UNDP's earlier Consultant, contributed a great deal in these regards with his development of models for the industrial production of plastics, for assessing economic returns for greenhouses (easily extended to other plastics use activities) and his demonstration studies of economic returns to plasticulture. Indeed, substantial progress beyond Dr. Anderson's work must await the results from CIQA's recently-started, large-scaled experimental projects.

Given the initiation of CIQA's experimental projects, it is now timely to establish routines for processing the experimental data as it becomes available and for initiating the companion studies required for the robust economic analyses of the plasticulture technology envisaged in Dr. Pruzan's original plan of work. The Consultant, in conjunction with Ing. Jimenez, has established the data processing routine required for Task A via a Work Plan for Ing. Jimenez for the period December 1, 1984 - April 30, 1985; this Work Plan is given in Appendix C. In terms of comparion studies which require early completion,

- the Consultant will have measures required for social B/C analyses (Task C) by June, 1985;
- the Consultant will have first-round estimates for P - Q relationships by June, 1985;

This schedule should put the completion of economic studies on track with on-going experimental efforts at CIQA.

2. Recommendations. To assure timely completion of CIQA's planned economic studies, the Consultant offers the following recommendations:

(i) it is of primary importance that a ½-time person of Ing. Jimenez's caliber continue data processing tasks through April, 1985, and prepare initial benefit-cost measures by mid-May, 1985.

By mid-May, 1985, it would be desirable to add an MA or Ph.D. level agricultural economist to CIQA's full-time staff. The Consultant has identified 3 M.A. candidates (Mexican nationals) at New Mexico State University, vitae for which were given to Dr. Fernandez. The Consultant also identified possible candidates during his visit to Chapingo in November. A problem arises, however, in that U.S. graduates want a great deal of money and other qualified Mexican nationals are reluctant to locate outside of the Mexico City area. Thus, it will likely be most difficult, if not impossible, to attract competent, experienced personnel who can reasonably be expected to be productive in CIQA's program.

An alternative to the direct hire of an agricultural economist is for the UNDP to contract, through Consultants, for the completion of specific research tasks. Considerable work can be accomplished by "contracting" with a University professor who in turn "contracts" with a graduate student for his completion of a study which serves as his/her thesis or dissertation. One or two studies would probably cost about $15,000 per study. If this option is desirable, and if the need for such studies is in fact apparent around April or May, 1985, the Consultant will offer suggestions in these regards.

(ii) the Consultant (or any alternative Consultant that the UNDP might prefer) will require approximately 60 days of work and 2 visits to CIQA during the period May 15 - August 31, 1985. Much less time is required if, in fact, CIQA is successful in attracting a competent Ph.D. agricultural economist to its full-time staff. If required, the Consultants time would be allocated as follows:

Phase 1: late May - early June: 7-10 day visit to CIQA to acquire data and initiate analyses; set out new work plan with Ing. Jimenez. Thirty days for completion of Task A, C and D reports and for implementation of Task E.

Phase 2: late July - early August, approximately 20 days: return to CIQA: presentations of completed analyses and reports; presentations of preliminary results for Task E. Establish Work Plan for analyses of results from Spring/Summer crop experiments by CIQA. Prepare final reports for (Winter crop results) Tasks A, C, D and E. Set out Work Plan for initiating Task B.

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