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An Analysis of Grain Storage and Price Stabilization Problems in El Salvador

FOOD & FEED GRAIN INSTITUTE
KANSAS STATE UNIVERSITY

MANHATTAN, KANSAS 66502

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Principal Investigator: John H. McCoy and Floyd F. Niernberger.

SUMMARY STATEMENT

The purpose of this assignment was threefold, (1) to estimate the capacity and recommend optimum location of future grain storage needs, (2) to analyze the management and operational activities of the Instituto Regulador de Abastecimientos (IRA) in its price stabilization program and (3) to make recommendations with respect to use of plastic film for temporary corn storage.

Projected 1975 (and later period) production of the four basic grains, corn, grain sorghum, rice and beans were available from an ongoing agricultural sector analysis. Estimates were made of the quantities of each grain that would enter commercial market channels and of the quantities that IRA would need to purchase to perform its price stabilization objective. The latter quantities were (in metric tons) corn 52,000, grain sorghum 26,000, rice (rough) 20,000 and beans 5,000. Based on a projected monthly schedule of purchases and sales, and using an estimated turnover rate of 1.6, minimum grain storage capacity needed by IRA by 1975 was estimated to be 62,790 metric tons. By 1980 the estimated capacity requirements were 84,700 metric tons.

Recommended sites for storage facilities were Santa Ana, San Martin and San Miguel-Usulutan. Considering facilities already in existence, the additional needed capacity by 1975 would be (metric tons), Santa Ana 12,240, San Martin 11,680, San Miguel 11,150.

Other recommendations were: that vigorous efforts be made to encourage and assist expansion of on-farm grain storage, efforts to provide an atmosphere for private commercial storage be encouraged, that technical

training be supplied general and junior management personnel through Kansas State University assistance, that a grading system for grains in conjunction with licensed warehouses be developed along with the necessary regulatory and enforcing agencies, and that a grain storage technical assistant be directly assigned to El Salvador to aid in developing public and private grain storage and marketing interests.

It was determined that storage of corn for short periods of time is feasible using plastic sheets for protection from weather, if adequate checks for quality maintenance are followed.

Dated September, 1969

AN ANALYSIS OF GRAIN STORAGE AND PRICE STABILIZATION PROBLEMS IN EL SALVADOR

Prepared by

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AID/csd-1588
Technical Assistance in
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at the
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AN ANALYSIS OF GRAIN STORAGE AND PRICE
STABILIZATION PROBLEMS IN EL SALVADOR

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AN ANALYSIS OF GRAIN STORAGE AND PRICE STABILIZATION PROBLEMS IN EL SALVADOR

by John H. McCoy and Floyd F. Niernberger

Food and Feed Grain Institute
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INTRODUCTION

The purpose of this report was to present and document information requested by the USAID Mission in El Salvador. The request asked for the following information:

(a) An estimation of future storage needs of El Salvador, especially for corn, grain sorghum, and rice.

(b) A study of management and operational activities of IRA, the government agency in charge of price stabilization of foodstuffs, with recommendations for greater efficiency through innovations.

(c) An analysis of the feasibility of using plastic storage as a temporary means of providing storage for an expected record corn crop.

The reader is referred to the following map for reference and to previous studies for general information on El Salvador and its agriculture [1] [3] [4] [15][1]. Should a more detailed analysis of the country be required, the ongoing agricultural sector analysis by Robert Nathan Associates for the Salvador National Planning Council is recommended upon its completion in December, 1969.

The role of storage in the maintenance of food supplies is vital. The consumption of staple food products is relatively constant throughout the year as compared to production. The maintenance of a more or less uniform supply necessitates storage. In addition, variations in production from year to year, due to yield, area planted, etc., must be absorbed in the market over time. To a much lesser extent variations in demand add complications to the storage problem. Changes in supply and demand result in price movements which often are not in the best interests of either producers or consumers. These circumstances prompted El Salvador to establish a government agency, the Instituto Regulador de Abastecimientos (IRA) with a view of stabilizing prices of specified products. Among it activities are the purchase, storage, processing, packaging and sale of grains.

In the sale of grains IRA competes with the private sector of the economy both at the retail level and wholesale level. IRA imports and exports grain. In the case of imports, IRA is the sole importer from countries outside the Central American Common Market.

In the aggregate, storage capacity at minimum, must equal the largest quantity on hand at any given time. From a practical standpoint it will be greater since some vacant storage space will result from segregation of

[1]Numbers in brackets refer to publications in the list of selected references appended to this report.

MAP OF EL SALVADOR BY DEPARTMENT AND ZONE

stocks. Additional loss may result from vacant space being inaccessible to those requiring it, because of location, transportation, etc. When consideration is given to reserve stock carryover from one production period to the next the required storage capacity is by necessity increased. The storage capacity available in most relatively developed countries producing the bulk of their own grain requirements will usually be large enough to hold approximately twice the tonnage harvested annually.

The retention of reserve stocks is often undertaken by the government of a country as a service to its people, in an effort to reduce effects of a sudden food shortage. This service becomes more desirable in countries where existing marketing flows are inefficient. The cost of maintaining reserve stocks against crop failure or for price stabilization are inevitably higher than those of shorter run trade or storage as engaged in by private industry. A government agency charged with this role will find difficulty in reaching the level of turnover that will compare with private firms operating domestically.

Once capacity estimates are completed, careful attention should be paid to the proposed design and materials used in construction. Savings on physical losses and deterioration in quality as well as the ability to hold the grain safely for the necessary time period should be considered along with costs of construction. Often the training of managers of grain stocks proceeds with difficulty and a chronic shortage of qualified personnel exists. The facilities should be designed to reduce the burden of operating skills in the maintenance of quality.

STORAGE CAPACITY REQUIREMENTS, FACILITY LOCATION AND INFESTMENT REQUIREMENTS, 1975 PROJECTION

The determination of future storage capacity needed by IRA to perform its price stabilization function, necessitates estimates of (1) grain production, (2) the proportion of production which enters commercial marketing channels, (3) the fraction of commercial marketings IRA needs to control, and (4) the annual rate of turnover in the storage facilities. In this analysis emphasis is placed on anticipated needs by 1975.

Grain Production. Total national grain production projections were available from the agricultural sectoral analysis. These are shown below.

Projected Grain Production By Years, (1000 Metric Tons).

Year	1975	1980	1985	1990
Grain				
Corn	348	451	587	761
Grain Sorghum	162	210	273	355
Rice (rough)	114	148	195	253
Beans	29	41	58	81

Source: Agricultural Sector Analysis, Robert Nathan Associates, Inc.

Even though El Salvador is a relatively small country, it was necessary to disaggregate the national total to obtain information which, along with other criteria, could be used in the selection of optimum storage sites. A breakdown by department (similar in structure to states in the United States) would have been desirable but production data by department in previous years, were available only for crop years 1960-61 to 1964-65 which, of course, does not include recent years. Historical and up-to-date production data were available by zone designation, i.e. Western, Central and Eastern. Conversations with personnel of the division of Agricultural Economics, (Ministerio de Agricultura y Ganaderia) indicated that these zones were delineated without economic criteria. However, each zone extends from the coast to the interior border and from topographic and geographic standpoints appear to have a substantial degree of homogeneity. Production patterns of the four crops in recent years were examined, Appendix Tables 1 to 12.

The percentage distribution of crops within each zone during the most recent 5 year period for which data were available (Table 1) was

Table 1. Distribution of Grain Production By Zone, Average of Crop Years 1964-65 to 1968-69

Zone	Corn	Beans	Rice	Sorghum
Western	19.4	25.5	13.9	19.6
Central	49.9	64.3	70.7	48.1
Eastern	30.7	10.2	15.4	32.3
Total	100.0	100.0	100.0	100.0

taken as the best available criteria for determining a zone breakdown of the projected national crop production obtained from the sectoral analysis. The resultant distribution of projected crop production is shown in Table 2.

Table 2. Projected Crop Production by Zone

Crop	Zone	1975	1980	1985	1990
		(1000 Metric Tons)			
Corn	Western	67	88	114	147
	Central	174	225	293	380
	Eastern	107	138	180	234
	Total	348	451	587	761
Grain Sorghum	Western	32	41	54	68
	Central	78	101	131	172
	Eastern	52	68	88	115
	Total	162	210	273	355
Rice (rough)	Western	16	20	27	35
	Central	81	105	138	179
	Eastern	17	23	30	39
	Total	114	148	195	253
Beans	Western	7	11	15	21
	Central	19	26	37	52
	Eastern	3	4	6	8
	Total	29	41	58	81
All Grains	Western	122	160	210	271
	Central	352	457	599	782
	Eastern	179	233	304	396
	Total	653	850	1,113	1,449

Commercial Marketings. It is known that some farmers retain from the commercial market, grains to be used for home consumption, however, no data were available to show the amount. Estimates were obtained by interview with IRA personnel, other government personnel, plant managers and USAID personnel. While the estimates were not entirely consistent, an approximate consensus was obtained as follows:

Crop	% Retained for Home Use	% Entering Commercial Market
Corn	25	75
Grain Sorghum	20	80
Rice	10	90
Beans	20	80

These factors were applied to projected production of each crop to obtain an estimate of commercial marketings, see Table 3.

Table 3. Estimated Commercial Marketings by Zone, 1975 and 1980

Crop	Zone	1975	1980
		(1000 Metric Tons)	
Corn	Western	50	66
	Central	131	169
	Eastern	80	103
	Total	261	338
Grain Sorghum	Western	26	33
	Central	62	81
	Eastern	42	54
	Total	130	168
Rice (rough)	Western	14	18
	Central	73	94
	Eastern	15	21
	Total	102	133
Beans	Western	6	9
	Central	15	21
	Eastern	2	3
	Total	23	33

Of these quantities, IRA will need to control a fraction of sufficient magnitude to gain the desired price stability. IRA's purchases of corn, rice, and beans during 1955 to 1967 are recorded in Tables 4, 5, and 6. This shows that in 1967, IRA purchased 17.4 percent of the rice produced. In 1961 14.3 percent of

the corn was purchased and in 1959, 9.9 percent of corn production was purchased. During most of its operations IRA has controlled only a minor fractionof the grain supplies. Under these circumstances it is not surprising that substantial seasonal variations in prices have occurred, (see Figures 1, 2, 3, and 4). It may be observed, however, in the annual average prices shown in Appendix Tables 13 to 16 that year to year price fluctuations (in contrast to seasonal fluctuations) were comparatively mild.

Proportion of Grain Needed by IRA for Price Stabilization. There are no precise criteria to indicate the percentage of commercial marketings IRA would need to control to acquire the desired price stability. Major reliance again was placed in the judgment of IRA and other government personnel acquainted with local conditions. These estimates centered on 20 percent of commercial marketings. By way of comparison, a study by the Banco Centroamericano [3] indicated an average of 18.6 percent with substantial variation among locations. Estimates in other studies have been as high as 33 percent. In this analysis, it is considered that purchases of 20 percent of commercial marketing would give IRA the ability to satisfactorily stabilize prices. However, it is not to be expected that complete stability would be obtained. A seasonal price increase equivalent to accumulated storage costs is to be expected in a competitive situation and unforeseen circumstance undoubtedly will, at times, affecc the market to some extent.

Table 4. Corn, Production and IRA Purchases, 1955-1967

Calendar Year	Production (qq)	IRA Purchases (qq)	IRA Purchases as Percent of Production
1955	3,118,910	-	-
1956	3,456,440	157,402	4.6
1957	3,228,059	147,496	4.6
1958	3,074,327	10,507	0.3
1959	3,270,022	324,229	9.9
1960	3,898,287	146,261	3.8
1961	3,102,038	443,595	14.3
1962	4,651,102	126,269	2.7
1963	4,495,539	24,377	0.5
1964	4,164,720	39,102	0.9
1965	4,413,451	160,366	3.6
1966	5,776,630	66,442	1.2
1967	4,505,000	147,707	3.3

Source: Production from Lloyd I. Homes, Estadisticas Seleccionadas con Relacion a la Agricultura, 1967. IRA Purchases from Departamento de Estudios Especiales, IRA, September 2, 1969.

Table 5. Rice, Production and IRA Purchases 1955-1967

Calendar Year	Production (oro)	IRA Purchases[a] (oro)	IRA Purchases as Percent of Production
1955	416,017	-	-
1956	392,725	-	-
1957	319,259	-	-
1958	266,984	-	-
1959	265,268	-	-
1960	284,788	-	-
1961	252,665	-	-
1962	362,216	-	-
1963	291,600	-	-
1964	467,350	6,188	1.3
1965	492,800	-	-
1966	712,545	9,647	1.4
1967	1,100,000	191,608	17.4

[a] Purchases of rough rice by IRA were converted to oro rice by factor of 0.65.

Table 6. Beans, Production and IRA Purchases 1955-1967

Calendar Year	Production	IRA Purchases (qq)	IRA Purchases as Percent of Production
1955	605,639	-	-
1956	390,549	-	-
1957	299,255	-	-
1958	231,078	156	0.1
1959	223,582	1,189	0.5
1960	216,608	1,905	0.9
1961	224,312	-	-
1962	392,902	21,905	5.6
1963	321,438	-	-
1964	263,761	-	-
1965	358,955	14,988	4.2
1966	338,013	700	0.2
1967	380,527	21,364	5.6

Source: Production from Lloyd I. Homes, Estadisticas Seleccionadas con Relacion a la Agricultura, 1967. IRA Purchases from Departamento de Estudios Especiales, IRA, September 2, 1969.

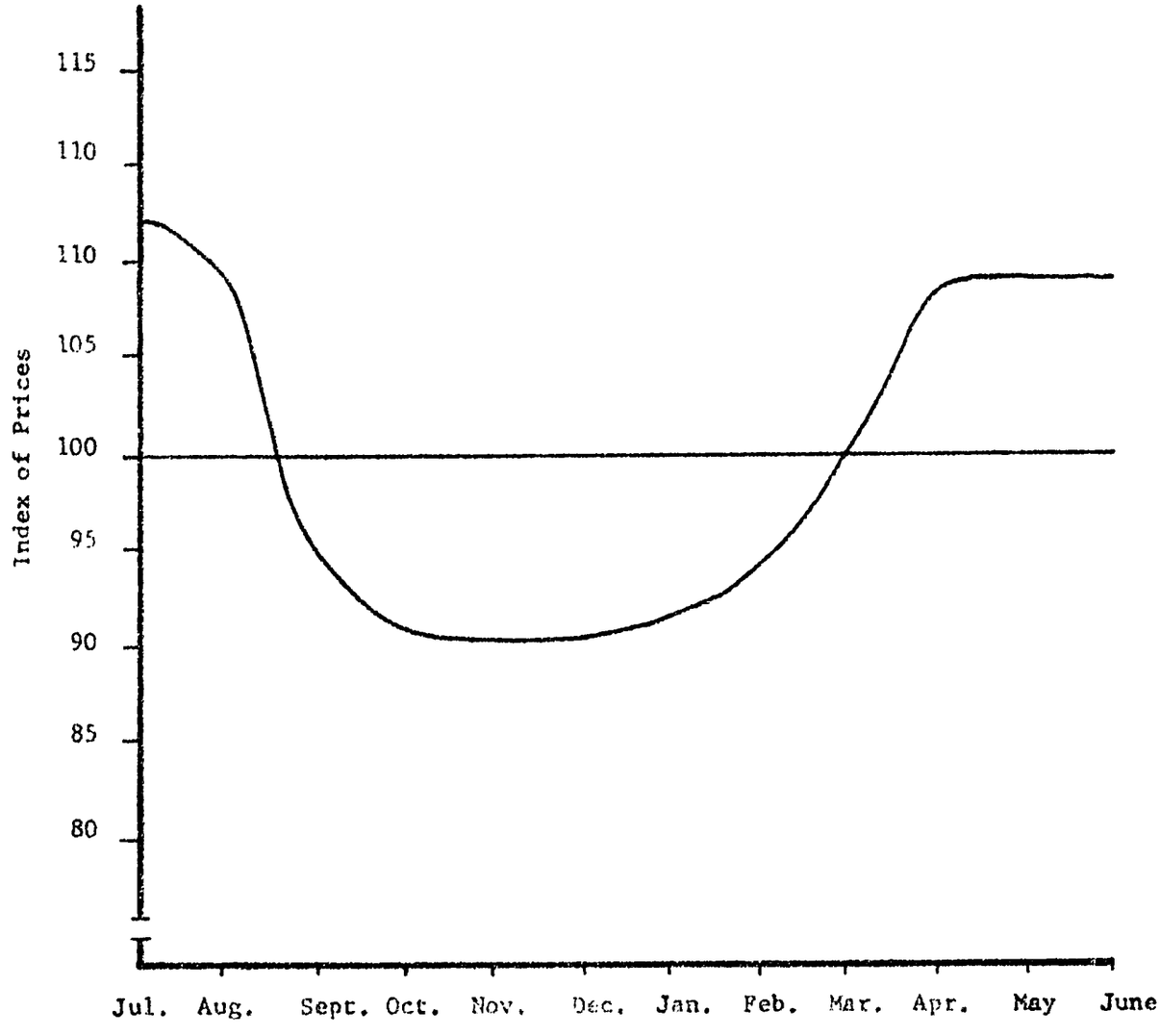

Figure 1. Corn, Seasonal Price Pattern Wholesale Prices at San Salvador 1964-68.

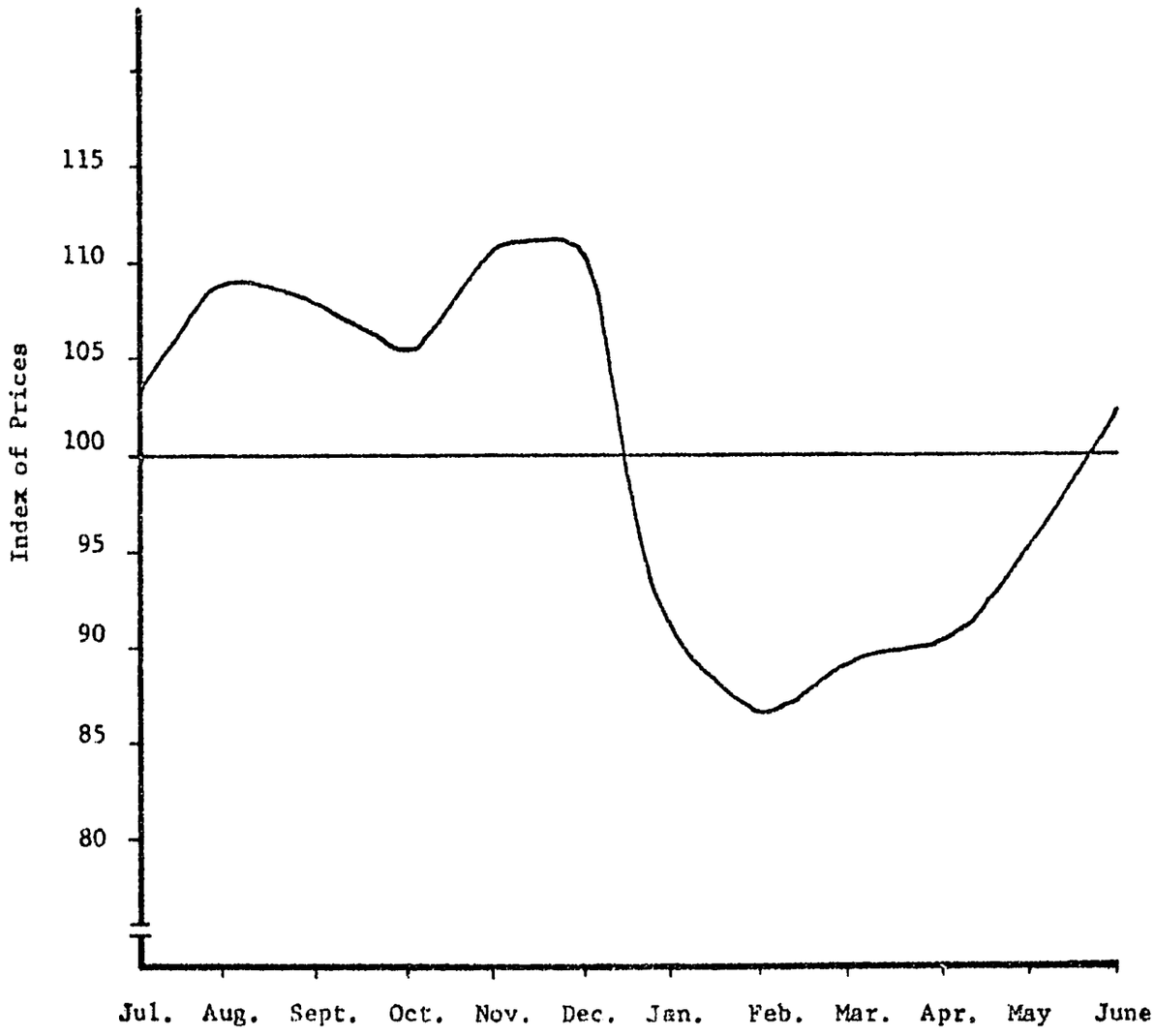

Figure 2. Sorghum, Seasonal Price Pattern Wholesale Prices at San Salvador 1964-68.

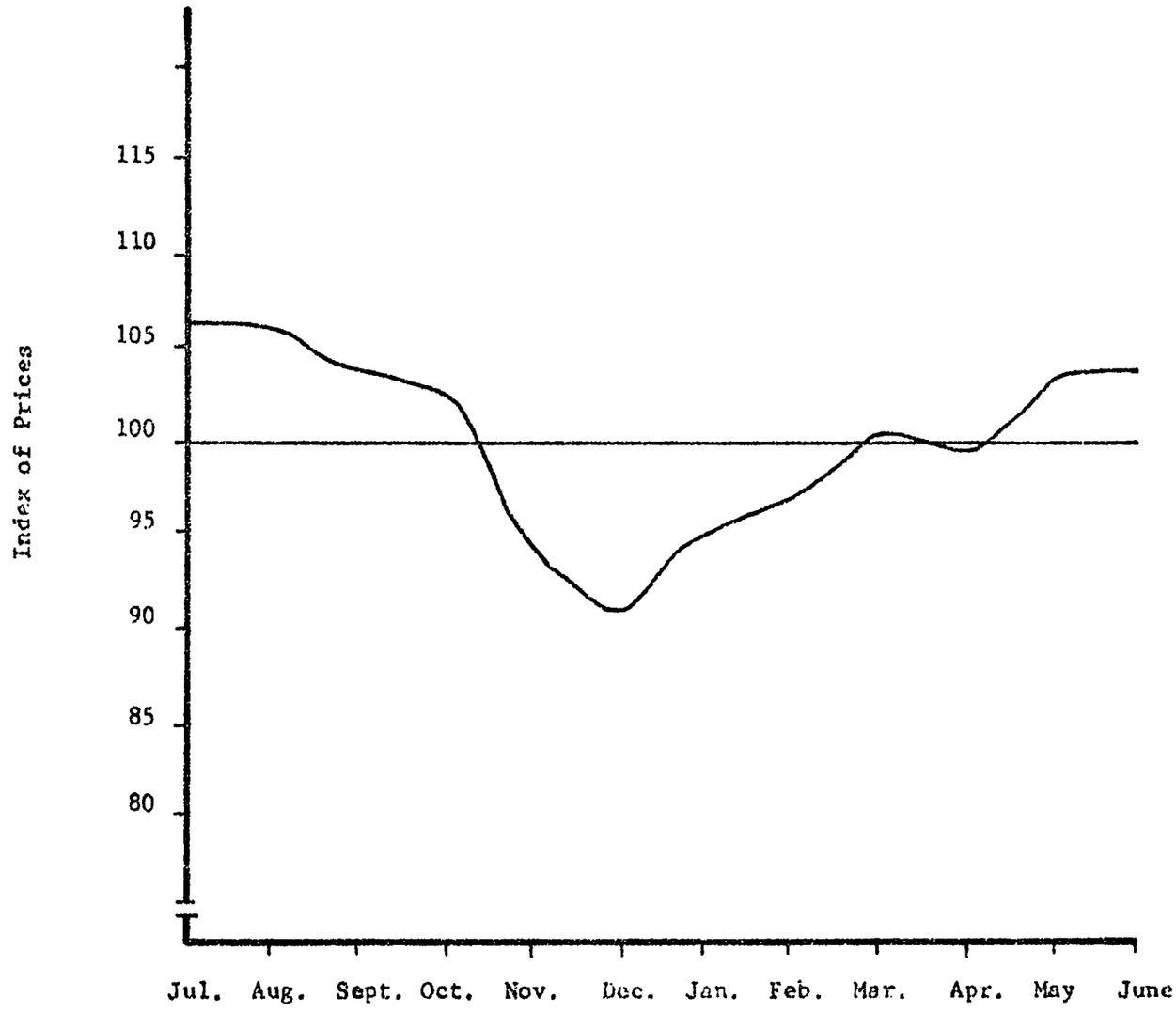

Figure 3. Rice, Seasonal Price Pattern Wholesale Prices at San Salvador 1964-68.

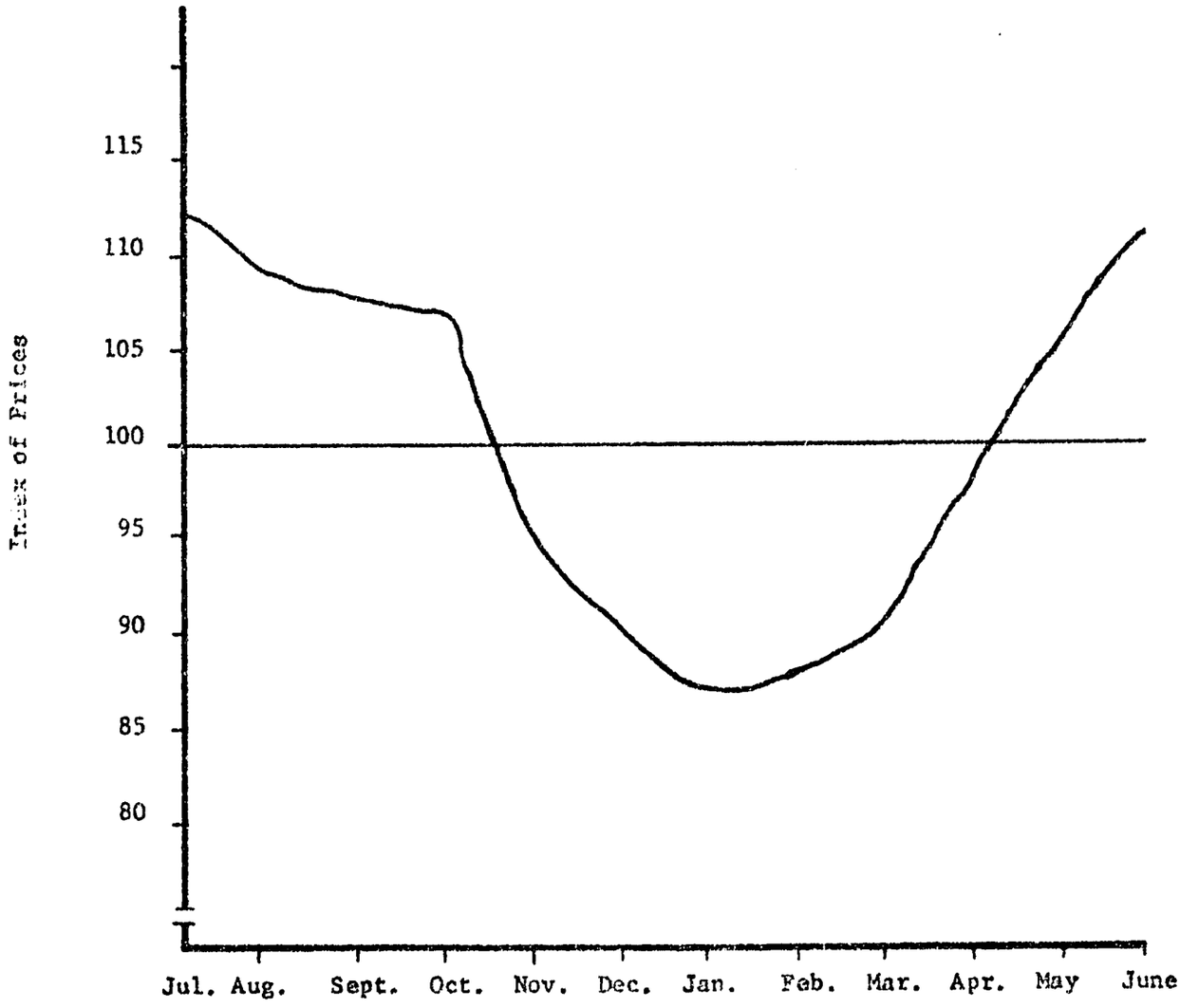

Figure 4. Beans, Seasonal Price Pattern Wholesale Prices at San Salvador 1964-68.

Table 7 indicates the quantities of each grain that would come under IRA's control with the purchase of 20 percent of commercial marketings. This does not mean that storage facilities of these magnitudes will be required since capacity requirements are associated also with turnover rates.

Table 7 Calculated Quantities to be Purchased by IRA

Crop	Zone		1975	1980
			(1000 Metric Tons)	
Corn	Western		10	13
	Central		26	34
	Eastern		16	21
		Total	52	68
Grain Sorghum	Western		5	7
	Central		13	16
	Eastern		8	11
		Total	26	34
Rice (rough)	Western		3	4
	Central		14	19
	Eastern		3	4
		Total	20	27
Beans	Western		1	2
	Central		3	4
	Eastern		1	2
		Total	5	8

IRA Total Storage Capacity Requirements. IRA's function as a price stabilization agency does not lend itself to obtaining a high turnover rate in storage facilities. Price stabilization by storage activities necessitates the concentration of purchases when grain deliveries are high (i.e., when prices would otherwise be depressed) and sales when deliveries are low (i.e., when prices would otherwise be high).

No direct information is available on grain deliveries but the seasonal price pattern undoubtedly reflects deliveries (see Figures 1, 2, 3, and 4). In general, the bulk of deliveries of corn, beans and rice coincide during the fall and winter months. Apparently sorghum deliveries are concentrated during the early months of the calendar year -- about the time corn deliveries are beginning to taper off. The present concentration of purchases within a relatively short time is not conducive to a high turnover rate. IRA's turnover record in the past reflects this situation. Calculations based on 1963-1966 data by the Banco Centramericano [3] show that the turnover at San Martin has been .94. It has been somewhat higher, at 1.33, in the Usulutan plant. It will be shown later that some improvement is possible in the turnover record at these facilities.

The turnover rate in IRA's facilities was determined by calculating a schedule of purchases and sales by month from which month-end stocks were derived. The point at which stocks on hand reach a maximum determines the minimum storage capacity needed. From a practical standpoint some additional capacity is needed for possible turning and working space and, in addition, it may not be possible to allocate bins with capacities which correspond exactly to quantities of the various grains. Obviously the grains could not be mixed simply to fill up available space.

The aggregate schedules of purchases and sales are shown in Table 8. The purchase schedule for each crop is set up to reflect the rate of purchase as a function of the seasonal price movement (Figures 1, 2, 3, and 4). In other words, purchases would increase as prices tend to decrease and vice-versa. Under this arrangement IRA would be out of the market (not purchasing) when prices tended to rise above the target level. On the contrary IRA would begin selling as prices tended to rise above this level and the rate of selling would be related to the seasonal price pattern above the seasonal average level. However, the sales schedule was modified in two respects. It was assumed that export sales of rice would not necessarily be related to the domestic rice price pattern. Therefore, export sales were concentrated in months of relatively heavy purchases to help improve the turnover rate. This may not be desirable in cases where world prices are depressed at that time of year. Secondly, in the case of domestic sales it was assumed that IRA would maintain a minimum monthly retail sales program and use the balance of its stocks in the manner described above to gain a price stabilizing effect. The maintenance of minimum monthly sales would tend to detract from IRA's ability to gain maximum stabilizing effect. However, it was assumed that to maintain satisfactory relations with its retail distributors, it could not be entirely out of the market for a part of the year. The basis for determining minimum domestic sales was somewhat arbitrary but it was noted in recent IRA operating records that some sales were maintained throughout

the year. An approximation was made of the percentage that minimum monthly sales were of total annual sales -- i.e. in the neighborhood of 2 percent, and this was used as a guide in projected minimum sales per month.

Table 8. Schedule of Aggregate Purchases and Sales by IRA, 1975 Projection. (1,000 Metric Tons)

Month	Purchases	Sales	Month-end Stocks
July		10.44	20.56
Aug.		16.64	3.92
Sept.	5.72	7.00	2.64
Oct.	9.96	4.52	8.08
Nov.	16.40	6.96	17.52
Dec.	19.05	6.91	29.66
Jan.	19.61	3.42	45.85
Feb.	17.59	3.52	59.92
Mar.	6.93	4.06	62.79
Apr.	4.88	9.60	58.07
May	2.86	11.17	49.76
June		12.76	37.00
Total	103.00	103.00	—

The handling of imports was not included in the schedule of purchases and sales. The Agricultural sector analysis indicated that net imports would amount to 40,000 metric tons in 1975 (i.e. 28,000 corn and 12,000 beans) Appendix Tables 17-22. Since normally some exportation of these crops also occurs, the quantity imported would exceed this net figure. Presumably importation will be shared by IRA and the private sector. It was not possible to estimate the share IRA is likely to handle. However, it was assumed that IRA would make its purchases during months when it has available space and hence would not need additional space for imports. If this were done, it would increase the quantity handled and give a somewhat better turnover rate than indicated in the following paragraph.

It is shown in Table 8 that aggregate month-end stocks reach a maximum of 62,790 metric tons during the month of March. This indicates the minimum storage capacity needed by IRA under the circumstances considered in this analysis. During a twelve month period IRA would handle 103,000 metric tons. This figure divided by 62,790 metric tons results in a turnover of 1.6.

Storage Capacity Requirements of Private Interests and Other Government Agencies. The balance of national storage requirements would need to be provided by other governmental agencies or private interests. The quantity stored on farms for home consumption, which was discussed earlier, is outside of the commercial economy. However, the possibility exists to expand farm storage. Commendable efforts are being made by the Federacion de Cazos de Credita, ABC and the Comision de Alianza para El Progresa. Encouragement and assistance should be given the agencies involved in this effort. To the extent that farm storage can be expanded IRA's burden will be reduced -- and the above indicated capacity requirements could be modified. Other government agencies and the private commercial sector would be expected to handle the remaining balance. At the present time the Federacion de Cazas de Credito has 41,600 quintals of storage space (i.e. 1,913 metric tons) and the Banco Hipotecario has 174,000 quintals capacity (i.e. 8,004 metric tons), see Table 9. It was estimated by IRA that other private commercial interests currently have about 50,000 quintals storage capacity (i.e. 2,300 metric tons). Together this amounts to 12,217 metric tons and with a turnover of 1.6 would permit the handling of 19,547 metric tons. By 1975, total commercial marketing of the four grains is expected to be 517,000 metric tons. If, as calculated above, IRA handles 103,000 metric tons a balance of 414,000 metric tons will remain. The proportion of this which might be stored on farms is simply a guess but if it amounted to one-fourth (i.e. 104,000 metric tons) then other interests would need to provide space for 310,000 metric tons and again assuming a turnover of 1.6 this would require 194,000 metric tons of storage capacity. If operated efficiently, private operations may be able to exceed this turnover rate. However, as the rate increases the function performed tends to become merchandizing rather than storage. Against an estimated current capacity of 19,547 metric tons this would appear to leave a rather formidable situation. However, it is recognized that the tabulations of current existing capacity do not consider the innumberable traders and merchants who even now in one way or another do store a large share of current production. In all likelihood, they will be needed to handle substantial quantities in the foreseeable future. At the same time, it is likely that commercial interests will expand their capacity and this probably will occur in or near the centers of population concentration such as San Salvador.

Location of IRA Storage Facilities. The selection of optimum storage location sites can be a complex problem involving such variables as concentrations of production, concentrations of consumption, storage costs, availability of transportation and transport rates, availability of qualified plant managers, the extent of imports and exports, etc. Neither time nor resources available permitted an exhaustive spatial analysis. However, characteristics of most of the critical variables are known. Uncertainty with respect to source of imports, due to the current Honduran disturbance is a complication which could not be entirely resolved at this time. There appear to be several relatively small areas of intense concentration of corn production, but outside of these, corn is produced rather uniformly throughout the country. Rice production is relatively concentrated. One area of concentration overlaps the boundary between the Eastern and Central zones near the coastal area. An area of rice concentration exists in

Table 9. A List of Storage Facilities[a] for Grain in El Salvador

Institution	Type of Ownership	Location	Capacity	Institution Sub-Total	Western Zone	Central Zone	Eastern Zone
				(Quintales)			
Instituto Regulador de Abastecimientos	Own	San Martin	437,500			437,500	
	Own	El Coro	30,000			30,000	
	Own	Santiago Nonualco	15,000			15,000	
	Rent	Soyapango	40,000			40,000	
	Rent	El Matazano[b]	60,000			60,000	
	Own	Usulutan	120,000		120,000		
	Rent	Usulutan	275,000	977,500	275,000		
Caja de Credito	Own	Chalchuapa	2,000				2,000
	Own	San Julian	2,000				2,000
	Own	Izalco	3,000				3,000
	Own	El Chilamatal	6,000			6,000	
	Own	Quezaltepeque	600			600	
	Own	Colon	8,000			8,000	
	Own	San Vicente	8,000			8,000	
	Joint	Santiago Nonualco	7,000			7,000	
	Own	San Miguel	5,000	41,600	5,000		
Banco Hipotecario	Own	San Miguel	174,000	174,000	174,000		
Total			[illegible]	1,193,100	574,000	612,100	7,000

(a) Instituto Regulador de Abastecimientos data from Departamento de Estudios Especiales, Caja de Credito Data from Ricardo Cabezas, Chief of Technical Department, Banco Hipotecario data from Ministerio de Agricultura y Ganaderia, Study Proyecto de Ampliacion de la Capacidad de Almacenamiento del Insituto Regulador de Abastecimientos

(b) Only rented when required for storage of milled rice for export

northern La Libertad, Department and another in the Western zone in Santa Ana and Northern Ahuachapan. Grain sorghum production is fairly uniformly distributed among zones -- although somewhat less concentration is apparent in the Western zone. Within zones a concentration is apparent in the more interior areas. Several minor areas of concentration are noted in bean production but bean production is not a controlling factor in storage site selection. Bean production is expected to be 29,000 metric tons of a total production of four grains amounting to 653,000 metric tons in 1975

A center population concentration exists in each zone i.e. Santa Ana in the Weste. zone, San Salvador in the Central zone and San Miguel in the Eastern zone.

An analysis of the production - consumption balance by zone indicated a close correspondence considering all grains in aggregate. Rarely does production in a given area exactly equal the utilization within that area. Since the bulk of grains produced in El Salvador are used for food, a first approximation of inter-zone movements may be obtained by comparing the population distribution by zone with grain production by zone. This is shown in the aggregate in the following tabulation.

Percentage Distribution of Population and Total Production of Four Grains, 1975 Projection

Zone	Percent of Population	Percent of Grain Production
Western	21.8	18.8
Central	51.4	53.8
Eastern	26.8	27.4

Source: Calculated from data provided by sectoral analysis.

It is apparent that a close correspondence exists and if all other factors which affect grain movement were equal, one would expect relatively minor movements among zones. Other factors are never exactly equal, for example, production of individual crops does not correspond to the aggregate distribution. Commercial market purchases of the urban population likely will be different from that of the rural population for two reasons: (1) the rural resident may retain part of his production for home use and therefore purchase less -- it was considered in this study that 25 percent of the corn, 20 percent of the grain sorghum, 10 percent of the rice and 20 percent of the beans would be retained for home use; (2) income differences could result in different consumption habits. Information was not available on the latter. An adjustment was made on the former. It was assumed that average per capita consumption (derived from the agricultural sector analysis of projections of total consumption and total population) would be the same for urban and rural residents but that the proportion of grain retained on farms would be consumed by farm residents and the balance of their consumption obtained from commercial marketings. Urban residents were assumed to purchase

their entire consumption from commercial marketings. It was assumed that utilization for livestock feed (furnished by the sectoral analysis) would be satisfied in a particular zone from production in that zone. This probably was generally the case for smaller "farm size" livestock enterprises. It may not be true for large farm enterprises and "commercial" livestock feeding and dairying units. No information was available to permit an adjustment for the latter.

With the above mentioned adjustment for differences in urban-rural purchases a marketing-utilization balance was determined by zone. This is shown in Table 10. Again it indicated only a minor difference between zone marketings and zone consumption in the aggregate of the four grains. There will be some interzone movement of individual grains but the major crop, i.e. corn appears to be fairly equally distributed with respect to consumption. In-so-far as aggregate storage capacity by zone is concerned, the requirements would be essentially the same whether interzone movements were considered at harvest time or whether the movement occurred at time of consumption. Therefore, interzone movement of individual crops were not calculated. An export movement of rice (1975 projection) was included in the IRA sales schedule although it does not appear separately.

The quantity of grain involved in each region was in itself sufficient to warrant a storage unit of a capacity sufficient to attain most of the economies of size in grain handling and storage. The distances involved in moving grain from within a given zone to a central location in that zone, are within feasible limits. With future economic development, the farm to market road system will be improved. A major impediment to delivering grain under the present system is the lack of satisfactory transport facilities by small farmers. Efforts are underway by IRA, The Federacion de Cazas de Credito and ABC, to facilitate the assembling and trucking of grain for small farmers. Encouragement and assistance should be provided these agencies. The small farmer is important in El Salvadorian agriculture. According to 1950 census tabulations, 80.6 percent of the farms were less than 5 hectares in size. In 1961 this had risen to 87.2 percent (Appendix Table 23). During this same period, the total number of farms increased by 30.2 percent. It is likely that at least a part of the increase in small farms was due to further fragmentation of farms which already were in the small category. However, farms in the size classifications of less than 5 hectares in 1961 produced 54.7 percent of the total corn production 57.9 percent of the beans, 66.6 percent of the grain sorghum and 43.3 percent of the rice (Appendix Tables 24, 25, 26, and 27). While it is recognized that many of those classified as farmers by the census were subsistence producers, the evidence still suggests that many small farms are at a disadvantage in marketing their grain. This would appear to be an area where cooperatives could provide a needed service.

The development of a system of local storages would present a serious problem in management. The availability of competent managers is very limited. Furthermore, such a system would tend to fragment storage to such an extent, the economies that might be gained by central units would be impaired. For these reasons, local storage operations by IRA are not recommended.

Table 10. Comparison of Commercial Marketings with Utilization, 1975 Projection

Crop	Zone	Commercial Marketing	Utilization of Commercial Marketing: Food	Feed	Other	Total
		(1000 Metric Tons)				
Corn	Western	50	49	4	1	54
	Central	131	116	20	3	139
	Eastern	80	61	6	1	68
	Total	261	226	30	5	261
Grain Sorghum	Western	26	22	3	2	27
	Central	62	51	12	5	68
	Eastern	42	27	5	3	35
	Total	130	100	20	10	130
Rice	Western	14	13	-	8	21
	Central	73	30	-	22	52
	Eastern	15	15	-	14	29
	Total	102	58	-	44	102
Beans	Western	6	5	-	-	5
	Central	15	16	-	-	16
	Eastern	2	2	-	-	2
	Total	23	23	-	-	23
Total All Grain	Western	96	89	7	11	107
	Central	281	213	32	30	275
	Eastern	137	105	11	18	134
	Total	576	407	50	59	516

On the basis of the foregoing analysis, it is recommended that IRA operate storage units at (1) Santa Ana -- which would be a new facility, (2) San Martin -- which would be an expansion of existing facilities and (3) San Miguel - Usulutan -- which would involve a new facility at San Miguel with continued operation of the existing plant at Usulutan.

Recommended Capacity for Individual IRA Sites. The determination of needed capacity in each installation followed the same procedure explained previously in determining total storage requirements for IRA. A schedule of purchases, sales and month-end stocks was calculated for each location based on the availability and utilization of grain in that zone (Tables 11, 12, and 13). The results for Santa Ana are shown in Table 11. This indicates a minimum required capacity of 12,240 metric tons. Table 12 shows a minimum need for 33,880 metric ton capacity at San Martin. Present owned facilities including El Coro and Santiago Nonualco are 22,200 metric tons -- leaving a needed expansion of 11,680 metric tons. At San Miguel-Usulutan 16,670 metric tons of capacity are needed as shown in Table 13. The owned capacity at Usulutan is 5,520 metric tons leaving a needed expansion of 11,150 metric tons. Below is a summary of existing and needed capacity by zone.

Required Additional Storage Capacity By Zone

Zone	Needed Capacity	Existing[1] Capacity	Additional Capacity Required
	(000)	(000)	(000)
Western	12.24	0	12.24
Central	33.88	22.20	11.68
Eastern	16.67	5.52	11.15

[1] Includes only IRA owned capacity in each zone.

Table 11.

Grain Flow, Santa Ana, 1975 Projection
1000 Metric Tons

Month	Inflow					Outflow					Month-end Stock
	Corn	Sorgh	Rice	Beans	Total	Corn	Sorgh	Rice	Beans	Total	
Carryover	-	-	-	-	-	-	-	-	-	-	7.25
July	-	-	-	-	-	2.09	.30	.73	.19	3.31	3.94
August	-	-	-	-	-	1.73	.75	.71	.16	3.35	.59
September	1.10	-	-	-	1.10	.19	.68	.37	.13	1.37	.32
October	1.80	-	.09	-	1.89	.19	.46	.03	.12	.80	1.41
November	2.00	-	.81	.12	2.93	.19	1.03	.03	.02	1.27	3.07
December	2.00	-	1.17	.17	3.34	.19	1.02	.03	.02	1.26	5.15
January	1.80	1.00	.57	.25	3.62	.19	.10	.03	.02	.34	8.43
February	1.30	1.40	.36	.23	3.29	.19	.10	.03	.02	.34	11.38
March	-	1.15	-	.19	1.34	.22	.10	.14	.02	.48	12.24
April	-	.90	-	.04	.94	1.63	.10	.03	.02	1.78	11.40
May	-	.55	-	-	.55	1.56	.10	.43	.10	2.19	9.76
June	-	-	-	-	-	1.63	.26	.44	.18	2.51	7.25
Total	10.00	5.00	3.00	1.00	19.00	10.00	5.00	3.00	1.00	19.00	—

Table 12.

Grain Flow, San Martin, 1975 Projection
1000 Metric Tons

Month	Inflow					Outflow					Month-end Stock
	Corn	Sorgh	Rice	Beans	Total	Corn	Sorgh	Rice	Beans	Total	
July	-	-	-	-	-	5.42	.78	2.14	.57	8.91	11.09
August	-	-	-	-	-	4.48	1.94	2.11	.44	8.97	2.12
September	2.86	-	-	-	2.86	.50	1.76	1.24	.40	3.90	1.08
October	4.68	-	.42	-	5.10	.50	1.21	.35	.37	2.43	3.75
November	5.20	-	3.78	.36	9.34	.50	2.68	.35	.06	3.59	9.50
December	5.20	-	5.46	.51	11.17	.50	2.65	.35	.06	3.56	17.11
January	4.68	2.60	2.66	.75	10.69	.50	.26	1.35	.06	2.17	25.63
February	3.38	3.64	1.68	.69	9.39	.50	.26	1.35	.06	2.17	32.85
March	-	2.99	-	.57	3.56	.58	.26	1.63	.06	2.53	33.88
April	-	2.34	-	.12	2.46	4.24	.26	.35	.06	4.91	31.43
May	-	1.43	-	-	1.43	4.06	.26	1.38	.31	6.01	26.85
June	-	-	-	-	-	4.22	.68	1.40	.55	6.85	20.00
Total	26.00	13.00	14.00	3.00	56.00	26.00	13.00	14.00	3.00	56.00	—

Table 13. Grain Flow, San Miguel[a] 1975 Projection
1000 Metric Tons

Month	Inflow					Outflow					Month-end Stocks
	Corn	Sorgh	Rice	Beans	Total	Corn	Sorgh	Rice	Beans	Total	
July	-	-	-	-	-	3.33	.48	.22	.19	4.22	5.53
August	-	-	-	-	-	2.75	1.19	.22	.16	4.32	1.21
September	1.76	-	-	-	1.76	.31	1.08	.21	.13	1.73	1.24
October	2.88	-	.09	-	2.97	.31	.74	.12	.12	1.29	2.92
November	3.20	-	.81	.12	4.13	.31	1.65	.12	.02	2.10	4.95
December	3.20	-	1.17	.17	4.54	.31	1.64	.12	.02	2.09	7.40
January	2.88	1.60	.57	.25	5.30	.31	.16	.42	.02	.91	11.79
February	2.08	2.24	.36	.23	4.91	.31	.16	.52	.02	1.01	15.69
March	-	1.84	-	.19	2.03	.36	.16	.51	.02	1.05	16.67
April	-	1.44	-	.04	1.48	2.61	.16	.12	.02	2.91	15.24
May	-	.88	-	-	.88	2.50	.16	.21	.10	2.97	13.15
June	-	-	-	-	-	2.59	.42	.21	.18	3.40	9.25
Total	16.00	8.00	3.00	1.00	28.00	16.00	8.00	3.00	1.00	28.00	—

[a] Includes Usulutan Plant.

The recommendation that the site for the new construction in the Eastern zone be at San Miguel rather than at Usulutan was based on the following information:

1. Using the last available production information by Department as shown in the Appendix Tables 28-31, it can be seen that San Miguel would be in a more central position to obtain beans and sorghum from producers. A local area of intense concentration of corn production is located in the Usulutan trade area. However, it appears that the extensive region of somewhat lighter production throughout the Department of Marazan and La Union together with northern parts of the Department of San Miguel more than outweigh the influence of the much smaller area of intense corn production. From the standpoint of delivery of corn, beans, and sorghum farmers, and especially by small farmers, San Miguel has an advantage over Usulutan. Usulutan is in the best location for rice receipts. An aggregate analysis of the estimated production of the four grains by 1975 indicates a preference for the San Miguel location.

2. While the existence of a plant at Usulutan might indicate some economies in further expansion, this would not be likely. The needed additional facilities, which are recommended to be basically of modern concrete construction could not be added at Usulutan in such a way to use handling facilities already in existence. The proposed construction can be used more efficiently in bulk storage of corn and sorghum, i. e. the major volume of production increase by 1975.

3. Usulutan is out of position in a transportation analysis of roads and center of distance in the Eastern zone.

4. The existing storage facilities at Usulutan could be used basically for rice processing. Approximately 3,588 metric tons of the storage space at Usulutan is in warehouse construction. Both receipt and sale of rice are in bags.

5. A production analysis of the capacity at Usulutan indicates about 240 to 280 quintals of milled rice per 24 hours. This would require approximately 353 to 412 quintals of rough rice per day at a 68 percent yield. Assuming 300 days of operation per year, the plant would be able to process 72,000 to 84,000 quintals of rough rice. This is about 3,312 to 3,864 metric tons per year of rice requiring storage. Packaging of milled rice for export and domestic consumption would continue at Usulutan.

6. The silo capacity can be used for corn cleaning and storage. If packaging of corn is limited to the larger size of 100 pounds for sale to middlemen in both the Eastern and near sections of the Central zone a very efficient corn storage and processing operation will result by utilizing capacity not required for the rice processing unit.

7. The possibility of obtaining a loan from a bank for the purpose of constructing a grain storage facility in the Eastern zone would be more favorable for the San Miguel location because of the regional aspects discussed in the Banco Centroamericano de Integracion Economica report.[3]

8. From the standpoint of receiving imported grain, the advantage is with San Miguel. San Miguel is on a more direct and shorter route to receive grain through Puerto Cutuco. If trade is resumed with Honduras, the advantage still is with San Miguel. An installation at San Miguel would add to management requirements but this is not considered to be a controlling factor.

9. San Miguel is a center of population concentration of the Eastern region. From the standpoint of distribution of retail packages, it has an advantage over Usulutan. San Miguel is more favorably located with respect to the areas of relatively heavy grain sorghum production.

IRA currently is renting some bodego type warehouses. The warehouses at Soyopango could be maintained in reasonably good condition for continued rental in an interim period. The rented warehouses at Usulutan are not considered to be in satisfactory condition for continued future storage of food grains.

Policy Considerations Relevant to Storage Activities. The previously described schedule of grain purchases raises a question of practical operations. If IRA were to maintain a constant purchase price throughout the purchasing period it is likely that producers would attempt to concentrate their sales to IRA as early as possible in the purchasing period. Without some control over deliveries, IRA probably could not maintain the schedule. Two alternatives are apparent. (1) IRA might consider limiting deliveries directly by a quota system. In a manner IRA is doing this currently. Small producers are given a larger delivery quota relative to their production than are large producers, (see Table 14).

Table 14 Corn Purchases by IRA by Size and Number of Registered Products

Manzanas	Crop Year 1967-68		Crop Year 1968-69	
	No. Producers	% Purchased	No. Producers	% Purchased
Up to 20.0	1,889	100	2,492	100
20.1 - 40.0	69	80	65	80
40.1 - 80.0	31	60	35	60
80.1 - 160.0	20	50	18	50
160.1 or greater	8	30	11	30

Source: Instituto Regulador de Abastecimientos, Departamento de Estudios Especiales, September 11, 1969.

(2) IRA might consider an indirect approach by a system of flexible prices, i. e. starting the early season price low enough to induce the desired quantity delivered and then increasing the price at a rate necessary to attain the scheduled quantities. Such an activity would require a thoroughly competent market and business analysis department in IRA's organization. The need for this sort of analysis already exists and will become greater if IRA expands its activities. Dr. Francis Kutish of the USDA on a previous assignment spent two years analyzing marketing problems in El Salvador. He has prepared a statement on the matter of flexible pricing which might be used in conjunction with a loan and purchase agreement program. This is presented as Appendix C in this report, for IRA's consideration.

A policy problem exists also with respect to imports and their effect on domestic prices. As a member of the Central American Common Market, El Salvador has responsibilities, limitations and privileges with respect to international trade. Full implementation of CACM policy would change the circumstances. Until such time as this policy can be implemented consideration could be given to arrangements which would make IRA the sole importer of grains. With this control IRA could manage imports in a manner that would be complementary to its domestic price stabilization efforts.

Another policy question is the maintenance of reserve stocks of grain for unpredictable contingencies. Contingency reserve stocks were not included in the projected storage program outlined in this report, although stocks were not entirely depleted even in the month of lowest stock-on-hand. The approach used in this analysis lends itself well to the determination of storage capacity needs in case a decision is made to carry reserves. It is necessary only to add a constant amount, equal to the desired reserves, to the month-end stocks in the grain flow Tables, i. e. Tables 11, 12, and 13. The immediate effect is to increase storage capacity requirements by the amount of the reserves. This will result in a reduction in the turnover rate.

Investment Requirements for IRA Storage Expansion. Proposed minimum storage capacity for Santa Ana based on the 1975 projection is 12,240 MT. If normal operating space is assumed, the constructed capacity required at Santa Ana would be approximately 15,300 MT. Of this amount silo storage is recommended to be 14,052 and warehouse storage of approximately 1,300 MT. The type of construction, equipment and installation is to be similar to the Model II grain storage unit proposed in the Banco Centroamerico Study [3] with the addition of 4 large silos of 556 MT capacity and 2 interstice bins of 183 MT capacity. A slightly larger warehouse space is proposed also. The costs of the installation at Santa Ana are estimated at approximately 80.00 C.A. pesos per metric ton or a total cost of 1,228,160 C.A. pesos. The per metric ton costs are similar to those proposed in the BCIE study of regional capacities, but higher than those of several recent bids of similar storage in the Central and Latin American region. It is believed that rising construction and materials costs would place bids in the near future near the BCIE figure.

Proposed minimum storage capacity for San Miguel based on the 1975 projections is 16.67 MT. Utilizing existing capacity at Usulutan reduces the new construction estimate to 11.15 MT. This would require approximately

13,933 MT of constructed capacity. It is recommended that silo storage be 12,757 MT and warehouse storage be 1,300 MT. for a slightly greater total of 14,057 MT. The unit would be similar to Santa Ana with the exception of 2 less large silos and 1 interstice bin. Using the same cost estimate of $80.00 C.A. pesos per metric ton would require 1,124,560 C.A. pesos for construction.

Proposed minimum storage capacity for San Martin based on the 1975 projections is 33,880 MT. Of this amount 22,200 MT is presently owned by IRA. A need for construction of 11,680 MT is projected. Considering population growth of the central area in conjunction with production expansion it is recommended that a unit similar to the one proposed for Santa Ana be built. A unit of this size would have a slightly larger capacity than required but allow for projected growth. Furthermore, it is recommended that the San Martin unit be the last priority of the three sites which means it will possibly operate at near the minimum level by the time construction is completed. The reason the San Martin expansion may be delayed is that the other sites have few alternatives in renting facilities for storage while San Martin is presently renting good warehouse facilities with the prospect of more being available. In addition, the liklihood of private investment in silo facilities is projected to occur first in the Central Zone near San Salvador.

A summary of proposed investments is shown in Table 15 below.

Table 15. Proposed Investment Needs in Grain Storage Facilities by Location, 1975 Projection.

Location	Capacity (metric tons)	Investment CA$		
		Total	Local	Foreign
Santa Ana	15,352	1,228,160	1,228,160	---
San Martin	15,352	1,228,160	1,228,160	---
San Miguel	14,057	1,124,560	749,706	374,854
Total	44,761	3,580,880	3,206,026	374,854

It is believed that IRA through appropriations from the government, in all probability, will have to finance construction of the proposed grain facilities at Santa Ana and San Martin. It has been assumed that the BCIE will be able to make arrangements to finance one-third of the cost of the San Miguel facilities since it is in the interests of the CACM to have a regional silo in this location.

STORAGE CAPACITY REQUIREMENTS, 1980 PROJECTION

The procedure used in determining storage requirements for 1975 is readily adaptable to approximating capacity needs for 1980 but this is not intended to be as detailed as the analysis for 1975. The following is concerned only with aggregate national requirements. If recommendations for plant location in the 1975 analysis are followed the sites would remain the same in succeeding periods. The ratio of allocated capacity among the zonal storage installations could change if concentration of production and/or population changes occur among zones in the period ahead. No attempt is made here to project such changes.

Projected national production of the 4 crops was available from the sectoral analysis. This is shown in the following table, (Table 16).

Table 16. Projected 1980 Production, Commercial Marketings And Quantities to be Purchased by IRA

Crop	Production	Commercial Marketings	IRA Purchases
		(1,000 Metric Tons)	
Corn	451.00	360.80	72.16
Grain Sorghum	210.00	168.00	33.60
Rice (rough)	148.00	136.16	27.23
Beans	41.00	34.04	6.81
Total	850.00	699.00	139.80

As the economy of El Salvador progresses it is expected that an increasing proportion of corn, rice and beans will enter commercial marketing channels. This is the case as economies move farther from subsistence to commercial status. In the case of grain sorghum no change is expected between 1975 and 1980 as it is likely that farm livestock enterprises will expand, encouraging the feeding of grain sorghum on farms to a degree that will offset the trend toward commercialization mentioned above. By 1980 the following proportions of specified crops are expected to enter commercial marketing channels: corn 80 percent, grain sorghum 80 percent, rice 92 percent, beans 83 percent. The quantities of grain are shown in Table 16.

The proportion of commercial marketings which IRA will need to control likely will be about the same as that considered for the 1975 projection, i.e. 20 percent.

The rate of turnover in IRA storage installations is not expected to improve if IRA is to succeed in price stabilization efforts. Turnover in the following calculations is 1.6. IRA purchases of 139,800 metric tons of grain using a turnover rate of 1.6 would require a minimum storage capacity of 87,380 metric tons. This would necessitate 24,590 metric tons of additional capacity over the 62,790 metric tons projected for 1975.

MANAGEMENT AND OPERATIONAL ACTIVITIES

Management Activities. Consideration should be given to increasing the amount of management and technical supervision in IRA for the following reasons:

1. The expansion of facilities for rice processing and production packaging has increased the supervision demands on management's time.

2. The proposal for new facilities requires that trained managers be developed to operate facilities at levels of acceptable competence.

3. The present lack of depth of personnel in the organization makes it difficult to send managers out of El Salvador for technical training without possible loss of efficiency and control of existing plant operations.

4. Replacement of present managers will be necessary as ill health or retirement age arrives and the possibility exists of loss of managers to more attractive positions in private industry.

It is recommended that two people be placed on a junior management training program as soon as possible such as the one suggested in greater detail later in this section. It is suggested that graduates of the 3 year college for agriculture be interviewed. At least one of the individuals should have an engineering interest and background in mathematics and related courses to permit development as a technical supervisor. His immediate training would be in the rice processing facilities, alternating between the 2 present plants in conjunction with the broad outline of the training program. The other individual would develop in packaging and warehousing operations in addition to the training program as outlined.

It is expected that, given assistance from management, the trainees could function as relief supervisors so that Mr. Mauro Marquez and Mr. Federico Escalon could be sent to technical schools in grain management in the period of time when storage and processing operations are least demanding. Possibly a goal of July or August of 1970 should be considered.

As the requirements of IRA for technical management expand, similar hiring or placing of individuals in a training program [12] should result so that by 1975 sufficient trained personnel would be available to staff the proposed plants adequately. This would require from 4 to 6 people, in addition to Mr. Marquez and Mr. Escalon, to have been through the training program in San Salvador and the grain management programs in the United States.

It is assumed that the administrative offices of IRA will develop management individuals besides the proposed grain managers at the plant level. These individuals should adequately supervise accounts, economic activities, feasibility studies, retail operations and provide information for the Board of Directors.

Recommendations Concerning Qualifications and Training of Plant Management Personnel

Training Managers and Other Key Personnel

In order to adequately serve as a manager or as key personnel (i.e. assistant managers and plant superintendents), employees should be chosen with certain qualities. Insofar as possible all key personel should be of management caliber. This is necessary in a program of continuing education to prepare personnel to assume management responsibilities in the event of vacancies.

Personal qualifications:

1. They must be thoroughly honest.

2. They should have at least a high school education.

3. They should have the capability of leadership.

4. They should be capable of developing the confidence of farmer customers and should understand their problems.

5. They should be capable of mixing well with employees and be sympathetic to their interests.

6. They should be capable of training other employees.

7. They should be capable of delegating responsibilities and seeing that they are fulfilled.

Managers and Key Personnel should be trained and provided knowledge as follows:

1. They should have thorough knowledge of market procedures for the commodities being stored and merchandised.

2. They should have thorough knowledge of the bookkeeping system being used.

3. They should have basic knowledge of grain grading and classification and all equipment used therewith.

4. They should have adequate knowledge of insect identification, recognition of insect damage, and insect control. This should include the use of both grain fumigants and grain protectants in bulk stored as well as bag stored grain.

5. They should have knowledge of rodent control.

6. They should have basic knowledge concerning the operation of all machinery used in the handling and processing of grain.

7. They should have general knowledge of building and equipment maintenance.

8. They should be able to draw up and analyze an operating statement and understand a profit and loss statement.

9. They should have basic knowledge of the grain drying process (Bin drying, batch drying and continuous flow drying) and know how to calculate shrink loss due to drying.

10. They should understand grain aeration. They should know when to aerate with consideration given to relative humidity and grain moisture content.

11. They should understand the basic problems encountered in maintaining quality of grains: excess moisture, moisture migration, molds, fungus, insect damage; and how to correct these problems.

Short Course Training Programs

1. FAO School - Colombia

A school has been under consideration in Colombia by the Food and Agriculture Organization of the United Nations for managers and key personnel of grain storage facilities but information available at this time indicates the school is not yet organized.

2. Kansas State University, Manhattan, Kansas

Kansas State University is prepared to offer a training program. It would be desirable if all trainees could speak English, however, if this were not the case, Spanish speaking instructors could be used or interpretation could be provided. This training should start with orientation in Washington D.C. for a few days followed by a program of approximately six weeks at Kansas State University. The program would consist of lectures, laboratory exercises, and field trips to storage, marketing and regulatory installations. Following is a tentative outline of such a program.

Grain Storage and Marketing Short Course

I. Introduction to Course

A. Importance of Proper Grain Storage and Marketing

1. Prevention of loss

2. Stabilization of prices

B. Purpose and Scope of the Course

1. Provide Basic Fundamentals of Grain Drying, Storage, Handling, Marketing and Transportation.

2. Provide Practical Knowledge and Techniques Needed in Grain Storage and Marketing.

II. Review of Grain Production and Utilization in El Salvador

A. Production

1. Grains Produced

2. Production Areas

3. Quantities Produced

B. Utilization

1. Consumption - Food and Feed

2. Export

3. Import

C. Basic Information

1. Population

2. Climate and Topography

3. Transportation

III. Fundamentals of Grain in Storage

A. Structure of Cereal Grain Kernels

B. Moisture and its Measurement

C. Chemical, Physical and Nutritive Changes in Grain during Storage

IV. Grain Inspection

A. Grain Standards

B. Grain Sampling

C. Grain Grading

1. Grading factors

2. Methods

V. Grain Handling

A. Movement of Grain

1. Hand Methods

2. Mechanical Methods

B. Methods and Facilities for Conditioning Grain

1. Cleaning Equipment

2. Temperature Monitoring Systems

C. Grain Drying

1. Principles of Grain Drying

a. Temperature - Moisture relationships
b. Effect on Drying on Quality

2. Types of Drying

a. Natural Drying
b. Unheated Air Drying (Aeration)
c. Heated Air Drying

3. Types of Driers

a. Bagged Grain
b. Batch System
c. Continuous Flow

4. Drier Operation

a. Heat Source
b. Air Flow Rates
c. Air-Grain Temperature Relationships
d. Weight Loss in Moisture Removal

D. Equipment Maintenance

VI. Storage

A. Type of Structures

1. Farm Storage

2. Bodega Storage (warehouses)

3. Silo Storage (Elevators)

B. Structural Maintenance

C. Storage Methods and Procedures

1. Warehousing

2. Elevators

a. Binning
b. Blending

D. Inventory Control

1. Bookkeeping

2. Preparation and Analysis of Operating Statements

VII. Sanitation Program

A. Housekeeping

1. Warehouse and Elevator Perimeters

2. Warehouse and Elevator Interior

3. Warehouse and Elevator Equipment

B. Insect Control

1. Biology and Identification of Insects and Their Importance

a. Biology of Major Pest Insects
b. Identification of Stored Grain Insects
c. Insects in relation to:

(1) Grain temperature and moisture content
(2) Fumigants
(3) Grain Condition

2. Control Methods

a. Housekeeping
b. Residual Sprays
c. Protectants

(1) Bags
(2) Grain

d. Fumigation

(1) Warehouse
(2) Elevator

e. Inspection

3. Pesticide Safety

C. Rodent and Bird Control

1. Biology and Identification

a. Rodents
b. Birds

2. Importance of Rodents and Birds in Relation to Grain

3. Control Methods

a. Structural Conditions
b. Traps
c. Baits and Poisons

D. Microbial Control

1. Importance of Micro-organisms in Grain

a. Development of Micro-organisms on Damp Grain

(1) Molds (Fungi)
(2) Yeasts
(3) Bacteria

b. Mycotoxins

(1) Production
(2) Effect on Man and Animals

2. Control Methods

a. Drying
b. Cooling
c. Proper Management

VIII. Marketing

A. Financing Grain Products

B. Market Prices and the Storage Function Price Reporting, Marketing Margins, etc.

C. Cooperative Marketing and Warehousing of Grain

D. Price Stabilization Program on Grains

E. Governmental Activities in:

1. Grades and Grading

2. Weights and Measures

3. Warehousing

F. Regulatory Controls in the Marketing of Seed, Fertilizer, Pesticides, etc.

G. Extension Programs and their Role in Grain Storage and Marketing

H. The Central American Common Market Import - Export relationships.

IX. Distribution and Transportation

A. Relationship between Production and Consumption Areas

1. Where do we store?

2. Where do we process?

3. How do we move between production and consumption areas?

B. Modes of Transportation

1. Local or farm

2. Truck - Roads

3. Railroad

C. Hazards during Transportation

1. Contamination - Insect, Rodent, Bird

2. Increased Moisture

3. Theft

D. Import - Export

1. Methods of Loading - Off loading

2. Inspection

3. Port facilities

X. Responsibilities of Warehouse and Elevator Managers

XI. Tours of Local Facilities to Point out and Demonstrate Course Material.

XII. Laboratories to Complement Lectures

A. Grain Inspection Methods

B. Tours in Part to Observe Handling Equipment

C. Models of Driers and/or Demonstration of Effects of Improper Drying

D. Inventory Control for Warehouses and Elevators - Bookkeeping, etc.

E. Insect Identification

F. Demonstration of Pest Control Methods.

Recommendation for Use of Technical Assistance In El Salvador's Grain Storage Operations

It is recommended that, if possible, arrangements be made for a grain storage technical advisor (GSTA) to be stationed in El Salvador for a two year period coinciding with initial operations of suggested new storage facilities. It is highly desirable that this person be relatively fluent in the Spanish language. Among the activities in which the GSTA could be helpful are:

1. Assist in the development of an in-serve training program designed to provide replacement and/or expansion personnel. This should consist largely of measures to insure that the assistant manager participate in major decisions and be conversant with all phases of operation. An important element in this regard is the selection of personnel at the assistant manager level who have the potential of moving to the manager position.

2. Discuss with plant managers all questions and problems of operation, e.g. drying, aeration, insect control, rodent control, determination of shrink, determination of grades, general housekeeping, the taking of inventory, preparation of operating statements, etc. It should be understood, however, that the manager would not be compelled to act on the advice of the GSTA and furthermore the GSTA would not be held responsible for any losses incurred in the grain storage operations.

3. Arrange management seminars as often as he deems necessary and in no event less than annually. Major purposes of such seminars would be to, (a) present available new information so the managers may keep abreast of advances in grain storage technology and (b) discuss current operational problems.

4. Review with each manager and other key personnel, for the first year at least, the plant's financial operating statement -- this statement to be provided the GSTA by IRA.

In addition to the above it is expected that the GSTA would be permitted to participate in discussions of grain storage policy by IRA.

<u>Operational Activities</u>.

San Martin Plant Visit

A. Receiving operations. No unloading operations were in progress during the visit. No facilities for rapid bulk unloading of trucks or rail were noted. If the receiving situation changes so that either bulk receipts by truck or rail become a significant portion of total receipts, it is recommended that a pneumatic unit be installed by the metal silos at the rear of the plant alongside the railroad tracks. The unit should have flexible connections so either truck or railcar can be unloaded to the silo headhouse. This unit could serve until bulk truck delivery

became sufficient to justify a truck dump with a hydraulic hoist -- then it could function as a stand-by unit for trucks and serve as a railcar unloader. The pneumatic unit could handle either boxcar or hopper car unloading with a simple attachment change.

Provision was noted for a bag dump sink at the rice dryer operations in connection with a bucket elevator lift. If bulk rice receipts increase to a large volume, an overhead truck hoist or portable front end lift may facilitate operations.

As bulk receipts increase, consideration should be given to installation of a metal removal system, such as a drum magnet in locations as near to unloading as possible.

The existing screw conveyor from the silos to the packing operations or transfer elevator leg should be replaced by a belt conveyor. If the space is not sufficient, a drag conveyor within the present conveyor trough would probably suffice. A belt conveyor should replace the screw conveyor distributing the grain to silos from the transfer elevator leg. These changes will reduce mixing of grains and insect contamination due to grain residue in the bottom of the screw conveyor troughs.

B. Drying and conditioning operations. The corn drying unit was not operating at the time of visit. If a substantial proportion of corn arrives this crop year at 16 to 18% moisture, the unit may not have sufficient capacity to handle both normal (40 to 50% of crop purchased) December receipts plus receipts from the expected crop increase. Additional dryer facilities may be required if above-average purchases occur, especially in view of the 12 to 13% moisture limit on corn to be placed in temporary storage using plastic if the need arises.

The drying facilities being installed for rice are rated at a total of 600 qq/hr. The units are manufactured in El Salvador at Santa Ana and use of the technical services of the manufacturer are recommended. The proper drying of rice is very important in relation to the reduction of the amount of broken rice when milling. This is discussed in greater detail in the section on rice processing. Close supervision of the drying air temperature and temperature of the outgoing grain is required. The technical representative of the dryer manufacturer should be required to aid in obtaining desired capacities; to furnish the equipment to test air-flow in inlets and columns; and see that air seals function properly. After the desired conditions for design capacity are reached, he should be requested to stop by the plant for consultations as needed.

C. Laboratory facilities and techniques. The laboratory appeared well managed and the layout of equipment was satisfactory. A question was raised about the purchase of a new moisture tester due to customer complaints. The requested purchase is recommended. The following program is proposed regarding moisture meters:

1. Standardize on the same model or manufacturer in all plants as soon as possible. Select a location in the laboratory and leave the meter there at all times.

2. Use a check sample of known moisture for twice daily tests of proper functioning, during months of large purchases.

3. Check voltage of electrical outlets in the laboratory on a periodic basis to determine if a satisfactory level of power uniformity exists.

Laboratory personnel. The senior man in the laboratory should be developed, if it has not already been done, for special project assignments by the technical supervisor. The better laboratory technicans are those whose familiarity with the processing units and storage operations permits them to detect trouble in the early stages of occurrance. It is proposed that he be developed on a part time basis in the following order of suggested importance.

1. To recognize types of grain insects, the types of damage and means of detection, best means of destroying insect and first aid safety procedures for all fumigants used.

2. To be capable of analyzing rice processing operations so that quality and grade factors are maintained.

3. To develop public relation techniques so that customers and sellers will have a favorable image of the plant even when complaints and/or mistakes occur.

4. To read current grain trade literature as provided by management in order to practice new procedures and methods.

5. To function as an informant of plant conditions and situations to the supervisor as he performs daily quality checks outside the laboratory.

It has been suggested elsewhere that grain grading license procedures be set up by the Government for those individuals involved in grading grain for both the export and domestic market. All laboratory employers who assign grain grades for IRA should be required to obtain the grain grading license.

Usulutan Plant Visit

A. Receiving operations. The truck receiving scale at Usulutan apparently is not long enough nor of sufficient weighing capacity to adequately weigh modern transport trucks. It is suggested that for this crop season a tabulation be kept of the number and type of trucks which arrive that incur difficulty with weighing. A volume comparison of receipts can be made and an analysis completed. As bulk receipts increase, the problem will be compounded. However, it is projected that Usulutan will become primarily a rice processing plant, which under present technology receives rough rice for processing in bags and sells milled rice for export or domestic sale in bags. For plant inventory control it is recommended

that consideration be given to periodic weighing of outgoing trucks as a check for weight and quantity of product from the warehousing operation.

B. Drying and conditioning operations. The rice receiving and drying facilities under construction are similar to the installation at San Martin. The same comments are applicable at Usulutan. A question which did not arise until the writing of this report is the feasibility of charging for custom drying operations for rice at Usulutan. Two separate units are under construction, which have a drying capacity of 800 qq per unit. Since the units are continuous, it would appear that only large producers could be efficiently handled if return of the same rice was desired by the producer. It was not indicated in the visit if this type of customer service is proposed by the plant.

The corn drying unit was in operation at the time of the visit. It is recommended that consideration be given to checking the unit for air flow when the technical representative is available with the necessary equipment at the rice drying facility.

C. Laboratory facilities and techniques. A similar proposal is advanced for training of the laboratory technician as discussed in the San Martin comments.

The adjoining rented warehousing operations could be subjected to a special project by the laboratory technician to reduce insect and rodent populations. It is recommended that facilities be provided to place all empty sacks in a central location in the rented warehouse area where they could be kept under fumigation. One section should be under active fumigation using a covered tarp for all newly emptied bags or return bags and another area for holding bags without contamination that have been fumigated and available for reuse operations.

The rented warehouse area is extremely susceptible to insect and rodent infestation and only the prompt removal and treatment of bags and trash will result in improvement.

A decision should be made to phase out future use of the rented facilities at Usulutan. Efforts would be justified in repairing major leaks during the slack season even though the warehouses are rented. Product loss due to moisture and mold growth plus the reduction of areas for the growth of insect population would offset nominal repairs. The low rental cost should be evaluated in view of product loss and damage to obtain a total picture.

Rice Management

Two recent studies of the rice industry in El Salvador have been made. Since the studies were made, IRA has expanded its facilities for the processing of rice at both Usulutan and San Martin. It is expected that expansion at both facilities will be completed in time for processing the crop arriving in November.

San Martin

Japanese Kyowa rice processing equipment is used. The apparent capacity is about 15 qq/hr. of milled rice. The milled rice being produced at time of milling was badly broken and it is doubtful that rice of better quality would exceed 12 qq/hr. The drying equipment is continuous, fuel oil fired and consists of a 200 qq/hr. unit and a 400 qq/hr. unit manufactured by Mardones. Rough rice received in bags can be emptied in a dump sink and elevated in bulk form over a scalper and then conveyed and elevated to the drier units if desired. It appears that 4 storage bins will provide the necessary space to hold rice prior to drying and that a bin is available in the mill-shed to store rice prior to milling. It was not determined whether any of the previously mentioned storage bins can also be used to hold rice for moisture equilibrium purposes prior to transfer to the milling unit. A dust bin is provided for the collection of air cleaning systems in the process. Milled rice is sacked by hand, hand weighed, and sewn into 100 lbs. bags using a portable sewing head.

Usulutan

Japanese Kyowa rice processing equipment is used. Capacity is apparently 10 qq/hr. of milled rice. The study by Zelaya [16] listed the capacity at about 12 qq/hr. The rice being milled at the time of this visit was estimated to consist of over 45.0% broken kernels. The drying equipment consisted of two units of two Mardones driers having a capacity of 400 qq/hr. each for a total of 1600 qq/hr. The units are the same model as the new 400 qq/hr. unit at San Martin. Each of the two drying units has a dump sink to empty sacks of rough rice, elevation to a scalper for cleaning then elevation to a complex of three bulk bins for possible storage prior to drying. The three bulk bins can also be used to store rice after drying prior to sacking. The drying units are located at a distance from the rice mill so that dried rice must be transported by sack to the rice unit where it is emptied in the receiving bin. The milled rice is then hand weighed and sewn into 100 lb. bags.

The IRA operations have excellent equipment in the Kyowa rice processing units. The manufacturer of the drier equipment, Gerardo Garcia Mardones, is not known by the authors but the models appear similar to units of U.S. manufacture. It is believed that in order for IRA to manufacture rice of a higher grade for the commercial trade a complete management and process flow is required. It is not enough to have the proper equipment in one section of the process if quality abuses occur prior or after the section. It has been suggested that a management trainee be employed to devote time in a special project of rice improvement at both plants. It is further suggested that the following areas of rice milling be investigated and proposals for improvement in the integrated flow of each section be made:

1. The variety of rice grown. In support of experiment station investigations, IRA should make known the difficulties of producing a marketable grade of rice from certain varieties grown in El Salvador. IRA should support a quality rice seed program through its contacts with the farmers and attempt to have the agriculture extension agents contact knowledgeable farmers for rice planting. A program of the type proposed

is probably in existance in other crops grown for export in El Salvador. IRA should research these programs and develop one that will have rapid results and take advantage of mistakes overcome by other export programs.

2. Through its price support and classification program, IRA may be able to compensate farmers who grow a rice that grades desirable in milling quality characteristics.

3. Rice drying. When dried artifically, care is required to avoid high drying temperatures, which cause checking and shattering of the rice kernel and results in the kernel breaking during normal handling. One means of preventing this loss is to dry rice having a high moisture, in several stages down to safe storage levels. No more than three to four percent of the moisture should be extracted in each stage or pass through the continuous type drier. Between drying stages, it should be held in storage so the moisture content reaches an equilibrium throughout the kernel as well as the entire batch. For best milling results, temperature of the drying air should approximate 130° F. If this temperature is used during each drying stage, broken kernel loss will be around five to six percent, an essential target for an efficient milling operation. Poor drying facilities, with the possible resulting losses, are costly for any food grain but especially so for rice because of its high food value.

As IRA develops its rice drying facilities some consideration should be given to obtaining the grain from the farmers at a higher moisture content and then artifically drying the grain. This would essentially bring the grain in sooner which has several advantages: (1) The rice would be harvested at a higher more optimum moisture for handling purposes; (2) direct movement to artifically drying facilities would reduce breakage in handling; (3) less insect and rodent damage would occur because of shorter periods of time rice would be held on the farms in patio dryers and poor storage facilities; (4) IRA would be able to exercise greater control over drying temperatures, use of bulk facilities, handling techniques, and storage conditions.

4. Rice milling. The yield of polished rice from rough rice varies according to the type of rice, the method of drying, and the efficiency of milling operations. The average yield obtained by rice millers from 100 pounds of rough rice will be 68 pounds of the finished product in polished form, 9 to 11 pounds of bran, and 21 to 23 pounds of rejects and hulls. The yield includes an allowance for 7 to 9 pounds of broken kernels. Milling results in the more developed rice exporting countries are somewhat higher with about 72 pounds of the finished product, 2 pounds of medium and fine broken, 9 pounds of bran, and about 17 pounds of hulls. IRA should begin a program of incoming weights and outgoing weights on the rice milling operation as the new crop is milled.

5. Rice Storage. It is preferable to store the rice in rough form in bulk to reduce handling damage and insect control. However, under present marketing procedures all rice is received in bags at IRA. Furthermore, the rice drying and processing equipment is not physically located at either plant to permit use of existing silos without resacking the grain for

movement at a point in the flow. Only the small bulk storage bins at the drying sites are avialable for bulk storage and this storage is basically in-process flow. Further consideration of storage at either location should include the location of bulk bins in a more favorable position for rice handling. The present export procedure is to ship milled rice in bags from the plant to a rented warehouse at the port where stocks are accumulated until the ship arrives for loading.

6. Rice accounting records. A cost card or similar accounting system should be developed at each plant to enable IRA to know at any given time the profits or losses resulting from rice processing.

The cost card requires sales prices on the milled rice and by-products, the purchase price of the rough rice, the sales package cost minus any credit for reusable bags and the yield of milled rice and by-products. The value of the card is in control and ready availability of costs for sales purposes.

The purpose of investigating the various aspects of rice processing is to develop a procedure that will allow a total systems approach to the rice industry. IRA would have an integrated flow of technology from receipt or purchase of rough rice from the producer to the final sales of products to consumers or middlemen. Each of the sections of the flow: producer, purchasing, storage, drying, milling, packaging, distribution, sales, can be developed to where it contributes the most to total profit. In this manner total profit from rice operations will be maximized. One section of the flow will not be unduly affecting profit of another section as often occurs in business practice. The modern technique of a systems approach to business operations can be applied to other IRA operations as experience is gained by management people in rice processing.

IRA Office Procedures

A study was made in the spring of this year by three business machine manufactures of the IRA general office operations and proposals were supplied. It is the opinion of the team that IRA must evaluate its own operations and future needs in information to effectively choose among the proposals. The type of questions IRA should ask itself are as follows:

1. Supply and purchasing information. Should not monthly data on quantities bought by grade and location be available for each commodity handled? Should not number of sellers by type such as size of farm, business category, or country be available for comparison with potential number of sellers in each category? Should not actual prices paid for each commodity purchase be available so cost card analysis can be made?

2. Sales and distribution information. Should not monthly data by quantity of each product sold including location of sales point and type of purchaser if other than a consumer be made available? Should not potential market for products be compared to actual distributions by desired criteria?

3. Operating costs. Should not each category of operation be broken down by costs directly assignable such as; storage, processing, packaging, distribution, transportation, administration, and research? Should all assignable costs to each category be classified by type such as; labor, purchases, maintenance, utility costs, administrative and management overhead, etc.?

4. Policy decisions. What data is required for setting of prices paid to producer and products sold to consumer? What data is needed to time purchases and sales by month? What information is required to consider allocation of the amount of resources to devote to storage, processing, packaging, research for best operating characteristics? What data is required to be available so profit opportunities are known and losses can be minimized when discovered?

After IRA has decided what information it needs to effectively fulfill its responsibilities to the producer and consumer it should evaluate the three office machine proposals. The specialists in office procedures from each of the companies can then be asked to re-evaluate their proposals in light of the additional information requested. It is believed a more satisfactory choice can be made by following the above procedure than to select a proposal based on the relatively routine business procedures presently covered in the report.

Grain Grading and Warehouse Receipts

IRA should request the government to establish a uniform system of official grades for grain that move within the domestic market. This will support the grading system that IRA now uses as well as the CACM grading system. A unified grading system among all buyers and sellers will permit IRA to function more effectively in competition with the now unregulated private trade engaged in domestic trading. In conjunction with this request, a procedure to license grain graders should be established. All graders of grain would have to pass a course of instruction and examination. In this regard, all grain graders at IRA facilities would after completing requirements be government licensed inspectors. The procedure of disagreement on grain grades would be resolved through a government program of appeal and less dissatisfaction with the grade assigned by IRA could result. One advantage of a uniform system would be the possibility of a more rapid movement to bulk grain handling among sellers and buyers.

Complementary to a system of official grade standards for the domestic market would be the formation of a uniform negotiable warehouse receipt. A system of licensed warehouses both public and private must first be established and a procedure for inspecting facilities and verifying stocks must be made. IRA is in effect issuing a warehouse receipt although more in the sense of a general receipt for purchased grains. Various banks and lending agencies have recognized the negotiability of the receipts and are presently loaning money on presentation of the receipt. A licensed warehouse procedure would encourage private as well as public concerns to issue warehouse receipts. Again this procedure will encourage the movement of grain in bulk rather than sack throughout storage facilities.

TEMPORARY STORAGE OF CORN USING PLASTIC FILM

Investigations. Prior to arrival, published literature on the subject of the use of plastic for short term (3 - 4 months) storage of corn was reviewed [2, 14] . No publications were discovered which dealt with storage under conditions expected in El Salvador. Conversations and correspondence were then carried out with individuals having actual experience involving storage of dry corn using plastic. The observations are:

Corn. Plan to store cleaned corn only, free from foreign material, dirt and broken kernels. Store only dry corn having a moisture basis as low as feasible but no higher than 13.0% dry moisture basis. Corn should be free from insect infestation and fumigant should be applied at time of filling and as required during storage period.

Storage Site. Select and clear a good ground storage site with drainage. Fill low spots if required, remove all rocks or sharp objects from area plastic will cover. Use a site sheltered from wind if possible and face the pile so the long side is against prevailing winds. Leave room to maneuver the equipment required to fill pile. The site should be fenced to prevent animals and theft losses. The site should be well lighted and clear of refuse. This will facilitate rodent control.

Materials Needed. Two large black polyethylene plastic sheets of 6 mil thickness. Two sheets 40 feet by 100 feet will hold about 5,500 quintals of corn. A small suction fan capable of moving 1,000 CFM of air is needed. A fractional horsepower motor would be required in order to provide 3,000 FPM velocity within the duct. A duct running the length of the pile and opening to the fan inlet is necessary. Openings in the duct evenly spaced along its length should provide the necessary air movement within the pile. Ropes to aid in keeping the plastic down, weights, and mending tape for the plastic is helpful. A portable elevator for distributing the corn on the pile is required to attain the necessary angle and height of corn for best results.

Technical Management. Periodic checks should be made depending on the original condition of the corn and local weather. Rips or holes due to wind or sharp objects should be mended with plastic tape. If power failure occurs, the fan should be restarted as soon as possible to prevent loss of vacuum and possible wind damage. Inspections for leaks should be made if water deposits are found and immediate drainage should be initiated. Checks for excessive moisture condensation should be made under the top sheet near the peak. Checks should be made for insect or mold damage. Immediate corrective action should be taken if any of the above difficulties are noted.

Upon arrival in El Salvador, daily relative humidity and temperature data was requested for the months of proposed storage on the location sites. IRA was able to supply 1968 data for Usulutan and 1966 data for San Martin. The Friez recorders were located in the laboratories of both plants when visited. The laboratory location of the recorders, would suggest that actual daytime temperatures in the open sunlight where storage would possibly be located, would be higher than shown on the records.

A possible supplier of plastic sheets in El Salvador was telephoned. The Rotoflex plastic company in Soyapango indicated that only 2 mil thickness was available in the 40 feet by 100 feet size of plastic sheet. This thickness is not sufficient for corn storage as proposed in El Salvador so plastic sheets apparently would have to be imported. A possible supplier of fans and motors is the Company of Mr. Gerarpo Garcia Mardones in Santa Ana which manufactured the continuous rice drying equipment installed at Usulutan and San Martin.

Recommendations. Under proper control conditions it is feasible to store corn in plastic at Usulutan and San Martin for short periods of time (3 to 4 months) in the dry season (Dec.-March). Two alternative proposals are supplied.

Alternative I

The first proposal is based upon the Welchert, Little article which is reproduced in Appendix D.

A. Recommended Materials:

1. Two sheets of black polyethylene plastic of 6 mil thickness in 40 feet by 100 feet dimensions.

2. Plastic repair tape.

3. Tie down ropes with weights.

4. A perforated duct constructed of local materials to run the entire length of the corn pile permitting a velocity of 3,000 feet per minute in the duct and a volume of 1,000 cubic feet per minute of air at the fan exhaust location.

5. A fan sized to deliver a volume of 1,000 CFM at a static pressure of 0.1 inch of water. A fractional horsepower motor is required to operate the fan.

6. A portable conveyor to elevate the corn to the center height of about 8 to 10 feet. The conveyor will be again used to reload the grain at the end of the storage period.

B. Recommended Procedure:

See instructions in article by Welchert and Little (Appendix D).

Additional instructions.

1. Place the perforated duct on the center of the 400 foot plastic ground sheet parallel to the 100 foot length prior to unloading the grain on the sheet.

2. Be sure a tight seal can be made from the duct through the plastic to the fan inlet after placing the top sheet over the piled corn. Use the plastic tape to seal the cut area in the plastic and around the duct outlet and fan inlet.

3. After fan is operating and plastic is drawn down snugly against the corn check for leaks in the plastic by close inspection of loose areas or possible air noise. Seal all leaks with tape. The suction pressure is required to aid in keeping wind damage from occurring to the plastic.

4. Utilize tie down ropes across the 40 foot width of corn pile by placing them across the plastic in 10 foot intervals and weighting ends with old rubber tires or similar materials so possible damage to plastic will not occur by the weighted material.

5. Clear and light area to reduce damage from rodent population.

C. Estimated Materials Cost per Unit.
Approximately 6 cents per quintal.

Two plastic sheets, plastic tape, ropes, weights, fumigant, duct material, motor, fan, starter delivered to site estimated at $310.00 U.S. Dollars.

D. Estimated Operating Costs per Unit.
Not available.

Site clearing, electrical connection and disconnection, electricity, use of portable elevator, management supervision, labor to load and unload the grain, rodent and insect control were not estimated due to lack of time to adequately assess a possible site location and determine local costs.

Alternative II

The second proposal is based upon information received from Dr. Harry Pfost of the Kansas Food and Feed Grain Institute after temperature, relative humidity, and local conditions in El Salvador were analyzed.

A. Recommended Materials for Each 100 feet of Pile Length.

1. Three sheets of black polyethylene plastic of 6 mil thickness in 40 feet by 100 feet dimensions or 40 foot width of roll to be cut into required length.

2. Three sheets of black or green reinforced plastic, such as Shell-Tarp, in 40 feet by 100 feet dimensions or 40 foot roll width.

3. Tie down ropes with weights or, if available, a net of small ropes with stronger tie down ropes.

4. A prefabricated metal duct or one of heavy wooden and metal wire duct construction, in easily handled sections.

5. A fan to provide 70 CFM of air per foot of length at a static pressure of 1.0 inch of water.

6. A portable elevator to elevate the corn a height of at least 20 feet.

7. Plastic repair tape and sufficient waterproof cement to join the seams of the three lower plastic sheet. The three upper reinforced plastic sheets need double seam sealing by cement.

B. Recommended Procedures:

Similar to general and additional instructions supplied in Alternative I.

Additional instructions.

1. See letter by Dr. Pfost (Appendix D).

2. Place and seal the ground sheets so that they are waterproof from ground dampness at the joints of the 40 foot sections.

3. Place the perforated duct on the center of the 100 foot length of plastic ground sheet parallel to the jointed 120 foot section prior to filling.

4. Use tie down ropes and netting over the plastic and place straw between the straw and plastic to act as insulation from direct sunlight as well as bird roosting protection.

5. Clear and light area to lessen rodent difficulties.

C. Estimated Material Cost per 100 foot by 85 foot unit.

Capacity of corn is approximately 38,000 quintals per unit. Estimated cost at 4 cents per quintal.

D. Operating, Management and Maintenance Costs is estimated at one-fifth of Alternative I.

SUMMARY AND MAJOR RECOMMENDATIONS

1. Projected 1975 production of the four basic grains (in metric tons) is: corn 348,000, grain sorghum 162,000, rice (rough) 114,000, beans 29,000. These data were available from an ongoing agricultural sector analysis.

2. Estimated commercial marketings in 1975 (in metric tons) are corn 261,000, grain sorghum 130,000, rice (rough) 102,000, beans 23,000.

3. Estimated annual quantities (in metric tons) which the Instituto Regulador de Abastecimientos (IRA) will need to purchase and store by 1975, to perform its function of price stabilization, are: corn 52,000, grain sorghum 26,000, rice (rough) 20,000, beans 5,000, i.e. a total of 103,000.

4. Based on a projected schedule of monthly purchases and sales, IRA can attain a turnover rate of 1.6 in the proposed storage facilities.

5. With a turnover rate of 1.6, IRA will require a minimum total storage capacity of 62.8 thousand metric tons by 1975 and 84.7 thousand metric tons to meet 1980 requirements.

6. It is recommended that IRA operate storage facilities at: Santa Ana, which would be a new installation; San Martin, an expansion of present facilities and; San Miguel-Usulutan, which would be new facilities at San Miguel and continuation of existing facilities at Usulutan.

7. Needed minimum nominal storage capacity by 1975, in excess of current facilities will be (in metric tons): Santa Ana 12,240, San Martin 11,680, San Miguel 11,150.

8. Currently rented warehouse space at Soyapango is satisfactory for continued use during a period of expansion.

9. A vigorous, effective program for on-farm storage would reduce IRA's burden of providing storage space. Programs designed to expand on farm storage facilities should be encouraged and assisted.

10. Private interests and other government agencies will need to provide an estimated 194,000 metric tons of storage capacity by 1975. At present their estimated currently available storage capacity is 19,547 metric tons.

11. Total estimated investment requirements for IRA's projected storage requirements by 1975 is 3,580,880 CA$.

12. Projected total IRA storage requirements by 1980 are 87,380 metric tons an increase of 24,570 metric tons over the projected needs by 1975.

13. It is recommended that a junior management training program be started as soon as possible to develop individuals in positions of assistance to the general managers of the plants in San Martin and Usulutan, and to prepare for proposed expansion.

14. It is recommended that plant managers and other key personnel be given training at Kansas State University, Manhattan, Kansas.

15. It is recommended that arrangements be made for a grain storage technical assistant to work for a two-year period with public and private grain storage interests in El Salvador.

16. It is recommended that a study of rice drying operations be made in order to aid in reducing the amount of broken kernels in the present rice processing units.

17. It is recommended that the proposals for improving office procedures submitted by three companies not be acted upon until IRA determines the information it requires to operate more effectively in purchasing and buying.

18. A system of official grades should be established by the government for all domestic trade in grain with licensing of all grain graders.

19. A system of licensed warehouses (public and private) should be established which could issue negotiable receipts for stored grain under proper safeguards.

20. Storage of corn for short periods of time is feasible using plastic sheets for protection in conjunction with adequate quality checks.

SELECTED REFERENCES

1. Agri Research, Inc. Increasing and Diversifying Agricultural Production in El Salvador. USAID, San Salvador, El Salvador, August 1962.

2. Andrew, Frank W. Use of Plastic for Temporary Storage. Mimeograph copy, Universary of Illinois, Urbana, 1969

3. Banco Centroamericano de Integracion Economica. Programa Regional de Almacenamiento de Granos Basicos. B.C.I.E., Tegucigalpa, D. C., Honduras, Marzo, 1968.

4. Battelle Memorial Institute. Projections of Supply and Demand for Selected Agricultural Products in Central America to 1970, 1975, and 1980. Battelle Memorial Inst., Columbus, Ohio, May 1968.

5. Consejo Nacional de Planificacion y Coordinacion Economica. Indicadores - Economicos y Sociales. CONAPLAN, San Salvador, El Salvador, January-March 1969.

6. Food and Agriculture Organization of the United Nations. Bigger Crops - And Better Storage. F.A.O., Rome, Italy, 1969.

7. Graf, Albert R. The Feasibility of Establishing A National Grain Storage System in Nicaragua. Mimeograph copy, Export-Import Bank of Washington, November 1962.

8. Holmes, Lloyd Estadisticas Seleccionadas con Relacion a la Agricultura. Mimeograph copy, M.A.G., El Salvador, June 1967.

9. Ministerio de Agricultura y Ganaderia. Direccion General de Economia Agropecuaria. Anuario de Estadisticas Agropecuarias Continuas. San Salvador, El Salvador, Selected Years.

10. Ministerio de Agricultura y Ganaderia. "Graneros para El Salvador". Agricultura en El Salvador, Ano 9, No. 2, pp 38-39. MAG, San Salvador El Salvador, March-April 1969.

11. Ministerio de Economia, Direccion General de Estadistica y Censos. Segundo Censo Agropecuario 1961. San Salvador, El Salvador December 1967.

12. Tolle, Dwight S. Manual for Elevator Managers and Warehouse Supervisors. Mimeograph Copy, USAID to Brazil, July, 1964.

13. Urbina, Rene Augusto. Comercializacion de Granos Basicos en El Salvador. M.A.G., Direccion General de Economia Agricola, Seccion de Mercadeo. San Salvador, El Salvador, Octubre, 1965.

14. Welchert, W. T. and James W. Little, "Suction-Controlled Plastic Grain Storage". Progressive Agriculture in Arizona, Vol. XX, No. 1, pp. 20-22 College of Agri., Univ. of Arizona, Tucson, Jan-Feb. 1968.

15. Zamora, Carols Alberto. Proyecto de Ampliacion de la Capacidad de Almaceamiento del Instituto Regulador de Abastecimientos. M.A.G. Departamento de Colaboracion Tecnica y Planificacion. San Salvador, El Salvador, Noviembre, 1967.

16. Zelaya, Salvador A. Et Al. A Rice Study. M.A.G., Direccion General De Economia Agricola y Planificacion, Departamento de Commercializacion San Salvador, El Salvador, April, 1968.

APPENDIX A

General Information

CONVERSION FACTORS

Weight

1	Quintal	=	46.0 Kilograms
1	Quintal	=	0.046 Metric Tons
1	Quintal	=	101.41252 Pounds
1	Metric Ton	=	1,000.0 Kilograms
1	Metric Ton	=	2,204.62 Pounds
1	Metric Ton	=	21.73913 Quintals
1	Kilogram	=	0.02174 Quintals
1	Kilogram	=	0.001 Metric Tons
1	Kilogram	=	2.20462 Pounds
1	Pound	=	0.45359 Kilograms
1	Pound	=	0.00986 Quintals

Area

1	Hectare	=	2.47104 Acres
1	Hectare	=	1.43 Manzana
1	Hectare	=	0.01 Square Kilometer
1	Manzana	=	0.6993 Hectare
1	Manzana	=	1.7267 Acre
1	Acre	=	0.40469 Hectare
1	Acre	=	0.5790 Manzana

ABBREVIATIONS

IRA	Instituto Regulador de Abastecimientos
MAG	Ministerio de Agricultura y Ganaderia
USAID	United States Agency for International Development
CACM	Central American Common Market
BCIE	Banco Centroamericano de Integracion Economica
FAO	Food and Agriculture Organization of the United Nations

APPENDIX B

TABLES

TABLE 1 Production and Area of Corn in the Eastern[a] Zone

Crop Year	Production (quintals)	Area Planted (Hectares)	National Corn Production (Percent)	National Corn Area Planted (Percent)	Corn Production as a Percentage of the 1965-69 Crop Year Avg.
1958-59	999,716	68,425	32.5	38.3	66.4
1959-60	975,462	72,970	29.0	41.0	64.8
1960-61	1,296,342	72,036	33.5	40.8	86.1
1961-62	1,070,960	62,839	34.1	40.5	71.1
1962-63	1,854,018	81,344	40.1	41.2	123.2
1963-64	1,216,635	52,677	27.0	30.5	80.8
1964-65	1,163,816	53,962	27.9	32.6	77.3
1965-66	1,439,270	76,042	32.6	39.4	95.6
1966-67	1,774,215	67.415	30.7	32.5	117.9
1967-68	1,468,450	99,995	32.3	36.4	97.5
1968-69[b]	1,681,191	100,200	30.0	35.1	111.7
1965-69[c]	1,505,388		30.7		

SOURCE: Dirección General de Economía Agropecuaria

a/ Includes the Departments of Usulután, San Miguel, Morazán and La Unión

b/ Preliminary Data as of June 30, 1969

c/ 1964-65 to 1968-69 five year average

TABLE 2 Production and Area of Corn in the Central[a] Zone

Crop Year	Production (Quintals)	Area Planted (Hectares)	National Corn Production (Percent)	National Corn Area Planted (Percent)	Corn Production as a Percentage of the 1965-69 Crop Year Avg.
1958-59	1,439,885	77,958	46.8	43.7	58.9
1959-60	1,629,205	77,524	49.8	43.5	66.6
1960-61	1,630,062	73,280	42.1	41.5	66.7
1961-62	1,372,425	66,035	43.6	42.6	56.1
1962-63	1,760,965	77,124	38.0	39.0	72.0
1963-64	2,224,129	86,753	49.4	50.3	91.0
1964-65	1,915,977	74,272	46.0	44.8	78.4
1965-66	2,035,930	83,297	46.1	43.2	83.3
1966-67	3,020,898	106,646	52.2	51.4	123.6
1967-68	2,298,260	128,840	50.6	47.0	94.0
1968-69[b]	2,951,656	135,320	52.7	47.4	120.7
1965-69[c]	2,444,544		49.9		

SOURCE: Dirección General de Economía Agropecuaria

a/ Includes the Departments of Chalatenango, La Libertad, San Salvador, Cuscatlán, La Paz, Cabañas and San Vicente.

b/ Preliminary Data as of June 30, 1969

c/ 1964-65 to 1968-69 five year average.

TABLE 3 Production and Area of Corn in the Western[a] Zone

Crop Year	Production (quintals)	Area Planted (Hectares)	National Corn Production (Percent)	National Corn Area Planted (Percent)	Corn Production as a Percentage of the 1965-69 Crop Year Avg.
1958-59	637,028	32,213	20.7	18.0	67.1
1959-60	668,249	27,548	20.4	15.5	70.4
1960-61	943,796	31,353	24.4	17.7	99.4
1961-62	701,280	26,227	22.3	16.9	73.8
1962-63	1,014,198	39,150	21.9	19.8	106.8
1963-64	1,060,901	33,078	23.6	19.2	111.7
1964-65	1,085,658	37,354	26.1	22.6	114.3
1965-66	937,975	33,542	21.3	17.4	98.8
1966-67	985,617	33,352	17.1	16.1	103.8
1967-68	773,290	45,260	17.0	16.5	81.4
1968-69[b]	966,053	49,830	17.3	17.5	101.7
1965-69 Avg.[c]	949,719		19.4		

SOURCE: Dirección General de Economía Agropecuaria

a/ Includes the Departments of Ahuachapán, Santa Ana and Sonsonate

b/ Preliminary Data as of June 30, 1969

c/ 1964-65 to 1968-69 five year average.

TABLE 4 Production and Area of Sorghum in the Eastern[a] Zone

Crop Year	Production (Quintals)	Area Planted (Hectares)	National Sorghum Production (Percent)	National Sorghum Area Planted (Percent)	Sorghum Production as a Percentage of the 1965-69 Crop Year Avg.
1958-59	700,983	39,159	41.5	44.0	92.4
1959-60	608,796	34,608	37.4	41.1	80.3
1960-61	754,515	38,972	42.5	44.7	99.5
1961-62	698,465	43,248	38.1	44.0	92.1
1962-63	1,075,069	45,461	44.3	43.3	141.8
1963-64[b]	-	-	-	-	-
1964-65	639,375	33,545	33.5	38.6	84.3
1965-66	956,300	51,958	41.7	46.8	126.1
1966-67	702,426	36,737	28.2	34.2	92.6
1967-68	662,800	56,200	28.2	37.8	87.4
1968-69[c]	830,000	60,073	30.7	37.0	109.5
1965-69[d]	758,180		32.3		

SOURCE: Dirección General de Economía Agropecuaria

a/ Includes the Departments of Usulután, San Miguel, Morazán and La Unión.

b/ Data not Available

c/ Preliminary Data as of June 30, 1969

d/ 1964-65 to 1968-69 five years average

TABLE 5 Production and Area of Sorghum in the Central[a] Zone

Crop Year	Production (Quintals)	Area Planted (Hectares)	National Sorghum Production (Percent)	National Sorghum Area Planted (Percent)	Sorghum Production as a Percentage of the 1965-69 Crop Year Avg.
1958-59	730,928	39,190	43.3	44.0	64.7
1959-60	612,299	34,017	37.6	40.4	54.2
1960-61	763,920	38,237	43.0	44.0	67.6
1961-62	817,140	41,510	44.5	42.3	72.3
1962-63	758,293	39,663	31.2	37.7	67.1
1963-64[b]	-	-	-	-	-
1964-65	635,525	31,605	33.3	36.3	56.2
1965-66	902,500	41,678	39.3	37.6	79.9
1966-67	1,435,290	55,133	57.5	51.3	127.0
1967-68	1,294,800	69,000	55.1	46.5	114.6
1968-69[c]	1,381,000	72,702	51.1	44.7	122.2
1965-69[d]	1,129,823		48.1		

SOURCE: Dirección General de Economía Agropecuaria

a/ Includes the Department of Chalatenango, La Libertad, San Salvador, Cuscatlán, La Paz, Cabañas and San Vicente.

b/ Data not Available

c/ Preliminary Data as of June 30, 1969

d/ 1964-65 to 1968-69 five years average

TABLE 6 Production and Area of Sorghum in the Western[a] Zone

Crop Year	Production (Quintals)	Area Planted (Hectares)	National Sorghum Production (Percent)	National Sorghum Area Planted (Percent)	Sorghum Production as a Percentage of the 1965-69 Crop Yr. Avg.
1958-59	257,222	10,691	15.2	12.0	55.8
1959-60	407,246	15,608	25.0	18.5	88.3
1960-61	258,390	9,857	14.5	11.3	56.0
1961-62	319,905	13,472	17.4	13.7	69.3
1962-63	595,873	19,903	24.5	19.0	129.2
1963-64[b]	-	-	-	-	-
1964-65	632,550	21,881	33.2	25.1	137.1
1965-66	437,100	17,343	19.0	15.6	94.8
1966-67	355,333	15,626	14.3	14.5	77.0
1967-68	392,400	23,200	16.9	15.7	85.1
1968-69[c]	489,200	29,725	18.1	18.3	106.0
1965-69[d]	461,317		19.6		

SOURCE: Dirección General de Economía Agropecuaria

a/ Includes the Departments of Usulután, San Miguel, Morazán and La Unión.

b/ Data not Available

c/ Preliminary Data as of June 30, 1969

d/ 1964-65 to 1968-69 five years average

TABLE 7 Production and Area of Beans in the Eastern[a] Zone

Crop Year	Production (quintals)	Area Planted (Hectares)	National Bean Production (Percent)	National Bean Area Planted (Percent)	Bean Production as a Percentage of the 1965-69 Crop Year Avg.
1958-59	26,373	2,324	11.6	13.8	71.3
1959-60	35,291	5,020	15.9	23.3	95.4
1960-61	28,520	3,114	13.3	16.1	77.1
1961-62	14,930	1,573	6.6	7.3	40.4
1962-63	83,867	9,355	21.0	28.4	226.8
1963-64	27,024	3,139	8.6	11.3	73.1
1964-65	23,035	2,262	8.6	10.6	62.3
1965-66	16,440	2,612	4.6	11.1	44.4
1966-67	60,387	3,962	18.0	15.0	163.3
1967-68	25,750	3,645	6.8	9.0	69.6
1968-69[b]	59,306	6,012	12.8	13.3	160.4
1965-69[c]	36,984		10.2		

SOURCE: Dirección General de Economía Agropecuaria

a/ Includes the Departments of Usulután, San Miguel, Morazán and La Unión

b/ Preliminary Data as of June 30, 1969

c/ 1964-65 to 1968-69 five year average

TABLE 8 Production and Area of Beans in the Central[a] Zone

Crop Year	Production (quintals)	Area Planted (Hectares)	National Bean Production (Percent)	National Bean Area Planted (Percent)	Bean Production as a Percentage of the 1965-69 Crop Year Avg.
1958-59	123,857	9,414	54.8	55.8	53.3
1959-60	123,110	12,408	55.3	57.7	53.0
1960-61	129.167	12,248	60.3	63.1	55.6
1961-62	144,510	14,690	63.4	68.4	62.2
1962-63	267,045	20,383	67.0	62.0	115.0
1963-64	225,455	19,242	71.7	69.3	97.1
1964-65	183,501	13,035	68.2	61.0	79.0
1965-66	243,830	15,438	67.8	65.7	105.0
1966-67	207,279	17,671	61.6	66.9	89.2
1967-68	247,790	27,930	65.2	68.8	106.7
1968-69[b]	278,819	25,530	60.3	56.4	120.0
1965-69[c]	232,244		64.2		

SOURCE: Dirección General de Economía Agropecuaria

a/ Includes the Departments of Chalatenango, La Libertad, San Salvador, Cuscatlán, La Paz, Cabañas and San Vicente.

b/ Preliminary Data as of June 30, 1969

c/ 1964-65 to 1968-69 five year average.

TABLE 9 Production and Area of Beans in the Western[a] Zone

Crop Year	Production (quintals)	Area Planted (Hectares)	National Bean Production (Percent)	National Bean Area Planted (Percent)	Bean Production as a Percentage of the 1965-69 Crop Year Avg.
1958-59	75,985	5,115	33.6	30.4	82.4
1959-60	64,056	4,080	28.8	19.0	69.4
1960-61	56,525	4,039	26.4	20.6	61.3
1961-62	68,375	5,206	30.0	24.3	74.1
1962-63	48,047	3,160	12.0	9.6	52.1
1963-64	61,921	5,374	19.7	19.4	67.1
1964-65	62,546	6,060	23.2	28.4	67.8
1965-66	99,430	5,447	27.6	23.2	107.8
1966-67	68,454	4,773	20.4	18.1	74.2
1967-68	106,580	9,020	28.0	22.2	115.5
1968-69[b]	124,275	13,728	26.9	30.3	134.7
1965-69[c]	92,257		25.5		

SOURCE: Dirección General de Economía Agropecuaria

a/ Includes the Departments of Ahuachapán, Santa Ana and Sonsonate

b/ Preliminary data as of June 30, 1969

c/ 1964-65 to 1968-69 five year average

TABLE 10 Production and Area of Rice in the Eastern[a] Zone

Crop Year	Production (Quintals)[d]	Area Planted (Hectares)	National Rice Production (Percent)	National Rice Area Planted (Percent)	Rice Production as a Percentage of the 1965-69 Crop Year Avg.
1958-59	76,586	3,780	29.4	30.7	63.7
1959-60	71,104	2,901	26.8	30.8	59.1
1960-61	109,800	3,832	38.6	35.2	91.3
1961-62	69,045	3,203	27.3	36.0	57.4
1962-63	87.300	2,684	24.1	24.7	72.6
1963-64	42,610	1,567	14.6	18.3	35.4
1964-65	111,125	3,007	23.8	20.3	92.4
1965-66	69,800	2,343	14.2	17.7	58.0
1966-67	100,895	3,490	14.2	17.7	83.9
1967-68	159,500	7,200	14.5	18.0	132.6
1968-69[b]	160,000	6,980	14.2	17.9	133.0
1965-69[c]	120,264		15.4		

SOURCE: Dirección General de Economía Agropecuaria

a/ Includes the Department of Usulután, San Miguel, Morazán and La Unión

b/ Preliminary Data as of June 30, 1969

c/ 1964-65 to 1968-69 five year average

d/ Milled rice estimated at 0.65 of rough rice.

TABLE 11 Production and Area of Rice in the Central[a] Zone

Crop Year	Production (Quintals)[d]	Area Planted (Hectares)	National Rice Production (Percent)	National Rice Area Planted (Percent)	Rice Production as a Percentage of the 1965-69 Crop Year Avg.
1958-59	135,592	6,685	52.1	54.4	24.6
1959-60	148,290	5,308	55.9	56.5	26.9
1960-61	123,133	5,124	43.2	47.1	22.3
1961-62	141,080	4,647	55.8	52.3	25.6
1962-63	230,360	6,974	63.6	64.3	41.8
1963-64	195,632	5,504	67.1	64.3	35.5
1964-65	236,200	8,252	50.5	55.8	42.8
1965-66	361,700	9,440	73.4	71.4	65.6
1966-67	523,010	14,075	73.4	71.4	94.9
1967-68	810,900	28,300	73.7	70.7	147.1
1968-69[b]	825,000	27,410	73.3	70.3	149.6
1965-69[c]	551,362		70.7		

SOURCE: Dirección General de Economía Agropecuaria

a/ Includes the Departments of Chalatenango, La Libertad, San Salvador, Cuscatlán, La Paz, Cabañas and San Vicente.

b/ Preliminary Data as of June 30, 1969

c/ 1964-65 to 1968-69 five year average.

d/ Milled rice estimated at 0.65 of rough rice

TABLE 12 Production and Area of Rice in the Western[a] Zone

Crop Year	Production (Quintals)[d]	Area Planted (Hectares)	National Rice Production (Percent)	National Rice Area Planted (Percent)	Rice Production as a Percentage of the 1965-69 Crop Year Ave.
1958-59	48,292	1,830	18.5	14.9	44.8
1959-60	45,874	1,192	17.3	12.7	42.5
1960-61	51,855	1,927	18.2	17.7	48.0
1961-62	42,540	1,038	16.9	11.7	39.4
1962-63	44,556	1,194	12.3	11.0	41.3
1963-64	53,358	1,484	18.3	17.4	49.4
1964-65	120,025	3,531	25.7	23.9	111.2
1965-66	61,300	1,434	12.4	10.9	56.8
1966-67	88,640	2,140	12.4	10.9	82.1
1967-68	129,600	4,500	11.8	11.3	120.1
1968-69[b]	140,000	4,610	12.4	11.8	129.7
1965-69[c]	107,913		13.8		

SOURCE: Dirección General de Economía Agropecuaria

a/ Includes the Departments of Ahuachapán, Santa Ana y Sonsonate

b/ Preliminary Data as of June 30, 1969

c/ 1964-65 to 1968-69 five year average

d/ Milled rice estimated at 0.65 of rough rice

APPENDIX

Table 13 — BEAN (NEGRO) PRICES - SAN SALVADOR — Colones per Quintal

Year	January	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avge. Cal. Yr.
	MONTH												
1964	22.21	19.68	19.99	21.68	23.52	25.31	27.46	25.45	24.11	23.00	21.88	21.44	23.36
1965	20.37	21.20	21.42	23.22	25.09	24.94	23.84	21.52	21.27	21.96	20.97	19.18	22.07
1966	19.18	18.23	18.07	19.48	20.87	20.29	19.17	22.71	21.06	23.34	19.56	18.85	20.07
1967	16.85	16.40	15.68	18.29	20.67	24.59	28.97	30.32	31.18	29.82	23.93	22.92	23.23
1968	21.43	25.61	27.38	29.84	31.24	31.65	30.95	24.92	26.22	25.51	21.50	21.57	26.20
5 yr.	100.04	101.12	103.59	118.51	121.39	127.72	128.39	124.52	123.84	123.73	107.84	103.96	114.73
Avg.	20.01	20.22	20.72	22.50	24.28	25.54	25.69	24.98	24.77	24.75	21.57	20.79	22.95

Source: Ministerio de Agricultura y Ganadería

APPENDIX

Table 14 — RICE PRICES SAN SALVADOR — Colones per Quintal

Year	January	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg. Cal. Yr.
	MONTH												
1964	23.14	24.33	24.49	24.34	26.02	25.21	23.23	24.10	24.08	23.36	22.61	21.60	23.95
1965	22.07	22.54	22.71	22.73	22.65	22.23	24.23	20.88	25.59	25.98	23.82	22.50	23.37
1966	24.15	24.80	26.74	32.64	26.32	27.98	30.35	28.53	25.94	23.64	21.79	23.64	28.46
1967	23.00	23.46	24.49	25.47	25.67	25.87	26.02	25.70	25.27	23.82	22.82	21.75	24.34
1968	22.45	23.38	23.65	23.94	24.53	24.12	24.07	23.36	23.76	23.27	22.60	21.66	23.48
5 yr.	115.81	117.51	122.08	119.12	125.21	125.41	128.58	128.47	124.61	120.07	113.54	110.15	120.60
Avg.	23.16	23.50	24.42	23.82	25.04	25.08	25.71	25.69	24.92	24.01	22.71	22.03	24.12

Source: Ministerio de Agricultura y Ganadería

APPENDIX

Table 15

CORN PRICES - SAN SALVADOR - Colones per Quintal

Year	January	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg. CY
	MONTH												
1964	7.99	9.28	9.23	10.23	10.67	10.60	11.46	11.56	10.51	9.50	9.81	9.88	10.06
1965	10.34	10.33	11.00	11.56	11.61	11.48	11.76	11.54	9.75	9.34	8.72	8.52	10.48
1966	8.52	8.35	8.80	9.43	9.22	8.43	8.59	7.90	7.28	8.15	7.74	7.78	8.35
1967	8.21	8.29	9.18	[illegible]	10.59	11.95	12.09	12.44	10.10	9.88	9.86	10.10	10.[illegible]
1968	10.22	10.21	11.45	12.49	11.70	11.56	11.57	10.77	9.16	8.37	8.80	8.65	10.39
5 yr.	45.28	46.46	49.66	53.98	53.79	54.02	55.47	54.31	46.80	45.22	44.93	44.93	49.85
Avrge.	9.06	9.29	9.93	10.80	10.76	10.80	11.09	10.86	9.36	9.04	8.99	8.99	9.91

Source: Ministerio de Agricultura y Ganadería

APPENDIX

Table 16

SORGHUM PRICES - SAN SALVADOR Colones per Quintal

Year	January	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg. CY
	MONTH												
1964	8.06	7.61	7.84	7.64	8.25	9.07	9.53	10.16	10.20	10.24	12.31	12.61	9.46
1965	9.39	9.32	9.55	9.77	10.37	10.20	10.32	11.26	10.82	10.59	9.[illegible]	8.87	10.02
1966	8.09	7.79	7.89	7.55	7.50	7.64	6.90	6.83	6.65	6.44	6.44	6.61	7.09
1967	6.26	5.79	5.59	6.14	6.72	8.46	8.82	10.30	10.97	11.07	11.62	10.84	8.55
1968	8.13	7.81	8.33	8.69	9.03	9.70	9.76	9.50	9.00	8.00	9.60	10.84	8.99
5 yr.	39.93	38.32	39.20	39.79	41.87	45.07	45.33	48.05	47.64	46.34	49.78	49.77	44.11
Avge.	7.99	7.66	7.84	7.96	8.37	9.01	9.07	9.61	9.53	9.27	9.96	9.95	8.82

Source: Ministerio de Agricultura y Ganadería

APPENDIX

TABLE 17 FOOD BALANCE: PRODUCTION, NET IMPORTS AND APPARENT CONSUMPTION, 1970, 1975, 1980, 1985, 1990

1 9 7 0

	Production		Net Imports		Consumption	
	(000 Metric Tons)	(Million Colones)	(000 Metric Tons)	(Million Colones)	(000 Metric Tons)	(Million Colones)
Corn	266	49	30	6	257 1/	48
Grain Sorghum	124	19	--	--	108 2/	16
Sugar	(128)	(21)	-53	(-9)	(75)	(12)
Panela	(25)	(3.5)	--	--	(25)	(3.525)
Sugar & Panela	153	25	-53	(-9)	100	16
Rice (Rough)	88	18	-34	(-7)	54	11
Beans	21	9	12	(5)	33	14
Cantaloupe	(10)	(1)	(-4)	(-.4)	(6)	(600)
Watermelon	(40)	(2.5)	(-14)	(-.9)	(26)	(1,638)
Cant. & Watermelon	50	3	-18	(-1)	32	2
Vegetables	(36)	5	(25)	4	61	9
Perennial Fruits	(152)	32	(24)	6	176	38
Milk	270	52	40	8	310	60
Beef	28	37	-4	(-5)	24	32
Pork	5	10	--	--	5	10
Poultry	9	12	--	--	9	12
Eggs	28	34	-1	(-1.2)	27	33
Fish	(3.3)	(1.4)	--	--	3.3	(1.4)
Shrimp	(4.3)	(7.4)	-4	(-6.6)	.3	(.8)
Fish & Shrimp	8	9	-4	-7	4	2

1/ Animal consumption 39,000 M.T. and ₡ 7 million
2/ Animal consumption 16,000 M.T. and ₡ 3 million

Source: Agricultural Sector Analysis, Robert Nathan Associates, Inc.

APPENDIX

TABLE 18 FOOD BALANCE: PRODUCTION, NET IMPORTS AND APPARENT CONSUMPTION, 1970, 1975, 1980, 1985, 1990

1975

	Production		Net Imports		Consumption	
	(000 Metric Tons)	(Million Colones)	(000 Metric Tons)	(Million Colones)	(000 Metric Tons)	(Million Colones)
Corn	348	64	28	5	313 3/	58
Grain Sorghum	162	25	--		132 4/	20
Sugar	(132)	(22)	-35	-6	97	16
Panela	(32)	(5)	--		32	5
Sugar & Panela	165	26	-35	-6	129	20
Rice (Rough) a/	114	23	-45	(-9)	69	14
Beans	29	13	12	(5)	41	18
Cantaloups					8	1
Watermelon					34	2
Cant. & Watermelon	72	(5)	31	(2)	41	3
Vegetables	(57)	8	(22)	3	79	11
Perennial Fruits	(209)	45	(19)	4	228	49
Milk	363	70	38	(7)	401	77
Beef	37	49	-5	(-7)	32	43
Pork	6	12	--	--	6	13
Poultry	12	17	--	--	11	16
Eggs	37	45	-1	(-1)	35	43
Fish					4.3	2
Shrimp					.5	1
Fish & Shrimp					5	3

3/ Animal consumption 63,000 M.T. and ₡ 12 million
4/ Animal consumption 30,000 M.T. and ₡ 5 million

(a/ To convert to "oro" use .65)

Source: Agricultural Sector Analysis, Robert Nathan Associates, Inc.

APPENDIX

TABLE 19 FOOD BALANCE: PRODUCTION, NET IMPORTS AND APPARENT CONSUMPTION, 1970, 1975, 1980, 1985, 1990

1 9 8 0

	Production		Net Imports		Human Consumption	
	(000 Metric Tons)	(Million Colones)	(000 Metric Tons)	(Million Colones)	(000 Metric Tons)	(Million Colones)
Corn	451	83	28	(5)	382 1/	71
Grain Sorghum	210	31			161 2/	24
Sugar	(160)	(26)	-35	(-6)	125	20
Panela	(42)	(6)			(42)	(6)
Sugar & Panela	203	32	-35	(-6)	167	26
Rice (Rough)	148	30	-58	(-12)	90	19
Beans	41	18	10	(4)	51	22
Cantaloup					10	1
Watermelon					44	3
Cant. & Watermelon	104	7	-50	(-3)	54	4
Vegetables	89	13	(14)	2	103	15
Perennial Fruits	(298)	64	--	--	297	64
Milk	486	94	36	(7)	522	101
Beef	51	67	-7	(-9)	44	58
Pork	8	16	--	--	8	17
Poultry	16	23	--	--	15	32
Eggs	48	60	-1		46	57
Fish					6	2
Shrimp					1	1
Fish & Shrimp					7	4

1/ Animal consumption 97,000 M.T. and ₡ 18 million
2/ Animal consumption 49,000 M.T. and ₡ 7 million

Source: Agricultural Sector Analysis, Robert Nathan Associates, Inc.

APPENDIX

TABLE 20 FOOD BALANCE: PRODUCTION, NET IMPORTS AND APPARENT CONSUMPTION, 1970, 1975, 1980, 1985, 1990

1 9 8 5

	Production		Net Imports		Human Consumption	
	(000 Metric Tons)	(Million Colones)	(000 Metric Tons)	(Million Colones)	(000 Metric Tons)	(Million Colones)
Corn	587	109	22	(4)	465 3/	86
Grain Sorghum	273	41	--	--	196 4/	30
Sugar	(197)	(32)	-37	(-6)	160	26
Panela	(54)	(8)	--	--	(54)	(8)
Sugar & Panela	252	39	-37	(-6)	214	34
Rice (Rough)	195	40	-78	(-16)	116	24
Beans	58	25	7	(3)	64	28
Cantaloup					13	1
Watermelon					57	4
Cant. & Watermelon	150	11	-80	(-6)	70	5
Vegetables	(126)	18	(7)	1	133	19
Perennial Fruits	(414)	89	(28)	-6	386	83
Milk	652	126	25	(5)	677	131
Beef	69	91	-9	(12)	59	80
Pork	11	22	--		11	21
Poultry	22	31	--		21	30
Eggs	64	79	2	(3)	61	75
Fish	7	3	--		7	3
Shrimp			-1		1	2
Fish & Shrimp					8	5

3/ Animal consumption 144,000 M.T. ¢ 27 million
4/ Animal consumption 77,000 M.T. ¢ 12 million

Source: Agricultural Sector Analysis, Robert Nathan Associates, Inc.

APPENDIX

TABLE 21 FOOD BALANCE: PRODUCTION, NET IMPORTS AND APPARENT CONSUMPTION, 1970, 1975, 1980, 1985, 1990

1990

	Production		Net Imports		Consumption	
	(000 Metric Tons)	(Million Colones)	(000 Metric Tons)	(Million Colones)	(000 Metric Tons)	(Million Colones)
Corn	761	140	--		564 1/	104
Grain Sorghum	355	54			237 2/	36
Sugar	(242)	(39)	-38	-(6)	204	33
Panela	(68)	(10)	--	--	68	10
Sugar & Panela	310	49	-38	-(6)	272	43
Rice (Rough)	253	52	-103	-(21)	151	31
Beans	81	35	--		81	35
Cantaloupe					17	2
Watermelon					73	5
Cant. & Watermelon	215	15	-125	(-9)	90	6
Vegetables	(172)	25		--	172	25
Perennial Fruits	(591)	127	-(93)	-20	498	107
Milk	(875)	169	--		875	169
Beef	94	126	-13	(17)	81	108
Pork	14	28			14	28
Poultry	30	43			29	41
Eggs	83	102	-2	(2)	80	99
Fish					10	4
Shrimp					1	2
Fish & Shrimp					11	6

1/ Animal consumption 197,000 M.T. ₡ 36 million
2/ Animal consumption 118,000 M.T. ₡ 18 million

Source: Agricultural Sector Analysis, Robert Nathan Associates, Inc.

Appendix

Table 22

Projection of Domestic Food Demand For 1970, 1975, 1980, and 1990 In Kilos and Colones

	1970		1975		1980		1985		1990	
	Quantity (Kilos 000)	Value (¢000)	Quantity (Kilos 000)	Value (¢000)	Quantity (Kilos 000)	Value (¢000)	Quantity (Kilos 000)	Value (¢000)	Quantity (Kilos 000)	Value (¢000)
Sugar	75,000	12,225	96,750	15,770	125,025	20,379	160,425	26,149	204,000	33,252
Panela	25,000	3,525	32,250	4,547	41,675	5,876	53,475	7,540	68,000	9,588
Total Sugar & Panela	100,000	15,750	129,000	20,317	166,700	26,255	213,900	33,689	272,000	42,840
Corn	257,000	47,545	313,283	57,957	382,416	70,747	465,427	86,104	563,585	104,314
Grain Sorghum	108,000	16,416	131,652	20,011	160,704	24,427	195,588	29,729	236,952	36,017
Total Corn & Grain Sorghum	365,000	63,961	444,935	77,968	543,120	95,174	661,015	115,833	810,000	140,330
Beans	33,000	14,355	40,986	17,829	51,315	22,322	64,416	28,021	80,718	35,112
Rice	54,000	11,178	69,120	14,308	89,586	18,544	116,424	24,100	151,416	31,343
Banana	85,000	19,890								
Citrus	37,500	9,375								
Pineapple	28,000	3,640								
Mango	4,000	732								
Avocado	22,000	4,400								
Total Perennial Fruits	176,500	38,037	228,391	49,220	297,403	64,092	385,652	83,111	498,260	107,378
Cantaloupe	6,000	600								
Watermelon	26,000	1,638								
Total melons	32,000	2,238	41,408	2,896	53,920	3,771	69,920	4,890	90,336	6,318
Total All Fruits	208,500	40,275	269,799	52,116	351,323	67,863	45,557	88,001	588,596	113,696
Yuca	11,500	621								
Potato	15,700	4,098								
Onion	4,800	835								
Tomato	16,100	2,100								
Cabbage	11,500	863								
Sweet Pepper	1,400	200								
Total All Vegetables	61,000	8,717	78,934	11,280	102,785	14,688	133,285	19,047	172,203	24,608
Milk1/	310,000	59,830	401,140	77,420	522,350	100,814	677,350	130,729	875,130	168,900
Beef	24,000	32,160	32,088	42,998	43,608	58,434	59,328	79,500	80,712	108,154
Pork	5,000	9,955	6,400	12,742	8,295	16,515	10,780	21,463	14,000	27,874
Poultry meat	8,500	12,155	11,365	16,251	15,444	22,086	21,012	30,047	28,586	40,877
Eggs2/	27,000	33,264	35,019	43,143	46,170	56,881	60,912	75,044	80,406	99,060
Fish	3,300	1,379	4,280	1,789	5,643	2,358	7,445	3,111	9,827	4,107
Shrimp	400	800	519	1,038	684	1,368	902	1,805	1,191	2,382
Total Fisheries	3,700	2,179	4,799	2,827	6,327	3,726		4,916		6,489
Total All Food		303,779		389,199		503,302		650,390		839,283

1/ Litres converted to kilos at 1,031 kilos per litre
2/ Eggs converted to kilos at .5 grams per egg

Source: Agricultural Sector Analysis

APPENDIX

Table 23 . Number and Per Cent of Farms, by Size of Farm, 1950 and 1961

Size of Farm (Hectares)	1950 (Number)	1950 %	1961 (Number)	1961 %	Per cent Change 1950 to 1961
Less than 1	70,416	40.4	107,054	47.2	+ 52.0
1 - 1.99	35,189	20.2	48,501	21.4	+ 37.8
2 - 4.99	34,868	20.0	37,743	16.6	+ 8.2
5 - 9.99	14,064	8.1	14,001	6.2	- 0.4
10 - 19.99	8,874	5.1	8,524	3.8	- 3.9
20 - 49.99	6.660	3.8	6,711	2.9	+ 0.7
50 - 99.99	2,107	1.2	2,214	1.0	+ 5.0
100 - 999.99	1,881	1.1	2,023	0.9	+ 7.5
More than 1,000	145	0.1	125	0.1	- 13.8
Total	174,204	100.0	226,896	100.0	+ 30.2

Source: Data from Tercer Censo Nacional de Población 1950 and 1961.

Appendix

TABLE 24 RICE, area planted and production by size of farm, 1950 and 1961

SIZE OF FARM (hectares)	AREA PLANTED 1950 (hectares)	(percent)	1961 (hectares)	(percent)	% change 1950-1961	PRODUCTION 1950 (kilograms)	(percent)	1961 (kilograms)	(percent)	% change 1950-1961
Less than 1	611	5.4	712	5.4	+16.5	879,670	5.9	1,051,878	6.0	+19.5
1 -- 1.99	1,354	12.1	1,769	13.4	+30.6	1,850,036	12.5	2,392,762	13.7	+29.3
2 -- 4.99	2,756	24.6	3,144	23.7	+14.0	3,759,899	25.4	4,141,655	23.6	+10.1
5 -- 9.99	1,744	15.5	1,647	12.4	- 5.5	2,247,149	15.2	2,202,643	12.6	- 1.9
10 - 19.99	1,475	13.1	1,250	9.4	-15.2	1,949,937	13.1	1,753,699	10.0	-10.0
20 - 49.99	1,418	12.6	1,340	10.1	- 5.5	1,805,270	12.2	1,696,030	9.7	- 6.0
50 - 99.99	646	5.8	835	6.3	+29.2	805,419	5.4	1,315,425	7.5	+63.3
100 - 999.99	943	8.4	2,191	16.5	+132.3	1,137,502	7.7	2,496,746	14.2	+119.4
1000 and more	278	2.5	375	2.8	+34.8	384,386	2.6	468,326	2.7	+21.8
TOTAL	11,225	100.0	13,263	100.0	+18.2	14,819,268	100.0	17,519,164	100.0	+18.2

Source: Segundo Censo Agropecuario, 1961. Ministerio de Economia, Dirección General de Estadística y Censos

Appendix

TABLE 25 GRAIN SORGHUM, area planted and production by size of farm, 1950 and 1961

SIZE OF FARM (hectares)	AREA PLANTED 1950 (hectares)	(percent)	1961 (hectares)	(percent)	% change 1950-1961	PRODUCTION 1950 (kilograms)	(percent)	1961 (kilograms)	(percent)	% change 1950-1961
Less than 1	11,936	14.6	23,639	18.5	+98.0	13,918,406	14.7	25,907,779	20.5	+86.1
1 -- 1.99	14,680	17.9	35,290	27.6	+140.3	16,373,056	17.3	28,314,575	22.4	+72.9
2 - 4.99	18,950	23.1	28,743	22.5	+51.6	22,146,507	23.4	29,969,401	23.7	+35.3
5 -- 9.99	10,366	12.7	12,563	9.8	+21.1	12,256,127	13.0	13,258,401	10.5	+8.1
10-- 19.99	8,519	10.4	8,753	6.9	+ 2.7	9,886,267	10.5	9,246,754	7.3	- 6.4
20 - 49.99	8,113	9.9	7,910	6.2	- 2.5	9,204,585	9.7	8,565,787	6.8	- 6.9
50 - 99.99	3,493	4.3	3,040	2.4	-12.9	4,101,832	4.3	3,381,496	2.7	-17.5
100- 999.99	5,010	6.1	6,140	4.8	+22.5	5,717,008	6.0	6,068,440	4.8	+6.1
1000 and more	813	1.0	1,682	1.3	+106.8	1,042,571	1.1	1,698,937	1.3	+63.9
TOTAL	81,880	100.0	127,760	100.0	+56.0	94,646,359	100.0	126,411,570	100.0	+33.5

Source: Segundo Censo Agropecuario, 1961. Ministerio de Economia, Dirección General de Estadística y Censos.

TABLE 26 CORN - area planted and production by size of farm, 1950 and 1961

SIZE OF FARM (hectares)	AREA PLANTED 1950 (hectares)	(percent)	1961 (hectares)	(percent)	% change 1950--1961	PRODUCTION 1950 (kilograms)	(percent)	1961 (kilograms)	(percent)	% change 1950 1961
Less than 1	23,565	13.3	42,069	18.6	+78.5	28,815,609	14.2	39,772,639	17.1	+38.0
1 -- 1.99	28,356	16.1	51,128	22.6	+80.3	31,563,321	15.6	41,081,077	17.7	+30.1
2 -- 4.99	39,159	22.2	47,354	20.9	+20.9	44,871,760	22.1	46,143,052	19.9	+ 2.8
5 -- 9.99	20,372	11.5	21,437	9.4	+5.2	23,106,321	11.4	21,022,602	9.0	- 9.0
10 - 19.99	16,692	9.5	15,313	6.7	- 8.2	18,629,168	9.2	15,676,189	6.7	-15.8
20 - 49.89	16,449	9.3	14,127	6.2	-14.1	18,329,318	9.0	15,625,359	6.7	-14.7
50 - 99.99	7,778	4.4	6,720	3.0	-13.6	8,749,153	4.3	8,928,055	3.8	+ 2.0
100- 999.99	17,165	9.7	19,942	8.8	+16.1	20,065,861	9.9	29,972,465	12.9	+49.3
1,000 and more	7,076	4.0	8,525	3.8	+20.4	8,722,418	4.3	14,439,083	6.2	+65.5
TOTAL	176,612	100.0	226,615	100.0	+28.3	202,852,929	100.0	232,660,521	100.0	+14.6

Source: Segundo Censo Agropecuario, 1961. Ministerio de Economia, Dirección General de Estadística y Censos

TABLE 27 BEANS - area planted and production by size of farm - 1950 and 1961

SIZE OF FARM (hectares)	AREA PLANTED 1950 (hectares)	(percent)	1961 (hectares)	(percent)	% change 1950--1961	PRODUCTION 1950 (kilograms)	(percent)	1961 (kilograms)	(percent)	% change 1950 to 1961
Less than 1	3,234	11.0	5,183	15.5	+60.2	3,516,889	11.3	3,609,657	17.0	+ 2.6
1 -- 1.99	4,155	14.2	6,208	18.6	+49.4	4,497,405	14.4	3,898,864	18.4	-13.3
2 -- 4.99	6,941	23.6	8,343	25.0	+20.1	7,400,338	23.7	4,760,216	22.5	-35.6
5 -- 9.99	3,704	12.6	3,953	11.9	+ 6.7	3,929,866	12.6	2,255,320	10.7	-42.6
10 - 19.99	3,179	10.8	2,697	8.1	-15.1	3,285,392	10.5	1,644,078	7.8	-49.9
20 - 49.99	3,045	10.4	2,362	7.1	-22.4	3,140,595	10.1	1,467,743	6.9	-53.2
50 - 99.99	1,454	5.0	1,188	3.6	-18.2	1,541,418	4.9	847,628	4.0	-45.0
100- 999.99	2,723	9.3	2,167	6.5	-20.4	2,886,391	9.3	1,554,448	7.3	-46.1
1000 and more	915	3.1	1,224	3.7	+33.9	1,008,143	3.2	1,147,614	5.4	+13.8
TOTAL	29,350	100.0	33,325	100.0	+13.5	31,206,437	100.0	21,185,568	100.0	-32.1

Source: Segundo Censo Agropecuario, 1961, Ministerio de Economia, Dirección General de Estadística y Censos

TABLE 28 Corn Production in Quintals by Departments.

	CROP YEARS a/				
	1960-61	1961-1962	1962-1963	1963-1964	1964-1965
Ahuachapán	222,080	238,715	449,732	396,315	341,064
Santa Ana	403,066	233,035	308,604	268,926	469,859
Sonsonate	318,650	229,530	255,862	395,660	274,735
Sub-Total Western Zone	943,796	701,280	1,014,198	1,060,901	1,085,658
Chalatenango	292,720	238,145	339,415	222,283	180,221
La Libertad	345,340	272,455	443,616	670,048	608,572
San Salvador	187,640	147,895	145,625	495,618	266,619
Cuscatlán	154,880	181,340	126,133	204,482	172,718
La Paz	369,975	217,625	338,176	382,317	346,352
Cabañas	87,310	97,260	130,342	85,406	87,874
San Vicente	192,197	217,705	237,658	163,975	253,621
Sub-Total Central Zone	1,630,062	1,372,425	1,760,965	2,224,129	1,915,977
Usulután	523,364	404,230	803,316	459,913	423,925
San Miguel	343,478	216,175	532,050	520,273	381,579
Morazán	123,520	172,255	207,636	61,806	143,002
La Unión	305,980	278,300	311,016	174,643	215,310
Sub-Total Easter Zone	1,296,342	1,070,960	1,854,018	1,216,635	1,163,816
TOTAL	3,870,200	3,144,665	4,629,181	4,501,665	4,165,451

SOURCE: Dirección General de Economía Agropecuaria

a/ Crop production is no longer reported by departments after the 1964-65 crop year. Production is presently the smallest division of area for which annual data are published.

TABLE 29 Sorghum Production in Quintals by Departments

	CROP YEARS[a]				
	1960-1961	1961-1962	1962-1963	1963-1964[b]	1964-1965
Ahuachapán	119,410	122,070	346,839	-	265,300
Santa Ana	107,730	116,590	174,030	-	224,775
Sonsonate	31,250	81,245	75,004	-	192,475
Sub-Total Western Zone	258,390	319,905	595,873	-	632,550
Chalatenango	196,685	250,540	270,547	-	154,600
La Libertad	96,050	82,040	114,277	-	110,825
San Salvador	46,855	28,140	15,979	-	29,800
Cuscatlán	78,320	100,320	76,170	-	53,225
La Paz	84,275	55,070	71,344	-	85,550
Cabañas	141,780	173,630	110,780	-	97,975
San Vicente	119,955	127,400	99,196	-	104,050
Sub-Total Central Zone	763,920	817,140	758,293	-	635,525
Usulután	163,540	152,735	284,453	-	148,675
San Miguel	214,065	164,175	319,282	-	139,550
Morazán	116,680	122,780	178,472	-	150,300
La Unión	260,230	258,775	292,862	-	200,850
Sub-Total Eastern Zone	754,515	698,465	1,075,069	-	639,375
TOTAL	1,776,825	1,835,510	2,429,235	-	1,907,450

SOURCE: Dirección General de Economía Agropecuaria

a/ Crop Production is no longer reported by Department after the 1964-65 Crop Year. Zone production is presently the smallest division of area for which annual data are published.

b/ Data not Available

TABLE 30 Rice Production in Quintals by Departments

	CROP YEARS a/				
	1960-1961	1961-1962	1962-1963	1963-1964	1964-1965
Ahuachapán	26,115	18,655	13,188	34,079	39,575
Santa Ana	14,105	16,170	25,358	1,297	68,000
Sonsonate	11,635	7,715	6,010	17,982	12,450
Sub-Total Western Zone	51,855	42,540	44,556	53,358	120,025
Chalatenango	12,740	20,935	22,784	8,002	10,525
La Libertad	21,553	3,165	43,144	11,832	64,000
San Salvador	24,610	33,130	5,926	2,925	17,975
Cuscatlán	12,940	16,810	14,145	2,974	29,425
La Paz	6,840	22,535	86,285	135,965	46,225
Cabañas	11,100	7,425	24,112	5,134	8,225
San Vicente	33,350	37,080	33,964	28,800	59,825
Sub-Total Central Zone	123,133	141,080	230,360	195,632	236,200
Usulután	70,230	30,695	42,946	33,337	85,350
San Miguel	22,450	14,600	22,091	6,461	14,150
Morazán	3,950	7,760	7,172	832	4,475
La Unión	13,170	15,990	15,091	1,980	7,350
Sub-Total Easter Zone	109,800	69,045	87,300	42,610	111,125
TOTAL	284,788	252,665	362,216	291,600	467,350

SOURCE: Dirección General de Economía Agropecuaria

a/ Crop production is no longer reported by departments after the 1964-65 crop year. Zone Production is presently the smallest division of area for which annual data are published

TABLE 31 Bean Production in Quintals by Departments

	CROP YEARS a/				
	1960-1961	1961-1962	1962-1963	1963-1964	1964-1965
Ahuachapán	4,390	3,490	6,000	16,871	15,000
Santa Ana	42,325	50,360	25,436	28,126	31,749
Sonsonate	9,810	14,525	16,611	16,924	15,797
Sub-Total Western Zone	56,525	68,375	48,047	61,921	62,546
Chalatenango	7,795	24,265	15,504	15,771	10,202
La Libertad	60,520	49,335	177,110	155,596	114,858
San Salvador	8,990	17,635	13,599	6,668	11,676
Cuscatlán	12,625	15,995	6,329	17,977	10,504
La Paz	19,400	8,325	19,148	6,870	8,092
Cabañas	13,900	18,975	10,902	14,441	12,008
San Vicente	5,937	9,980	24,853	8,132	15,961
Sub-Total Central Zone	129,167	144,510	267,045	225,455	183,501
Usulután	14,630	9,620	23,010	2,448	7,431
San Miguel	6,345	1,655	49,954	16,690	10,405
Morazán	4,465	3,150	8,741	3,703	1,596
La Unión	3,080	505	2,165	4,183	3,603
Sub-Total Eastern Zone	28,520	14,930	83,867	27,024	23,035
TOTAL	214,212	227,815	398,959	314,400	269,082

SOURCE: Dirección General de Economía Agropecuaria

a/ Crop Production is no longer reported by Department after the 1964-65 Crop Year. Zone production is presently the smallest division of area for which annual data are published.

APPENDIX C

By

Francis A. Kutish
USDA

There seems to have been a reduction in the seasonal variation in the price of maize, frijoles and arroz over the past 18 years. This is probably due to a combination of two forces: The increasing freedom and amount of trade in the basic grains among the common market countries, and the effects of the stabilization agencies of the various common market countries. However, the IRA has not been successful in containing the seasonal price variation of these grains within the limits set for the maximum and minimum prices. Furthermore, some producers have been getting the benefits of the price support purchases by IRA; others have not and have sold their grain below the minimum support price.

Thus, there is need to examine the methods used by IRA for price stabilization purposes. The present method consists of a purchase program. To be eligible, a producer must sign an agreement by which he offers to deliver a stated quantity of grain to IRA. Then IRA will purchase this quantity of grain from the producer during the post-harvest period -- or a certain proportion of the offering, if the total offered exceeds the amount of resources at IRA disposal. However, the grain must be delivered to the IRA silo or warehouse.

This method has several shortcomings: It results in a hardship for small producers who must either assemble and transport small quantities of grain a long distance or else not be eligible for IRA price support purchase. In practice, many sell at substantially lower prices to intermediaries.

Second, it results in IRA running a public warehouse, with a very small turnover of grain and accompanying high storage cost. Third, it forces IRA to seek to greatly expand its storage capacity -- which likewise places a heavy demand on capital.

The IRA could use its resources much more effectively to support producer's prices if it would operate in such a manner as to encourage a maximum holding and storage of grain on the farms themselves. This could be done by combining a loan guarantee or purchase agreement with a variable purchase price or price support.

Such an IRA loan guarantee or purchase agreement could have an advancing price support load, with the support level advancing 15 centavoes per quintal per month from October through March. The producer who signed up for such a program would agree to store the grain and be responsible for maintaining its quality. He could either get a loan on it from the bank, the Cazas de Credito or ABC, or carry it himself if he so desired.

At the end of March, he producer would be obligated to either deliver the grain to IRA who then would pay off the loan on the quantity of corn delivered -- or as usually in the case, many of the producers could sell

the grain himself if the market price was higher and pay off the loan directly. If the producer had not taken out a loan but only a purchase agreement, he could deliver the grain and get the full support price paid to him -- or if the market price was higher than the support price, he could sell the grain in the market.

This advance in the support rate probably would appeal mostly to those producers who could finance the holding of the grain or their own farms. Thus the IRA's outright purchase of grain during the early post harvest season could be directed mainly at making such purchases available more easily to the small producers who would not be in a position to obtain storage and storage financing for their own-on-farm storage.

These are the producers who for the most part now are not able to take advantage of the IRA support program. Instead, they must sell at lower prices to traders and speculators.

By February and March, IRA should have begun to have resold part of this grain for consumption -- providing space for the takeover of such purchases as would be necessary from its loan guarantee and purchase agreement activities.

APPENDIX D

Article by W. T. Welchert and James W. Little

Letter from Dr. Harry Pfost

Suction - Controlled

Plastic Grain Storage

By W. T. Welchert and James W. Little

Materials Needed

1. Two large polyethylene plastic sheets of 6 mil thickness. A sheet 32' x 100' is suggested for the base (4 mil is OK for the base). A sheet 40' x 100' is suggested for the cover. Cost estimated at one cent per square foot.
2. A used evap-cooler package unit with fan and motor in good working order. A fan capable of developing at least ¼ inch of static water suction at either full capacity or zero air delivery and operating continuously without harm is required.
3. A one inch by about 3' x 6' solid wood panel or equivalent to form the top of duct between the grain and fan. Side panels are also suggested to reduce the stress on the plastic.
4. A roll of 2" plastic tape. Cost less than $1.00.

Procedure

1. Select and clear a good ground storage site with drainage in all directions or build up a ground storage pad.
2. Spread the bottom 32' x 100' sheet of 6 mil plastic on the cleared ground pad. Use some temporary weights to hold the film in place.
3. Unload the grain directly on the sheet. Set the auger to unload on the centerline of the sheet and as high as necessary or permissible so that the grain seeks its own level of repose and is centered on the 32 foot wide sheet. The angle of repose for sorghum and barley is about 30 degrees from the horizontal. Hence a pile 7½ feet high will result in a base covering about 30 feet and the top-cover distance required is about 35 feet. Keep grain at least 5 feet from both ends of plastic sheet and 2 feet from the edges. It is easier to unload with the elevator located in the middle of the width of the sheet rather than from the side. In this case, spread the bottom of the sheet and then roll it up about 10' of the length. Set the elevator over the rolled up section. As the pile progresses move the elevator forward and unroll the sheet forward.
4. Set a used evap-cooler at one end of the pile. A 4000 CFM forward-curved centrifugal fan evap-cooler package unit with a ⅓ horsepower motor has been used successfully on a 130 ton pile of sorghum by Willis Combs at Queen Creek. It's probable that 200 tons might have been stored with this same material and equipment.
5. Place a wood panel about the width of the cooler frame on top of the cooler and push it into the grain pile to form the top of the fan duct inlet. Handle side panels in the same way to form duct.
6. Cover the grain pile and fan frame with the 40' x 100' plastic sheet. The edges of the top sheet should be tucked under the edges of the bottom sheet. Roll the grain at the edge of the pile out slightly to anchor the plastic edges and form a seal. At the exhaust fan end, tape the plastic around the fan exhaust outlet. Mr. Combs simply rolled the excess plastic edges together and

Mr. Welchert is Extension Agricultural Engineer, Mr. Little an Agricultural Agent in Pinal County.

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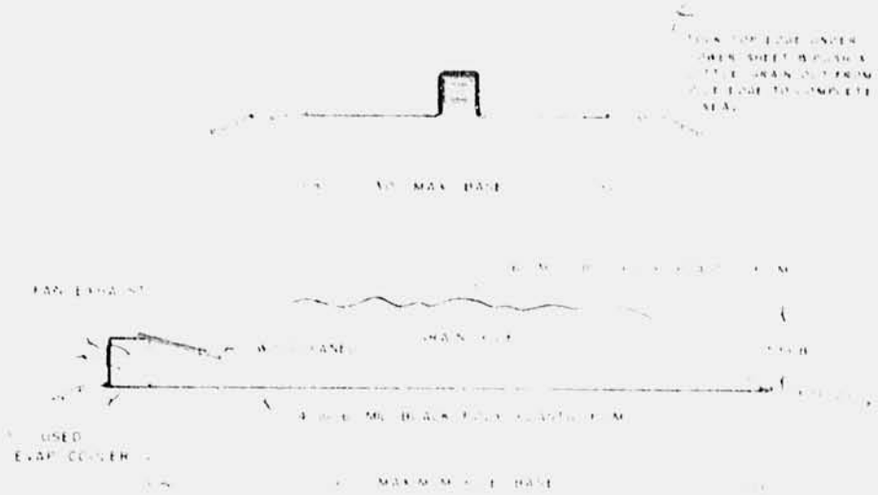

ENGINEER'S DRAWING shows placement of the evaporative cooler device, location of fan exhaust, general specifications of the grain storage unit.

(Continued from Previous Page)

anchored the roll with a little soil.

7. Turn on the fan and the plastic should draw down tight on the grain pile in a matter of several minutes. Plastic under suction tends to be self-sealing. Operate the fan continuously throughout the storage period. A conventional evap-cooler fan can easily maintain ¼ inch of static suction. Forward curved centrifugal fans actually unload the motor slightly when not exhausting air. (The fan motor current drops about 10% of full air delivery capacity.) However, the motors used in evap-coolers *do not* generally have any safety or overload protection. In fact, their design normally anticipates a cool running environment in the evaporated air stream. Normally, an electric motor is designed with an overload factor of 1.1 to 1.2. For evap-cooler motors this is not the case. *Do not* exceed the rated current load on the motor plate. Use an ammeter and adjust the pulleys to stay within the rated current.

Comments

A chicken wire fence should be installed around the area to keep cats and dogs from breaking holes through the plastic. Actually, a few small pin holes are not likely to be of concern so long as these openings are not more than the fan can draw off while still maintaining ¼ inch of static suction. If a portion comes loose and the air comes in faster than the fan can draw it off, the suction will drop to nearly zero and there will be a problem of keeping the cover in place. Fortunately, small holes or a rip can be repaired with tape or small plastic sheet.

Likewise, short power failures are not serious because it will take some time to lose all of the vacuum through the exhaust fan opening. When operating continuously, this plastic covered pile will stay in place without a ripple with surface winds in excess of 60 mph.

A ¼ inch static suction is equivalent to a uniform pressure on the plastic cover of 1.3 pounds ft² or about 3000 pounds for a 125 ton storage cover.

Grain stored in this manner should not exceed 12% moisture content. Sunlight either penetrating a translucent material or absorbed on the surface as in the case of black polyethylene can produce a surprising effect. The surface temperature of the cover may approach 160° F. during midday. During early morning the surface may cool down to 50° F. or less. Such temperature differential may cause moisture to condense just under the surface of the plastic if high moisture grain is present. The high surface temperature creates a vapor pressure difference in the pile which sucks the moisture to the surface and the sudden night cooling causes it to condense. So if you suspect some local high moisture grain lift the cover and inspect for a film of moisture in the early morning.

If grain of questionable moisture content is to be stored, an aeration system may be incorporated in this system. Thus far, not much engineering data are available to completely insure success with an aeration system even though Andrew's experience at Illinois involved corn that was generally above the normally accepted safe storage level. However, conditions are just not the same.

Arizona's low relative humidity results in a low equilibrium moisture content and the high temperatures tend to increase all forms of biological activity. The higher the storage moisture content is above equilibrium the greater the storage danger. To combat high moisture content, air must be moved through the grain and air flow should be uniformly distributed. If the volume of air movement is sufficient, some drying is accomplished. To do this we must first add an air inlet opening at the end of the pile opposite the fan.

(Continued on Next Page)

SUCTION-CONTROLLED plastic temporary grain storage setup in actual use in Arizona. Notice how effectively the suction causes the plastic to cling to the contours of the piles of grain. Also note crimped edges of the plastic, where it meets the ground.

(Continued on Next Page)

This area should be about twice the size of the fan outlet area, but in no case more than enough to reduce the 1/4 inch of static pressure required to hold the plastic cover in place. Further, fan capacity should be increased and or the pile size decreased so that we can anticipate an air exchange of from 1 to 5 CFM per ton of grain at 1/4 inch static vacuum or more. This specification requires that we match the fan capacity at a given static resistance to the resistance of air flow through the grain. The static resistance in sorghum will vary from about 1/2" static resistance at 10' grain depth and 5 CFM per ton to as much as 7" static resistance at 100' grain depth and only 1 CFM air flow per ton. As air flow required increases and the grain depth increases, the static resistance to air flow increases rapidly. Even at the lowest beneficial air flow for aeration through 10' of sorghum we quickly exceed the static characteristic of an evap-cooling fan which usually does not exceed 0.4 inches of water. Thus, fans with higher static vacuum capacity are required as outlined in USDA Marketing Research Report 178 "Aeration of Grain." On the other hand, some air may flow at 1/4" static pressure. The question is, how much? It is doubtful that the air flow amount will approach minimum aeration level. Hence, we can assume that an aeration design for high moisture content grain storage will require a fan capable of developing 7" of water static suction. This rules out the use of evap-cooler fans.

Grain harvested from the field during the day is usually quite warm when stored. One of the advantages of aeration is that the cool night air can be drawn through the pile to cool this grain down to a temperature more near the average for the season. It's an easy matter to flip the plastic back in place over the inlet duct for daytime operation.

Plastic films exposed to the sun will show continuous deterioration because the ultraviolet fraction of the sun's rays cause a chemical reaction. Six mil polyethylene will stand at least one year's exposure. With care, the top cover can be salvaged for use again next season. It is suggested that the top cover be used on the bottom for the second season. It may be possible to salvage the bottom sheet but it is generally assumed that this will be severely damaged when loading out the grain. If odd sizes are required because of some mistake in pile dimension, (i.e. a 40' film does not cover the top of a pile) plastic film handlers have a film solvent cement that will glue sheets together.

The total out of pocket investment cost for storing 130 tons of sorghum on the Combs farm was $82.00. The cost of continuous operation of the 1/3 horsepower electric motor is about 12 cents per day.

If an aeration system is required, it is suggested that you call the Extension Agricultural Engineer at the University for design assistance.

KANSAS STATE UNIVERSITY Manhattan, Kansas 66502

September 5, 1969

Mr. Floyd Niernberger
c/o Claud L. Horn
Chief PASA
United States Embassy
San Salvador, El Salvador

Dear Floyd:

Have sent cable with exact information requested.

I think the idea of storing under plastic for a few months is the only feasible solution to the emergency problem. However, I would prefer to see a greater depth used for two reasons. The volume to surface area will increase greatly and reduce the cost for material--both duct and plastic. The aeration fans in layer sizes will also be cheaper. Also the reduction in surface area will probably help reduce the effects of condensation on the plastic when the temperature drops. I would prefer to see about a 20' depth which will provide an 85' width of pile at a 25° angle of repose. Such a pile will provide 19 tons/foot or 690 bu/foot. If aeration is needed about 70 cfm per foot of length at one inch H_2O pressure should be adequate.

The duct diameter should taper slightly to maintain a uniform pressure over the length. This can be staggered or stepped rather than a pure straight taper. The reason for this is that as air leaves the duct the velocity drops and the pressure tends to rise as the velocity drops. This effect is frequently greater than flow resistance pressure drop.

If prefabricated metal duct for drying is not available, then make the ducts good and strong to withstand the pressures. The durability of plastic is not too good. Reinforced plastic is preferable to plain. Edges should be carefully tied down. A rounded pile is desirable and then ropes over the plastic will help hold it against the grain. Some addition protection on the top, such as straw, would be desirable to keep the plastic from being punctured by the claws of large birds. Rodents are a problem and the area should be cleared of all plant growth or other material which may offer hiding places. Lights on the area at night would be desirable.

Phostoxin is probably the best insecticide for uses of this type.

Sincerely yours,

H. B. Pfost
Professor

HBP:jab