

Research Paper

**INSTITUTIONAL AND LAND CONSTRAINTS
TO IRRIGATED AGRICULTURE IN THE AZUA PLAINS
OF THE DOMINICAN REPUBLIC**

**Randy Stringer, William C. Thiesenhusen,
Patricia Ballard, and Wayne Kussow**



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TENURE
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Resource Use and Development

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ABBREVIATIONS

ODESIA	Oficina de Desarrollo Integral Agropecuario
PROSEMA	Proyecto de Servicios y Maquinarias Agrícolas
SEA	Secretaría de Estado de Agricultura
INDRHI	Instituto Nacional de Recursos Hidráulicos
IAD	Instituto Agrario Dominicano
YSURA	Yaque del Sur-Azua
CIAZA	Centro de Investigaciones Aplicadas a Zonas Áridas
INDESUR	Instituto para el Desarrollo del Suroeste
IADB	Inter-American Development Bank
SEEBAC	Secretaría de Estado de Educación, Bellas Artes y Cultos
INESPRE	Instituto de Estabilización de Precios
CEDOPEX	Centro de Promoción de Exportaciones
IDECOOP	Instituto de Desarrollo y Crédito Cooperativo
ODC	Oficina de Desarrollo de la Comunidad
BAGRICOLA	Banco Agrícola
OTA	Departamento de Tierras y Aguas

I. INTRODUCTION

by

Randy Stringer

In the parched Azua valley of the Dominican Republic, irrigation is not only essential for agriculture, it is crucial to the area's entire economy. Without irrigation there would be no need for the tomato processing plants nor the melon exporters. A dozen government agencies would have to move most of their staff and services to other regions of the country. Over 2,100 small farmers would be forced to leave with their families as would countless wage laborers dependent on jobs generated by agriculture. In short, the economic base would be reduced to only two main activities: the making of charcoal and the rearing of goats.

The problem is that the area's average rainfall of 369 mm. falls during a three-month period. The other nine months are completely lost to crop production except for around 2,000 hectares irrigated with water pumped from a natural underground aquifer. That is why, starting in 1977, the Dominican government has invested at least DR\$150 million to provide the necessary infrastructure and to construct 350 kilometers of canals in the valley. This important project, which can potentially irrigate 12,000 hectares, is known as YSURA.

YSURA has been very expensive. A dam had to be built on the Yegua River and water diverted to the Tabara River, where another dam was constructed. Next, the principal canal was excavated along with the laterals which criss-cross the project site. These concrete canals supply water to approximately 9 percent of all the irrigated farmland in the country. Yet the original expectations of YSURA were much greater, and the anticipated costs much less than what has resulted. The initial investment, estimated to be DR\$33 million, was to have irrigated 25,000 hectares for 10,000 families.¹ The Azua valley was supposed to have been turned into a garden.

Indeed, there have been some important quantifiable benefits. Since April 1978, when water first began to flow down the canals, the population of the area has doubled. The project's new farmers began cultivating vegetables and other cash crops rarely grown in the area. The established tomato companies greatly expanded their processing capacity, while numerous exporters, contractors, input-suppliers and transporters moved into the prospering region. The great expectations faded quickly, however, as incomplete construction, natural calamities, inappropriate planning and, sometimes, poor operation and management practices plagued YSURA.

1. Gary Hartshorn et al., The Dominican Republic Environmental Profile (Santo Domingo: U.S. Agency for International Development, 1981).

One of the worst problems occurred shortly after the canals were completed. Because the construction company abandoned the project without digging drainage ditches, many of the parcels located in the lower-lying areas became waterlogged as early as August 1978, only four months after irrigation began. Then, one year later, in August 1979, Hurricane David ripped through the valley devastating the region and leaving over 4,000 hectares inundated. That represented about 45 percent of the cultivated land. The combined effect of the hurricane and the lack of drainage caused acute problems: the water table rose eight meters, damaging the laterals with the increased water pressure; roads and small communities were flooded; and most of the drinking water was contaminated. By January 1984, less than 25 percent of the inundated land had been recovered. The rest remains marginal or useless because of waterlogging and salinity--a situation that now poses serious challenges for the Dominican Republic.

YSURA represents an ironic predicament for two reasons. First, major sections of the arid Azua valley have been turned into a "wet desert." This is especially disturbing since the main purpose of the project is to provide productive land for those farmers who practice slash and burn agriculture on marginal lands. Or, at the least, to keep additional landless from moving on to marginal and fragile lands like those located in the nation's important watersheds. The second reason is that YSURA has transformed idle land into productive farm land and then back to marginal land. Since there are no new agricultural frontiers in the Dominican Republic, irrigation is one of the few ways to establish intensive cultivation on previously unused and under-utilized lands. The Dominican government faces the dual task of expanding irrigation systems and improving on the existing ones.

The set of three papers in this research paper focus on how the small-scale farmers are responding to this troublesome situation and how they are reacting to the constraints imposed directly and indirectly by the irrigation system. The papers discuss both physical and social constraints which affect the area. The first paper, by Rodríguez et al., provides an historical overview of the Azua region and the YSURA project. The YSURA project is placed in context of agrarian reform in the Dominican Republic. Thus while it provides a micro-view of the reform process, it also confronts the special problem of access to water.

The next paper, by Kussow, provides an assessment of the status of the soils and water supplies as well as a delineation of the technical problems associated with water delivery systems. This paper concentrates on the management issues related to crops, water, soil, drainage and salinity from both the farmers' and the government agencies' perspectives.

The purpose of the third paper is to describe the role of small farmers, the Dominican agencies and the private corporations in the development of the region. The private corporations in this venture are the melon and tomato agroindustries in the Valle de Azua and especially in the YSURA project area. These industries are of central importance to the development of the valley since they organize major uses of technology, water and labor, and control the majority of the monetary circulation of the project (credit, marketing and distribution of costs and benefits). While these companies also react to

institutional pressure (i.e., regarding water use, price negotiations, etc.), their fundamental logic responds to the necessities of the market and overall profit motivations.

Water Systems Development: An Overview

In a recent paper, Bromley suggests that all irrigation systems are characterized by two interdependent sets of constraints: technological externalities and institutional uncertainty.² Technological externalities occur because water use by one farmer affects the amount and timing of water use by another. Rules and regulations are usually established to encourage fair water allocation, but these rules are often hard to enforce.

Institutional uncertainty results when, for example, some irrigators selectively ignore the rules and conventions established to control technological externalities. A farmer uncertain of the availability of water in the future will be tempted to over-irrigate, thus limiting the amount of water for downstream users. One of the principal constraints of the YSURA farmers is institutional uncertainty. The government agencies managing the project have not been able to establish a consistent set of operating procedures. Sometimes, because of inadequate funding, these agencies cannot properly maintain the canals and locks, and the water flow is severely restricted. Rules are also changed periodically and certain crops, such as rice, are prohibited in some areas one year and then banned throughout the project area the next. Farmers do not know when or where the drainage ditches will be excavated, nor are they consulted, and this results in still further uncertainty. There are many other similar examples.

In a broad sense, the aim of these papers is to determine how farmers are reacting to these circumstances. Are they simply responding rationally to government regulations and market incentives which result in improper water use? Is the real problem at the farm level and could this situation be corrected if new husbandry skills were developed and adopted? Do we have a sufficient understanding of the institutional relationships to deal effectively with water-related problems?

Two more general questions must be answered: Can irrigation projects actually deliver what planners suggest and help to ease the pressure brought on by landless and land-poor families? Also, do the problems of YSURA reflect fundamental flaws in the agrarian structure of the Dominican Republic which will have to be corrected before micro-level, on-farm management training will help?

It is important to remember that problems of waterlogging and salinity are not unique to the Dominican Republic. Irrigation projects all over the world have experienced many similar difficulties. The FAO estimates that about 50 percent of the irrigated land in the world is affected by salinization.

2. Daniel Bromley, Improving Irrigation Agriculture, Institutional Reform and the Small Farmer, World Bank Staff Working Papers, no. 531 (Washington: World Bank, 1982).

More than 70 percent of the land in Egypt, Iran, Iraq and Pakistan has been damaged, and around 12 million hectares in India are afflicted by salinity and waterlogging.³ These studies suggest that common problems include technical faults in design, improper management practices and poor leadership.

None of these problems is new. Ancient civilizations in Iran, Iraq, India and China supported over one million people in irrigated valleys. Yet all these agriculturally based civilizations collapsed at least in part for the same reason: the land became too salty and crops could no longer be grown.⁴

Despite these perpetual obstacles, there are also many successes, and irrigated land continues to expand at a rate of 3 percent per year.⁵ The 20 percent of the world's agricultural land which is irrigated produces 40 percent of the world's output.⁶ An estimated \$100 billion has been spent on irrigation systems since 1950 and increasing attention is being given to improving existing systems.⁷ The principal focus has turned to reducing waste and improving efficiency.

Table I-1 shows the potential for increasing irrigated land in Latin America, Asia, Africa and the developed countries. Latin America had 17.6 million additional hectares available, more than 1.5 times its actual level in 1970. Table I-2 reveals the distribution of irrigation in Latin America and the Caribbean and the overall percentage growth between 1961-76.

The Dominican Republic is ranked very low in terms of growth rates. According to the 1981 Country Environmental Report, the total potential land for irrigation in the Dominican Republic is 550,000 hectares with 300,000 hectares expected to be irrigated by 1985. This represents a growth rate of 1.6 percent per year. Clearly, expanding into new areas can help intensify agricultural production, but the YSURA project demonstrates the importance of improving on existing systems before building more of these costly projects.

The Organization of Production in YSURA

The YSURA beneficiaries share a number of common farming characteristics. Before Hurricane David, each farmer received 3.75 hectares of land, and each

3. C.E. Houston, "Irrigation Development in the World," in Arid Land Irrigation in Developing Countries (New York: Pergamon Press, 1977), pp. 425-32.

4. Arthur F. Pillsbury, "The Salinity of Rivers," Scientific American 345 (July 1981): 54-65.

5. Leonard Berry, Richard Ford and Richard Hosier, "The Impact of Irrigation on Development: Issues for a Comprehensive Evaluation Study," AID Program Evaluation Discussion Paper no. 9 (Washington: USAID, October 1980).

6. V.A. Kouda, "Arid Land Irrigation and Soil Fertility: Problems of Salinity, Alkalinity, Compaction," in Arid Land Irrigation in Developing Countries (New York: Pergamon Press, 1977), pp. 211-36.

7. Scaff Brown, Speech to International Irrigation Conference on Irrigation, Santiago, Chile, 1983.

TABLE I-1
Potential Irrigated Land Area, 1970

REGION	LAND UNDER IRRIGATION (million hectares)	POTENTIAL AREA	POTENTIAL INCREASE	POTENTIAL INCREASE AS % OF TOTAL FOR ALL REGIONS
Developed countries	47.9	175.3	127.4	44
Latin America	10.3	27.9	17.6	6
Africa	13.7	36.2	22.5	8
Asia	<u>133.7</u>	<u>254.9</u>	<u>121.2</u>	<u>44</u>
Total	205.6	494.3	288.7	100

Source: Leonard Berry, Richard Ford and Richard Hosier, "The Impact of Irrigation on Development: Issues for a Comprehensive Evaluation Study," AID Program Evaluation Discussion Papers, no. 9 (Washington: USAID, October 1980), p. 17.

one affiliated with an "association," or group of farmers. The project is divided into five zones, with several associations of between 15 to 100 farmers established in each zone. These associations serve both production-marketing functions and social purposes. In many ways the associations are similar to service cooperatives: the group members pool their financial and input requirements in order to obtain credit and purchase the necessary goods and services collectively; they determine, through discussion and voting, which crops will be produced; and, finally, they decide which company will market their products.

Unlike service cooperatives, however, there are no monetary fees collected regularly and these associations make few efforts to capitalize their organization. The elected officers are paid only for expenses incurred traveling on association business; they do not receive any type of permanent salary.

Each association consists of the general assembly, in which the members have one vote apiece, a set of elected officers known as the directorate and several committees. In practice, the committees are non-functional and meetings are held irregularly except during planting season when important crop decisions are being made and credit needs are determined. Accounting duties are the responsibility of the individual farmers. However, the Instituto Agrario Dominicano (IAD) keeps records for those farmers financed by the government bank, the Banco Agrícola. The vegetable and fruit companies also maintain records with each parcelero individually.

TABLE I-2

Distribution of Irrigated Land in Latin America and the Caribbean
(thousands of hectares)

COUNTRY	1961-65	1976	PERCENT GROWTH 1961-76
Dominican Republic	113	135	17.5
St. Lucia	1	1	0.0
St. Vincent	1	1	0.0
Trinidad	11	20	81.8
Puerto Rico	39	39	0.0
Jamaica	23	32	59.1
Martinique	1	2	100.0
Cuba	456	730	60.1
Guadeloupe	1	2	100.0
Haiti	38	70	84.2
Panama	15	23	53.3
Belize	2	2	0.0
Costa Rica	26	26	0.0
El Salvador	18	33	83.3
Guatemala	38	62	63.2
Honduras	60	80	33.3
Mexico	3,700	4,820	30.2
Nicaragua	18	70	88.8
Argentina	1,587	1,820	14.7
Bolivia	74	120	62.2
Brazil	546	980	79.5
Chile	1,084	1,280	78.1
Colombia	231	285	23.4
Ecuador	446	510	19.3
Guyana	100	122	22.0
Paraguay	30	55	83.3
Peru	1,041	1,150	10.5
Surinam	14	30	100.0
Uruguay	32	58	81.2
Venezuela	218	320	46.8

Source: Adapted from Berry et al., "Impact from Irrigation Development."

The directorate, and especially the president, usually negotiates for the group with the contractors and acts as the group's official representative in confrontations with government agencies or private contractors. A farmer with irrigation-related problems turns to the president first for help, both privately and during a general assembly meeting.

After the crop decisions are made, some associations require that all the members contract with the same tomato processor, or melon exporter. Based on past experience, the general assembly chooses the company by voting. Other associations might decide what to plant collectively, but then negotiate individually with whomever they choose. Once a farmer signs a contract with a private company, most of the production decisions pass to that company. A strict planting schedule is established so the company is able to coordinate its processing capacity with the estimated supply. The contractors provide financing directly or help arrange for it through the Banco Agrícola. They furnish technical assistance, including advice on the amount, type, and timing of fertilizer and pesticide applications. The companies also direct the timing, amount and method of water use. Mechanized services, including transportation at harvest, are another part of the contract.

The following papers develop the implications of these issues in terms of both policy and program needs.

References

- Berry, Leonard; Ford, Richard; and Hosier, Richard. "The Impact of Irrigation on Development: Issues for a Comprehensive Evaluation Study." AID Program Evaluation Discussion Papers, no. 9. Washington: Agency for International Development, October 1980.
- Bromley, Daniel. "Improving Irrigated Agriculture, Institutional Reform and the Small Farmer." World Bank Staff Working Papers, no. 531. Washington: World Bank, 1982.
- Brown, Scaff. Speech to the International Irrigation Conference on Irrigation, Santiago, Chile 1983.
- Hartshorn, Gary et al. "The Dominican Republic Environmental Profile." Washington: USAID, July 1981.
- Houston, C.E. "Irrigation Development in the World." In Arid Land Irrigation in Developing Countries, pp. 425-432. New York: Pergamon Press, 1977.
- Kouda, V.A. "Arid Land Irrigation and Soil Fertility: Problems of Salinity, Alkalinity, Compaction." In Arid Land Irrigation in Developing Countries, pp. 211-236. New York: Pergamon Press, 1977.
- Pillsbury, Arthur F. "The Salinity of Rivers." Scientific American 345 (July 1981): 54-65.

II. AGRARIAN REFORM IN THE DOMINICAN REPUBLIC: THE CASE OF YSURA

by

Pablo Rodríguez, Leo Colón, Juan Ogando,
Randy Stringer, and William C. Thiesenhusen

One of the most significant political developments of the immediate post-Trujillo years in the Dominican Republic is the emergence of the campesino as a potent political force, one with which parties must reckon. Juan Bosch proved on December 20, 1962, that the candidate who could win the rural vote would be victorious in the election. He was not the first to come to this conclusion. Joaquin Balaguer began the redistribution of land to landless campesinos less than three months after Trujillo's death.¹ He was followed by Rafael F. Bonnelly and other members of the Council of State, who passed the law in 1962 creating the Dominican Agrarian Institute (Instituto Agrario Dominicano, IAD), the administering agency for what turned out to be a modest agrarian reform.

Today, this reform includes about 14 percent of the agricultural land of the country and about 50,000 families. These data vary depending upon their source, however. If the Trujillo colonists are counted, 59,000 families may be a more realistic estimate, but desertion was common at the time since few services were available to beneficiaries and settlement tended to be on more marginal lands than now and often more for military purposes on the Haitian border than for agricultural improvement. Besides, the labor market was tighter and alternatives to farming somewhat easier to find. If some of the Trujillo-established colonies are not counted, the figure may be as low as 48,000 families (see Table II.1).

Reform in the Dominican Republic

Most agrarian reforms of the early 1960s in Latin America can be traced to the exigencies of the Alliance for Progress, which proclaims, on the part of the United States, "No reforms, no aid." Furthermore, bound by the moral obligation of the Punta del Este Charter, most Latin American countries felt that at the very least laws should be passed on the subject.

In the Dominican Republic, the dynamics seem to have been more endogenous. The coincidence of Trujillo's death in 1961 after a thirty-year dictatorship with the need of successor governments for a political base may have been the key to this island nation's reform law. That it occurred at the time that other nations in the area were mobilizing for the Alianza was just the luck of the draw.

1. Marlin D. Clausner, Rural Santo Domingo: Settled, Unsettled, and Resettled (Philadelphia: Temple University Press, 1973), p. 263.

TABLE II.1

Agrarian Reform in the Dominican Republic: Type of Asentamientos, Families Benefited, and Land Distributed, as of January 1983

TYPE OF ASENTAMIENTO	NUMBERS	%	FAMILIES BENEFITED	%	LAND DISTRIBUTED (in tareas)	%
Colonies, before 1962	40	9.03	11,451	19.27	2,238,396	37.58
Individual parcels, after 1962	267	60.27	32,284	54.34	2,734,312	45.90
Collectives, after 1972	136	30.70	15,676	26.39	983,988	16.52
Total	443	100.0	59,411	100.0	5,956,696	100.0

SOURCE: Oscar Delgado, "Diagnóstico socio-económico de los asentamientos individuales y colectivos," Proyecto FAO TCP/DOM2201 (February 1983), p. 3.

Whether what has happened in the two decades since 1962 can be called agrarian reform is more a matter for philosophers than social scientists. Frank Rodríguez is quoted as saying:

The results of the application of the agrarian laws demonstrate the absence of political will to carry out what is called for in the law. The application of the law is focussed in ways that do not come into conflict with traditional power sectors in the countryside.²

Hesitant to use the term "agrarian reform" at all, Oscar Delgado separates the activity of IAD into what he calls "New-Colonization" and the "Sector Administered by IAD."³

2. Frank Rodríguez, "Elementos de discusión para una política de reforma agraria," in Realidad económico actual de la República Dominicana y perspectiva a corto plazo (Santo Domingo, 1976).

3. Oscar Delgado, "Diagnóstico socio-económico de los asentamientos individuales y colectivos," Proyecto FAO TCP/DOM2201 (February 1983), pp. 33, 37.

TABLE II.2
Use of Asentamiento Land

TYPE OF ENTERPRISE	AVAILABLE AREA		USED AREA	
	(tareas distributed)	%	(tareas distributed)	%
Crops	2,132.2	36.2	1,375	64.5
Livestock	296.6	5.0	148.3	50.0
Both ^a	2,628.9	44.6	1,051.5	40.0
Forestry	840.2	14.2	159.7	19.0
Totals	5,897.9 ^b	100.0	2,734.5	46.8

SOURCE: Santiago Moquete Ortiz, "La agricultura campesina y el mercadeo de alimentos en la República Dominicana," FAO/CEPAL Consultant's Report (Santo Domingo, April 1983), Cuadro 22, p. 140.

^a Some sources, such as Delgado, classify some of this as unusable land.

^b These are data which come from an early 1982 source and this accounts for the slight difference from data in Table II.1.

Idle Lands

As the Government of the Dominican Republic defines it, only 2.1 million of the 5.9 million ta (16 ta = 1 ha) in the reform sector are suitable for crops, of which only 64.5 percent is utilized. Fifty percent of the area considered appropriate for grazing livestock is used, as is 40 percent of the land considered appropriate for both uses.⁴ For one reason or another, then, land in the reform sector is underutilized to a disturbing extent.

Individual vs. Group Farming

Some 62 percent of the land which IAD distributed came from public lands and 38 percent from private domain. For the present, there is no possibility in Dominican law that beneficiaries might own their plots in fee simple. Only usufructuary rights and provisional titles were distributed. If abandoned, the land reverts to the state. The family may inherit the use rights of bona

4. Santiago Moquete Ortiz, "La agricultura campesina y el mercadeo de alimentos en la República Dominicana," FAO/CEPAL Consultant's Report (Santo Domingo, April 1983), p. 37, and Cuadro 22.

TABLE II.3
Land Distributed and Beneficiaries, by Year,
According to Individual or Collective Organization

YEAR	INDIVIDUAL		AREA DISTRIBUTED	
	Parcels	Collectives	Individual	Collectives
1962	863	-	61,188	-
1963	719	-	63,358	-
1964	2,214	-	183,386	-
1965	-	-	-	-
1966	321	-	39,696	-
1967	1,901	-	155,865	-
1968	1,447	-	109,757	-
1969	2,057	-	155,273	-
1970	1,345	-	81,783	-
1971	3,621	-	378,536	-
1972	6,498	-	596,902	-
1973	5,592	2,770	485,853	160,324
1974	1,683	117	138,611	6,163
1975	1,108	822	78,519	72,500
1976	1,336	1,826	105,977	70,484
1977	139	-	3,074	-
1978	1,440	1,194	92,134	73,659
1979	-	1,962	-	134,000
1980	-	1,986	-	125,187
1981	-	3,244	-	237,787

SOURCE: Carlos Bravo Barros, "Informe del consultor," TCP/DOM/2201 (Santo Domingo, February 1983), Cuadro 15, p. 36.

fide assignees. Sales of property are, of course, not possible. Most of the land in the reform was distributed as individual parcels. In 1972 the same law which passed rice farms over 500 ta to IAD (Law 290) also gave it the power to found collective settlements. In 1978 this group farming activity was stepped up and areas other than those in rice were included. From 1979-81, no individual parcels were distributed.⁵ (See Table II.3.)

Delgado discusses the dynamics of the process and it is not necessary for that to be repeated here. One important matter worthy of emphasis, however, is

5. Carlos Bravo Barros, "Informe del consultor," TCP/DOM/2201 (Santo Domingo, February 1983), pp. 32-33.

that the focus of IAD changed from individual to collective settlement after 1978. As a result, there was a tendency to neglect the individual parcels in terms of credit and services after that date, a problem that may now be on its way to being solved. Delgado notes, "Except for irrigated rice farms, individual asentamientos were generally abandoned beginning in 1979. Without credit, without technical assistance and without organization of any type, they have, without doubt, arrived at a state of marginality."⁶

Land Use

The majority of land on asentamientos is used for domestic and not export crops. Rice production, valued at DR\$44 million in 1971, is far and away the most important crop grown in the reform sector. The next crop in terms of value is beans (habichuelas), valued at DR\$3 million.

In terms of national production, the reform sector appears to pull its weight. It provides 36.5 percent of the rice crop of the country, 16 percent of the corn, 9 percent of the beans, 23.2 percent of the sorghum, 5 percent of the plátanos, 22 percent of the vegetables, 16 percent of root crops, and 22 percent of the peanuts. (See Table II.4.)

Problems for Beneficiaries

The beneficiaries of the land reform process in the Dominican Republic are better-off than day laborers and have more land than the average minifundista (a countrywide average of about 50 ta compared with 14.9 ta).

But there are still some major problems which include:

- 1) faulty credit delivery;
- 2) improper apportioning and sometimes lack of irrigation water;
- 3) inadequate use of land such that for a variety of reasons some is left idle;
- 4) inappropriateness of scale of the production unit and underdevelopment of campesino organizations to serve it;
- 5) lack of incentive prices—since 1975 the terms of trade have turned rather decisively against agricultural production for domestic consumption (Table II.5).

Abandonment of parcels is less of a problem now than in the days of Trujillo because of the high rate of rural underemployment, currently estimated by Delgado at 50 percent,⁷ urban unemployment, and much higher population pressure on land currently.

6. Delgado, "Diagnóstico socio-económico," p. 69.

7. Ibid.

TABLE II.4

Percentages and Quantities of Agricultural Crops Grown in
the Dominican Republic on Land Reform Asentamientos, 1981

CROP	NATIONAL PRODUCTION (000 quintales)	VOLUME OF PRODUCTION SUPPLIED BY ASENTAMIENTOS	PERCENT SUPPORT BY ASENTAMIENTOS
		(000 quintales)	(%)
Rice	5,708	2,081	36.5
Corn	900	146	16.2
Beans	962	90	9.4
Sorghum	423	98	23.2
Peanuts	373	83	22.3
Plantains	685	37	5.4
Guandul	290	45	15.5
Vegetables	3,170	707	22.3
Root crops	3,487	561	16.1
Tobacco	827	41	5.0

SOURCE: Santiago Moquete Ortiz, "La agricultura campesina y el mercadeo de alimentos en la República Dominicana," FAO/CEPAL Consultant's Report (Santo Domingo, April 1983), Appendix, Cuadro 24, p. 16.

A Micro-View of the Reform

The purpose of this paper is to focus on one area in which reform settlements have been established to give a micro-view of the reform. In this project, in Azua Province, some DR\$150 million were spent over the past five years or so in settling people and installing proper infrastructure (especially irrigation water) for some 190,800 ta. Some 2,058 beneficiaries were given usufructuary land rights there. Besides IAD, at least twelve other government entities are working or have worked on the project.⁸

The large settlement and irrigation project founded in 1977 in what is one of the poorest parts of the country was pre-dated by a much smaller colonization effort in the area that began in 1969 on which 491 families were settled. The plots were supposed to be family farms and this is the kind of IAD activity which Delgado called "neo-colonization." The Israeli technician

8. Johnson details this work in his ISA work. He mentions SEA, ODESIA, CIAZA, PROSEMA, INDESUR, INDRHI, ODC, IDECOOP, SEEBAC, INESPRES, and CEDOPEX (Bradley T. Johnson, El valle de Azua (Santo Domingo, 1982), pp. 8-33.)

TABLE II.5
Price Indices and Derivation of Approximations
of the Domestic Terms of Trade

YEAR	INDEX OF PRICES RELEVANT TO THE REFORM SECTOR (IPRRS)	INDEX OF INDUSTRY PRICES (IIP)	INDEX OF EXCHANGE $(\frac{IPRRS}{IIP} \times 100)$	INDEX OF CONSUMER PRICES (ICP)	INDEX OF EXCHANGE $(\frac{IPRRS}{IIP} \times 100)$
1968	100.0	100.0	100.0	100.0	100.0
1969	007.6	98.9	108.8	98.9	108.8
1970	100.6	99.7	100.9	101.8	98.8
1971	101.2	107.1	94.5	106.2	95.3
1972	98.6	114.4	86.2	114.5	86.1
1973	125.7	133.0	94.5	132.5	94.9
1974	148.3	158.4	93.6	149.9	98.9
1975	190.1	186.2	102.1	171.6	110.8
1976	179.6	195.4	91.9	185.1	97.0
1977	205.4	220.4	93.2	208.8	98.4
1978	185.6	230.6	80.5	223.7	83.0
1979	181.8	258.8	70.1	244.2	74.3
1980	248.5	302.1	82.3	285.1	87.2

SOURCE: Carlos Bravo Barros, "Informe del consultores" TCP/DOM/2201 (Santo Domingo, February 1983), Cuadro 26.0, p. 59.

who showed that vegetables could be grown using well water from the sub-soil for irrigation in the area lent his name to the effort: the "Alexander Dothan" occupied an honored place in the parched valley near Azua City, the provincial capital, on a fan of land facing the Caribbean and surrounded by sierra that draws the moisture from the air before it reaches the valley. Some 120 km west of Santo Domingo, the site was occupied in the Trujillo period by El Sisal Dominicano, a company which employed political prisoners (and apparently more conventional civilian types also) sent to this hot-land Siberia, reportedly by the dictator himself. Trujillo once, albeit for a short period, occupied the building perched on a knoll now used by the project administration and known by everyone in the valley as the White House.

Stories abound to this day that sisal, with all the back-breaking labor and other bad memories it evokes, should never--even in jest--be mentioned aloud; the crop all but disappeared from Azua with Trujillo's demise.

For different reasons the other occupant of the valley in the 1950s and 1960s also quit the valley and, with the departure of the two of them,

employment opportunities all but disappeared. The tenants of the North American Fruit Company former holdings didn't require nearly as much manpower as did the expatriate fruit enterprise.

It was correctly decided that providing local employment for job-seekers would involve a great deal more irrigation water than at present. Drawing water from the aquifer, which both the colonists and, more frequently, the banana company had tapped with multiple penetrations, had initiated a continuing salinization process. The state irrigation agency (INDRHI) moved first to remedy the problem of salinity and provide opportune conditions for settlement in the area by building canals and damming the river YAQUE DEL SUR-AZUA, thus giving the settlement area its obligatory acronym, YSURA. YSURA was approved in 1977, as were 12 new settlements on state land and the incorporation of Alexander Dothan. In 1979, just as financing became available and the project infrastructure set in place, the area was raked by Hurricane David and so much capital and property were damaged or destroyed that the scars are still evident. One event little publicized at the time was that the three-month rainfall rose from an average of a sparse 321 mm to 1,120 mm in 1979.

On first blush, this would seem the only benefit a hurricane might provide. Rather, what it did to the sandy, infertile, and undependable soil was to raise the water level in especially low-lying zones such that only aquatic plants could survive. The paradox left for 1983 is that while some parts of the valley are having problems with too little water being delivered in timely fashion, other parts have too much water and are overgrown with impenetrable rushes and other swamp-like vegetation. Some areas are cursed with an abundance of water and others damned by its scarcity.

Thus in a zone with problematic water delivery--and a capital-scarce area with the vast majority of its population in deep poverty--initial activity by INDRHI and IAD gave the region more than a glimmer of hope.

As things worked out, the project ultimately affected 185,600 ta (11,600 ha). They are distributed as follows:

- a) 8,750 ha in production;
- b) 960 ha for population centers and services;
- c) 760 ha for settlement reserves; and
- d) 1,130 ha that will remain out of production.

Principal crops are bananas (plátanos), tomatoes, corn, sorghum, beans (habichuelas), milk, melons, and other vegetables (hortalizas).

The project aimed at its inception to raise family income to DR\$3,000, which probably equals DR\$4,500 today, and to provide parcel holders with houses, electricity, potable water, health care facilities, and schools for the children.⁹

9. See IAD/YSURA, Proyecto Yaque del Sur-Azua (Santo Domingo: IAD/YSURA, 1978). There are other goals, but these seem to be the most important.

The Collective Idea

Efforts to create agrarian settlement collectives corresponded to the founding of YSURA and, with the exception of the families settled in Alexander Dothan early in the decade, most settlers came to YSURA to become beneficiaries knowing that they would be collective members. What "collective" means in the sense of the reform in the Dominican Republic is much more akin to the idea of the production cooperative than to the notion of the collective of the USSR. For example, members were paid equal portions of the net income at the end of the year and, if cash had been lent to them during the year, it was considered an advance to be repaid with interest with the harvest and not a wage per se. The ideology behind the collective drive was the same one which swept most Latin American countries at the time, generated by domestic political parties whose ideology was additionally sparked by such international agencies as IICA, FAO, OAS, and ILO. The general notion was that Latin American agriculture should develop its own unique and, hence, appropriate institutional forms unfettered by those it could have copied in either North America or the Soviet bloc.

The political movement for cooperative farming had sound underpinnings in social science, especially in economics:

- 1) It was felt that a countervailing power among the peasants would be the most potent way to counteract what was seen as the growing dominance in countries of the domestic and international capitalistic sector—including as it did corporations, intermediaries, and multinationals—and the increasing dominance of power-bloc international politics. In legitimated groups there was more strength than in individuals acting alone.
- 2) It was felt that despite a body of literature arguing against the existence of economies of scale being decisive in agriculture, some parts of the production process of most crops enjoyed them (in harvesting usually and often planting). In still other cases (coffee and sugar) the most persuasive economies of scale came in milling and processing. In other crops, such as cotton, the entire balance tilted toward larger-scale farming, almost regardless of the wages of labor.
- 3) It was felt that subdividing existing fields into small plots would be expensive, especially because the expropriated farms or the government-held properties were worked as single units before the reform. Road building, irrigation canal adjustment, and fence construction were viewed as costly. Some who argued that division into small properties would involve high costs also felt that there was a certain inevitability about the larger-size property. Small parcels were only a luxury way-station before a return to large farms. Since the small-farm stage was only transitory, it might as well be skipped rather than traveled through.
- 4) Others who argued for the production cooperative had a certain disdain for decisions which individual campesinos might make and felt that beneficiaries, if left to their own devices, might make unwise planting, management, and marketing choices. If units remained large they

would be more attractive for professionals who could make more rational decisions than campesinos. If necessary, they could also steer the group to market its produce through official channels.

- 5) It was felt that technical services and credit were more efficiently supplied to a few larger units than to many smaller ones.

Unfortunately, scant effort was spent either listening to what campesinos wanted or convincing them of the wisdom of the group farming idea. The plan was merely imposed as a "good thing." So this ideology has fallen on hard times in YSURA. After several years of experience and, contrary to the wishes of IAD, collectives, little-by-little at first and now much faster, have developed into predominantly individual farms. Some individuals have tended to continue collective farming because the agrarian bank (BAGRICOLA) states that it will not lend to collectives which completely disintegrate into parcels, and they feel that they will earn the ire of IAD also. For 25 of YSURA's "collective" fincas on which records are kept centrally (about one-third of the distributed area in the project), 13.5 percent of the collectively distributed land is still in collectives while 86.5 percent has been divided into individual properties (see Table II-6). Some beneficiaries on settlements which still have some collective property told us it would be broken down into individual farms next year. On asentamientos which had been divided we found a perplexing inequality in the size of the resulting farms. It appears that in the process of subdivision an almost frontier mentality prevails as the economically strongest beneficiary grabs off for himself the largest portion of the heretofore collective area he can manage to take.

The reasons given by interviewees for division were:

- 1) We get the same percentage of the net income if we work hard or if we don't work at all.
- 2) We see that some crops are planted and cultivated on time and others not. When we control planting and weeding, we do it right.
- 3) We never see the bookkeeping; we know neither costs of production nor total production. The check we got at the end of the year was always much lower than we expected, and the income we received was much inferior to what we earn now.
- 4) We can't keep our family working because no place is allowed for them to be paid wages.
- 5) We can't pass unencumbered land on to our children after our death.

The complaints thus seemed to be directed not against the collective as such, but against the way the rules were designed and the seemingly arbitrary and rigid, almost capricious, manner in which they were carried out.

This lack of flexibility has been fatal for the collective model in YSURA. If there are still supporters of collectives in the area we didn't find them. The model of the old Alexander Dothan individual parcels in the area came to be the desired solution, together with just enough organization to obtain

TABLE II.6

Asentamientos Founded as Collectives and the Extent of
their Transition to Individual Parcels, August 1983, YSURA

ASENTAMIENTO	AREA OF COLLECTIVE PARCELS (ta)	AREA OF INDIVIDUAL PARCELS (ta)
21 de Enero	250	200
Quisqueya	450	170
La Buena Unión	350	200
Salvadora	500	200
Unidad Campesina	300	200
San Antonio	549	2,204
San Francisco	600	2,106
La Esperanza	785	2,246
Ramón M. Mella	650	3,436
Maria T. Sánchez	691	2,665
La Primera	345	1,443
San Isidro II	175	1,613
Las Mercedes	0	1,788
La Maestra	0	1,213
Nuevo Porvenir	150	1,063
Nueva Esperanza I	350	1,438
Los Remedios	0	1,900
Santa Fe	0	1,900
16 de Agosto	0	1,900
San Isidro II	0	1,900
El Progreso	0	1,900
Nueva Esperanza II	0	1,900
San Miguel	0	1,980
Sánchez	0	1,980
La Vigia	0	1,900
Total	6,145 (13.5%)	39,445 (86.59%)

credit, possibly to obtain a lower input and higher produce price. "If organization short of collective farming can help economically, we'll accept it," appears to be the attitude; "if not, we will reject it."

On the other hand, beneficiaries are not adverse to working together if they perceive benefits to themselves. In one part of the formerly collective area, we found a group of campesino beneficiaries cultivating a large field of an unusually healthy-looking stand of sorghum. It turned out that they had arrived at an equitable division of the large formerly collective field into small parcels and, while not visibly divided by fences, each group member knew which part was his. They were caring for the weeding of their plots separately, but they prepared the soil, did the planting, and would harvest in common. This seems to illustrate the flexibility of campesinos themselves in designing a tenure system to capture existing economies of scale.

There was, in the area, another exception to the penchant for individual farming, and it involved an imported herd of 500 mostly purebred Holstein-Friesians. Almost everything needed for the enterprise was also imported: cooling equipment, tank truck, front-end loader and tractor for the manure, herring-bone milking parlor--even guard rails for the feeding and holding pens.

An Israeli technician and a Canadian dairyman--the project is a joint Israel-Canada-Dominican Republic effort--were also brought in. The entire effort is so costly that it hardly qualifies for study, at least on the basis of its possible replicability elsewhere in the Dominican Republic.¹⁰

The Economic Case

On the other hand, the farmer beneficiaries of Alexander Dothan, many of whom came to the area in the early 1970s and were incorporated into YSURA at its founding, probably present a more accurate representation of what the future may be like for YSURA. Consequently, it was decided to focus on the present organization and the economic and social status of a sample drawn from parcel holders who settled in the early 1970s in the area.

The Nueva Vida and La Brillante associations were picked. Neither had compelling technical difficulties. Together, they include 98 parcel holders, or 20 percent of the original group of Alexander Dothan parceleros. It was decided to draw an approximate 15 percent sample at random of the population of the two asociaciones--154 families--for intensive interviews: 22 percent on the La Brillante settlement (N = 23 families), and 13 percent on Nueva Vida (N = 75).

A questionnaire was administered in on August 3 and 4, 1983, and the results were tabulated later in Santo Domingo.

Last year La Brillante association broke off from Nueva Vida for reasons which apparently involved political ideology and also a feeling that Nueva Vida

10. IAD, "Proyecto ganadero agroindustrial, Asentamiento YSURA: plan anual de trabajo" (Santo Domingo, August 1980).

was too large for members to receive proper attention to their problems from the governing body (see Section C). Other initially larger asentamientos in the area had also broken apart and always into groups of twenty or so. It appears almost as though the "long-run average cost curve for association," if one can translate this sociological concept into economic terms, drops to a low point at twenty members and then begins to rise again, a hypothesis which might be tested further.

It appears that a disproportionate number of the better-off members of Nueva Vida joined the breakaway group since three of the top five family net cash income receivers in the sample were from La Brillante and only one La Brillante member was in the lowest five. (It should be pointed out that in this reorganization all La Brillante members kept the parcels they had been farming since 1971.)

Including imputed values for in-kind consumption, the average parcel beneficiary earned DR\$4,280 (Table II.7). If it is assumed that each parcelero

TABLE II-7

**Income and Comparison with Opportunity Costs of Labor:
A Sample of Parcel Holders Compared to the
Most Likely Alternative--Work as a Day Laborer
(in DR\$)**

	LA BRILLANTE	NUEVA VIDA	COMBINED
A. Net cash parcel income	4,606	2,790	3,395
B. Net cash family income	4,798	2,945	3,563
C. Net family income (including imputed values in-kind of consumption)	5,552	3,645	4,280
D. Opportunity costs of family labor (assuming 300 days at DR\$4 a day for each full-time male over 15 and 100 days for each male student over 15)	2,880	2,280	2,480
E. Income advantage of parcel (C - D)	2,672	1,365	1,800
F. Value of working capital (except land and house)	1,070	1,388	1,283
G. Income and capital advantage of parcel possession	3,742	2,743	3,083

and each male family member over 15 who lives under the family roof and is not in school could have found work for 300 days during the year and that each male family member over 15 who attends school could have found work for 100 days, the average parcel holder working elsewhere could have made an average of DR\$2,480, giving the average family a DR\$1,800 advantage over day labor, considering that day labor in the zone seems to be paid about DR\$4 per day.¹¹ Another advantage that the parcel holder has over most day laborers without a minifundio and/or a solar (houseplot) is that the holder can have some capital: animals or machinery. Two of the higher-income receivers had motor scooters (the distance between homes, which are typically in a caserio or villario, and plots may be as much as 1.5-2.0 km); many more had dairy cows. The average value placed on working capital was DR\$1,283, giving the parcel holder a DR\$3,083 advantage over the day laborer.

One goal of the original project was to give the average beneficiary an income of DR\$3,000 (in 1978 pesos). Assuming that the inflated value of DR\$3,000 is now DR\$4,500, it can be seen that this group of colonists falls short of the goal by DR\$329.

Our data are not detailed enough to allow the economic or statistical analyses that might suggest why certain incomes are being received. All that it is possible to do is to reveal the static picture.

Parcel holders with the highest incomes seemed to share some of the following characteristics:

- 1) have highest yields;
- 2) obtained most education themselves and/or with children of above average schooling;
- 3) engage in double-cropping;
- 4) cultivate plátanos (a perennial crop which yields well with rather low yearly operating costs);
- 5) use credit and repay promptly at harvest;
- 6) have little idle land during any one cropping season;
- 7) possess few irrigation problems;
- 8) exhibit best practices of husbandry on parcel.

The issue of raising production is an important one, and one gets the impression that most parceleros could increase their incomes just by tending their parcels more carefully. One hypothesis worth further testing is the idea that the parcel seems to have brought some measure of leisure for the holder and its tending is often done by older male children.

The top campesino in the group, who also happened to have been elected president of La Brillante last year, made DR\$7,504 on his cultivated area and

11. By custom or tradition, female family members in the area do not do wage work.

sold milk worth DR\$864, thus giving him a take-home pay of DR\$8,368. His parcel showed careful husbandry and attention to the details of farming. Because all the plots are the same size, about 60 ta, it may be speculated that his income is related to soil quality or water supply. As to the first, technicians assured us that his soil seemed no better or worse than the other parcels'. But he was also able to get ample irrigation water all during the season. A few receiving the lowest incomes had some irrigation problems. One interviewee displayed his: a simple lack of concrete supports for a plastic irrigation pipe over a ditch from the canal to his property and that of three of his neighbors. While the four had tried to fix it in a makeshift manner, it seemed that only concrete--which they didn't have--would do the job. Because they didn't receive water, their production for the year was either lost entirely or greatly jeopardized. The problem could have been fixed with DR\$100, but, despite carrying out many "trámites," the four had obtained no results.

TABLE II.8

Variations in Yields of Major Annual Crops, La Brillante and Nueva Vida:
Low, Median, Mean, and High, Reported by a Sample of Beneficiary Campesinos,
1 August 1982 - 1 August 1983 (in pesos^a per tarea)

CROP	LOW	MEDIAN	MEAN	HIGH
Tomatoes	4	38	54	128
Beans	3	21	17	28
Melons	4	60	64	108
Sorghum	12	30	26	37
Corn	5	31	25	70

^a US\$1 = DR\$1.6.

It would appear from Table II.8 that if yields could be raised at the low end of the spectrum to the average, fairly large income increases could be realized. Much of the remainder of the problem could be solved, it seems to us, by better husbandry. There are also a number of small problems. The lowest yield of tomatoes was obtained by a parcel holder who couldn't get hold of the standard containers in which they must be sold; knowing that without the boxes the tomatoes were useless, he didn't even harvest them. Yet another problem was that the tractor bought by the Nueva Vida association was regularly late in performing what needed to be done on time for maximal yields.

Table II.9 carries this message further. We know that parcellation elsewhere seems to be associated with the income distribution becoming more unequal.¹²

In the present case, while settlers in 1971 came here equally poor, the top third among them receives 54 percent of the total income, while the middle tercile receives 31 percent. It is not unexpected in situations like this that some should progress and others not. One urgent matter, however, is to figure out whether policy can raise the incomes of the bottom third (note that the top two-thirds of income-receivers have an income above the opportunity cost of labor--see Table II.9, line 4). The question is: Do those who remain poor have problems which are technical or ones which institutional challenges,

TABLE II.9

Income Distribution from a Sample Survey of La Brillante and Nueva Vida,
Using Net Cash Family Income, 1 August 1982 - 1 August 1983

INCOME-RECEIVING FAMILIES	AVERAGE INCOME OF TERCILE (in DR\$)	SHARES OF TOTAL INCOME IN THE TERCILE (in %)
1. Top third	5,807	54
2. Middle third	3,274	31
3. Bottom third	1,607	15
Median income = DR\$3,088		

adjustments in the rules of the game, or education can change? Or is the matter one of attitude or psychological makeup which is beyond our ken? Our data do not permit us to say.

One social benefit which the reform seems to have brought is that it is possible for families of parcel holders to receive more education. (On whether this would have happened in the absence of the project, we cannot speculate.) While the average number of years spent in school by parents is barely enough to enable them to read and write, many of their children will probably have

12. William C. Thiesenhusen, "Chile's Experiments in Agrarian Reform: Four Colonization Projects Revisited," American Journal of Agricultural Economics 56 (May 1974): 323-30.

that ability, considering that literacy in Spanish probably comes with three of four years of school (Table II.10). The figures include a number of children who are still attending school. Therefore, lines C and D of Table II.10 are important, for they combine to show a ratio (line E) which indicates that a large number of the eligible are still in school. That this ratio is as high as it is may be another benefit of the project: when family income is assured, fewer school-age children need to work.

TABLE II.10
Education of Parents Compared with That of Their School-Aged Children,
in Years, and the Ratio of School-Aged Children Under 20 Years of Age Who
Are Still in School to the Total Number of Children Under 20, August 1983

	LA BRILLANTE	NUEVA VIDA	COMBINED
A. Average years parent spent in school	2.2	1.9	2.0
B. Average years school-aged children spent in school as of August 1983 (no other adjustment)	4.5 (n = 30)	3.7	4.0 (n = 77)
C. School-aged children under 20 who are still in school	26	27	53
D. School-aged children under 20 in the sample	26	33	59
E. Attendance ratio (C/D)	1	.82	.90

There are several other interpretations which might be put on these education data, however. It may be that the largely uneducated groups of parcel holders value education so highly that it has a high claim on all income above subsistence. At least two parcel holders currently have children in the university in Santo Domingo, a feat that would have been unheard of in a group of campesinos just ten years ago. Also, a fairly large percentage of children in their late teens are still in school, and two are in trade high schools. Another interpretation for the large school enrollment is simply access to the grade school, which is nearby and staffed with four full-time teachers.

The first claim on net cash family income is the needs of the family for purchased staples or other food, housewares, clothing, transportation to town, recreation, medicines, etc. The average family spends DR\$3,091 (Table II.11)

TABLE II.11

Amount of Cash Available to Pay for Consumption Needs of Family,
Compared to What Families Reported Spending, and Possibilities
for Debt Payment, 1 August 1982 - 1 August 1983
(in DR\$)

	LA BRILLANTE	NUEVA VIDA	COMBINED
A. Value of net cash family income	4,798	2,945	3,563
B. Value of reported family consumption for items to be purchased with cash (food, housewares, clothing, recreation, etc.)	3,815	2,729	3,091
2. Amount remaining for other debt payment, taxes, or land payment	983	216	472

for these purposes. This means that there is an average of DR\$472 left--which might be used toward new capital (though none had capital debts) or for making a payment on land, should the government of the Dominican Republic decide this was a wise move. One caution: these data deal with means, and only seven of the fifteen sample members could make a payment of about DR\$1,000, four more could make part of such a payment, and four could make no payment unless their consumption was squeezed or their production raised. It is this bottom group that tends to have production credit debts.

The Asociativa Nueva Vida and La Brillante

Beginning in 1973 in rice areas and in other areas in 1978, asentamientos have been experimenting with and evolving toward a new type of production-marketing arrangement, neither collective nor fully individual and designed to solve the problems of both. It is known in the Dominican Republic as the asociativa. The difference between the ideal form of this model and a full service and marketing cooperative seems to be that, for the present, no membership fee is charged. In brief, farming is done on individual plots with decisions and labor a matter for the operator-manager and his family. Inputs and credit are obtained as a group and, to the extent that a similar product is grown, marketing is a joint effort. Each farmer must repay his own credit; that is, individual default does not become the liability of the group.

The asociativa may own capital, such as a tractor, which members can utilize upon payment of a fee. In Nueva Vida-La Brillante, what passes for an asociativa is quite different, however.

In the rest of the country many of these new groups appear to have been a response to economic and social difficulties. Among the highly independent legatees of Alexander Dothan, the asociativa was almost solely a response to the Banco Agrícola's mandate that it would cut its administrative costs by forcing group borrowing instead of lending in response to individual petition. Each asentamiento would need to organize itself into one or several groups which would, in turn, pool credit requests. If the banco responded favorably to the joint application, the organization would dole out credit to its members. The still-high delinquency rates among some of NVLB asociativa members are an indication that organization has done little to aid production and marketing in the area.

La Nueva Vida was founded in May 1979. It originally consisted of 106 parceleros (the general assembly), a set of elected officers, the directorate, and several committees. Initially, many of the members had high expectations that the new association could help them resolve certain production-related problems. At one of the early meetings, the general assembly voted to levy a one-peso per month assessment in order to respond to one of the settlement's most urgent production needs: a tractor. The Banco Agrícola financed the new tractor for a five-year term, at 9 percent interest, and for a cost of DR\$40,000. Before the year was up, it became clear that fewer and fewer members were paying monthly dues, and that the association would be unable to repay the tractor loan on time.

By 1982, the tractor debt issue, together with numerous other troublesome problems having to do with politics and personalities, forced a split among the membership. A new asociativa, La Brillante, was organized, with 23 parceleros, compared to La Nueva Vida's 75.

Several parceleros suggested that the original size of Nueva Vida simply made it too clumsy. The asociativo's officers could not keep up with everyone's requests, and there was little administrative control or guidance. Slowly the organization itself fell into a malaise. Only rarely was there a quorum for the biweekly meetings, and often no one would come. The only times when the full membership would be present was when a credit disbursement was to take place.

A second issue which rankled the membership was that after receiving tractor services parceleros might refuse to pay, saying they needed to wait until harvest. Some, even after selling their crop, refused to pay. Soon, the lethargic Nueva Vida organization was just barely keeping up with the interest payments of DR\$3,400 per year. Then there was the matter of favoritism. Those members with closer contacts with the president seemed to receive services more quickly; others took to using the tractor as a personal method of conveyance.

Finally, the parceleros chafed under what seemed to them as a complete lack of attention to serious production problems. For instance, one member had part of his plot arbitrarily taken over by another. The tractor services came six weeks late to one producer. Then there was the shortage of packing crates. Consequently, because of these problems, many of which could have been easily solved and were not even complex, a dissatisfied group left Nueva Vida to establish La Brillante in July 1982.

La Brillante has the same basic organizational structure as Nueva Vida: five elected officers and seven committees. In practice, the committees are non-functional, being anachronistic holdovers from IAD's original asentamiento structure. The only cost to the group--the president's and the treasurer's travel--is divided between all the members equally.

The association does not meet on a regular basis; it sees no reason to nor does it plan to place more emphasis on further group activities in the future. Soliciting and disbursing credit remains as the only significant function of the association, and the idea behind La Brillante seems to be that the organization with the fewest functions works best. La Brillante has no intention of falling into what they regard as Nueva Vida's folly of buying a tractor or other commonly held capital. They would rather rent at a higher rate from outside the reform area so long as they could count on fewer problems.

Every phase of the production process outside of credit is the responsibility of the individual parcel holder. In fact, many do not even participate in the Banco Agrícola's credit programs. Rather, they are financed completely by the melon or tomato contractors who sign on directly with the parceleros to supply them with a plowed and dragged field, fertilizer, seeds, technical assistance, and to buy their production at the end of the year.

Tentative Draft Conclusions

We recognize that the data in this study could be interpreted in many different ways. The pressing matters that come to our attention are:

- 1) Some flexible system of "association" should be established and reinforced to provide beneficiary campesinos with countervailing power along the lines of a service and marketing cooperative.
- 2) Short courses or some "on-the-job" training should be established which would provide beneficiaries with information on husbandry practices and some simple bookkeeping together with some more literacy training.
- 3) The division of colectivas should be supervised at least to the extent that gross inequities are avoided. A bit more control now may avoid a great deal of friction at a later date.
- 4) The entire area should be canvassed by a technician who can determine which parcels suffer for want of some simple technical solution to a problem, and he should be empowered to set in motion a remedial procedure. It would seem that the resident IAD technician could be the logical person to accomplish this task.
- 5) The matter of labor use in the area should be studied to determine such matters as what constitutes full employment of a parcel-holding family and how, in a parcel-holding community with an "association," employment opportunities can be enhanced, especially considering that division of the parcel upon death of the family head is a move fraught with difficulties. Put in another way, there must be scope for intensifying production and employment opportunities outside the parcel before the next generation takes over. Given extremely

large families in the area, all parcellation usually does is make it possible for the present generation to have an adequate income.

Problem Issues

1) What is it that causes a group of parcel holders to receive extremely low incomes (compared with other parcel holders and with the opportunity costs of labor)? To what extent might certain policies encourage them to produce more?

2) Among other benefits the reform sector receives from the state, land, subsidized infrastructure and credit, and a house need to be specifically mentioned. Should this amount of subsidy require more of the surplus to be siphoned off aside from what is withdrawn through unfavorable domestic terms of trade? What would the incentive effect be of better terms of trade for domestically consumed agricultural products combined with a land tax or a "use tax" paid to the state, or even a land payment? It would seem that, if a land tax were to be imposed, the entire private sector of agriculture should also have a tax levied on it. Or, if the political difficulties of this are too great for the moment, the "land use tax" may be utilized and it might be administratively possible to avoid excessive delinquency if those who pay know that the tax will be earmarked for local use.

3) How can excessive subdivision upon the death of the recipient couple be prevented?

4) How can excessive costs for division of irrigation systems, building of roads, and raising of fences be made more affordable as the transition from colectiva to asociativa is made?

5) If land is titled and sold to beneficiaries in response to campesino pressure for land of their own (instead of merely use rights), how can selling to powerful outsiders be prevented? Could title be transferred only with the permission of the association to avoid selling it to outsiders? Are restrictive covenants which prevent selling for 20 years more enforceable? Or might some kind of zoning of agrarian reform asentamientos accomplish the same thing?

How can the purchase of parcels inside the association by the strongest members be avoided?

6) What is the proper role of contract farming? On the settlements studied, there was contract farming for tomatoes and melons. These are perishable, highly labor-intensive crops such that the contractor cannot easily substitute a capital-intensive technology and simply "use" the beneficiaries' land without paying rent for it.

The appropriateness of this farming method, it would seem, depends on the parcel holder being able to make a significant labor and management contribution to the crop while learning some of the necessary management skills. Its success, we feel, should be gauged on whether an incentive and/or price can be promised in advance of seeding and whether inputs are not priced too high. All of these costs should be known by the parcel holder so that he can make rational planting decisions.

References

- Bravo Barros, Carlos. "Informe de consultor." TCP/DOM/2201. Santo Domingo, February 1983.
- Clausner, Marlin D. Rural Santo Domingo: Settled, Unsettled and Resettled. Philadelphia: Temple University Press, 1973.
- Delgado, Oscar. "Diagnóstico socio-económico de los asentamientos individuales y colectivos." FAO proyecto no. TCP/DOM/2202. Santo Domingo, February 1983.
- Dominican Republic. Instituto Agrario Dominicano (IAD). "Proyecto ganadero agroindustrial, Asentamiento YSURA." Santo Domingo, August 1980.
- _____. _____./YSURA. Proyecto Yaque del Sur-Azua. [Brochure.] Santo Domingo, IAD/YSURA, 1978.
- _____. _____. Departamento de Planificación. Plan de consolidación de asentamientos campesinos: Asentamiento Abraham Canaan. Santo Domingo, July 1980.
- _____. _____. División Desarrollo Social. "Investigación social." Proyecto YSURA-Azua. July 1980.
- _____. _____. Fondo Especial para el Desarrollo Agropecuario. Proyecto Yaque del Sur-Azua, plan anual de trabajo. Santo Domingo, September 1978.
- _____. _____. _____. Proyecto Yaque del Sur-Azua: YSURA, plan anual de trabajo. Santo Domingo, September 1977.
- _____. _____. Oficina de Programación y PIDAGRO. Planeamiento integral proyecto Yaque del Sur-Azua. Vol. 1. Santo Domingo, July 1977.
- _____. _____. _____. "Proyecto ganadero agroindustrial asentamiento, YSURA, plan anual de trabajo." Santo Domingo, March 1980.
- _____. _____. Programa Conjunta OEA-Israel-BID. Proyecto el sisal. Santo Domingo, January 1969.
- _____. Secretaría de Estado de Agricultura. Subsecretaría Técnica de Planificación Sectorial Agropecuaria. "Análisis de los principales problemas que afectan al sector durante el período 1982-1986." Borrador. [Document for SEA/IICA.] Santo Domingo, May 1983.
- Johnson, Bradley T. El tomate industrial en la República Dominicana. Institute Superior de Agricultura, 1983.
- _____. El valle de Azua. Instituto Superior de Agricultura, 1982.
- Moquete Ortiz, Santiago. "La agricultura campesina y el mercadeo de alimentos en la República Dominicana." CEPAL/FAO. Santo Domingo, April 1983.
- Thiesenhusen, William C. "Chile's Experiments in Agrarian Reform: Four Colonization Projects Revisited." American Journal of Agricultural Economics 56 (May 1974): 323-330.
- United States. Agency for International Development/Dominican Republic. "Project Paper on Small Farmer Agricultural Rehabilitation." AID/LAC/P.036. 1979.

III. SOIL AND WATER IN THE AZUA VALLEY

by

Wayne R. Kussow

Current Situation

What follows is a brief assessment of the current status of the soils and water supplies in the Azua valley and a delineation of problems observed. Impressions gained from several references and eight days of discussions with government representatives, managerial staff of private companies operating in the valley and farmers constitute the basis for this report.

Soils

The soils in the valley of Azua are formed in fluvial sediments derived from the surrounding mountains. The sediments are known to be several hundred meters in depth and contain an aquifer capable of supplying substantial amounts of water for irrigation purposes. Water deposition of the sediments has resulted in size gradation of the sediments. Coarser materials such as sand-gravel mixtures are generally concentrated around the western and northern boundaries of the valley while clay-sized materials tend to dominate in the central area. This general pattern of sediment gradation is disrupted in the vicinities of the Tabara, Palmarejo and Jura rivers and lesser streams that traverse the valley. Coarse sediments border the rivers and grade into finer materials as one moves away from the river beds. It is logical to assume that in geologic time these streams have meandered back and forth across the valley floor. The result is great horizontal and vertical diversity in the physical characteristics of the sediments. Vertical diversity is reflected in well logs that show clay lenses commonly interspersed between layers of sand and gravel.¹ The soils of the valley therefore occur in highly irregular patterns over short distances and any two soils with similar surface textures may have very different physical characteristics in the subsoil.

Soils of the Azua valley were not classified and mapped until 1981. A semidetalled map was completed that year by the Department of Land and Water (DTA) of SEA. Fourteen mapping units are organized on a scale of 1:30,000 and at the sub-order level of soil classification. Analyses of the surface horizons of eight modal soil profiles (Table III.1) reveal that all have alkaline pH and contain substantial amounts of calcium carbonate. Surface texture ranges from sand to sandy clay. The organic matter contents, cation exchange capacities, and soluble salt contents are highly variable. Soils formed in terraces bordering the coastal swamp are highly saline (EC=15). Soils in the central part of the valley and typified by Pueblo Viejo soil do not appear to

1. Z.L. Shifton et al., Hidrogeología del valle de Azua (Tel Aviv: Tahal Consulting Engineers, 1971).

TABLE III.1
Select Characteristics of Modal Soils in the Azua Valley*

SOIL	TEXTURE	pH	CaCO ₃ (%)	O.M. (%)	CEC	EC (mmhos cm ⁻¹)
Los Jobillos	sandy clay loam	8.4	6.59	0.75	34.2	0.31
Ansonia	loam	8.4	7.92	1.51	19.2	0.56
Pueblo Viejo	clay loam	7.7	9.97	2.13	14.1	1.77
Río Tabara	sandy clay loam	8.0	9.70	1.59	6.52	0.46
Río Palmarejo	sandy clay	8.4	14.3	3.00	32.6	0.37
Casa Blanca	-	7.9	30.2	1.97	12.0	0.46
El Puerto	-	8.6	19.8	3.59	30.0	15
Los Negros	sand	8.5	13.5	0.26	14.0	15

* Adapted from DTA, Estudio semidetallado de suelos de la llanura de Azua (San Cristóbal: CESDA, 1981).

be saline (EC=4), but do contain enough soluble salts to be of concern from a management perspective.

Soils in the valley have also been classified by DTA as to suitability for irrigation. Criteria developed by the U.S. Bureau of Reclamation provided the basis for this classification. The criteria, based on topography and soil physical and chemical characteristics, divide land into six levels that reflect the expected economic return to irrigation ("payment capacity"). Class 1 land has the highest payment capacity while class 6 land is not suitable for irrigation.

None of the soils in Azua valley has class 1 irrigation suitability. Some 10,000 ha, or about 37 percent of the total valley area, are deemed to have class 2 suitability. Inadequate drainage prevents another 9,000 ha from being in the class 2 classification, where low soil fertility and a need for leveling prevent the land from being placed in the top irrigation suitability category. Drainage is deemed essential for dealing with salt problems on about 2,500 ha in the vicinity of Pueblo Viejo. Limitations recognized elsewhere include coarse texture that precludes furrow irrigation (4,000 ha) and excessive salinity, high erosiveness, or permanently high water table, all of which preclude any agricultural use of approximately 2,500 ha.

Low soil fertility and salinity were identified by DTA in 1981 as limiting factors in the irrigation suitability of soils in Azua valley. Analyses of

abrface and subsoil samples (Table III.2) taken in 1983 from 23 fields destined for cantaloupe production serve two functions: (1) to broaden understanding of the extent of fertility and salinity limitations; and (2) to provide some basis for judging whether or not these problems have declined or increased in recent times. The exact locations of the fields sampled are not known, but are believed to be concentrated in the central portion of the valley.

All of the soils sampled contain adequate amounts of potassium, copper, and manganese for crop production. In contrast, 78 percent of the soils are low in phosphorus (15 ppm). The remaining 22 percent contain medium phosphorus levels (16-30 ppm). The laboratory making the analyses judged iron supplies to be inadequate, but this does not agree with interpretations developed in the U.S. Zinc levels are marginal (1.5 ppm) in 96 percent of the soils, which explains why the nutrient is typically applied along with phosphorus and nitrogen. The one zinc analysis of 18.4 ppm (field 6, soil depth b) is assumed to be anomalous, perhaps the result of soil sample contamination.

By definition, saline soils are soils whose saturation electrical conductivity (EC) exceeds 4.0. This is the salt level at which yields of salt-sensitive crops begin to decline. As shown in Table III.2, two of the 23 soils are saline at present. However, unless care is taken to properly irrigate and drain soils on fields 1, 2, 3, 4, 8, 12, 14, 16 and 20, salts have the potential for significantly reducing crop yields.

Percent sodium saturation (PSS) is an index of the hazard for soil dispersion. Any soil with a PSS greater than 15 is classified as "sodic" and there is danger that the soil will disperse, thereby losing its natural structure and becoming impervious to water. Such soils cannot be drained and are lost for agricultural production unless difficult and costly measures are taken to reduce the PSS and restore soil structure. As shown in Table III.2, the subsoil in field 3 has a PSS greater than 15. The hazard is not indicated elsewhere in the fields sampled.

Water

Irrigation water in the Azua valley is at present derived primarily from surface water diverted from the Yaque del Sur River. Water in the extensive aquifer underlying the valley is perceived as being nothing more than supplemental even though it has the capacity to irrigate some 3,500 to 4,000 ha annually. Both sources of water appear to be of high quality for irrigation purposes. The surface water reportedly has an electrical conductivity (EC) of less than $0.5 \text{ mmhos cm}^{-1}$ while the EC of the aquifer water ranged from 0.4 to $1.5 \text{ mmhos cm}^{-1}$ in 1970-71. Thus, in contrast to many arid regions of the world, irrigation water is not the primary source of salinity in the Azua valley.

Although individual farmers may occasionally complain about not having adequate water at certain times, the overriding issue in the valley is excessive water. In October of 1982 IAD prepared a map indicating that the water table was within 0.5 m of the land surface in 15.0 percent of the area encompassed by YSURA and was at a depth of 0.5 to 1.5 m in another 32 percent of the area. A water table depth of 1.5 m is minimal for crop production, even for shallow-rooted crops. For deep-root crops and where soil-borne salinity is a problem, a water table depth of 2.0 m or more is advised.

TABLE III-2
Analyses of Soil Samples from 23 Farmer Fields in Azua

FIELD	SOIL DEPTH ^a	PLANT AVAILABLE NUTRIENTS				
		P	Fe	Zn	EC ^b	PSSC
		 ppm			mmhos cm ⁻¹	
1	a	19	7.5	1.5	1.95	5.6
	b	2	6.7	1.1	2.50	9.5
2	a	8	24.2	1.2	3.15	2.8
	b	5	15.0	1.2	2.65	2.5
3	a	14	8.3	1.2	3.60	7.9
	b	5	6.7	1.0	2.70	15.1
4	a	18	6.7	2.6	2.60	9.5
	b	8	6.7	1.2	3.15	8.7
5	a	10	7.5	1.1	2.45	1.7
	b	3	9.2	0.9	1.20	0.9
6	a	18	5.8	1.2	4.70	9.3
	b	5	5.8	(18.4)	3.60	11.8
7	a	18	7.5	1.2	1.35	0.2
	b	8	6.7	1.0	1.00	0.8
8	a	20	6.7	1.2	2.80	4.6
	b	8	5.8	1.1	2.50	4.0
9	a	9	6.7	1.2	0.87	0.1
	b	2	6.7	1.0	0.72	0.5
10	a	8	9.2	1.2	1.09	0.2
	b	3	7.8	1.0	1.25	0.5
11	a	12	8.3	1.2	1.15	1.7
	b	5	7.5	1.1	0.80	1.2
12	a	9	13.3	1.1	2.80	2.6
	b	4	11.7	1.0	2.15	1.7
13	a	8	6.7	1.2	0.80	0.4
	b	2	7.5	1.1	0.78	1.1
14	a	8	13.3	1.0	1.45	0.6
	b	3	9.2	1.2	3.21	2.4
15	a	13	7.5	1.4	0.65	0.2
	b	4	8.3	1.1	1.50	1.1
16	a	15	6.7	1.3	3.20	1.9
	b	4	9.2	1.2	0.75	0.4
17	a	7	7.5	1.2	0.82	0.2
	b	4	9.2	1.2	0.85	1.2
18	a	5	10.0	1.1	2.20	2.9
	b	2	10.0	1.1	1.50	0.8
19	a	13	8.3	1.2	0.71	0.4
	b	7	7.5	1.2	0.64	0.1
20	a	15	16.7	1.2	3.40	2.6
	b	7	7.5	1.3	1.10	0.6
21	a	11	13.3	1.2	4.20	3.5
	b	4		1.1	2.00	3.2
22	a	4	6.7	1.2	0.68	0.5
		-	-	-	-	-
23	a	7	5.8	1.1	0.68	0.2
	b	3	7.5	1.1	2.40	3.3

[continued]

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- a "a" = approximately 0-15 cm; "b" = approximately 15-30 cm.
 - b Electrical conductivity of saturated paste.
 - c Percent sodium saturation of cation exchange sites.

Since 1982, INDRHI (the national irrigation institute) has been actively engaged in installation of an extensive network of open drainage canals. The project began in 1982 on the western side of the valley, reportedly because of the need to intercept surface water coming from the Sierra Martín García. In terms of kilometers of drainage canals dug, the project is close to 70 percent complete. In terms of the portion of the valley benefited the completion rate is more on the order of 50 percent.

There is a general consensus within the valley that the drainage system is functioning and the problem of the high water table has been surmounted. One example of the effectiveness of the drainage canals is at the CIAZA (Center for Agricultural Investigations in Azua). During the first year that drainage was provided, the water table dropped 1.1 m, from 0.4 m depth to 1.5 m, and this has made it possible for the CIAZA to reactivate its field research program. Along drainage canals constructed elsewhere in the valley, the water table has been observed to subside 1.0 to 2.0 m over a period of 6 to 8 months.

Farmers in the valley are not in total agreement regarding the value of drainage. Some have seen little benefit and are quick to criticize the placement of the canals. To some extent this criticism reflects lack of understanding of the time required for groundwater movement, particularly in the finer textured soils in the central portion of the valley. Given the great heterogeneity that exists in the valley's soils, it is not surprising that neighboring lands drain at noticeably different rates.

Salinity

In other instances where drainage is not perceived by farmers as being the answer to their problems, the issue appears to be salinity. Field observations suggest that this is the case in the vicinities of Los Negros, Rosario, La Cienaga, and Guaya canal. Several farmers in these areas reported that tomato plantings made in recently drained fields germinated very erratically. In some instances the crop was a total loss while in others a partial seedling stand was established. For example, one farmer reported that of 60 tareas planted, only 15 will produce a crop.

Salinity in the Azua valley derives from two sources: (1) the soils themselves; and (2) seawater intrusion. The latter is of concern only in areas bordering the sea and appears of minor importance except in the area immediately to the south of Los Negros.

Soil-borne salts become a problem only when allowed to rise into the root zone of crops or, even more devastating, to the soil surface. When at the soil surface, the salts have the potential of preventing seed germination. Salts below the depth of seeding but within crop rooting zones reduce yields by preventing crops from absorbing sufficient water even when irrigated.

The rise of soluble salts into the crop rooting zone or to the soil surface occurs through capillary action brought about by drying of the soil surface and by elevation of the water table. The latter mechanism likely accounts for the majority of the saline areas in the valley today.

The extent of salinization of soils in the valley and the intensity of the problem have not been quantified. Salt fluorescences on soil surfaces are abundant in areas previously inundated and now being drained. Farmers report severe salinity problems in many areas drained during the past several months. The areas most severely affected seem to be south of a line that roughly passes through Los Negros - Rosario - Guayacanal - Pueblo Viejo - Las Cerreras. If, in fact, this is an area of intensive salinization, then approximately one-fourth of the valley's soils are not capable of producing economic yields of many of the crops currently being grown.

The impact of salts in rooting zones on crop yields elsewhere in the valley is unknown. Salts may very well be a primary reason for the variability in crop yields among the different zones in the valley (Table III.3). Burning of lower leaf margins, a phenomenon commonly observed on melons and tomatoes, is indicative of excessive salts in root zones and often appears to be confused with or confounded by leaf diseases.

Boron toxicity often accompanies and accentuates salt injury to crops. Whether or not phytotoxic levels of boron are present in the valley's soils has not been investigated. Maize is an excellent indicator crop for boron toxicity. Narrow, necrotic bands occur along the entire margins of leaves when excessive boron is present. Because maize is not normally grown in January, there was little opportunity to look for boron toxicity symptoms. However, the symptoms were observed on corn planted around the borders of a tomato field in zone D₃.

Crop Yields

Crop yields reflect the level and type of resources available for production and how effectively those resources are utilized. In Azua, irrigation eliminates water as the major growth-limiting factor. Fertilizers and pesticides are available and in use. Thus, crop yields in the valley reflect the effectiveness of production-input utilization, the level of crop management, and any uncontrolled soil factors that adversely influence crop yields.

Six crops account for 94 percent of the total market value of crops grown in Azua valley. The six crops, in order of decreasing economic importance, are (1) tomatoes, (2) peanuts, (3) sorghum, (4) plantains, (5) maize, and (6) cantaloupes. Among these six crops, tomatoes dominate by contributing 62 percent of the market value of the valley's produce.

Yields of major crops in Azua and of these crops in the Dominican Republic and elsewhere are tabulated in Table III.4. The 1981 yields in Azua were

TABLE III-3

Crop Yields in 1983 and Productivity Indices for Various Zones in the Azua Valley^a
(kg/ha⁻¹ unless otherwise indicated)

CROP	Y I E L D B Y Z O N E									
	Asen. A	Asen. B	A _{1/2}	A ₄	A ₆	C ₁	C ₂	D ₁	D ₂	D ₃
Sorghum	1,000	2,860	1,530	2,060	3,360	3,360	1,650	1,570	1,460	2,180
Maize	1,740	2,540	2,110	968	1,620	1,150	2,130	1,090	1,090	1,450
Cantaloupe	(249 BX)	(551 BX)	(320 BX)	-	(375 BX)	-	-	-	-	-
Tomato	17,200	9,430	-	-	27,400	30,800	27,300	-	-	14,500
Cassava	1,790	5,820	-	7,910	-	-	5,090	-	-	-
Peppers	6,660	6,240	-	-	-	2,540	-	-	-	-
Dry beans	892	841	1,090	-	-	-	-	125	423	484
Sweet potato	-	-	14,500	14,500	-	-	-	-	3,180	-
Peanut	848	576	-	-	-	-	-	2,800	-	-
Productivity index ^b	0.53	0.72	0.77	0.75	0.80	0.70	0.72	0.50	0.37	0.54

^a IAD, "Memorias año 1983; proyecto YSURA" (Azua, December 1983).

^b Productivity index = $\frac{\Sigma \text{ relative yield of each crop}}{\text{number of crops}}$

TABLE III.4
Crop Yields in Azua, the Dominican Republic, and Elsewhere
(kg/ha)

CROP	Y I E L D S					
	Azua ^a		Dominican Republic	Cuba	Mexico	World
	1981	1983		1981 ^b		
Sorghum	3,640	2,170	3,750	1,100	3,562	1,510
Tomato	19,600	20,700	22,700	8,060	15,400	20,800
Maize	1,820	1,700	2,080	1,230	1,810	3,370
Plantain	10,900	6,640	-	-	-	-
Cassava	6,540	6,840	10,000	6,900	10,000	9,060
Dry beans	1,090	422	764	749	683	567
Peppers	5,090	960	-	-	-	-
Sweet potato	5,820	14,000	10,000	4,070	14,100	12,400
Peanut	1,450	3,020	772	1,000	1,240	1,000
Onion	7,270	7,270	7,330	6,400	-	12,300
Cantaloupe	5,820	10,400	12,143	7,200	14,900	13,800

^a 1981 data taken from Johnson et al., El valle de Azua (Santiago, 1982); 1983 data taken from IAD, "Memorias año 1983; proyecto YSURA" (Azua, December 1983).

^b FAO, 1981 FAO Production Yearbook, vol. 35 (1982).

nearly equal or slightly below those reported for the country as a whole and generally surpassed by a small margin yields in Cuba and Mexico. Globally, Azua yields of sorghum, dry beans, and peanuts were somewhat superior. On the other hand, yields of maize, cassava, sweet potatoes, onions, and cantaloupes were inferior to world averages. Yields of sweet potatoes and cantaloupes in Azua were notably better in 1983 than 1981 and were comparable to world yields of 1981.

The general impression gained from the data in Table III.4 is that crop yields in the Azua valley are generally not superior to those obtained in the rest of the country or elsewhere in the world. This raises some unanswerable

questions regarding the production potential of the valley, the effectiveness with which water and other inputs are being utilized, and the economic returns on the vast sums the government has invested and is continuing to invest in YSURA.

Some indication of the presence of soil-related limitations on crop production in the valley can be obtained by examining yields from the various zones. As shown in Table III.3, yields range widely from one zone to another. The differences between the lowest and highest yields for a given crop range from 2.2-fold for cantaloupe to 8.7-fold for dry beans. These yield variations clearly indicate substantial differences in the crop yield potentials of the various zones. The extent to which this variation is soil-related is unknown.

Productivity indices (Table III.3) were computed for each zone to roughly characterize their yield potentials as reflected in the 1983 yield data. The indices suggest that the valley can be roughly divided into two and possibly three regions with different crop yield potentials. The region with highest yield potential consists of those zones with productivity indices ranging from 0.70-0.80 and includes Asentamiento B, A 1/2, A₄, A₆, C₁, and C₂. The region of intermediate yield potential includes zones Asentamiento A, D₁, and D₃. Whether or not to include zone D₂ in this region or designate it as a part of a region with low yield potential is debatable. Yield data for 1983 from zones A 1/1 and A₃ are too few in number to categorize them according to yield potential. However, the few numbers available suggest that zone A₃ belongs in the region of highest yield potential and A 1/1 in the region of lowest yield potential.

Historical Perspective

Excessive amounts of water and salinity have troubled and continue to trouble crop production in the Azua valley. Although they will be discussed separately here, it is important to realize that the two problems are closely interrelated. Salts move with water in soil. Where the salts accumulate reflects the preponderant direction, rate, and extent of water movement.

Excess Water

In August of 1979 Hurricane David swept through the Azua valley and was followed by 12 days of continuous rain. A short time later, Hurricane Frederick added more rain and the precipitation for the year totaled more than double the annual average rainfall. To many people in the valley, Hurricane David marks the time when high water tables and flooding became problematic. In actual fact, the two hurricanes merely aggravated a pre-existing problem.

Improper drainage is a historical problem in Azua. This is best evidenced by the presence of a gleyed (reduced) horizon at 50 cm in the modal profile of

2. Dominican Republic, Departamento de Tierras y Agua, Estudio semidetallado de la llanura de Azua, Doc. Téc., no. 21 (San Cristóbal: CESDA, 1981).

the Los Negros soil.² Problems of flooding and high water table are well documented in the report of Shifton et al.³ They reported that throughout 1971 a triangular area bounded by La Cienaga, Rosario, and Guayacanal and amounting to about 10 percent of the valley's total area had free water on the soil surface. A water table at less than 1.0 m was observed in 1970 and 1971 in the area south of a line running approximately through Los Negros and Pueblo Viejo. Hence, during the years 1970 and 1971 excess water rendered nearly 25 percent of the valley unsuitable for crop production.

Flooding and high water tables did not reach "crisis" proportions until 1981—almost two years after Hurricane David. Multiple factors led to this crisis. Those readily identifiable are:

- 1) naturally impeded drainage in the lower end of the valley;
- 2) failure to provide artificial drainage;
- 3) cessation of well pumping once water from the Yaque del Sur River was available;
- 4) indiscriminate irrigation by farmers that was facilitated by continuous flow of water in the irrigation canals; and
- 5) substantial infiltration of water from earthen canals connecting concrete diversions in lateral and sub-lateral irrigation canals to points of water usage in farmer fields.

Although there are charges and counter-charges regarding which of the above factors are most significant and who is at fault, there is agreement in the valley that the network of drainage canals being installed has surmounted but not completely overcome the drainage problem. Several answers exist as to why drainage and irrigation canals were not installed simultaneously. The most plausible explanation is that the need was not fully perceived when the irrigation system was constructed and if even it had been perceived, political and social pressures for settlement were too great to allow time for installation of drainage canals.

Salinity

As in the case of excess water, salinity is not of recent occurrence in the Azua valley. Salts have always existed at varying depths and quantities in the soils. Although far from being thoroughly investigated, soils with the highest salt content appear to be those situated south of Los Negros, El Puerto, Rosario, Guayacanal, and Pueblo Viejo.

Shifton et al.⁴ analyzed well water during 1970-71 and observed considerable salinity in the vicinity of Los Negros and in the southeast corner of

3. Shifton et al., Hidrogeología.

4. Ibid.

the valley. Well water salinity around Los Negros increased notably between 1965 and 1971 and was attributed to seawater intrusion brought about by excessive pumping in the area.

Rising water tables and flooding in the valley have undoubtedly moved salts into crop rooting zones or to soil surfaces. Thus, the land area where salts now limit crop yields or prevent production has expanded in recent times. Estimates of the current salt-affected area vary widely, from 200 to 2,500 or more hectares. The fact of the matter is that the problem has not received much official attention and its extent and severity are not known.

The Future of Azua

Installation of drainage canals is a vital first step toward resolution of the water and salinity problems in the valley. But it is only the first step. Many follow-up actions will be required to assure the well-being of farmers and agriculture in Azua. Perhaps the most critical need at this moment is technical expertise in soil and water management and salinity control. Other needs, some already apparent and others anticipated, will have to be satisfied as the problems faced become less and less general in nature and more crop-, soil- or location-specific. The following concerns and observations serve to identify the types of actions and activities on which the future of the valley depends:

Water Management

- 1) The irrigation system is showing signs of age. An ongoing, adequately funded and properly staffed maintenance program is not in place.
- 2) Water use efficiency is an unknown practice. Losses between the lateral and sub-lateral canals and farmers' fields appear substantial, but this needs to be verified. It may well be that such losses are contributing significantly to ground water and high water tables. On-farm water use efficiency can likely be improved substantially via land leveling. Estimates are that leveling can reduce water requirements by 30 percent or more.
- 3) On-farm water use can undoubtedly be improved and, in the process, help alleviate the excess water problem. Statements such as "Farmers use 150 to 160 percent more water than necessary" and "Substitution of siphons for open-ditch irrigation can increase 3- to 4-fold the amount of land irrigated with a given amount of water" need to be verified and, if proved true, appropriate actions taken to foster farmer adoption of improved irrigation practices.
- 4) Actual water requirements for specific combinations of crops and soils have not been established. Soil and crop differences are not adequately recognized. Soils in the valley are highly heterogeneous. Hence, water requirements are equally variable in the valley. There seems to be no recognition of the fact that where salinity is a problem, water requirements must include a leaching requirement on top of the actual crop requirement. The current soils map has a scale of 1:30,000 and is too general to serve as a guide for delineating zones with different water requirements. A soils map with a scale of

1:5,000 is considered to be the minimum for irrigation projects and areas of intensive agricultural development.⁵

Soil Management

1) Water holding capacity, water infiltration rates and conductivity, and crop rooting depths are intimately related to soil physical properties and in turn relate to irrigation requirements, drainage, and salinity control. Under improper management, the physical properties of soils can deteriorate rapidly. Some evidence of this is already evident in the form of tillage pans and poor soil structure. The issue is not receiving any attention at the present time.

2) As shown in Table III.2, past fertilization practices in conjunction with inherent soil differences have led to rather wide differences in the fertility of soils in the valley. For lack of a soil-testing service in the valley and fertilizer recommendations based on field research, farmers are applying fertilizer at rates that ignore soil fertility differences. Not only is this inefficient from an economic perspective, but it also has the potential for creating serious nutrient imbalances. Of particular concern at this time is the well-documented phosphorus-induced deficiency of zinc in soils such as those in Azua that have inherently low zinc supplies.

3) Another soil management concern relates to the influence of tillage practices on water requirements and salt accumulation. Seed bed configurations merit investigation from the perspective of reducing water requirements and ensuring that salt accumulation does not occur near seedlings. CIAZA is doing some research of this nature with tomatoes and should be encouraged to expand this to include progressive building of the broad seedbeds required to prevent contact of cantaloupe with free water.

Crop Management

1) Crop selection can be critical as lands in the southern portion of the valley are drained. These soils commonly suffer from excessive salts. Crops vary considerably in their salt tolerances. Hence, at least until the salts in newly reclaimed lands can be leached, proper crop selection may well be the deciding factor in whether farmers experience success or failure.

2) There is ample evidence in the valley that growing the same crops year after year leads to build-up of disease and insect populations. Serious thought needs to be given to crop rotation as nematode and disease-control practices. Crop rotation also has the potential for reducing reliance on fertilizer nitrogen and improving soil physical properties.

3) Yields of crops grown in the valley (Tables III-3 and III-4) are less than what might be expected for an irrigated region. The reasons for this merit investigation.

5. U.S. Department of Agriculture, Soil Survey Manual, Handbook no. 18 (Washington: GPO, 1951).

Drainage Management

1) Drainage canals lose their effectiveness when weed growth and siltation are allowed to occur. Just as in the case of irrigation canals, continual maintenance is essential.

2) The open-ditch drainage system currently being installed will not and does not function efficiently in regions of clay-textured soils. The problem is the relatively slow rate at which water moves through fine-textured soils. Sub-surface drainage systems such as tile systems will be required if these areas are to be made highly productive. Fortunately, INDRHI is already thinking along these lines. The main barrier to subsurface drainage systems is the initial cost. Once properly installed, their maintenance costs are generally less than those of open ditches.

3) Continued well pumping in the valley is important, mainly from the standpoint of control of ground water level. Arguments that pumping is not effective in this regard are refuted by the studies of Shifton et al.⁶ Their data show that between 1965 and 1971, pumping increased the depth of the water table by one meter or more over a wide area in the valley and by up to six meters in the vicinity of intensive pumping. The IAD is responsible for maintenance of the wells and pumps and obviously lacks the resources to carry out this responsibility effectively. Reports of pumps being in disrepair for periods of several months at a time came from numerous locations and sources.

Salinity Management

1) The extent and severity of salinity in the valley is largely unknown. Until the dimensions of the problem are established, it is impossible to map out an effective reclamation and control strategy. Farmers have already experienced staggering economic losses due to unsuspected salinity, and the problem can only grow in the months and years ahead unless technical expertise in salinity management is quickly introduced.

2) That salinity has not had more devastating effects in the valley until now is largely due to the fact that the soils contain an abundance of free calcium carbonate. With proper leaching, calcium from the carbonates serves to displace sodium from cation exchange sites and thereby promote leaching. What is deficient in the valley is research that establishes leaching requirements, i.e., how much water in excess of actual crop requirements must be applied to leach salts and to keep them out of the rooting zone of crops.

6. Shifton et al., Hidrogeología.

References

- Dominican Republic Departamento de Tierras y Aguas (DTA). Estudio semidetallado de suelos de la llanura de Azua. Documento Técnica, no. 21. San Cristóbal: CESDA, 1981.
- _____. Instituto Agrario Dominicano (IAD). "Memorias año 1983; proyecto YSURA." Azua, December 1983.
- Food and Agriculture Organization (FAO). 1981 FAO Production Yearbook. Vol. 35 (1982).
- Johnson, B.T.; Cuevas, L.P.; Crouch, L.B.; and Reyna, C. El valle de Azua. Santiago: ISA, 1982.
- Shifton, Z.L.; Greitzer, Y.; Frink, M.; and Damison, R. Hidrogeología del valle de Azua. Tel Aviv: Tahal Consulting Engineers, 1971.
- United States. Department of Agriculture. Soil Survey Manual. Handbook, no. 18. Washington: Government Printing Office, 1951.

IV. THE PRIVATE CORPORATE PARTNER IN THE AZUA JOINT ENTERPRISE EXPERIMENT

by

Pat Ballard

The transformation of marginal lands in the Azua valley is being conducted through a "joint venture" where the participants are the Dominican government, private corporations, and small-scale farmers, principally the beneficiaries of agrarian reform. Water provision by the Dominican government has been the factor which has given this joint venture its viability.

The purpose of this paper is to describe the role of one of the partners in this venture, the melon and tomato agroindustries in the Valle de Azua and especially in the YSURA project area, in the use of water. These industries are of central importance to the development of the valley since they organize major uses of technology, water, and labor, and control the majority of the monetary circulation of the project (credit, marketing, and distribution of costs and benefits). While these companies also respond to institutional pressure (i.e., regarding water use, price negotiations, etc.), their fundamental logic responds to the necessities of the market and overall profit motivations. To understand the conditions which give rise to the forms of production and water use in the YSURA project, then, it is necessary to describe the nature of these companies and their activities at the national and international levels.

Agroindustries in the National and International Context

Melons

There are three melon companies which are active in the project area, all of which have some degree of foreign capital investment. The first company to begin contracting production in the project was formed as a joint venture between Israeli, U.S., and Dominican capital in 1981, in which the technical assistance and management are predominantly Israeli. The second company was formed in 1983 by a group which splintered from the Israeli venture, was financed by Dominican and U.S. capital, and received financing from the Banco Agrícola as well as a great deal of help from IAD, which thought the competition between melon companies would be good for the producers. The third company, a Mexican firm, has its major activities just outside the project area but is increasing its production contracting within the project. It is the only company which owns its own land in the region (+8,000 tareas). All three of these multinational firms market their produce in the United States, and none is large enough to influence wholesale prices, which are determined by winter market conditions in the United States.

The sources of financing and ultimate disposition of the products and profits are intimately tied to the international market. These firms respond

to management decisions, many of which are made outside of the Dominican Republic, and to market restrictions determined by international competition. This competition concerns: (1) market access, (2) labor and input costs, (3) product quality, (4) transportation access and costs, and (5) government regulation (quotas, tariffs, taxes, profit repatriation, product quality control).

The companies in the project area in general are competitive in the U.S. winter melon market. The climate and the ecological conditions in the valley permit production of USDA No. 1 cantaloupe (the second highest grade, one step below "Fancy"), which is competitive in quality with Florida or Texas melons. The financial conditions also appear to be favorable. Unit labor costs are much lower than in the United States, and while chemical input costs may be higher, these are probably offset by cheaper labor and access to government-subsidized capital equipment, infrastructure, tax incentives, etc. Transportation by truck, sea, and air to Miami is thought to be cheaper and better developed than that available to the Central American exporters. Vertical integration with brokers and wholesalers in Miami affords the required market access and reduces the flow of resources to intermediaries. Market access is often cited as a main reason why the Dominican government decided to permit these companies into the area, since it is generally thought that vertical integration with U.S. capital involved is a requirement for entry into the U.S. fresh fruit and vegetable market. These advantages are not overwhelming, however. One company representative said that a shipment of 150,000 boxes in April 1983 yielded no profit, since by that date Florida and California melons had already come onto the market.

The only other melon supply source which is a strong competitor is that of Mexico, which according to one company's source will increase melon production by over 600 percent in 1984. Given Mexico's proximity to the U.S. market, and the large volume of production, at least one company in the Dominican Republic predicts the Mexicans will force prices for winter melons to fall. However, it is not felt that in the medium term the quality of production can be maintained, and in addition falling prices should result in a cutback in production in Mexico. This source of competition has caused enough concern so that one company sent a representative to Mexico to observe the development there.

Otherwise, the companies' outlook is optimistic as U.S. demand for melons in the winter season has increased steadily, and prices have shown an upward trend. Both the companies and IAD personnel interviewed feel it is likely that more companies will move into the area, and some have already inquired about the possibilities of contracting production.

Competition between the melon companies within the valley is generally viewed by the institutions there as beneficial, although the companies themselves have differing opinions. At least one company reported that when they increased prices to producers for smaller melons, another company followed suit. However, tensions also run high, and one company reports incidents of sabotage of its equipment, threats to personnel, etc. Further competition may increase the tensions, or lead to company expansion elsewhere, or lead to collusion between the larger firms.

The case of Company X, the largest melon contractor, illustrates the international market links of these multinationals. The company is a subsidiary

of a firm which contracts production of fresh fruits and vegetables in Guatemala and Costa Rica. The firm formerly had operations in El Salvador, but moved to the Dominican Republic as the civil war in Salvador increased in intensity. They were attracted to the Valle de Azua by the government-provided infrastructure and the growing conditions, and also have operations in Santiago, where they contract production of honeydew melon and pineapples for export.

The company sends 95 percent of its YSURA produce to Florida and New York via ship, contracting with CCT and other major shipping lines which run four times a week; 5 percent of its produce goes by air. Transport costs were not divulged, but other companies have cited 11¢/lb by air and 5¢/lb by ship, or by other arrangements \$2,200-2,300 per loaded ship; some mentioned approximately US\$4 per box.¹ Company X feels there is a cartel operating among the shipping lines since "all their prices go up together." However, it is generally happy with the services.

Company X is vertically integrated, financed by its parent company, and ships to its own broker/wholesaler. Cantaloupe are sent by truck to several points in the United States, as far away as California. The company's production in the area in December 1983 was 120,000 boxes, and the peak production of 150,000 boxes occurred in April 1983.

Company Y ships mainly by sea; however, it has a "big transportation problem." According to Company Y officials, ships leave only once every five days, are often off-schedule, and stop in Puerto Rico where the cargo is off-loaded onto larger ships, resulting in loss of time. Since the maximum time from farm gate to final consumer is considered to be two to three weeks, this company feels it can reduce losses by shipping by air although the cost is considerably higher. Unfortunately, we could not reconcile these two views.

Company Y sells 75 percent of its exports through one broker who is also a large grower in the United States as well as part-owner of an investment company which operates throughout the Caribbean and who was inspired in part by the Reagan administration's Caribbean Basin Initiative. This company also engages in financial ventures and is active in the cattle sector, oil refinement, and capital management.

The melon companies do not in any significant way process the products they export---the melons are merely washed, selected for size and quality, packed in boxes, and refrigerated for shipping. There is, therefore, very little value added after the melons leave the farm gate. However, the value realized in marketing is proportionately very high in relation to the value realized in production: according to one company, producers are paid approximately \$4 pesos/box, which then resells for \$28/box F.O.B. Pompano Beach, Florida.

While none of the companies interviewed was willing to discuss its rate of return on investment, one IAD official noted that "It must be well over 100

1. A box consists of from 6 large to 30 small melons. It is not known how much a box weighs.

percent per year," and some say this is a conservative estimate. We will take up this subject again in the section, "Distribution of Project Benefits and Costs."

These companies, then, respond to market conditions in the United States and are dependent upon market information, capital, and management decisions whose origins are both higher in the company hierarchy and tied to overall investment decisions of diversified multinational operations. This means that the ability of these companies to respond to government regulation, changing market conditions, etc., is limited, and their success depends upon their ability to maintain an unspecified high rate of return.

Tomato Companies

Tomato companies were among the first to participate in production contracting in the YSURA project. One company has been "growing" tomatoes for 9-10 years and processing for 7 years; the other company began operations in 1966 in Santiago. A group of Israelis opened the area to tomato production in the early 1960s and proved the viability of production. One company at first shipped to its parent company in Santiago, then later moved its operation to Azua, while the other company still ships its tomatoes to its processing plant in Santiago.

The tomato companies are both Dominican-owned and, although one occasionally is financed by sources in the United States, the bulk of the investment capital is Dominican. Tomato contract production in YSURA is exclusively for industrial use, and all processing occurs within the Dominican Republic (in one case within the project area itself). Both of the companies have occasionally exported their finished products--tomato paste, juice, and catsup--to Haiti, to other Caribbean countries, and in one instance to a large U.S. firm. However, exporting has become increasingly difficult recently, and most products are sold on the internal market. The companies own no agricultural land of their own in the area. Production contracting is carried out in a fashion similar to the melon companies.

Company A sells 100 percent of its product in the internal market through an affiliate of the same name located in Santiago. A company official estimated national internal demand for tomato products at 900,000 cases per year, with overall national production last year at 1.2 million cases (of 42 lbs gross weight each). Shortages on the internal market, he maintained, are artificially created by wholesalers holding back stock to force prices up, which may explain the difference in these figures. Demand is apparently inversely tied to overall economic conditions within the Dominican Republic. Consumption of tomato products increases as real incomes decrease, thereby encouraging consumers to switch to lower-cost foodstuffs, particularly pastas, traditionally eaten with tomato paste.

Company A sells its products through its affiliate to over 2,000 clients, including wholesalers and supermarket chains. Company B, which claims to be as "big as or larger than" Company A, processed 1,200,000 quintals (60,000 tons) of tomatoes last year. Its marketing has been "all within the company for many years," with sales going to wholesalers and supermarket chains.

Both companies are exploring the possibility of increasing exports, especially to Haiti, the Caribbean basin, and Canada, and feel that the Caribbean Basin Initiative may improve their situation. However, currently there are several obstacles to greater participation: international prices are not very attractive, costs of imported inputs tend to offset lower labor costs, and the U.S. (especially California) is able to produce tomatoes of better quality with higher technology under better climatic conditions. Productivity in the Dominican Republic, it is believed, is too low for effective competition.

A major concern of the tomato companies is the increasing cost of imported inputs, which they feel may be severely aggravated if the government's fund CEVEMA, which supports the subsidized prices, is eliminated. One company has stockpiled inputs, but anticipates it will have to return to the market this year, and production costs may rise dramatically. This company depends upon imported tin plate, seed, chemical inputs, and machinery (90 percent of which is Italian), but the cans are made in the Dominican Republic, and cardboard cartons are also manufactured in the Dominican Republic from imported or recycled material. The other company imports seed from California and all chemicals from Germany, Switzerland, and the United States. Its machinery is U.S. and Italian, and the cans are imported prefabricated from the U.S. as well. While the former company is associated with the government through its arrangements with the Banco Agrícola, and therefore apparently has special privileges vis-à-vis the CEVEMA fund, the latter company does not and purchases exclusively from private importers. The management of that company expressed its concern about the availability of dollars and the worsening terms of trade, but feels this "will affect everyone equally" and so will not place them at a competitive disadvantage.

The viability, then, of tomato contracting depends upon the overall economic conditions in the country, government policy regarding imported inputs, and the possibility of raising prices. At least one company is pessimistic about the possibility of raising productivity in the fields due to a lack of improved seed adapted to local conditions (especially climate). There may be significant resistance to price increases, however, given that tomato products are considered to be a dietary staple. Other problems which affect the future development of these companies will be discussed in later sections.

Generally speaking, the tomato companies invest Dominican capital, and although dependent upon foreign inputs, add significant value to the product through processing. As domestic firms, however, they are subject to cost-price squeezes from deteriorating terms of trade.

Agroindustry Operations in Production Contracting

Contract production with small producers such as the farmers in the agrarian reform project is very attractive to the agroindustries since it generally allows for a higher rate of profit than would be the case if the companies engaged directly in production or if they contracted with large-scale farmers. According to two company representatives, smaller producers dedicate more labor to their crops and can more readily respond to production problems (i.e., unseasonal rains) than their larger counterparts. The larger producers are more

mechanized and thereby less able to harvest when the weather is unfavorable. Larger producers are, however, generally better organized and more able to make demands for higher prices, or to switch to other markets. Smaller producers are likely to have less market information, poorer transportation access, and in general higher per unit "transaction costs," and so accept lower prices.

The producers in the YSURA project are almost completely dependent upon the companies for technical assistance, inputs, credit, markets, and transportation. These relations of dependency give the companies a great deal of control over the production and marketing process, which is usually not afforded when dealing with larger producers.

Production contracting is probably preferable to engaging in private production, since in production contracting nearly all of the risks are transferred to the producers and not absorbed by the companies. The companies are obligated to purchase only that part of the harvest which meets their quality standards. In YSURA production contracts are structured to afford the companies a high degree of control while reducing risks to the companies to an absolute minimum. One tomato company, for example, had 18-20,000 tareas in the Santiago area, owned by only 8 farmers. These contracts were abandoned for small parcels in the south where "minifundia dominate."

One melon company manager explained the production contract relation succinctly: "We are farming. We do the preparation, the cultivation, everything through the producers. The farmers are doing the manual labor--some of the fumigation, also the harvest." This company and others insist upon tight control over the production process "from the cradle to the grave," and feel that without this control, the quality of produce would decline, as would the overall volume of production. "We are working with a very low class of producers," one official stated, and productivity increases in the valley are attributed almost entirely to the supervised contract. This attitude tends to contradict previous statements regarding the preferences for smaller, more attentive producers, but the attitudes of the companies' employees toward the producers are often ambiguous--and some would even say paternalistic.

There appears to be a fairly high degree of competition both within the industries and between tomato and melon contractors to obtain contracts with proven producers. Bad debts, poor yields, lack of initiative or poor land are conditions which can exclude a farmer from a company's operations, although the most consistent reason seems to be poor soil conditions (salinization) or problems with inundation. The companies compete, then, to reduce risks and obtain the greatest volume and highest quality product.

All of the firms interviewed were reluctant to give exact figures on the number of farmers under contract or the number of tareas in production. The limited information received is presented in Table IV.1. One tomato company recently halved the number of tareas in production in YSURA and increased its contracts in the north, a switch which was "not for reasons of land or climate," but apparently to minimize transport costs. We also speculate that their concern about expansion of melon production in the project area or actual land use conversion on the part of the farmers may have played a role.

TABLE IV-1
Number of Parceleros and Number of Tareas
in Production by Agroindustries Interviewed

	YSURA PROJECT		COUNTRY TOTAL	
	# Parceleros	# Tareas	# Parceleros	# Tareas
Melon Company X	400	14,000	n.a.	n.a.
Melon Company Y	n.a.	n.a.	n.a.	n.a.
Tomato Company A	n.a.	3,000 ^a 28-30,000 ^b	2,000+	37-39,000
Tomato Company B	200-300*	5,700	n.a.	34,000

* Probably underreported, given number of tareas.

^a Financed through the Banco Agrícola.

^b Financed by the company.

Credit arrangements vary from company to company, but one IAD official estimated that around 90 percent of the credit available to contract producers is provided by the agroindustries, and 10 percent by the Banco Agrícola. Although it was intended that the Banco Agrícola would supply credit, inefficiencies in payments by the bank apparently caused companies and producers to change credit arrangements. At least one company charges no direct interest on its loans, while the Banco Agrícola reportedly charges 9 percent, sometimes on funds before they are disbursed. Producers also receive advances or are paid frequently during the harvest season, whereas the Banco Agrícola apparently disbursed payments only at the end of the season, and then payments were delayed. "The Banco Agrícola was killing the goose that laid the golden egg," one manager explained, "[since producers] were starving while waiting for the harvest." Melon Company Y noted that, upon beginning operations, it anticipated that 70 percent of its capital would be physical and 30 percent operational, but instead of placing 20,000 pesos in a rotational fund, they had to invest 100,000 to cover credit to producers.

This newer credit arrangement seems to be functioning smoothly, and liquidations generally occur within 10 to 30 days, according to the companies. At least one official also reported that his company works very closely with the Banco Agrícola, whose operations are becoming more efficient and are being managed with much more vigor than in the past.

All of the companies interviewed provide producers with seed or plants, fertilizers, chemical inputs, and technical assistance, as well as transport the harvest to their facilities. Land preparation is often done by the companies, although many also make use of the services of PROSEMA (Proyecto de Servicios y Maquinarias Agrícolas), a government institute which prepares land at a low cost. Both of the tomato companies claim that they are leveling some land as part of the preparation, but only in areas where topography is a significant obstacle to production.

Melon production is highly mechanized and involves significantly less manual labor than tomatoes (however, precise statistics were lacking). Planting and cultivating are performed mechanically, while harvesting is done by hand. Company Y owns one tractor and rents another from IAD. It did not report the number of technicians it has in the field. Company X owns "60-70 percent" of its own equipment and has two operation centers with 12 technicians in the field (or one technician for every 1,100 tareas).

Tomato production apparently involves hand and mechanized sowing but cultivation and harvesting are manual. Company A did not reveal its source of machinery but reported having 13 permanent field technicians and 8-10 additional technicians during the 3-month peak harvest season (or 1 permanent technician for every 2,300 tareas and, with temporary employees, 1 for every 1,400 tareas).

All of the companies interviewed determine the type, quantity, and form of application of fertilizers, herbicides, pesticides, and fungicides used in production. Problems with black marketing of these inputs (parceleros at times sell these inputs outside the project area) have led at least some companies to remove labels from the chemicals so they cannot be easily identified--however, this should be a cause for concern since these products are a definite health hazard. Field observations also revealed a lack of care (and probably knowledge) with respect to human contamination, especially on the part of farm laborers. Several government officials also reported that the use of chemical inputs is "indiscriminate." The problems of input application lie both in the lack of knowledge about application and in the type of inputs used, which also may make the export of tomato products difficult. An INDRHI official claimed that certain (chlorinated) pesticides used are banned in the U.S., and is concerned enough about health effects to undertake his own investigation of alleged poisonings.

Tomato companies expect the number of pesticide applications will continue to increase, as several years of continuous production often lead to an increase in disease and pest infestations, while the efficacy of the pesticides declines. It appears that the melon producers are in fact experiencing significant problems with disease and fungi, a condition which is also likely to be exacerbated over time if the pesticides are in fact being applied incorrectly. There was at least one melon disease which technicians apparently did not know how to control chemically, although the company has a technical assistance contract with the University of Florida to find solutions to such problems.

Nearly every company interviewed complained that IAD lacks the expertise and the resources to provide much technical assistance to tomato and melon

growers. There is no laboratory available to analyze plant specimens, diagnose diseases, etc.

Transport of the harvest from the field to the packing plants is provided by the companies. Until last year the tomato producers were debited for losses occurring during transport, but strong objections to this changed the policies so that the companies now absorb transport losses. Tomato companies all contract with private truckers, a cheaper arrangement, but there are continual problems with the services since the trucks are overloaded and break down frequently. Tomatoes are weighed at a station with an IAD representative present, but many producers complain that some companies subtract too many pounds for fruit that is damaged, especially considering that some of the losses are due to the companies' packing system and others caused by weight loss which occurs while waiting for trucks to arrive (we noted some full crates at the roadside for more than 24 hours). So while theoretically the companies are responsible for transport losses, producers apparently still suffer some penalties from excessive delays in the arrival of the trucks.

Melons are selected for size and quality upon arrival at the packing plant. Melons which are rejected are returned to the producers for sale to local buyers. The system operates on faith, since the producers are not on hand to observe the selection process.

Agroindustries and Water Use

The previous section describes the high degree of control over the production and marketing process by the melon and tomato companies. At the farm level, water is simply another input, whose use by the farmers in the production process is also influenced in large part by the companies. Since water use is locally a very important question, local government officials are very cognizant of the implications of this company influence over water use.

A common dilemma derives from the fact that, while individual water-use practices may be rational (highly productive) at the farm level, when excess individual use is aggregated across several farms, external diseconomies (or environmental externalities) can result. If we leave aside for a moment the role of the government, the flooding and salinization in the Valle de Azua can be seen as a fairly classical example of such a diseconomy, since overuse of water by some producers has led to water shortages for others; overuse by some has also contributed to inundation and salinization of parcels where the water table is high, where drainage is poor, or at the end of the canals. In this section we will discuss the rationale behind water use at the farm level, the diseconomies produced for the system as a whole, as well as the obstacles and possible alternatives for more efficient resource allocation.

To understand water use at the farm level, we must refer back to the rationale underlying contract production, in which the farmer himself modifies only slightly the production decisions and standards defined by the industries. First, it is clear that the industries aim to maximize profits by obtaining the highest volume and quality of production at the lowest possible cost. Second, none of these companies is tied, by means of direct ownership, to

particular parcels of land, but rather can shift operations around the area, limited only by the amount and quality of land available and competition for this land. There is also the possibility of shifting production outside the area entirely. Third, production contracting allows the companies to shift most of the risks of production onto the producers. These three general factors common to the agroindustries combine to create a situation in which there are very few incentives for the companies to reduce the external diseconomies of water use, at least in the short term.

Producers also attempt to maximize their returns, but their relations with the companies at times place them in a contradictory position vis-à-vis their own interests. If, on the one hand, a producer wishes to maximize his own profits, he must produce according to the specifications of the company with which he has a contract. The penalty for failing to do so, especially if this results in lower yields or poorer quality, may be financial loss as well as loss of a contract the following year. On the other hand, the farmer is tied to a particular parcel of land upon which the future (long-term) survival of the family depends. Lacking the geographical mobility of the companies with whom he contracts, the producer must attempt to balance a season's profits against the maintenance of the productivity of his parcel for the coming seasons. This rationale, however, becomes unbalanced when producers, due to unfavorable economic circumstances (e.g., cost-price squeeze) or external controls, are forced to focus exclusively on short-term survival, where the long-term viability of production may be sacrificed.

Factors Affecting the Water Use of Agroindustries

The agroindustries combine labor, capital equipment, and inputs in certain proportions to minimize costs and maximize yields. Water is a free good in this equation, since neither the companies nor the producers pay for the quantity of water consumed. Therefore, the quantity of water consumed by a particular crop does not affect the overall decision about which crops should be grown. Water use does represent an expense in terms of the labor involved in its application, and hence minimizing this cost is part of the overall equation. Water can also take the place of labor in certain forms of application, i.e., as a medium to diffuse herbicides. Water application also represents a capital expense for infrastructure, but in the case of Azua, this expense is shouldered by the state. Once the infrastructure is in place, the major function water plays is to intensify production, to raise the productivity of labor. At a certain point, however, there are diminishing and even negative returns, not because water represents a costly input, but because overuse can for various reasons reduce yields.

There are two basic questions that must be answered with respect to the logic of water use in the Azua situation: does X quantity of water, which minimizes labor time, capital costs, etc., and maximizes yields over all production units (from the companies' perspective), create negative environmental externalities for the system as a whole? And if so, who pays for these externalities?

Labor time is minimized in water application by canal irrigation which allows for a free flow of water and minimum supervision. According to one agroindustry owner, the "fast way is to turn the water on and leave it

It costs less to produce this way because you don't need anybody out there [supervising]." Another technician in a government agency observed that many farmers also prefer to spend their time in other activities than watching over water flows. Generally speaking, for a variety of reasons, irrigation is not significantly supervised in the valley.

Capital costs are also reduced by using open canals. First, there is no need to purchase equipment, such as siphons, tiles, etc. Second, certain chemicals can be applied simply by dissolving them in water, thereby reducing the need for sprayers (and the labor involved in dissemination). Third, the equipment used to sow and cultivate the crops is designed for canals and seedbeds of specific forms and dimensions, so that continually adjusting equipment to reduce canal size or the distance between the canal and the plants, etc. for different parcels might involve significant labor expenses.

Short-term risks may also be reduced by applying the maximum amount of water possible without damaging the crops, e.g., during sowing. Soil moisture reserves protect against an unforeseen canal closure or the possibility of a delay in irrigation for other reasons, such as unevenness in water distribution beneath the soil.

Free-flow canal irrigation (boca abierta), then, tends to minimize costs and reduce risks. However, it can also produce diseconomies at the farm level. Without adequate control over the water flow, and exacerbated by topographical undulations and poor drainage, certain areas in a given parcel receive too much water, leading to spots of inundation or salinization if the water table or salt levels are high. This latter condition is more likely to occur in certain areas within the project than in others, however. Land leveling, which would increase the efficiency of canal irrigation and drainage by an estimated 30 percent,² represents an expense which, in general, the companies are unwilling to bear.

Melons are more likely to be adversely affected by overuse of water than tomatoes, since melons cannot tolerate moist surface conditions. The melon companies have switched from open canal irrigation to siphon irrigation, which can reduce the amount of water use by at least 30 percent if applied correctly, according to one INDRHI official, while allowing for fuller penetration of water into the soils. However, the seedbed configuration of melons still necessitates large volumes of water, which are not actually used by the plant, to penetrate the distance to the seedling or the maturing roots (approximately 9" from the canal to the seedling, with canals approximately 18" wide).

The tomato companies all irrigate with the boca abierta method and use quantities of water which the melon companies claim are "three times that which is necessary." Producers interviewed were very aware of the problems produced by irrigating with this method, which they felt "washes all the topsoil away" and increases problems of flooding and salinization especially if drainage is inadequate or if soils are not allowed to leach. Melon company representatives criticized the staff of CIAZA, the government arid-lands research institute,

2. The estimate is from INDRHI.

for "not knowing anything about farming" and faulted their research for not adequately measuring economic returns of different production packages. Perhaps part of their dissatisfaction is due to the fact that CIAZA is attempting to develop seedbed configurations which apparently do not fit existing company machinery configurations. Several producers pointed out to us certain problems with the melon seedbeds, but complained that they are told what and when and how to produce by the companies and are unlikely to risk a confrontation with company representatives by changing procedures.

Even if water is used rationally on the farms, in terms of maximizing returns, this does not mean overall water use is rational. A parcel located at the lower end of a slope receives the runoff (surface, if drainage is inadequate, or through an elevated water table) of the parcels "upstream." If water is not used carefully on the farm, these external effects are even more aggravated, and the farmer also suffers losses of crops, and even land, to salinization, inundation, or waterlogging diseases. If the effects of excessive water use are entirely externalized, neither the producer nor the agroindustries suffer, as long as there is an adequate quantity of good land available for production. If land productivity is reduced, however, the farmer of such land suffers losses which can seriously affect his livelihood, whereas the companies will face losses only if the condition is so generalized as to reduce the overall volume of production and sales.

The agroindustries will usually avoid contracting production in those areas (and on specific parcels) where salinization or inundation is a problem. The tomato companies do advance credit in the affected areas, but only for the number of tareas on a parcel which they feel will be productive. In several cases, due to technical inexperience, this amount was overestimated, or the decision to advance credit on recently reclaimed land was premature, and producers either barely broke even or became indebted. The melon companies maintain that they entirely avoid those areas and parcels which have problems with salinization and inundation. By this means, they avoid the risks associated with overuse of water. According to one INDRHI official, "The companies don't care whether the cultivators flood the land or not. Because if a company damages the land of a farmer today during this harvest, for the next harvest they will use other farmers with good land."

On the other hand, the companies do realize that their future in the valley depends on having satisfied producers as well as productive lands growing what they buy. Even though some officials stated that "we don't care about the amount of water use--we care about higher production," concern about the overall problems of salinization and inundation is expected to arise when competition over non-afflicted or reclaimed land becomes too intense to satisfy their production requirements. Even then the companies have the option of abandoning the valley if they feel the costs of improved water use are too high, although such abandonment would have to be carefully assessed.

This lack of incentives to improve water use efficiency is also reflected in the agroindustries' and producers' lack of concern about drainage system maintenance, which is becoming a serious problem. It has been claimed that the only concern is for the irrigation canals since these canals bring water to the producers. At present the law states that the producers are responsible for keeping the canals clean, but there are no mechanisms for enforcement.

Companies recommend that INDRHI use herbicides to kill the weeds in the canals, but INDRHI officials feel this would be unsatisfactory since local people use the water for fishing and further irrigation.

An area where INDRHI officials feel the companies in particular show a lack of concern about water use efficiency is in land preparation, since very little land leveling occurs. Land leveling would improve the flow in the canals, diminish spot flooding, and improve drainage. But who will bear such costs? IAD, INDRHI, the companies, the producers?

The companies are also encouraging producers to begin planting earlier each year in order to get the produce to the U.S. market while there is little competition. However, INDRHI's water-delivery schedule was not met, leading to a certain confusion about amounts and timing of water use. Apparently there were more conflicting instructions than usual, which in itself complicated an already difficult, and probably inadequate, program of teaching producers about proper on-farm water management techniques.

INDRHI officials feel that the companies, besides simply lacking incentives to improve water use efficiency, actually impede the efforts of government agencies which are involved in this task. If a company feels, for example, that parceleros are receiving too little water, the management lodges a complaint with powerful allies in the capital, who then attempt to pressure the officials in Azua. Companies also put pressure on the parceleros to ignore the advice of the government technicians regarding irrigation practices, which creates confusion and intimidates producers, especially those who have participated in the course on irrigation management given by the government. Another practice consists of bribing the water distributors to deliver more water than is permitted by INDRHI, although it is not clear whether it is the parceleros or the companies which actually pay the bribes or how extensive such practices are.

The environmental problems created in part by overuse of water have generally not affected the agroindustries' overall production. The companies have the incentives to change practices only where an improvement in yields is expected and the means to do so are immediately cost-effective. At this point in time it appears to be cheaper and less risky to use a quantity of water which creates problems for producers in the lower and eastern reaches of the valley.

It is unclear, however, why the companies resist participation in land leveling, implementation of more efficient forms of irrigation such as siphons, etc., since in principle the costs are passed on to the producers. There are at least two probable reasons for this. First, any individual company wants to be assured that all other companies engaged in the same type of production will also follow suit, otherwise the company which incurs the higher cost will lose its competitiveness. In the case of the melon companies implementing the use of siphons, all companies agreed to do so at the same time, under pressure from the government. Second, negotiations over prices to producers are based in part upon producers' production costs, so that higher production costs have a direct effect on the profit rates of the companies if these costs cannot be passed on in the form of higher prices to consumers. The melon companies have a higher profit margin than the tomato companies, and so can afford to increase

production costs somewhat more readily. The companies have no inherent objection to improved water use, as long as neither they nor the producers they contract with have to pay for it. Improvement in water use, then, may have an effect on the overall distribution of project benefits, a subject we take up in the following section.

Distribution of Project Benefits and Costs

While this section does not pretend to be in any sense an exhaustive evaluation of project benefits, we feel it is important to raise several issues relevant to policy discussions about water use. Overcoming the particular problems associated with the YSURA project's water use administration is a process directly linked to the distribution of the project benefits and costs and the problems associated with changing this distribution, in which the agroindustries play a central role.

There are several objectives which can justify the investment of millions of pesos of public funds in an irrigation project of the scale of the YSURA venture; they include: providing producers with access to a sufficient quantity of high quality agricultural land so as to generate income and improve living conditions, increasing employment in agriculture and industry and thereby raising incomes, developing greater agricultural production to meet internal market demand and reduce dependency on imports, increasing exportable surpluses to earn foreign exchange, and creating industries with forward and backward linkages within the domestic economy and hence generating further investment and economic growth. It is important to add, however, that the achievement of those objectives over five years is laudable, but not sufficient. The agricultural and economic benefits of the project must be sustainable over the long term to really be significant.

There are several important issues that can be raised regarding the sustainability of project benefits. One concern is with access to sufficient high-quality land in the valley. At present, access to land of high quality is certainly not equally distributed among the parceleros. This more than any other factor accounts for variations in yields and income among producers. Also, in part, unequal income distribution is attributable to differences in the quantity of land each parcelero has. The reform's distribution of land use rights theoretically should result in nearly equal opportunities to farm. The decision to assign land collectively attempted to achieve this equality of opportunity. However, the collectives did not function. More importantly, the process of division of the collective land frequently occurred without government supervision and often without the participation by all of the beneficiaries within a project. At present some parceleros have access to up to 160 tareas while others have no more than 10 tareas. Also, although legally prohibited, some parceleros rent out land or otherwise cede control over the land to others. This produces a class of "absentee landlords" as well as a class of "large landowners," both of which violate the letter and the spirit of agrarian reform legislation.

In addition to a growing inequality in access to land due to subdivisions and transfers, there are problems with the process of reclaiming inundated

land. Some producers in the valley were never affected by inundation; some were affected for only a brief time; others have been affected for at least five years but are now producing again; and yet others have land which remains unproductive. Land reclamation efforts have focused on those areas which are easiest and least expensive to reclaim (and, some say, where the producers are best organized and have the most political power). The difficult eastern half of the valley, which is to be drained by refurbishing a dry riverbed, has not yet been greatly affected by reclamation efforts, and the area around the beach, especially near Los Negros, is only beginning to produce in spots. There are also pockets of saline soils where reclamation will be costly. Producers who have access to these lands are seriously disadvantaged, and it is unclear whether their livelihoods will be improved substantially even when the drainage system is fully implemented; problems with salinization, poor soils, and difficult drainage conditions may persist. Farmers in the Los Negros area have access to land classified as "not suitable for agricultural use" since these areas are subject to salinization by sea-water intrusion and the soils are naturally very poorly drained. Given the continued problems with water management and the limited resources available for their solution, many of these farmers already do, and may continue to, form an underclass of subsistence or below-subsistence producers/wage workers.

The implications of these trends toward unequal land division and rental and absentee landlordism could become serious, especially as melon production increases. If melons (or other crops) produce high enough incomes, especially under highly mechanized conditions, the tendency toward absentee landlordism and land rental may well increase as some farmers who began with more or better land acquire that of others, almost certainly leading to a two-tiered social structure of medium-income landlords employing low-income rural wage labor. Since the latter have very little political representation in the project, their position may be difficult to distinguish from that of rural wage workers in the non-reform sector. Under this scenario, the intended primary beneficiaries of agrarian reform, then, will no longer be the principal producers in the valley.

A second issue revolves around the direct generation of employment opportunities. The project has no doubt expanded both agricultural and industrial employment in the zone, through the opportunity for agricultural wage labor and family labor, as well as in processing and transportation. With these benefits, however, we should consider two important factors: the expansion of melon production, and the level of incomes derived from this employment.

Tomato production, as mentioned before, is labor-intensive compared with melon production, both at the farm level and in processing. The tomato company for which we have data, for example, employs 50 or 60 permanent workers in its processing plant, with an additional 800 seasonal employees working three shifts four months out of the year. Wages for seasonal workers range from \$125 to \$1,500 pesos/month. This does not include transport workers. While we have no data on the melon companies' employment, observation of one large firm indicated probably no more than 30 or 40 people employed during the peak harvest season in the packing plant, not including technical or transport workers. The employment generation of melon production, then, is only a fraction of that of tomatoes; hence a shift to melons, such as is currently occurring, will signify lower employment than might otherwise be expected.

The overall effects of this shift on income may be slightly offset if, as one tomato company official charged, it is true that melon companies are paying better agricultural wages and therefore drawing off labor from tomato production. This competition over labor may have a positive effect on rural wages, or a negative effect on tomato production, resulting in fewer workers employed at higher wages. But if melon production expands sufficiently to affect the tomato industry negatively, numerous industrial jobs could be sacrificed both in the valley and in the country. Overall it is probably correct to say that income levels from rural wage labor will in the long run be more affected by the organization and political representation of these workers than by competition between companies, and the former factor, as noted before, is virtually absent in the project area.

One important project benefit is the development of agricultural production to meet internal food needs. Since the valley is a significant producer of basic foodstuffs (i.e., bananas and corn) in addition to tomatoes and melons, this objective is at least being partially met. Yields are problematic in the zone, but this is probably due to the problems of inundation and salinization mentioned previously.

The production of tomatoes for industrial use in the internal market also fulfills this objective since this type of product is one that is frequently imported by underdeveloped countries, and there is evidently a high internal demand. Melon production, however, is much more questionable. While low-quality melons do enter the internal market, the vast majority of the production is for export. If larger areas are devoted to this export crop, food production for the internal market will likely be sacrificed; based solely upon this criterion, melon production would be inappropriate.

Melon export does fulfill the next criterion of a project benefit, the generation of foreign earnings through export duties. Repatriation of profits is controlled by law, but discussions with several officials indicated that a far larger percentage than legally permitted of the dollars earned is being repatriated. This and other problems were taken up recently in a newspaper editorial which we feel is worth quoting at some length:

We have all celebrated . . . the increase in the exports of melons cultivated in Azua. We have read that the Banco Agrícola has made loans of six million pesos to the melon cultivators. There should have been other sources. The exporters of melons do not have to turn over dollars to the Central Bank. If the loans are for many years, and if the depreciation of the peso continues, the loan repayments will also be reduced, if they are going to be paid with the income from the exports made in dollars and converted only partially into pesos. The same will occur for other payments if these are not readjusted. By this means the quantity of dollars that would be converted into pesos to pay for local expenses will diminish, including salaries, payment to producers, amortization of debts in pesos. And the quantity of dollars which are retained outside the country will increase.³

3. Listín Diario, January 1984, p. 6.

The question of foreign earnings, then, is tied intimately to the terms and conditions of exchange between the dollar and the peso, as well as the regulations governing profit repatriation. Generally, profit repatriation terms must be generous in order to attract private foreign investment such as that involved in melon production. But changing conditions must be taken into consideration when evaluating the level of generosity and the actual benefits derived from foreign private investment of this type.

Also, since there is virtually no processing in melon production, it cannot be said that there are other, indirect investment effects which generate foreign earnings from this industry. Melon companies purchase only cardboard cartons from the local market, and nearly all machinery is imported. Therefore, the only forward and backward linkages generated are in transport incidents (which are also almost all imported) and in income multiplier effects.

Tomato production, on the other hand, has significant forward and backward linkages insofar as it requires the fabrication of cans, bottles, cartons, etc., as well as advertising and the creation of local distribution chains. Tinsplate is imported by one company, but goes through significant processing before being used for tomato products; the products themselves require marketing and transport and thus use labor and local materials. Even if tomato products are exported, a large number of the forward and backward linkages are retained.

The multinational ownership of the melon companies also means that it is less likely the profits generated from production will be reinvested in Dominican industry or agriculture. The Dominican tomato companies, on the other hand, are more restricted in their investment opportunities and at the same time tend to be diversified in their internal investments, so that it is more likely that the profits generated will be reinvested locally--although what actually happens with such profits is not known.

In general, then, a far greater proportion of the value generated in tomato production and processing is produced by and realized in the Dominican economy than is the case with melon production managed by multinational firms. As noted before, this local orientation of the tomato companies subjects them to cost-price squeezes, since costs and prices reflect real incomes and exchange rates in the Dominican Republic. The profit rate of the tomato firms is subsequently lower than one would expect to find in the case of melon production, where there is less use of inputs, particularly labor, and where prices are determined not by supply and demand conditions in the Dominican Republic, but in the United States.

Thus far we have not discussed the proportional distribution of the economic benefits between the various participants (the Dominican state, the producers, and the agroindustries), but such a discussion is critical to an overall evaluation of project costs and benefits.

It is obvious that the largest portion of the economic benefits (in an absolute sense) accrues to the agroindustries in the region. Generally speaking, large-scale private investors almost by definition have access to resources which permit a higher rate of return on investment than that available to small-scale individual producers. When this investment capital is vertically integrated and constitutes a regional monopsony as well, the rate of

return on investment increases accordingly. In the case of the Valle de Azua, we must also include in the analysis what amounts to very significant government subsidies. These subsidies are justified on the basis of promoting agrarian reform, but a legitimate question is whether the majority of the benefits arising from the subsidies do in fact flow to the reform sector, and not to outside economic interests.

The most substantial subsidy is the government-provided infrastructure of irrigation, drainage, roads, etc., as well as virtually free water resources. It is difficult to calculate all the state investments to date in the valley, but it is safe to say that they constitute major capital investments. In addition, other capital investments in equipment (tractors, etc.) are also subsidized, in that at least some companies receive government loans and lease government equipment, buildings, etc., which result in substantial savings to them. Other programs that provide subsidized inputs and services are also utilized extensively by the agroindustries. Nor do the companies participate in the maintenance of the infrastructure, which would represent a significant operating cost.

Insofar as the producers do not pay the real cost of water, infrastructure maintenance, etc., and receive subsidized credit, services, etc., the costs of production are lowered. As mentioned previously, negotiations over prices to producers are based in large part on production costs, so that the lower the production costs, the lower the prices paid by the agroindustries.

The key question that remains is: What proportion of the benefits from these subsidies accrues to the producers and what proportion to the agroindustries? Again, there are differences between melon and tomato production systems. If we take the figures provided by one of the melon companies, producers are paid \$4 pesos/box of melons, which are resold in Miami for US\$28/box, at the current exchange rate of 1.79 pesos per US\$1; producers then receive around 9 percent of the final sale price, and the melon companies around 91 percent, which is an enormous "farm-to-market" spread, especially given that just one company, vertically integrated, receives this margin (even after taxes, duties, etc.).

The distribution of the risks of production is equally interesting. Under production contracting, the producers absorb all losses up to the farm gate. According to one melon company official, a "normal" production loss is between 10 percent and 20 percent of the harvest. According to this same official, a "normal" marketing loss (from farm gate to final consumer) is around 1 percent. So, producers absorb the majority of the losses, pay most of the immediate production costs, and receive around 9 percent of the market price.

Certainly these figures will be different for the tomato companies, which have significantly higher production and marketing costs and lower prices, but these production costs will be lower than those of tomato operations in other parts of the country which do not have access to the Azua government-subsidized water resources, credit, etc.

It can be reasonably asserted, then, that in the case of the melon industry, benefits accruing to producers are almost incidental compared to the benefits accorded the companies from the use of public funds. If we add to

this result the relatively low employment generated by the melon industry, the degree of multinational participation and hence profit repatriation, and the small number of forward and backward linkages with the rest of the Dominican economy, it would appear that the costs of supporting such an enterprise would be greater than the benefits accruing either to the producers or to the Dominican economy as a whole, especially when considering the opportunity costs of engaging in other agricultural activities such as tomato production.

Alternative forms of organization and marketing should be considered--e.g., producer cooperatives, state marketing--which could help the Dominican government to recapture a larger portion of the public investment. The costs to the state of the project at present are very high, while the resources available are very low, so low as to threaten the sustainability of the YSURA project. As it stands, the YSURA agrarian reform project amounts to a significant subsidy for private capital but provides a decent livelihood for only 1,500 farming families and a few thousand workers. The future of the project rests upon the ability of the state to redistribute the costs and benefits in order both to salvage and to improve the investments already made, and to generate resources which can be used for further social investment.

Government Institutions and Water Use

Although there are several government agencies in the Valle de Azua which are authorized to play significant roles in the management of water resources in the region (e.g., INDESUR, ODESIA), both in infrastructure development and in coordination, it appears that the most important state elements are IAD and INDRHI.

IAD is responsible for the administration of the YSURA project and exercises this role fairly independently of SEA or other regional coordinating agencies. INDRHI is responsible for water distribution and water-systems operations, and coordinates its activities with IAD. These two institutes are together largely responsible for the daily operation of the project, including infrastructure development, administration and maintenance, technical assistance, production management, etc. In 1981, IAD had 97 persons working in the YSURA project, while in 1982 INDRHI employed 76 people; these 173 people make up about one-half of the total personnel working for state institutions in the project area (not including PROSEMA or CIAZA, whose projects are more clearly limited). Of the two agencies, IAD is less involved in water-systems operation and management than INDRHI, since its role is mainly confined to technical advice and education of producers in water management, and it is admitted that the level of technical expertise to be found in IAD with regard to water management is quite limited. For this reason, we will focus almost entirely on INDRHI and the problems that agency is experiencing with respect to water administration.

The major problems currently confronting INDRHI are lack of financial resources and control over water use. The causes and consequences of these problems are interrelated: resources which might increase control over water use are scarce--in part because of an allocation failure, in part due to the overall economic conditions in the country and state priorities in planning and budgeting resources, and in part due to the failure of the state to capture a

sufficient portion of the surplus generated in the valley. The lack of control over water use, in turn, increases the costs of project maintenance.

Lack of financial and physical resources has contributed greatly to two major problems with respect to the sustainability of the agrarian reform project and its underpinnings, the water system: (1) insufficient supervision over the water distribution and use process, and (2) insufficient maintenance of the irrigation and drainage canal systems (leaving aside the question of actual improvements).

Before discussing these points, however, it is useful to establish that the situation in the valley was in crisis as late as 1981, and second, that INDRHI had a limited ability to respond to the crisis. The water system itself was inherited from a Mexican consulting firm, which apparently designed the system on the basis of certain models applied in Mexico. A system of irrigation canals was constructed, but no drainage system was installed; it is unclear whether a drainage system was included in the plans, but it is clear that the system was put into operation prematurely, in response to political pressures for project completion. In 1978, only a few years after the system began operating, two hurricanes hit within a space of a few weeks, and without drainage, a significant portion of the system became inundated. (There are, however, indications that flooding was becoming a problem previous to this time.) The response to the situation was very slow—it was not until 1982-83 that the first major drainage canals were put into operation.

The reasons for this lack of response are hazy, but indicative of overall systemic problems. First, it may be that the magnitude of the problem was not yet recognized. However, it appears that the data base necessary to predict the crisis was available, since Tahal Consulting Engineers performed very detailed feasibility studies which clearly indicated the water table levels, etc. If the crisis could have been avoided, why was it not? At least one INDRHI official felt there was a lack of monetary resources to take definite action, and a lack of political will to make these resources available. Another official, from IAD, felt that the problem was not so severe at the time as to provoke a response, and that bureaucratic channels (e.g., in the process of seeking additional funds) reacted very slowly. What does seem clear is that it was necessary for the system to face a crisis before any articulated response was forthcoming, and this is probably due to a combination of the reasons given by these officials, especially with regard to obtaining funds.

The Problem of Project Maintenance

INDRHI's funds are allocated through the state and special projects—e.g., the YSURA project receives funding from the Inter-American Development Bank and the government, and the amount received from the state depends upon the politics of the budgeting and planning process at the national level. Operating expenses and monies for improvements, then, are limited by the priorities assigned to them in the political process, and currently this occurs within an atmosphere of severe fiscal constraint due to the overall economic crisis facing the Dominican Republic.

These political factors seem to play a major role in at least one of the project's deficiencies, which is the lack of maintenance of the irrigation and

drainage canals. The IADB allocated no funds for irrigation project maintenance, although experts from AID indicate that 10 percent of the total project cost should be allocated for maintenance alone. There is currently no inspection program or inspectors who systematically detect and report maintenance problems; rather, the water distributors are expected to bring problems they notice while on duty to the attention of the officials at INDRHI. As will be pointed out, these water distributors are probably insufficiently trained and too overworked to carry out this task adequately.

It is difficult to ascertain simply through interviews and the brief inspections possible during the field trips the extent of the damage already rendered to the system through lack of maintenance. Individual opinions run the gamut from "the system's going to collapse--the doors, canals, everything is deteriorating" to "minor repairs are needed." However, the opinions tend to lean toward the former, and everyone concedes that while the costs of repairs are currently not very great, if a more effective maintenance program is not established soon, the costs will become high. Some feel that irrigation canal maintenance is the major problem--several laterals have large cracks and vegetation growing through them; many gates are in poor condition, etc. Others feel that drain canal maintenance is the more significant problem--drain canals must be cleaned regularly, and most are earthen and susceptible to erosion. The canals visited were generally overgrown with large weeds, and in at least one area, erosion had seriously affected the canal, requiring the services of a consulting engineer and major repairs. Drain canals are not maintained by anyone, it appears, and although the parceleros are encouraged by INDRHI officials to perform minimal maintenance, very few actually do.

INDRHI's top manager is appointed by the President. He is apparently able to affect significantly the orientation of the institute, but his employment depends upon ties with the administration in power. Thus far, very few directors have seen fit to allocate any significant portion of the project's budget to maintenance. What is occurring, then, is a devalorization of the capital invested by the state, which will change the overall cost:benefit ratio of the project by either shortening the project life (or the time span over which benefits can accrue) or increasing the cost relative to benefits.

The Problem of Regulating Water Use

It has already been shown that the incentives to use water in a manner which generates environmental problems are largely derived from the logic of production required by the agroindustries, and that these agroindustries are able to exert considerable pressure on local state officials and producers by direct and indirect means. However, the state agencies retain some ability to regulate water use through the delivery system if not by other means (e.g., pricing or otherwise charging for services). INDRHI regulates the total amount of water entering the system and, theoretically, the amount of water entering the laterals and sub-laterals at any given time, up to and including delivery of water to the individual farms. How, then, can problems occur if the state retains this physical control?

First, we have pointed out that much of the problem arises from the form of irrigation employed. To change the form of irrigation requires capital and

labor investments which are generally outside of INDRHI's fiscal and physical limits, although the agency has participated to some extent, e.g., a land-leveling program, tube provision. Certain steps could be taken to reduce on-farm water use which are within INDRHI's domain (involving changes in the overall infrastructure of the system), e.g., replacing the earthen sub-lateral canals with concrete to reduce leakage, but INDRHI officials indicate that the resources necessary to do this are not available, even where leakage is so severe that water flows to certain laterals must be kept to a minimum (e.g., Lateral 6).

INDRHI can and does reduce the amount of water entering the system when demand is low, therefore reducing water loss, e.g., during the evening and over holidays. Even this generates complaints and pressure from the companies, who prefer to have water in the canals at all times. It would be preferable, according to INDRHI, to irrigate at night when evaporative losses are lower, but the companies and the producers almost never do this. Generally, however, INDRHI distributes the amount of water demanded by the producers and the companies; in many interviews, there were no complaints that INDRHI does not deliver the amount of water desired on time. This means, therefore, that the agency participates in overuse of water at the farm level; it is acknowledged that producers use too much water, and obviously INDRHI is delivering it.

INDRHI's central problem in this situation is that it lacks the resources, especially manpower and vehicles, to regulate effectively or "police" water use on the farm. The water distributors who are responsible for opening the canal gates are underpaid and therefore subject to bribery, often do not have vehicles, and have large areas to cover each day. Each cabo de agua is supposed to record the amount of water delivered to each farm, deliver only the amount required by each farm only at the time required, and turn off the water or deny it if overuse is occurring. Given the circumstances just described, and the probability that training is insufficient, it is acknowledged that the cabos do not do an adequate job. In general it can be said that INDRHI control over water stops after the water leaves the lateral canals.

Summary

Virtually every person interviewed noted that, given the extremely limited resources at its disposal, INDRHI is doing a good job. But the situation with regard to system maintenance is deteriorating rapidly, the institutional response to irrational water use is weak, and the overall orientation at INDRHI seems to be unbalanced: INDRHI is seeking immediate, short-term, physical responses to inundation and perhaps losing sight of the longer-term needs of the project for maintenance, improvement in infrastructure, and alternative institutional and social means to reduce the environmental problems still being generated. This is quite likely due more to INDRHI's structural position and its technocratic composition than to neglect: the agency is restricted by limited resources, pressures from the companies and higher-level state officials, its own political appointees, and a fairly high turnover rate in its employees (typical throughout the state agencies in the area).

The burden of project development and maintenance rests entirely upon the state, so that the social costs of private production activities must be

absorbed finally by the Dominican Republic taxpayer, workers, and agricultural producers. As the state's fiscal crisis deepens as it attempts to attract capital by absorbing many of the costs of investment and production and refrains from recapturing the surplus (e.g., through taxation), its ability to respond to social and infrastructural needs is reduced even while costs increase. This is the case with the YSURA project, where the state has committed itself to providing all of the infrastructure necessary for contract production, whose costs are each year greater due to the lack of incentives to use the system rationally. There exists no effective means of capturing the subsidized profits generated in the valley and thus defraying the escalating costs.

It seems obvious that the state organs must gain greater control over the production process in the valley by developing and implementing minimum standards for irrigation equipment, water use, and maintenance. The use of appropriate technology and massive educational efforts are indispensable to combat overuse of water, salinization, and drainage problems. The creation of water-user associations seems a prerequisite to spread clear responsibility for these tasks, as well as to create greater local participation in decision-making and generate accords between advantaged and disadvantaged producers. All of the agroindustries must begin to participate in absorbing the long-term costs of production, possibly by shouldering the cost of training technicians, engaging in land-leveling programs, switching seed-bed conformations, providing for tube irrigation and nighttime irrigation, and working with those farmers who suffer from problems of inundation and salinization to provide the technological and financial means to improve their production.

The state, in turn, must exercise the political will necessary to guarantee the continuity of the YSURA project and to assure that the social and economic benefits generated accrue to the Dominican people who bear the costs.

