Economic and Trade Environment Impact on Agriculture. A Regional Assessment for 1991/2000

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ABSTRACT

Both trade and economic environments had positive effects on the agriculture carried out at Yaqui River 041 Irrigation District (ID 041) in the State of Sonora, Mexico. Financial (producers outlook) and economic (society's outlook) profitability improved significantly between 1991, 1996 and 2000. Government support granted to producers by means of a new direct payments mechanism was higher than the previous government support established through market intervention, which was in operation till 1993.

INTRODUCTION

A national aggregate evaluation of impact on Agriculture of the economic and trade environments, especially of NAFTA, could lead to false appraisals like the one which could be generated by an adverse effect on producers owing to substantial grain imports. These imports are due to an insufficient domestic production and not necessarily should impact producers incomes. For example, in 1996 wheat and maize imports and international prices were the highest in decades and these high international prices in turn were the cause for high domestic prices for producers.

Like this, an objective evaluation should incorporate a regional evaluation, because effects on each region should be different in accordance with local resource availability (capital, labor, land and water), technology, free entry to domestic and international markets and capacity on the part. of producers to gain access to government support programs. This assessment should include also a multi-annual horizon of economic, financial and climatic variables. Taking into account these presuppositions, an assessment for the Yaqui River Irrigation District 041 (ID 041) in the Yaqui Valley, State of Sonora, Mexico for 1991/2000 is offered.

BACKGROUND

In 1991/2000 within the framework of a new structural economic adjustment program, the Mexican Government put into effect extensive reforms in economic and sectorial policies, which modified substantially the economic environment and impacted the country's development and agriculture.

These reforms, in the case of agriculture meant less government intervention in production, banking and marketing, a deregulation of production factors markets (especially of land and water), and to stronger links to international markets, among others. This gave rise to changes in the agricultural economic environment, particularly in prices paid and received by producers.

ID 041 agriculture took place within this environment, characterized by instability in the Macro-economy, international prices, and climate. International prices showed a high dispersion and transmitted these fluctuations to domestic prices within an open economy scheme. Grains and oilseeds international prices recorded their highest level in 1996 and fell continuously from 1997 onwards and in 2000 showed their lowest level for the decade.

Table 1 **México. Grain imports from the United States 1990-2000**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MAIZE											
Quantity (000 Ton)	3,648	1,318	1,137	289	3,054	2,859	6,314	2,566	5,246	5,052	5,194
Value (US$ 000)	401,130	148,354	128,886	35,225	340,440	359,123	1,002,717	317,196	589,869	527,300	510,645
Average Price (US$/Ton)	109.9	112.6	113.3	121.9	111.5	125.6	158.8	123.6	112.4	104.4	98.3
SORGHUM											
Quantity (000 Ton)	2,900	3,313	4,957	3,614	3,373	2,150	1,971	2,136	3,205	4,027	4,718
Value (US$ 000)	328,331	372,560	548,474	366,066	386,390	254,727	299,434	250,001	349,081	375,515	441,334
Average Price (US$/Ton)	113.2	112.5	110.7	101.3	114.6	118.5	151.9	117.0	108.9	93.2	93.5
BREAD WHEAT											
Quantity (000 Ton)	358	312	409	967	625	792	1,554	1,067	1,591	1,824	1,732
Value (US$ 000)	51,093	39,154	61,796	134,353	91,549	144,897	324,894	175,737	214,139	214,798	197,239
Average Price (US$/Ton)	142.7	125.3	150.9	138.9	146.5	183.1	209.1	164.7	134.6	117.8	113.9
COTTON											
Quantity (000 Ton)	32	33	83	146	126	106	150	218	402	201	373
Value (US$ 000)	49,053	55,021	106,815	188,377	192,611	190,543	257,238	354,104	615,689	285,352	476,237
Average Price (US$/Ton)	1,545.7	1,662.4	1,282.9	1,290.3	1,528.7	1,801.0	1,716.4	1,624.3	1,530.4	1,418.2	1,277.4
SOYBEANS											
Quantity (000 Ton)	842	1,481	1,914	1,758	2,073	2,018	2,648	2,912	3,100	3,287	3,455
Value (US$ 000)	203,377	343,727	439,718	415,723	533,436	479,270	762,776	851,347	754,216	659,261	678,215
Average Price (US$/Ton)	241.5	232.0	229.7	236.5	257.3	237.5	288.1	292.4	243.3	200.6	196.3

Source: United States Department of Agriculture, Economic Research Service (USDA/ERS), "Foreign Agricultural Trade of the United States ", various years.

Table 2 **México. Inflation and Macroprices Annual Average 1988-2000**

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Inflation (%) [1]/	114.2	20.0	26.7	22.6	15.5	9.8	7.0	35.0	34.4	20.6	15.9	16.6	9.5
Nominal interest rate (%) [1]/													
Treasury Bill (28 days)	69.2	45.0	34.8	19.3	15.6	15.0	14.1	48.4	31.4	19.8	24.8	21.4	15.2
Loans	n.a.	n.a.	n.a.	n.a.	n.a.	22.0	20.4	58.6	36.9	24.6	28.7	25.9	18.7
Average cost of funds	67.6	44.6	37.1	22.6	18.8	18.6	15.5	45.1	30.7	19.1	21.1	19.7	13.7
Real interest rate (%) [2]/													
Treasury Bill (28 days)	-21.0	20.8	6.4	-2.7	0.1	4.8	6.7	10.0	-2.2	-0.7	7.6	4.1	5.2
Loans	n.a.	n.a.	n.a.	n.a.	n.a.	11.2	12.5	17.5	1.9	3.3	11.0	7.9	8.4
Average cost of funds	-21.7	20.5	8.2	-0.1	2.8	8.0	8.0	7.5	-2.7	-1.2	4.5	2.7	3.8
Nominal exchange rate (pesos/dollar)													
Official/market [1]/	2.273	2.462	2.813	3.018	3.095	3.116	3.375	6.419	7.601	7.950	9.240	9.560	9.470
Equilibrium [2]/	2.273	2.521	2.954	3.453	3.839	4.102	4.308	5.881	7.601	8.812	9.879	11.087	11.783
Over (+) / Under (-) valuation [2]/	0.0	2.4	5.0	14.4	24.0	31.7	27.6	-8.4	0.0	10.8	6.9	16.0	24.4

1/ Source: International Monetary Fund (IMF), "International Statistics", various years.
2/ Source: By the author.
n.a./ Not available.

On the other hand, the macroeconomic environment showed high inflation - an 18.7% average for 1991/2000 - with big fluctuations. Besides, the real exchange rate also fluctuated wildly, with a 15% annual appreciation for the Mexican peso, being more than 20% in 1992/94 and 2000[1]. High real interest rates (on average) for loans were usual.

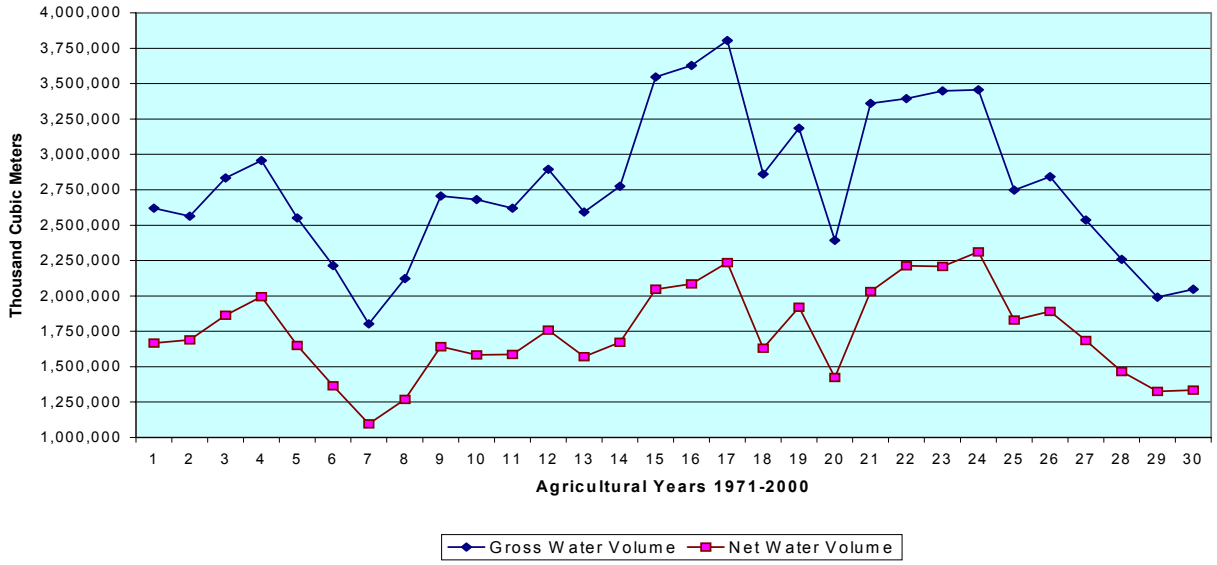
Irrigation water availability was also erratic. In four years (1991/94) a “very good” water net water volume was available (2.19 billion cubic meters), which signifies, approximately, a 1.49 index including double cropping. This means that 100% of available land for the first crop was used (220,000 ha) and water availability allowed for 107,800 ha of second crops.

In two years (1995/96), net water volume was 1.86 billion cubic meters, which can be characterized as “good”, which signifies a 1.26 index. In 1997 available water was 1.70 billion cubic meters which can be classified as “fair”, which signifies a 1.15 index.

In three years, (1998/2000), the net available water volumes were the lowest since 1977/78, 1.25 billion cubic meters, which signifies a 0.85 double cropping index, which allows for cropping of 85% of the total available area in the first crop and nothing in the second. These low volumes have only been present in 7 years of the last 30, three of them in 1998/2000.

[1] *Mexican peso appreciation relative to the US dollar can be computed through the differences in the wholesale price index of the US and Mexico, being 1988 the base for the 1989/95 period and 1996 the base for 1997/2000. Further information is provided in the Annex.*

Figure 1
Irrigation District 041 Yaqui River. Available Water for Irrigation



RESULTS

A technical, financial and economic assessment of the ID 041 production system takes into account what happened in the years 1991, 1996 and 2000 as reference for the 1991/2000 decade. The applied methodology is briefly described in the Annex, and *in extenso* in Puente-González A. (1999).

Harvested Area

Owing to financial, economic, climatic and biologic factors, the cropping pattern of ID 041 showed significant changes in the three years being used as reference. In 1991 and 1996 a total harvested area of some 330,000 ha was observed, being "good" years. In those two years, 91.7% and 93.4% of total harvested area was planted to the six main crops: maize in fall, wheat and safflower in winter, cotton, maize and sorghum in spring and soybeans, maize and sorghum in summer.

Table 3 **Production Indicators**

Indicators	Average Pattern	Fall-Winter			Spring			Summer		
		Maize	Wheat	Safflower	Cotton	Maize	Sorghum	Soybeans	Maize	Sorghum
Yield (ton/ha)										
Agricultural year 1991	3.66	4.11	4.44	2.04	2.61	3.70	4.08	2.33	n.h.	3.53
Agricultural year 1996	4.60	5.41	5.31	2.04	2.96	4.60	4.83	2.49	4.40	4.06
Agricultural year 2000	5.43	5.69	5.66	2.25	3.40	5.10	4.80	n.h.	5.10	4.80
Harvested area (ha)										
Agricultural year 1991	310,360	71,164	124,857	3,975	30,650	6,044	4,369	68,885	n.h.	416
Agricultural year 1996	301,180	80,335	90,124	21,171	39,650	7,437	16,681	81	34,483	11,218
Agricultural year 2000	214,036	4,414	191,281	10,813	5,216	529	266	n.h.	1,175	342
Water use (1,000 m^3)										
Agricultural year 1991	1,899,360	337,895	757,519	10,380	234,394	36,031	30,326	489,594	n.h.	2,890
Agricultural year 1996	2,088,812	574,951	594,832	53,482	325,518	62,029	113,555	482	287,594	76,369
Agricultural year 2000	1,274,338	30,898	1,147,686	32,439	46,944	4,232	1,862	n.h.	8,225	2,052

n.h./ Not harvested

Because of water scarcity in 2000, total harvested area was only some 240,000 ha, that is to say some 90,000 ha less than in 1991 and 1996. In 2000, 89% of total harvested area corresponded to the six main crops.

Wheat continued to be the main crop, as was the case in the previous 5 decades. The highest wheat harvested area (191,281 ha) was that of 2000, or 79.6% of that year's total harvested area. Besides, the wheat cropping pattern suffered big changes owing to biological factors. In 1991 most of the area sown to wheat was bread wheat, mainly for the domestic market, while in 1996 and 2000 this percentage falls to 15/20% because of karnal bunt, and most of the cropped wheat is now pasta wheat, mainly for export.

Another critical adjustment, also of biological origin, has to do with soybeans. While in 1991 the area sown to this oilseed was 68,885 ha,(20.4% of the total harvested area), from 1996 onwards, soybeans practically disappeared from the cropping pattern owing to white moth attacks. Because of this, an existing balance (technical and financial) of a crop rotation, winter wheat and summer soybeans, valid since the 1960s was broken. When soybeans disappeared from the cropping pattern, winter safflower increased its area and so did maize and sorghum in spring and summer (depending on water availability).

In cotton, another main component of the cropping pattern, harvested area reached 30,000 ha in 1991 and 1996, in answer to high international prices and water availability. In contrast, in 2000, area cropped with cotton fell to 5,000 ha, as a result of low international prices and constraints in available water.

All these changes which affect the economic, financial, climatic and biological environments can be observed in the profitability, competitiveness, protection, subsidies and comparative advantage indicators[2] which are shown below.

Profitability

Before the implementation in depth of the Economic Reforms (1991) and after their consolidation (1996 and 2000), IDR 041's agriculture showed a higher return on capital than CETES (United Mexican States Treasury Bills). In 1991, when government intervention in input, product and production factor price fixation was still strong, real return on capital (nominal return on capital[3] minus the inflation rate) was 4.2% for the total production pattern, while the real yield for CETES was -2.7%. This 4.2% rate is determined practically by high real returns on capital, of 23.1% in fall maize and 17.2% in cotton, crops which were sown extensively that year. Wheat profitability was in an equilibrium point (total income = total costs). Safflower, soybeans and sorghum showed negative profits, which means that producers didn't recover neither their fixed costs on machinery and equipment nor imputed land rent. In these cases producers generated a cash flow with their produce, but not enough for savings and capitalization.

Table 4 **Financial Profitability**

Indicators	Average Pattern	Fall-Winter			Spring			Summer		
		Maize	Wheat	Safflower	Cotton	Maize	Sorghum	Soybeans	Maize	Sorghum
Real Return on Capital [1]/										
Agricultural year 1991	**4.2%**	**23.1%**	**-0.4%**	**-21.0%**	**17.2%**	**8.8%**	**-35.1%**	**-11.1%**	**n.h.**	**-43.7%**
Agricultural year 1996	**14.4%**	**42.9%**	**33.9%**	**-11.3%**	**2.3%**	**-28.6%**	**-18.5%**	**-11.0%**	**-25.7%**	**-31.1%**
Agricultural year 2000	**8.1%**	**-12.5%**	**10.4%**	**-35.3%**	**19.5%**	**-24.1%**	**-37.4%**	**n.h.**	**-21.9%**	**-36.7%**
Real Return on Capital [2]/										
Agricultural year 1991	**4.2%**	**23.1%**	**-0.4%**	**-21.0%**	**17.2%**	**8.8%**	**-35.1%**	**-11.1%**	**n.h.**	**-43.7%**
Agricultural year 1996	**41.1%**	**75.2%**	**64.0%**	**14.2%**	**24.8%**	**-9.0%**	**3.4%**	**13.7%**	**-4.9%**	**-11.3%**
Agricultural year 2000	**49.3%**	**23.0%**	**55.0%**	**-24.9%**	**24.8%**	**9.8%**	**-28.2%**	**n.h.**	**13.0%**	**-27.4%**

1/ Excluded government direct payments.
2/ Included government direct payments.
n.h./ Not harvested.

[2] *These indicators are based on economic and financial budgets(income, costs and profits) for each crop and for the cropping pattern. Financial budgets are based on market prices, while economic budgets are based on efficiency prices (equilibrium exchange rates, machinery, equipment and inputs international prices, opportunity costs for land, labor, capital and water), technical coefficients for technology being the same for both budgets. Further information on these indicators is provided in the Annex.*

[3] *Nominal return on capital = net financial profit / financial production cost. Net financial profit = gross financial income (yield*market price) – total financial production cost. Total financial production cost = (inputs, domestic factors, machinery and services)*(market prices)*

In 1996 and 2000 government intervention disappeared for all practical purposes, in price fixation for inputs, products and production factors. Government support to producers took another form, by way of direct payments through the Procampo program and through marketing support programs.

In 1996, in a context of high international prices, an open economy and exchange rate adjustment, producers obtained, without taking into account government direct payments, a high 14.2% real rate of return on capital for the whole production system, while the real rate for CETES was a dismal – 2.2%. This rate of return was determined especially by a very high 42.9% real rate of return on capital for fall maize and of 33% for wheat, which were the main crops that year. If the Procampo payments are added, the real rate of return on capital for the whole system increases significantly to a whopping 41.1%.

In 2000, for the whole production system the real rate of return on capital decreased to 8.1% owing to low international prices, but still higher than the 5.2% paid by CETES. This profit rate was determined especially by a 10.4% real rate of return on capital for wheat and of 19.5% for cotton. If the Procampo and marketing support payments are added, the real rate of return on capital for the whole system increases significantly to a colossal 49.4%.

Competitiveness

The six main crops as a whole increased their competitivity, as calculated by the Private Cost Ratio (PCR)[4], that is to say its capacity to increase relative to net profits in financial added-value (or gross national product).

In 1991, PCR was 0.94, which means that only 6% of the added-value could be attributed to producers' net profits. This rate increased to 17% in 1996 and to 13% in 2000. Competitiveness estimates include neither Procampo direct payments nor marketing programs supports to producers.

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[4] *Private Cost Ratio = domestic factors (land, capital, labor, water) financial production cost ÷ financial added-value*
Financial added-value = financial value of output (yield ×market price) — financial intermediate consumption
Financial intermediate consumption = Input, machinery and services financial production cost
Financial production cost = quantity × market price

Table 5 **Financial Competitiveness**

Indicators	Average Pattern	Fall-Winter			Spring			Summer		
		Maize	Wheat	Safflower	Cotton	Maize	Sorghum	Soybeans	Maize	Sorghum
Private Cost Ratio [1]/										
Agricultural year 1991	0.94	0.76	1.01	1.42	0.81	0.89	2.11	1.18	n.h.	2.99
Agricultural year 1996	0.83	0.64	0.67	1.20	0.97	1.85	1.42	1.17	1.68	2.07
Agricultural year 2000	0.87	1.32	0.83	2.78	0.74	1.93	3.35	n.h.	1.73	3.21

1/ Excluded government direct payments.
n.h./ Not harvested.

Price Protection

Previous to the economic reforms, one of the main mechanisms of government intervention in agriculture was a support price for grains and oilseeds, in general totally dissociated from international prices. In 1991 this protection was in force for some crops, especially maize and to a lesser extent in wheat. This can be seen in ID 041 with a domestic price nominal protection[5] of 70% in maize and of 34% in wheat. On the other hand, cotton, soybeans and sorghum domestic prices did not enjoy protection.

When NAFTA started in 1994 domestic prices began to be linked closely to international prices, and therefore protection levels decreased. For example, in wheat this was 18% in 1996 and 0% in 2000, while in maize, protection fell to 20% in 1996 and 22% in 2000.

Table 6 **Price Protection**

Indicators	Average Pattern	Fall-Winter			Spring			Summer		
		Maize	Wheat	Safflower	Cotton	Maize	Sorghum	Soybeans	Maize	Sorghum
Output Protection										
Agricultural year 1991	1.21	1.70	1.34	1.00	0.82	1.70	0.98	0.99	n.h.	0.98
Agricultural year 1996	1.12	1.20	1.18	1.00	0.94	1.20	1.03	0.92	1.20	1.03
Agricultural year 2000	0.99	1.22	0.99	1.00	1.01	1.22	0.96	n.h.	1.29	0.91
Effective Protection										
Agricultural year 1991	1.53	3.01	1.82	1.04	0.84	4.67	1.56	1.10	n.h.	2.11
Agricultural year 1996	1.23	1.26	1.22	0.92	1.02	3.82	1.32	0.98	2.67	1.49
Agricultural year 2000	0.97	2.23	0.95	1.01	1.03	2.46	0.59	n.h.	3.23	0.53

n.h./ Not harvested.

Like this, in 2000, on average for the six main crops, domestic prices were equal to their equivalent international prices.

[5] *Nominal output protection coefficient = market price ÷ international price*
International price = equivalent export/import price in the production area

These changes in government intervention in the agricultural market (mainly grains and oilseeds), can be appreciated through the Effective Protection Coefficient (EPC)[6].

In 1991, EPC was 1.53 meaning that owing to political distortions production factors were better remunerated (especially capital) and a higher net profit for producers was obtained, some 53% more than what would have been possible in the absence of these distortions.

In 1996 the effects of policy changes were apparent as EPC decreased to 1.23, especially due to a EPC decrease in fall maize and in wheat. This change is clearer still in 2000 when effective protection to wheat disappears, that is to say when Financial Added-Value is equal to Economic Added-Value, and generating a 1.00 EPC for the whole system, that is toy say that no price protection was available either for products or inputs.

Subsidies

The withdrawal of government support through input, product and production factors (especially to the interest rate) prices was more than compensated through the Procampo direct payments and marketing programs.

In 1991, when a government price support framework to inputs, products and production factors was still in place, the Producer Subsidy Equivalent (PSE)[7] was 22.1% for the whole ID 041's production system. This coefficient means that for every MX$ 1.00 of production, 22 cents can be imputed to government direct support.

By 1996, government support through the price mechanism had decreased substantially which was compensated through the Procampo direct payments. These supports generated a 18.6% PSE and also higher profits for producers as has been mentioned earlier. In 2000, government support through the price mechanism was practically non-existent, but was given continuity through the Procampo program of direct payments.

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[6] *Effective Protection Coefficient = financial added-value (market prices) ÷ economic added-value (efficiency prices). See footnote in page 10.*

[7] *Producer Subsidy Equivalent = net transfers ÷ gross financial income (or financial value of output)*
Net transfers = net financial profit — net economic profit
Net economic profit = gross economic income (yield × efficiency price) — total economic production cost
Total economic production cost = (input quantity, domestic factors, machinery and services) × (efficiency prices)

Table 7 **Subsidies**

Indicators	Average Pattern	Fall-Winter			Spring			Summer		
		Maize	Wheat	Safflower	Cotton	Maize	Sorghum	Soybeans	Maize	Sorghum
Producer Equivalent										
Agricultural year 1991 1/	22.1%	47.4%	23.4%	-6.2%	-6.4%	55.0%	14.4%	5.3%	n.h.	17.3%
Agricultural year 1996 2/	18.6%	19.2%	15.8%	4.1%	10.9%	47.9%	27.5%	13.1%	43.2%	29.2%
Agricultural year 2000 2/	37.9%	67.9%	39.2%	20.2%	5.9%	63.7%	-5.8%	n.h.	70.1%	-11.2%

1/ Excluded government direct payments.
2/ Included government direct payments.
n.h./ Not harvested.

Besides, the government put into effect marketing support programs, which gained in importance when international prices fell in 1997. In this way, in 2000 if Procampo payments are added to those of marketing support PSE increased significantly to 37.7%[8], mainly due to a 39.0% PSE for wheat, and therefore gave origin to the high profit rate already mentioned.

In this sense, ID 041 producers enjoyed a better financial situation (at least up to 2000) by way of the new government support framework applied after NAFTA began, than previously through government market intervention.

Comparative Advantages

Throughout the 1990s economic efficiency of ID 041 agriculture – measured through the Domestic Resource Cost Ratio (DRCR)[9] – was strengthened. This means that Mexico as a country saved foreign currency through domestic production. However, this efficiency is based in only two crops, wheat and cotton. In 1991, only cotton showed comparative advantages, while in 1996 cotton, wheat and fall maize showed comparative advantages. In 2000, wheat and cotton strengthened their comparative advantage. Area sown to wheat was 79.6% of the area sown to all crops and 89.6% of the area sown to the 6 main crops.

In wheat, a DRCR of 0.74, means that Mexico as a country saved foreign currency owing to domestic production. This ratio determines a 0.78 DRCR for the whole production pattern. A 0.78 ratio for the 2000 agricultural year shows that in terms of an "implicit exchange rate", for production of the main crops MX$ 9.21 were necessary (domestic factors economic cost) to generate US$ 1.00.

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[8] *These direct support payments don't include those pertaining to the Alianza para el Campo capital building support program.*

[9] *Domestic Resources Cost ratio = domestic factors (capital, labor, land, water) economic cost ÷ economic added-value*
Economic added-value = economic value of output (yield × efficiency price) — economic intermediate consumption
Economic intermediate consumption = input, machinery and services economic cost
Economic production cost = quantities × efficiency prices

Table 8 **Comparative Advantage**

Indicators	Average Pattern	Fall-Winter			Spring			Summer		
		Maize	Wheat	Safflower	Cotton	Maize	Sorghum	Soybeans	Maize	Sorghum
Domestic Resource Cost [3]/										
Agricultural year 1991	1.20	1.87	1.45	1.14	0.64	3.60	2.88	1.11	n.h.	5.64
Agricultural year 1996	0.76	0.55	0.54	0.83	0.83	6.60	1.68	1.00	4.02	2.79
Agricultural year 2000	0.78	2.90	0.74	2.78	0.68	4.38	1.77	n.h.	5.21	1.53

3/ Water market price as water economic price.
n.h./ Not harvested.

This implicit exchange rate is lower than an equilibrium exchange rate of MX$ 11.78 per US$ 1.00 and also lower than the MX$ 9.47 per US$ 1.00 market rate then prevailing.

CONCLUSIONS

- ID 041 producers have shown a great ability to circumvent international prices, macroprices and climate instability.
- To be able to avoid these instabilities, producers have benefited from significant government support to wheat production. These supports gave rise to very high profits in wheat production, which is the main crop.
- A decrease in producers' income because of a lower total sown area owing to a decrease or cancellation of area subject to double cropping due to water scarcity, as well as the disappearance of soybeans as an ideal second crop because of white moth attacks, was compensated through a greater government support to wheat.
- Cotton and wheat will go on being, at least in the medium term, the base crops for ID 041, as they have been for the last 5 decades.
- Wheat and cotton secure profits for producers and comparative advantages to Mexico.
- The government's direct payment support policy has provided big benefits to producers. These payments have been considerably higher than those that were handed out through government market intervention.
- High government support levels have had negative effects on technology innovation and on diversification of the cropping pattern, therefore limiting a greater creation of Added-Value and higher water economic productivity.
- Owing to the above, the water price paid by producers most probably doesn't reflect fully the scarcity economic value of this resource.

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Annex . Methodology

1) Exchange Rate

a) Nominal Exchange Rate

Nominal Exchange Rate is generally expressed as the quantity of a certain currency's units necessary to buy a US dollar (USD)

Indirect Nominal Exchange Rate:

$$\mathbf{En_{indirect}} = \frac{\mathbf{Pesos}}{\mathbf{1\ USD}}$$

Direct Nominal Exchange Rate:

$$\mathbf{En_{direct}} = \frac{\mathbf{USC}}{\mathbf{1\ Peso}}$$

b) Real Exchange Rate

$$Er_{indirect} = En_{indirect} * [p^m/p^d], \qquad Er_{direct} = En_{direct} * [p^d/p^m]$$

Where p^m is a general index for a certain USD price in world markets. These indices are usually put together through the Wholesale Price Index (IPM) for p^d and for p^m. Some times the Consumer Price Index and GNP's implicit deflator are also used, but IPM is more representative for internationally traded goods.

c) Equilibrium Exchange Rate

A deciding factor for movements in the exchange rate is the difference between domestic inflation and foreign inflation. If domestic inflation is greater than foreign inflation, and other factors remain equal, domestic currency should appreciate. Parity Purchasing Power Theory (PPP) maintains that this is the determining factor for movements in the exchange rate in the long-term (6 to 10 years).

Therefore, the Equilibrium Exchange Rate (PPP) can be set for any year relative to the Equilibrium Exchange Rate for the base year (e^*_t). When a base year in which the Nominal Exchange Rate was in equilibrium is selected (e^*_o), this expression can be used to compute an equilibrium rate time series.

$$e^*_t PPP = \left(e^*_0\right)\left(\frac{\frac{p^d_t}{p^d_o}}{\frac{p^m_t}{p^m_o}}\right)$$

Where:
$e^*_t PPP$ = Equilibrium exchange rate (Parity Purchasing Power) for year t.
e^*_0 = Equilibrium exchange rate for year 0 (base).
p^d_t = domestic currency price deflator for year t.
p^d_0 = domestic currency price deflator for year 0 (base).
p^m_t = foreign currency price deflator for year t.
p^m_0 = foreign currency price deflator for year 0 (base).

2) Interest Rate

a) Nominal Interest Rate (r_N)

Interest rate without corrections due to inflation, which in a certain period is paid and received in financial markets.

b) Real Interest Rate (r_R)

Nominal Interest Rate (r_N) corrected by inflation, i, (modified purchasing power). Therefore:

$$r_R = \left\{\frac{(1 + r_N)}{(1 + r_i)}\right\} - 1$$

3) Profitability

a) Net Profits

Net Profit is equal to Gross Income less Production Cost. Thus, Net Profit is a profit surplus which will be found after all production resources are paid. In other words, Net profit is a reward for the producer-businessman for his production and

management efforts, based on his capacity for innovation and entrepreneurship. It can also be defined as a reward for undertaking production risks and for his management skills.

$$\Pi i = \left(Y_i p_i^f\right) - \left(\sum_{j=1}^{k} a_{ji} p_j^f\right) - \left(\sum_{j'=1}^{k'} a_{j'i} p_{j'}^f\right)$$

Where:

Πi = Product *i* net profit.
Y_i = Product *i* yield.
p_i^f = Market (financial) price for Product *i*.
a_{ji} = Resource *j* (others') amount used.
$a_{j'i}$ = Resource *j'* (own) amount used.
p_j^f = Market (financial) price for resource *j* (others').
$p_{j'}^{oc}$ = Opportunity cost for resource *j'* (own).

b) Return on Capital

Net Profits are expressed in absolute terms and can't be used for efficiency comparisons among differently sized Production Units, so another measurement for relative terms should be used: Nominal Return on Invested Capital, which is the ratio between Net Profit and Total Cost:

$$RE_n = \left[(\Pi i) \div \left[\left(\sum_{j=1}^{k} a_{ji} p_j^f\right) + \left(\sum_{j'=1}^{k'} a_{j'i} p_{j'}^f\right)\right] X100\right]$$

As Net Profit is expressed in nominal terms, it should be deflated through a reference inflation rate, to adjust resources' and production prices to the same base. When following this procedure, Real Return on Invested Capital is obtained. Like this, return on capital can be compared to other investment alternatives for diverse time frames.

4) Competitiveness

The financial profit indicator is not enough to compare systems which produce different kinds of goods, because net profits should be residual (gross income - total production cost) coming from systems which use diverse input levels to produce goods, and showing wide price differences. This comparison distortion could be toned down comparing similar goods, such as wheat and maize, but should grow larger when comparing very different crops, for example maize and tomatoes. This ambiguity is inherent to net profit comparisons between systems producing different goods due to different capital intensities. This problem can be overcome through the Private Cost Ratio (PCR), which can be calculated dividing the Domestic Factors Cost (DFC) by the Financial Added Value, Added Value being the difference between Value of Output (VO) and Traded Inputs Cost. PCR expresses how a system is capable of paying domestic factors (including a

normal return on capital) and still remain competitive. That is to say, which should be the equilibrium point after obtaining normal profits (residual equals = 0). If RCP is less than 1 (<1), producers should attain extraordinary net profits; if RCP is equal to 1 (=1), producers can obtain normal net profits (residual equal to 0), and if RCP is more than 1 (>1), producers achieve negative net profits.

$$PCRi = \frac{\sum_{j'=1}^{k'} a_{j'i} p^f_{j'}}{Y_i\, p^f_i - \sum_{j=1}^{k} a_{ji} p^f_j}$$

Where:

PCR_i = Product *i* Private Cost Ratio.
$a_{j'i}$ = Domestic Factor *j'* Technical Coefficient.
$p_{j'}^f$ = Domestic Factor *j'* Market Price (Financial).
Y_i = Product *i* yield.
p_i^f = Product *i* Market price (Financial).
a_{ji} = Traded Input *j* Technical Coefficient.
p_j^f = Traded Input *j* Market Price (Financial).

5) Protection

a) Nominal Protection Coefficient

Nominal Protection Coefficient (NPC) for a product expresses the ratio between its financial price (domestic) and its economic price (international). International price should be its parity import price equivalent for the production area, converted into domestic currency by means of the economy's exchange rate opportunity cost. If NPC is higher than 1 (>1), domestic producers or intermediaries should be receiving a higher price after enforcement of this policy. This is known as positive protection. If NPC is lower than 1 (<1), producers and intermediaries are being discriminated against, that is to say protection is negative. If protection is equal to 1 (=1), producers and intermediaries are facing domestic (financial) prices equal to international (financial) prices, that is to say, prices equivalent to those prevailing without any intervention policies. For inputs, NPC should be interpreted in exactly the opposite manner.

$$NPC_i = \left(p_i^f \Big/ p_i^e \right)$$

Where:

NPC_i = Nominal Protection Coefficient for product or good *i*.
p_i^f = Financial Price (domestic) for product or good *i*.
p_i^e = Economic Price (international) for product or good *i*.

b) Effective Protection Coefficient

Price Protection Policy is often applied to both input and product prices. When the Effective Protection Coefficient (EPC) is calculated, it is possible to capture product and input price policy incentives impacts on the production structure. The purpose of EPC is to determine how a production pattern operating within the current protection structure differs from one working under a free trade model. To estimate EPC empirically, the approach should be based on added-value. EPC estimates added-value generated by an industry, within the current protection schedule and compares it with a hypothetical value added calculation for a non-protection condition.

Like this, the Effective Protection Coefficient is a ratio between added value at financial prices (domestic) and added-value at economic prices (international). If EPC is higher than the unit (>1), producers will be getting a greater return for their inputs due to intervention, that is to say, a positive protection. If EPC is smaller than the unit (<1), producers could have got a higher return on their production factors if they had sold and bought both output and inputs at international prices, that is to say, they enjoyed a negative protection. If CPE is equal to the unit (=1), structure protection is neutral, that is to say, producers are not favored or penalized.

$$EPCi = \frac{Yi\, p_i^f - \sum_{j=1}^{k} a_{ji}\, p_j^f}{Yi\, p_i^e - \sum_{j=1}^{k} a_{ji}\, p_j^e}$$

Where:

EPC_i = Effective Protection Coefficient for product *i*.
Y_i = Yield for product *i*.
p_i^f = Financial Price (domestic) for product *i*.
a_{ji} = Technical Coefficient for traded input *j*.
p_j^f = Domestic Price (financial) for traded input *j*.
p_i^e = Economic Price (international) for product *i*.
p_j^e = Economic Price (international) for traded input *j*.

6) Transfers and Subsidies

a) Net Transfers

Transfers can be defined as the differences existing between financial valuations and economic valuations for income, costs and profits. Any difference between estimated market and efficiency prices can be attributed to policy or to imperfect markets. In the absence of imperfect markets, all differences between financial and economic prices are due to policy distortions.

$$TRi = \left(Y_i p_i^f - Y_i p_i^e\right) - \left(\sum_{j=1}^{k} a_{ji} p_j^f - \sum_{j=1}^{k} a_{ji} p_j^e\right) - \left(\sum_{j'=1}^{k'} a_{j'i} p_{j'}^f - \sum_{j'=1}^{k'} a_{j'i} p_{j'}^e\right)$$

Where:

TR_i = Product *i* net transfers.
Y_i = Product *i* yields.
p_i^f = Product *i* financial price (domestic).
p_i^e = Product *i* financial price.
a_{ji} = Traded input *j* coefficient.
$a_{j'i}$ = Domestic factor *j'* coefficient.
p_j^f = Traded input *j* financial price (domestic).
p_j^e = Traded input *j* economic price (international).
$p_{j'}^f$ = Domestic factor *j'* financial price (domestic).
$p_{j'}^e$ = Domestic factor *j'* economic price (efficiency).

b) Producer Subsidy Equivalent

The producer subsidy equivalent (PSE) , expressed in percentages, could be defined as the ratio between total net transfers and value of output for a specific product. Also, PSE could be defined as a percentage of gross financial income required by producers to maintain net profits at present levels, within a free and competitive international market. In terms of aggregate domestic values, ESP indicates which percentage of current production value is due to transfers which originate in government policies.

$$PSE_i = \left(TR_i \Big/ Y_i p_i^f\right) X100$$

Where:

PSEi = Product *i* subsidy to producer equivalent.
Tr_i = Product *i* Net Transfers.
Y_i = Product *i* yield.
p_i^f = Product *i* financial price (domestic).

7) Comparative Advantages

The comparative advantage concept can be calculated empirically through the Domestic Resources Cost (DRC). DRC is a measurement for the cost of resources - labor, capital and land - for a country as a whole and for an industry in particular necessary to obtain a currency unit. If CRD is less than the unit the local economy saves foreign currency when producing that good or set of goods, due to the fact that the opportunity cost for domestic resources is less than foreign currency earned through exports or saved through imports' substitution. A DRC>1, indicates that a country doesn't have a comparative advantage for good *i* due to higher production costs earned or saved net foreign currency when producing good *i*. Finally, when CRD=1, the economy neither earns or saves foreign currency when producing good *i* When DRC is expressed in domestic currency units per foreign currency units, it represents an "implicit exchange rate" for a specific good. If this implicit exchange rate should be less than the economic opportunity cost for the exchange rate (or equilibrium exchange rate), then the good should be internationally competitive.

$$DRCi = \frac{\sum_{j'=1}^{k'} a_{j'i} p^e_{j'}}{Y_i p^e_i - \sum_{j=1}^{k} a_{ji} p^e_j}$$

Where:

$a_{j'i}$ = Technical Coefficient for Domestic Factor *j'*.
$p_{j'}^e$ = Economic Price (efficiency) for Domestic Factor *j'*.
Y_i = Yield for Good *i*.
p_i^e = Economic Price (international) for Good *i*.
a_{ji} = Technical Coefficient for Traded Input *j*.
p_j^e = Economic Price (international) for Traded Input *j*.