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May 1971

Observations and Recommendations for Improving Grain Storage and Marketing in Bolivia

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FOOD & FEED GRAIN INSTITUTE
KANSAS STATE UNIVERSITY

MANHATTAN, KANSAS 66502

SUMMARY OF REPORT/PUBLICATION

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Authors: Floyd F. Niernberger and Harry B. Pfost

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Contractor: Food and Feed Grain Institute, Kansas State University, Manhattan, Kansas

Principal Investigators: Floyd F. Niernberger and Harry B. Pfost

SUMMARY STATEMENT

The team spent two weeks in Bolivia to evaluate storage and related marketing requirements for the development of the wheat, rice, corn, and soybean industries. Priority was placed on the wheat sector because of emphasis on increasing domestic production by the Ministry of Rural Affairs and Agriculture and USAID/RDD/USU.

Generally, environment for storage of grains without quality deterioration in Bolivia is very good. Both the production areas and population centers are located at higher altitudes with accompanying cool, dry weather much of the year. Samples of grain observed in storage and in marketplaces did not appear to have been subjected to either insect or mold damage. The conditions described prevail in the areas of La Paz, Potosí, Suire, and Cochabamba. In these areas, it should not be necessary to design storage facilities with more than minimal grain drying and aeration capacity. However, storage should be designed and operated so that insect control by fumigation can be easily performed if found to be required. Buildings should be designed to keep rats and mice from entering. Good housekeeping should be exercised regularly inside the warehouses to prohibit breeding and hiding places.

In the Santa Cruz area, climatic conditions are less favorable for storage. Relative humidity data indicates eight months of average humidity at or above 70 percent. Grain in this area which is harvested over 14 percent moisture should be dried before storing for periods exceeding several weeks. An experiment has been proposed on corn storage to determine if mold will be as much of a grain-quality deterioration problem as the relative humidity data suggests. Information on this experiment is contained in the Appendix to this report. If the tests reveal that mold is a potential problem, three suggestions are proposed: (1) grain intended for long-term or eventual out-migration should be moved to a higher altitude, which has a cool, dry climate; (2) grain showing signs of heating or molding should

be redried; and (3) grain stored in bulk showing signs of heating or molding can be aerated for cooling and drying whenever relative humidity is below 70 percent.

A lack of storage facilities at producer assembly points is evident. In addition, a marketing network to move supplies and seeds in and grain out of these assembly points to population and secondary storage centers is required.

Facilitating marketing functions are lacking in grain marketing. It was recommended that the Government provide these services as grain production increases.

The present regulations on wheat purchases do not provide incentives for private investment in storage facilities. An increasing price level throughout the storage season coupled with small producer loan payments is proposed.

OBSERVATIONS AND RECOMMENDATIONS FOR IMPROVING GRAIN STORAGE AND MARKETING IN BOLIVIA

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PREFACE

The Minister of Rural Affairs and Agriculture of Bolivia requested USAID assistance in determining storage and related requirements for the development of the wheat, rice, corn, and soybean industries. The USAID Mission in turn requested that such a survey be conducted under the Kansas State University contract AID/csd-1538 to supply technical assistance in food grain drying, storage, handling, and transportation.

Initial contact on this request was made through Utah State University by Dr. Bruce Anderson. Subsequent arrangements for the KSU team to travel to Bolivia were made through USAID/Washington and Utah State University. Funds for the necessary logistics support for the study were programmed by the Mission in the existing Utah State University Project 364.5, Cereals PIO/T#511-364.5-3-00029, AID-USU Contract #LA-319.

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INTRODUCTION

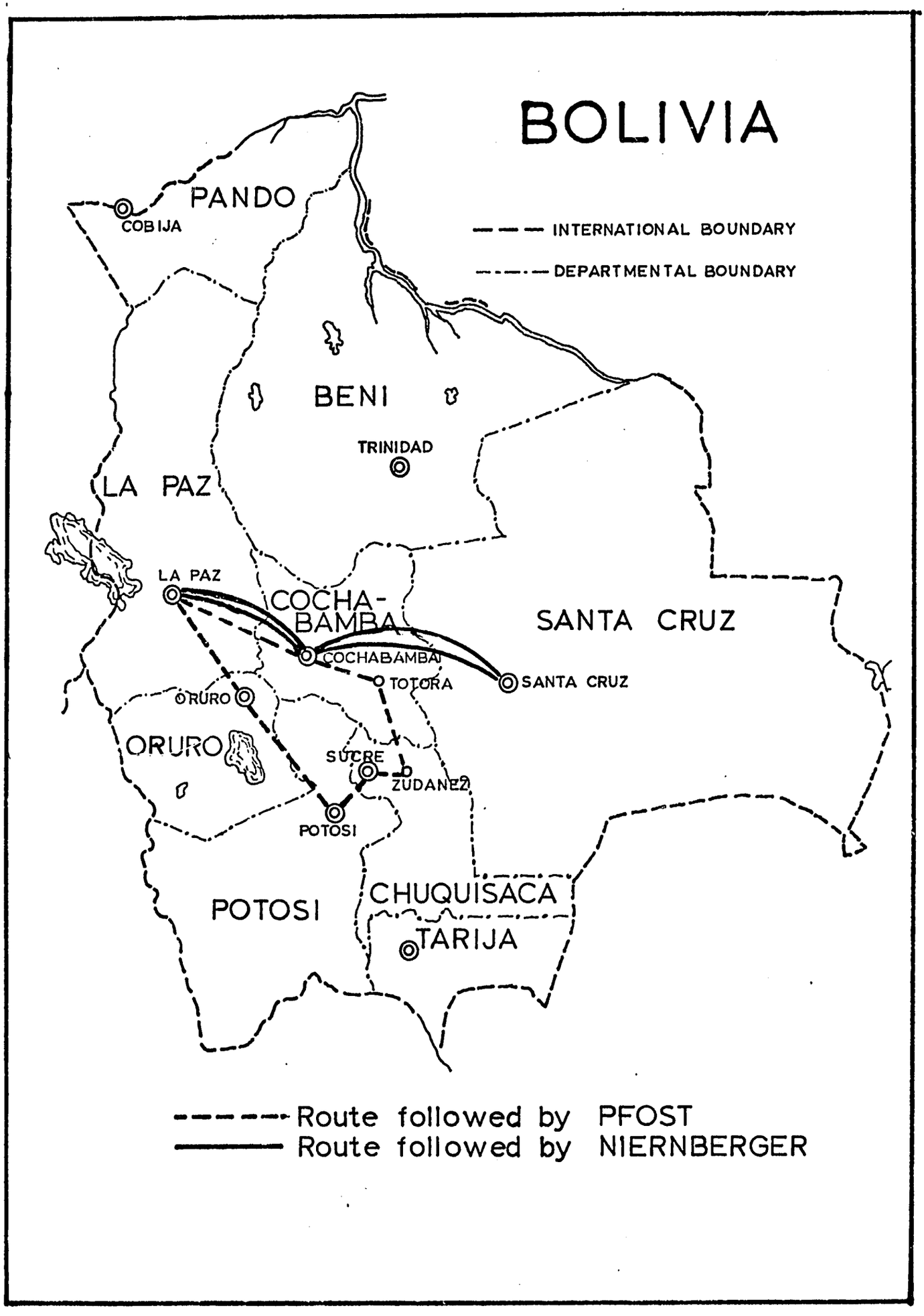
This report has been prepared at the request of USAID to present observations and recommendations made during the evaluation visit to Bolivia May 17 through 29, 1971, by Dr. Floyd F. Niernberger and Dr. Harry B. Pfost. The team members were given excellent cooperation during their stay in La Paz and while visiting facilities in the major cereal crop-producing areas of Bolivia. Acknowledgement is given to members of the following: USAID/RDD/USU team, Bolivian Wheat Institute, USAID Mission in Bolivia, Ministry of Rural Affairs and Agriculture, and grain trade visited in Bolivia.

The USAID Mission request was for assistance in determining storage and related requirements for the development of the wheat, rice, corn, and soybean industries in Bolivia. Upon arrival, priority was requested for analysis of the wheat program due to emphasis on increasing domestic production by the Ministry of Rural Affairs and Agriculture and USAID/RDD/USU.

A one-day grain storage and marketing seminar was presented May 20 to interested Ministry and USAID team members in La Paz. The outline of topics discussed in the seminar is included as Appendix I of this report. In addition, principles of management training for grain storage and marketing operations, which were not discussed in detail due to time limitations, are provided in Appendix II.

Several fine reports on crop production, marketing of products, and fertilizer marketing have been made in Bolivia and the authors recommend full attention be given to these reports in conjunction with the recommendations made in this brief evaluation.

The major recommendations contained in the report were presented orally to USAID officials in La Paz at a debriefing session prior to the team's departure. A preliminary typed report was given to USAID/RDD/USU on the day of departure. The team feels all possible efforts were made by the local USAID group members to provide communication among the team and Bolivian officials who will actually be guiding the grain storage and marketing program. This action was highly commendable. This final report only serves to document communications held and hopefully will serve to stimulate action to help bring about an efficient grain storage and marketing system in Bolivia.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ZUDANEZ
POTOSI
POTOSI
CHUQUISACA
TARIJA
Route followed by PFOST
Route followed by NIERNBERGER

SUMMARY OF OBSERVATIONS AND RECOMMENDATIONS

Storage and Transportation

1. In general, storage of cereal grains should not present major problems in Bolivia because of low temperatures and relative humidity much of the year.

2. The only cereal production areas that would appear to present storage problems should be subjected to a storage test as outlined in Appendix III.

3. Buying stations are needed in most areas of predominately small farms. The small farmers cannot be expected to bring grain more than about 30 kilometers to market.

4. Construction of all country buying stations is recommended to be of native materials whenever possible, utilizing cooperative labor, and of bagged warehouse design.

5. The only bulk storage recommended to be built for wheat within the next 10 years would be at flour mills where classifying and comingling of purchases is possible.

Marketing

1. It is believed that the marketing system for the grains analyzed will be of bagged materials handling for a number of years in the future.

2. Facilitating marketing functions such as grading and inspection, weight and measure inspection, training and certifying inspectors, market news, financing inventories at all marketing levels, regulation of margin charges, and import and export controls are nonexistant or inadequate at the present time. They must be developed for an efficient marketing system. Where supporting functions exist, regulations are not enforced to prevent possibility of improper use.

3. Margins for all services performed in grain handling and marketing should be officially recognized. Control of these margins must be exercised by the Government to assure reasonable charges for the services of cleaning, drying, handling, storage, and transportation.

4. Information on purchase prices and margin charges at major purchasing points should be provided through public dissemination to the producers and merchant truckers.

5. Recognition must be made of the differing basic objectives between price support policies and marketing functions in the Bolivian wheat project so that conflicting actions are not undertaken.

6. The fixed producer price for wheat at the same level throughout the year at flour mills does not provide incentive for storage capital at any level of assembly.

7. It is recommended that the producer price level be changed from a fixed level price throughout the year to an advancing price level. Price advances would start at the end of the harvest and continue until the beginning of the next harvest. This method should provide storage incentive at different assembly levels.

8. It is recommended that loan purchase agreements be made available to the small producer so he may participate in the advancing price schedule for storage incentive if he so desires.

9. It is recommended that country storage facilities be encouraged to handle all grains in the local area, handle crop inputs such as seed and fertilizer, and engage in facilitating services so capacity utilization will be increased and operating costs reduced over single-crop storage facilities.

10. It is recommended that a nutritional survey be made of Bolivia to provide a basis to estimate potential cereal demand and elasticities of demand for the basic food crops.

OBSERVATIONS ON EXISTING CONDITIONS

This section will deal with observations about existing conditions of grain storage, transportation, and marketing. Due to the limited time available to the team, certain points may have been neglected. Also, the areas examined were looked at in view of existing problems; thus, many of the good points of the Bolivian grain system will not be mentioned. It should be noted that the team was impressed with the management and operating ability of the private grain industries visited. It would be a mistake not to utilize the knowledge of these people in determining probable effects of proposed actions by Governmental agencies, such as the Bolivian Wheat Institute.

Storage and Transportation

Bolivia is fortunate, compared to many neighboring countries, insofar as technical problems of grain storage are concerned. The climatic conditions of most areas are characterized by cool, dry weather. There is little evidence that stored grain is subject to mold or insect attack. Samples of grain observed in storage or in markets show little evidence of insect damage and no evidence of mold. Apparently climate and/or altitude inhibits rats, and mice are the major rodent problem.

The above conditions prevail in the areas of La Paz, Potosí, Sucre, and Cochabamba. In these areas, it should not be necessary to be concerned with grain drying or aeration. Storage facilities should be designed and operated so that fumigation for insects can be performed if it is discovered to be necessary. Buildings should be designed to restrict the access of rodents; poison baits and good housekeeping should control the limited rodent problem.

In the Santa Cruz area, the climatic conditions are less favorable for storage. Mean monthly relative humidity data is given in Table 1, as taken from the report by Hargreaves (6). Since some types of grain molds will grow and increase at humidities as low as 70% relative humidity, some attention must be given to drying and storage practices.

Table 1. Mean Monthly Relative Humidity and Temperature in °C for Santa Cruz 1943 - 57

	J	F	M	A	M	J	J	A	S	O	N	D
HM(RH)	.77	.75	.75	.74	.77	.78	.71	.61	.60	.66	.67	.70
T	26.4	26.3	25.8	23.8	22.0	20.4	19.6	22.8	25.5	25.4	27.0	27.1

In the Santa Cruz area, grain which is harvested at over 13-14% should be dried before storing for periods of over a few weeks. This, of course, dictates that almost all rice must be dried. Since this area may present storage problems, a few tests should be conducted to determine if it will be necessary to take precautionary steps to prevent mold in grain which is stored for periods of months. Dr. Kelly of the British Tropical Agricultural Team told Dr. Niernberger that he would make tests on corn if a test design were submitted. A suggested test design is shown in Appendix III.

If the preceding tests show that mold is a potential problem, three solutions are possible:

1. Grain intended for long-term storage could be moved to a higher altitude to take advantage of cooler temperatures.
2. Grain which shows signs of heating or molding can be redried.
3. Grain which shows signs of heating or molding when stored in bulk can be aerated to cool and then be dried whenever the relative humidity is below 70%.

Since rice drying presents peculiar problems which have been recognized, consideration should be given to improving the existing practices.

Economic studies should be made to compare the cost of sun drying, heated-air drying in batch or continuous dryers, and drying in bulk in bins.

Under the present system, many farmers are tempted to sell to a speculator rather than wait for the availability of drying and milling facilities. In many areas the rough rice is graded before drying and milling and the farmer simply is docked for moisture and foreign material by an amount which will pay for the cost of cleaning, drying, and removal of the husk (milling). Storage facilities appear to be a severe limitation to providing the farmer with a ready market at harvest.

Existing storage facilities for most of the grain produced in Bolivia consists of small storage bins on the farm where grain is stored for consumption by the family. Because of the favorable storage conditions, very simple buildings and bins or containers are adequate. Probably most farmers have facilities which will protect home-stored grains from rodents and birds. Some studies need to be made of farm storages in the lower elevation to determine if molding is enough of a problem to justify an educational program regarding drying. Such studies will also show if insect infestation is resulting in enough loss to justify a program of education and distribution of insecticides (such as Phostoxin which is available from Casa Bernarde S.A., Casilla de Correo 685, La Paz) to help preserve the family's supply of grain.

Grain which leaves the farm appears to move in two important ways -- by animal and truck transport. Many farms are not located adjacent to roads which are generally traveled by truck. It appears from discussion with several persons that the limit of burro transport is about 30 kilometers. This implies that at this limit, the marginal value of the grain is about equal to the cost of the transportation.

The importance of this observation is that if the farmer is to be served by an improved marketing system, he should be provided a market within about 30 kilometers. Otherwise, he will probably elect to dispose of the surplus in another way, such as producing eggs or meat which will have a lower transport cost.

Truck transport costs have shown that costs may average about $b.0.37/T Km (7). Other reports have stressed that itinerant truckers are receiving higher margins, but the higher margins involve other services, such as providing financing to the farmer, storage of the grain if no market is available, and selling costs such as standing with an idle truck at a market to sell grain at retail.

Storage facilities for grain which enters commercial channels are very limited. No data is available regarding total capacity of storage facilities in Bolivia. The flour mills visited have capacity to store one to two months of milling capacity.

Marketing

The marketing systems for wheat, rice, corn, and soybeans were examined. Field trips were taken to flour mills (two), a formula feed mill, a cottonseed extruder plant, a formula feed custom mix plant, local custom grinders (three), rice mills (three), a pasta plant, and local city markets (five). Much of what follows is based on observations and communication through interpreters with citizens engaged in operating the facilities, acting as sellers, or actual customers.

Wheat

In 1970 it was estimated 53,500 M.T. of wheat was grown in Bolivia (10). Approximately 30 percent of this amount is estimated to move into commercial marketing channels by A. Ballerstaedt of the National Wheat

Institute (NWI). It is estimated that about three-fourths of the wheat entering the commercial market is made into flour (4). The remainder is sold and consumed in various ways such as trigo mote (peeled kernel form), chicha (alcoholic drink), or possibly ground into whole wheat flour. It was impossible to find data about the proportion of distribution of these products. Ing. Ballerstaedt estimated 95 percent of the wheat milled into flour moved to commercial bakeries and only 5 percent was sold in the form of family flour.

Wheat not entering commercial marketing channels would be ground into whole wheat flour, processed into trigo mote, made into chicha, or used for animal feed or seed.

Bolivia produces about 25 percent of the wheat consumed by the population (11). Importation sources vary but have been mainly the United States and Argentina. The wheat imported is of sufficient quality so that it can be milled into white pan-bread type flour. The weaker gluten criollo wheat varieties produced domestically are blended with imported wheats in order to produce satisfactory white bread flour.

The domestic wheat moves by producer resources or merchant trucker to the market. It appears that presently no Governmental agencies purchase wheat in producer regions. The majority of producers appear to be limited to sales at the wheat mills for the crop they produce and wish to transport to the market themselves. Unless they have ready access to a marketing arrangement or stall, they probably would realize as much money marketing through the merchant truckers in areas where truckers' competition reflects the market price less transportation. The difficulty is that the producer often does not have access to market information and is unable to judge whether an offer by the trucker is, in fact, fair. Bolivia does have a Governmental decree which states that a flour mill must purchase all delivered

domestic wheat regardless of supplier. The NWI also has a published list of prices at the various mill locations for several varieties of wheat, as well as rates for various impurities and grades. Premiums, as well as discounts, are paid for hectoliter weight, while discounts exist for dockage. Theoretically, these factors should permit the farmer to know the selling price and, therefore, estimate on-farm sales price. In practice, the grade and discount factors are not regulated or controlled, so they are an unknown variable. The buyer is not inspected by a third party and in some cases equipment for grade determination does not exist.

Secondly, the mills have limited storage and cannot purchase all wheat tendered to them at a given time. Queues* can result and time waiting for acceptance again becomes an unknown cost factor of producer delivery where distances between producer region and mill is great. Finally, the option to market his own crop may not, in fact, exist for the producers who have received production loans from a merchant trucker. His sale is restricted to the merchant trucker at the price he is offered or at least to the extent of his debt.

Wheat moving through the flour mills appears to follow normal processing methods. Extraction rates are difficult to determine from data, but visual appearance and discussion would indicate a 70 to 75 percent yield. A Government decree (09169) requires importers to purchase domestic flour to the extent of at least 50 percent of their importations. This decree, in effect, means all domestic flour produced is sold to an import agency for book-balancing purposes since Bolivia does not presently produce sufficient wheat to satisfy the minimum requirement. The intent, however, is to assure a market for all wheat grown domestically. The necessity for legislating the market for domestic wheat is, of course,

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*Queues - waiting lines

due to the lower quality for bread-baking purposes of the criollo varieties now being grown.

The distribution of flour from the flour mills to the bakeries was not explained adequately. In a discussion with the miller at Cochabamba, it seemed that a proper receipt from the importing agency would permit a baker to pick up flour at the flour mill. No evidence of this being done was noted during the visit and the explanation may not have been adequately interpreted. In any case, the estimate of 95 percent of the flour moving directly to bakeries meant little additional marketing functions were being performed by flour mills.

No visit to bakeries was scheduled, but conversations indicated that many small shops with pick-up customer service were the rule.

An analysis of the wheat marketing system must recognize Government intentions. It appeared that the Government was committed to increasing domestic wheat production to a much greater proportion of consumption needs. The implications of this action are discussed later.

It is evident that Government decrees affecting wheat marketing need to be supported by facilitating services of the Government. Functions such as grain standards, weight and measure control, storage price agreements, regulation of storage facilities, warehouse receipts for loan storage, producer and processor credit, licensing of import and export operations, and bonding of personnel engaged in responsible positions appear to be facilitating services not presently performed by the Government. Training and regulation of personnel engaged in facilitating services would have to be performed by the Government.

Rice

In 1970 it was estimated 69,310 M.T. of rough rice was produced in Bolivia (9). Of this amount, about 86 percent moved into marketing channels

(9). Exportation of rice began in 1970 with 644 M.T. of milled rice being sold.

The marketing flow can be outlined in general as follows: The producer harvests the heads of rice and stores these at the farm until he n needs money or has time to thresh. His family threshes the amount required or the entire crop, which is then transported as rough rice to the local rice mill. Facilities are usually available at the mill for patio drying of the rice or mechanical drying. If the producer so desires, he may sell the rough rice to the mill, if it is privately owned, or to speculators located at the Cooperative mills instead of waiting his turn at the rice mill. During the busy season, queues occur and the producer may wait up to two weeks to have his rice milled. If patio space is filled, there may be a charge for use of facilities or a queue for drying space. The producer must handle the rice himself during patio drying and be responsible for its safe keeping until his turn for milling arrives. Each producer's rice is identity preserved in the process from arrival through milling.

The mills charge a processing fee for users and do not take title to the rice. Presently all rice processed in commercial mills is being sold to the Banco Agrícola, which has representatives at the mills. The milled rice is priced, depending on grade (percent broken kernels), by the local representative of Banco Agricola, who pays only by check. The producer, therefore, incurs the costs of production, transport to local mill, drying cost, milling cost, and possible theft or quality loss until sale to the Banco Agricola. It was our understanding that rice could not be brought to these larger mills for home consumption. Rice consumed at home would normally be taken to single-pass attrition mills in the local community.

Production of rice is concentrated in an area above Santa Cruz (3). Indications were that the rice marketing system is presently under severe pressure. Some closed markets were reported by local producers and large price fluctuations were indicated. The Cooperative mills and agents appeared to lend a stabilizing influence to local producers whose normal markets had deteriorated. The monopolistic existence of the Banco Agricola at the mills was not adequately explained by the representatives questioned. One buyer reported losses in the purchasing operation, while another denied this. It appeared the Banco was purchasing all rice tendered at the Cooperative mills. The owner of one Cooperative mill complained that the Banco was not moving finished rice out of his mill fast enough; thus, he would soon be out of storage space and be forced to cease operations until rice was shipped out. Several conclusions were drawn on the basis of visits to the mills. One was a general shortage of adequate storage space for milled rice beyond short-term (6 weeks) storage. Second was the observation that the Santa Cruz area would not be a good location for long-term storage due to climate. Third, no storage payments were being made by the Banco, forcing the miller to levy charges back to the producer through milling charges. Generally, there was no incentive for capital investment in storage unless the investor could pass the cost back to the producer hidden in the milling charges.

It appeared that similar facilitating services lacking in wheat marketing are also needed for rice. However, the strong Cooperative presence should be able to perform most of the services if regulation and control is given by the Government.

Corn

Only a small percentage of corn produced in Bolivia moves into commercial marketing channels as estimated by A. Ballerstaedt. About 28 percent of the total corn production over the past several years is of the so-called sweet type (10).

Food corn sold in the market consists of variety as well as form differences. Customer preferences might require a food market to carry two or three varieties of ground corn. Forms noted at several markets included cob, whole, ground, and peeled. A customer would purchase the form and variety desired to prepare mote, chicha, api, tostado, etc. If desired, the customer could have whole kernels ground to meal in the many small single-pass attrition mills located throughout the communities. We did not hear of any large corn mills making meal or flour; neither were any industrial processors noted. It was observed that the more efficient corn marketing system involved merchant truckers with market locations in the large cities. The itinerant merchant trucker selling off the truck at the weekly market seemed to be relatively inefficient. In the several instances noted where producers brought corn directly to a local market with single-pass milling equipment, we were unable to satisfactorily judge marketing costs.

Corn for formula feed purposes is sold by producers or truckers direct to the formula feed mills. Usually a Cuban variety is preferred and a premium over local hard varieties is paid.

Corn remaining on the farm for food can be ground, boiled, dried like snacks, eaten on the cob, etc. Corn did not appear to make up as large a part of the Bolivian diet as in many Central American countries. However, it probably ranks after potatoes and wheat as a basic food of the majority of the people. Very little dietary or nutritional statistics were found

in Bolivia; thus, potential for human consumption of the corn crop is difficult to estimate.

Corn for animal purposes was fed at the farm and the price of corn for this purpose was estimated to be below production costs, but no alternative seemed available to the producer in many of the mountainous regions.

Marketing of corn appears inefficient, but transport and assembly costs for the volume required by the market would seem not to justify additional marketing investment in facilities unless additional cereals or produce could be handled in the same facility.

Soybeans

Production of soybeans has doubled every year since 1967 when 300 M.T. were grown (2). During a visit to a cottonseed oil processing plant, the wife of the owner stated that no soybeans were presently being domestically processed for oil to her knowledge. If any processing were being done, it would be of hydraulic or screw-press type. No processed soybean oil extracted meal was seen in the formula feed plants visited. Mention of loan applications for construction of soybean plants was made (2); however, feasibility studies for the proposals were not seen.

The only commercial use of soybeans seen on visits was at the Cochabamba formula feed plant. Here, steam cooking equipment had been used for processing the whole bean, followed by patio drying and grinding to reduce the whole bean to the best granulation for poultry feeds. The manager of the firm indicated cottonseed meal and bloodmeal were the dominant protein sources for formula feeds.

To develop a marketing system for soybeans would require, of course, a processing plant for oil removal. Present demand exceeds supply of edible

oils in Bolivia. It would seem logical that the Government support high-yielding oil varieties of beans and create favorable conditions for private investment in a processing plant.

DISCUSSION AND RECOMMENDATIONS

Storage and Transportation

Three major alternatives seem to exist for the future.

1. Continue the present system. The advantage of this would be that no Government financing would be involved and hopefully the existing itinerant truckers, processors, and other private interests will expand their facilities to accommodate the increased production of wheat. The disadvantages in terms of high storage and marketing costs have been discussed here and documented by others.

2. By government decree, flour mills might be forced to take delivery of wheat whenever it was offered. This would require that mills drastically expand their storage. Since it is not known whether the mills can absorb this additional storage cost, the net result might be equivalent to nationalization of the mills.

3. Since transportation is difficult and apparently much of the grain moves to market during or shortly after the harvest season, it appears logical to provide a network of country grain storages which would supply terminal storages, or mills, in the major population centers. We believe this system will provide the farmer with the most readily available market and provide the mills or consumers with grain at the most convenient times.

As this system is visualized, it would provide for a very simple storage structure at points perhaps 50 kilometers apart along railroads or highways in major grain-producing areas. This elevator would receive grain and store it until it was transported to the point of further storage or use. It would also provide a place for storage and distribution of seed, fertilizer, and other supplies needed by farmers.

Since some grain areas may not offer sufficient production to justify a permanent storage, they may be serviced by trucks which purchase at regular intervals in these smaller production areas and deliver to the nearest permanent storage. This system has been used successfully in Costa Rica.

Because of the small volumes handled by the country grain storages, every attempt must be made to utilize the facilities and personnel to the fullest. Hence, possible activities include:

> Purchase all grains available for sale in the area. Purchase other products which might be produced by farmers, such as potatoes, wool, etc.
>
> Sell farm supplies.
>
> Resell grains to the local community. Here a distinct service may be rendered by interchanging products between storages, e.g. corn might be trucked from an elevator in Santa Cruz to one in Potosí and offered for retail sale there.

We feel that this dual role of purchases and selling will do much to increase the general efficiency of merchandising of foods in the country. The same principle has been used in Costa Rica where all grain storages have an associated retail outlet. In fact, the grain system has additional retail outlets in cities where they do not have grain storage installations.

The system as visualized can be owned and operated in several ways.

1. The entire system could be privately owned.
2. The entire system could be owned by the Ministry of Agriculture.
3. There might be a combination of cooperative and national ownership.

For example, the country elevators might be owned by a local cooperative and the elevators in larger cities might be owned by a Governmental agency. One advantage of this system would be that the local farmers might contribute a major part of the labor required to build the facility.

The problem of where to locate elevators and their size cannot be made on the basis of data now available. As the wheat program develops,

it will become more evident where the major production will be located and the amount. Probably the extension agents will be able to furnish the best data on which to base decisions since they will have the most knowledge of local conditions. The decision of the Ministry of Agriculture to place a buying and storage facility in the major wheat area north of Zudañez will provide much-needed data regarding the feasibility and operating costs for facilities such as we are recommending.

Appendix IV describes several of the factors to be considered in selecting the size and location of grain storage and marketing facilities. It includes a discussion of the selection of size of equipment, such as driers, that are a part of any grain storage facility. The problems which are considered and the method of attacks are general but should be applicable to Bolivian conditions. It is impossible now with the lack of production data and construction and operating costs to arrive at a rational solution to the problem of where these local marketing facilities should be located.

Since quality maintenance does not appear to be a great problem throughout most of the populated area of Bolivia and the area where most of the grain is grown, storage structures and equipment can be very simple. In general, it would seem that the storage structure should be designed for the storage of bagged grain since all of the grain within the foreseeable future will be delivered to the buying point in sacks and will be shipped on to points of consumption in sacks. Sacked grain can be stored in almost any type of a weather-proof structure and many excellent weather-proof structures made of sun-dried (adobe) brick exist.

It would seem that this type of construction generally should be used for the walls. The floors would undoubtedly be of poured concrete, although this may not be mandatory, as sun-dried brick may be adequate for many

areas. The wall footings should be constructed of concrete, concrete block, or rock to give some protection against rodents or other animals. The roof would be probably of sheet metal or corrugated cement asbestos depending on which is the cheaper. The roof trusses may be either of wood or steel depending on relative costs in the area. The roof trusses may be assembled on the site if electricity is available for welding. If not, they may be pre-assembled and shipped to the location. Regardless of whether roof trusses are steel or wood, a design should be developed by a local structural engineer to provide the strength necessary to withstand wind loads which exist in Bolivia. It will probably be found that a uniform truss design for a building width of perhaps 12-15 meters can be developed and used throughout the entire country.

In calculating the capacity required in the storage structure, it is usually assumed that about 2/3 of the total floor area can be used for actual storage. This leaves sufficient area for aisles between and around the stacks of sacked grain to provide passageways for inspection, insect treatment, etc. For sacked grain storages using manual handling, it is probably not desirable to plan to stack the grain more than 4 meters high. This would require a wall height of about 5 meters in order to be able to have access to the top of the stack for inspection, insect control, etc. If this height is excessive for the construction techniques used, then it may be reduced accordingly. Within the actual stored pile of grain, it is probably safe to assume that approximately 0.7 M.T. of grain can be stored per cubic meter. Equipment for the local grain storages would consist of:

Portable platform scales to weigh incoming sacks of grain. These scales should have a capacity of about 250 kilograms.

Very simple cleaning equipment probably should be installed. This can be powered equipment such as the small grain and seed cleaners

frequently used in the United States for cleaning seed. A non-powered grain cleaner is being developed at Kansas State University for possible installation in buying facilities in Honduras. This cleaner is a 2- or 3-screen cleaner with the screens steeply inclined. The very fine and very course material can be removed, but it will not provide for separation of stones which are approximately the size of the whole grain.

Portable platform scales can also be used for weighing the cleaned and resacked grain. The refilled sacks may be sewn with an electric sewing machine if power is available or handsewn if not.

Two-wheeled hand trucks to move sacks of grain and pallets to store grain off floors can be provided as required.

The main storage area can be used for the storage of fertilizer and other agricultural supplies but must be well cleaned after used and before grain is stored in the same area. Since insecticides must be handled rather carefully, it is probably desirable to store them in a separate area where grain will not normally be stored. Also, herbicides should not be stored near the seed.

A small office and sales room, as required, can easily be located at one end of the main storage building.

The site location for grain storage structures should be chosen in such a way that it will not be subject to flooding. Usually in a country such as Bolivia this will not be too great a problem, but one should check with people who have lived in the community for some years to determine what areas will be free from flooding. If the building is located on a slope, it should be graded so that surface water from uphill will be directed away from the building. If the site around the building is kept free from vegetation, there is usually minimal danger from rodents or other large animals attempting to enter the grain storage structure. The problem of fencing the site or otherwise providing protection from theft is a matter for local decision.

Marketing

The analysis of the wheat marketing system indicated a major area of difficulty in the present market structure. A price stabilization system is in operation for wheat purchases and flour sales at mills and population centers. The prices are maintained at the same level throughout the entire year. Evidence that price stabilization is occurring to a major degree is contained in the market price surveys of Noticias de Mercado (8). It was impossible to determine whether the producer, middleman, or consumer was receiving the major benefit of price stabilization, but several items were evident.

The decree that guarantees wheat price is for mill-delivered wheat. This requirement results in hardship for most Bolivian producers who have small quantities to deliver. These producers must either assemble and transport small quantities of grain to the mill, possibly over several days' journey, or else not be eligible to receive the guaranteed price. In practice, many are forced to sell to an intermediary at substantially lower prices.

A more serious difficulty is the level price guarantee throughout the crop year. There is no recognition of storage costs for wheat from one harvest to the next. Without a recognition of storage margin, there will not be investment forthcoming for storage facilities. It would appear that with set purchase and sales prices, the flour miller is being forced into operating storage facilities with the milling margin. This would indicate the mill could only justify expansion of storage by its contribution to overall milling efficiency. At the La Paz flour mill, a storage facility started over a year and a half ago was not being actively worked on. At Cochabamba, little interest was expressed in expanding wheat storage facilities. The conclusion is that the flour mills will not be constructing

additional wheat storage facilities for the expected large increase in wheat production under present marketing conditions.

The National Wheat Institute apparently has concluded that it must provide storage since private investment in storage facilities is doubtful. Sufficient funding is available to construct and maintain wheat collection centers, possibly in Cochabamba, Potosí, Jarija, and Zudañez. We were told operating costs were planned to be covered by efficiency in operation and use of the discount system when purchasing wheat from producers. As already explained, a discount for hectoliter weight and dockage exists in the wheat marketing system, although little test equipment is in existence at the producer purchasing points. The discount system provides a legal way to reduce producer price from the guaranteed price. From conversations, it was gathered that this method is extensively used.

Costs of grain storage in Bolivia have been roughly estimated by the NWI. It will be several years before sufficient data can be generated in NWI-operated facilities to determine whether overall efficiency in grain marketing can, in fact, cover storage costs.

If production goals (11) are achieved over the next few years, it is evident the Government will be forced to provide storage for the crop increases, since incentive for private storage is lacking. As the Government becomes involved in storage to a greater degree, demands for capital and operating expenses will increase. It is believed that under present conditions, increased grain production will result in the Government operating a public warehouse system. Costs will be high because mills and intermediaries will purchase local area, easily assembled crops to the extent of their storage facilities early in the season. The Government will be forced to handle the high-assembly-cost, small-unit-delivery crop for the entire length of the crop season. This will result in low turnover of

grain in facilities, more risk of storage losses over the longer time period, and generally high storage costs for the volume of grain handled. The Government could be trapped into the position of having to construct increasing quantities of storage to handle producer increases because private storage had no incentive for expansion.

It is recommended the Government use its marketing resources more effectively by providing storage incentives at all levels of assembly. This can be accomplished through an increasing price guarantee throughout the crop season starting at harvest. Since data on storage costs are not available, the price adjustment could start below estimates and be advanced over several seasons until the desired degree of participation was reached.

For example, if storage at the farm level were determined to be in the best interests of the Government, a purchase agreement program would be combined with the advancing price support level. A producer would have the option of a loan on his wheat for home storage. The price support level would advance 15 centavos/quintal/month starting from July through March, or whatever crop season months best serve local conditions of Bolivia. At the end of March, the producer who signed a purchase agreement loan would be obligated to deliver the wheat to the assembly area or pay the loan off. If the wheat were not under loan, the producer could deliver at any time he wished to receive the then current price support level.

A storage incentive support price could potentially attract private investment at all levels of marketing, including flour mills. It would appeal to individuals or firms who could finance the holding of grain. It should free Government storage efforts to concentrate on the small producer who normally is not in a position to store and must sell at reduced prices to traders and speculators.

In addition to price support considerations, recommendations can be made in the area of increasing marketing efficiency. Country purchasing stations are needed to lower assembly costs and provide producers with a regulated market. Either cooperative or private enterprise purchasing stations could fill the need as long as each type is regulated by Government facilitating services. The capacity and locations of the country stations would depend heavily on the production area to be served and the terrain. The assembly area station is envisioned as providing bagged grain storage (wheat, corn, rice, soybeans, etc.) for about two to three months of each grain's harvest season. Grain stored in less desirable areas (due to high relative humidity, transport difficulty, etc.) should be moved to secondary centers on a priority schedule to avoid quality deterioration or inaccessibility.

Secondary storage, again for bagged products, should be constructed in population or consumption centers, in processing areas where climate is conducive to storage, and export points or routes. The secondary centers can provide quality maintenance for longer periods of time (6 - 8 months). If properly situated, they can supplement the market flow due to irregularities and provide distribution efficiencies.

Government funds for construction of country level centers would not necessarily be needed if cooperative efforts are possible. Materials and labor could be provided by local area producers using a cooperative organization for operation. Secondary storage areas would be constructed with Government loans or capital attracted to storage investments because of incentives.

Operating costs will depend to a very large degree on capacity utilization and provision for margin operations. Capacity utilization can be increased by handling all grains or crops in the region destined for

commercial markets. Additionally, inputs for the area such as seed and fertilizer can be handled through the same facilities since storage periods do not overlap. Finally, utilization can be increased by scheduling of shipments to secondary facilities in periods of high receipts (inventory turnover).

Margin operations can lower overall operating expenses by contributing to income. Cleaning and drying facilities should be considered. Quality upgrading of receipts can result in greater direct access to markets. Thus, grading should be both a purchasing and shipping consideration. Receiving, handling, and loading margins should be incorporated into the purchase bid for grain. Margins to consider are:

1. Handling margins. Knowledge of transport costs to the major sales or market points is necessary. Costs of receiving, transferring, and loading should be known. The sales offer price should be sufficiently above the purchase price so that the difference will result in covering costs plus a profit.

2. Services margins. Cleaning, drying, seed treatment, and similar types of services should again be priced above actual charges to reflect investment return.

3. Discount margins. Moisture, dockage, damage, foreign materials, and grade type discounts are required to adequately cover shrinkage, drying, cleaning, and quality deterioration costs as well as grade changes. Sometimes these margins are fixed by law, but often times competition allows grading methods to more accurately reflect actual costs plus normal profit.

4. Storage margins. A charge to reflect time use of investment funds in providing storage facilities for grain preservation until market demands reflect consumer wants.

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APPENDIX

I. Seminar Lecture Notes
"Grain Marketing and Storage Fundamentals"
La Paz, May 20, 1971

II. Personnel Training Recommendations
"Training Grain Handling Managers"

III. Grain Storage Test at Santa Cruz

IV. Sizing of Grain Elevator Facilities

SEMINAR LECTURE NOTES

"Grain Marketing and Storage Fundamentals"

La Paz, May 20, 1971

(1) Developing an Efficient Grain Marketing System
(Desarrollo de un Sistema Eficiente de Mercadeo de Granos)

A. Characteristics of an Efficient Marketing System
(Características de un Sistema Eficiente de Mercadeo)

1. Distribution of grain and grain products to buyers at the right time and place and in the right form
(Distribución de granos y sus productos a compradores a tiempo y lugar oportuno y en forma correcta)

2. Reasonable marketing costs and charges
(Costos y cargos razonables de mercadeo)

3. Reflect to producers the demand of consumers
(Manifestar a los productores las demandas de los consumidores)

B. Major Marketing Functions
(Principales Funciones de Mercadeo)

1. Grain merchandising
(Negociaciones de Granos)

a. Possession utility - who?
(Valor de Posesión - quién?)

b. Pricing
(Establecimiento de Precios)

c. Buying and selling
(Comprando y vendiendo)

d. Margins reflecting value added
(Margenes que reflejan el valor agregado)

2. Grain distribution
(Distribución de granos)

a. Place utility - where?
(Colocar valor - donde?)

b. Assembly
(Recolección)

c. Transport
(Transporte)

d. Delivery
(Entegra)

e. Margin reflecting transport costs)
(Márgenes que reflejan costos de transporte)

3. Grain conditioning and processing
(Acondicionamiento y procesamiento de granos)

   a. Form utility - what?
   (Valor de condición - cuál?)

   b. Cleaning and drying
   (Limpieza y secamiento)

   c. Blending
   (Mezclado)

   d. Processing
   (Procesamiento)

   e. Packaging
   (Empacada)

   f. Margins reflecting quality and form differentials
   (Márgenes que reflejan la calidad y diferencias de forma)

4. Grain storage
(Almacenamiento de granos)

   a. Time utility - when?
   (Tiempo de utilidad - cuando?)

   b. Warehouse
   (Bodegaje)

   c. Maintaining quality and quantity
   (Conservar calidad y cantidad)

   d. Seasonal price differentials reflecting storage costs
   (Diferencias estacionales de precios que reflejan costos de almacenamiento)

C. Supporting Marketing Functions
(Apoyando funciones de mercadeo)

1. Financing inventories
(Financiación de inventarios)

2. Grading and inspection
(Clasificación e inspección)

3. Market news
(Información sobre mercados)

4. Others
(Otros)

4. Terminal elevators
(Silos centrales)

   a. Weighing and grading
   (Pesada y clasificación)

   b. Pricing
   (Establecimiento de precios)

   c. Buying from other handlers and producers
   (Compra a otros manipuladores y productores)

   d. Cleaning, drying and blending
   (Limpieza, mezclada y secada)

   e. Long-term storage
   (Almacenamiento a largo plazo)

   f. Transport and sale to processors, exporters and other outlets
   (Transporte y venta a procesadores, exportadores y otros)

5. Grain processors
(Procesadores de granos)

   a. Weighing and grading
   (Pesada y clasificación)

   b. Pricing
   (Establecimiento de precios)

   c. Buying from grain handlers and producers
   (Compra a manipuladores de granos y productores)

   d. Short- and long-term storage
   (Almacenamiento a corto y largo plazo)

   e. Conditioning and processing
   (Arreglo y procesamiento)

   f. Packaging
   (Empacada)

   g. Transport and sale of products
   (Transporte y venta de productos)

6. Wholesale distributors of products
(Distribuidores mayoristas de los productos)

   a. Purchase from processors
   (Compra a los procesadores)

   b. Warehousing of products
   (Almacenamiento de los productos)

c. Separation and packaging into smaller lots
(Separada y empague en lotes más pequeños)

d. Transport and sale to retailers and consumers
(Transporte y venta a minoristas y consumidores)

7. Retail distributors of products
(Distribuidores minoristas de los productos)

a. Purchase from wholesalers or processors
(Compra a mayoristas o procesadores)

b. Short-term warehousing of products
(Almacenamiento de productos a corto plazo)

c. Sale and transport to consumers
(Venta u transporte a los consumidores)

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(2 and 3) Equipment and Facilities for Grain Marketing and Storage
(Equipo e Instalaciones para Mercadeo y Almacenamiento de Granos)

A. Receiving Points
(Puntos de recibo)

1. Receive mostly bags from any transportation and ship by truck daily to weekly
(Se reciben principalmente bultos de cualquier transporte y se embarcan por camión diaria o semanalmente)

2. Equipment required
(Equipo requerido)

3. Scales for bags
(Básculas para pesar los bultos)

4. Grading and moisture tester
(Aparato para clasificar y medir humedad)

5. Bag storage
(Almacenamiento de los bultos)

6. Load generally to trucks
(Cargue principalmente a camiones)

B. Country Elevators
(Silos del campo)

1. Receives grain primarily by truck from receiving points or growers. Should receive both bag and bulk mostly from truck. Loads out truck and rail.

D. Key Functions by Level in Marketing System
(Funciones claves por nivel en sistemas de mercadeo)

1. Producers
(Productores)

a. Harvest
(Cosecha)

b. Transport to market
(Transporte al mercado)

c. Sales to handlers or processors
(Venta a manipuladores o procesadores)

2. Gathering points in traditional production areas
(Lugares de acopio en areas tradicionales de producción)

a. Weighing and grading
(pesacda y clasificación)

b. Pricing
(Establecimento de precios)

c. Buying from producers
(Compras a productores)

d. Transport and sale to country elevators or other handlers
(Transporte y venta a silos de campo u otros compradores)

3. Country elevators
(Silos de campo)

a. Weighing and grading
(Pesada y clasificación)

b. Pricing
(establecimiento de precios)

c. Buying from producers and gathering points
(Compra a los productores y lugares de acopio)

d. Cleaning, drying and blending
(Limpieza, secada y mezclada)

e. Short-term storage
(Almacenamiento a corto plazo)

f. Transport and sale to terminal elevators and processors
(Transporte y venta a silos centrales y procesadores)

(El grano es recibido principalmente por camión de los puntos de recibo o de los cultivadores. Se debe recibir tanto en bultos como a granel. Despachos por camión y ferrocarril).

2. Equipment required
(Equipo requerido)

a. Grading and moisture testing
(Para clasificar y medir humedad)

b. Trucks, scales
(Camiones, básculas)

c. Bulk or bag
(A granel o en bultos)

d. Cleaning equipment which will produce standard grade
(Equipo de limpieza para producir grado standard)

e. Working bins
(Silos de trabajo)

f. Drying equipment, small and large lots
(Equipo para secar, lotes pequeños y grandes)

g. Bulk and bag storage for short-time storage
(Almacenamiento a granel y en bultos para almacenamiento a corto plazo)

h. Bagging equipment
(Equipo para empaque)

i. Bulk load-out
(Cargue a granel)

C. Terminal Elevator
(Elevador central)

1. Receives from large growers, receiving points or country elevators. Should receive both bag and bulk from truck and rail, sometimes barge. Ships bag and bulk by truck, rail and barge.
(Recibo de grandes cultivadores, puntos de recibo o silos de campo. Deberá recibir tanto en bultos como a granel por camión y ferrocarril algunas veces por lanchón. Remite en bultos y a granel por camión, ferrocarril y lanchón.)

2. Equipment required
(Equipo requerido)

a. Grading and moisture testing
(Aparatos para clasficiar y medir humedad)

b. Scales for truck and automatic scales for rail and barge
(Básculas para camión y básculas automáticas para ferrocarril y lanchón)

c. Receiving as required
(Recibo según la necesidad)

d. Cleaning as in country elevator
(Limpieza como en los silos del campo)

e. Drying mostly bulk
(Secada principalmente a granel)

f. Storage - bulk and bag for long-term storage
(Almacenamiento - A granel y en bultos para almacenamiento a largo plazo)

g. Aeration equipment for bulk
(Equipo de ventilación para secamiento a granel)

h. Thermocouple equipment for bulk storage
(Equipo termocuple para almacenamiento a granel)

i. Fumigation equipment
(Equipo de fumigación)

j. Should consider economics of flat versus vertical storage
(Se debe considerar la economía de almacenar en lo plano contra almacenamiento vertical)

k. Should have bulk load-out for all transportation which is applicable
(Deberá disponerse de medios de cargue a granel para todo el transporte aplicable)

D. Processor
(Procesador)

Processors may need facilities similar to a country elevator or terminal elevator.
(Los procesadores pueden necesitar facilidades similares a silos de campo o silos centrales).

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(4) Setting Margins and Charges to Cover Costs
(Fijar márgenes y recargos para cubrir costos)

A. Relationship between Marketing Costs and Margin from Producer to Consumer
(Relación entre costos de mercadeo y margen de productor a consumidor)

1. Costs the major factor (say 95% of total margin)
   Costos el principal factor (digamos 95% del margen total)

2. Profits a minor factor (say 5% of total margin)
   (Utilidades un factor pequeño -- digamos 5% del margen total)

3. Margins and charges must be adequate to cover costs
   (Los márgenes y los recargos deberán ser adecuados para dubrir los costos)

   a. Cleaning and drying (including shrinkage)
      (Limpieza y secada, incluyendo merma)

   b. Receiving, handling and loading
      (Recibo, manejo y cargue)

   c. Storage
      (Almacenamiento)

   d. Transportation and distribution
      (Transporte y distribución)

   e. Processing
      (Procesamiento)

   f. Packaging
      (Empacada)

B. Categories of Costs
   (Categorias de Costos)

   1. Fixed costs of facilities and equipment
      (Costos fijos de facilidades y equipo)

      a. Depreciation
         (Depreciación)

      b. Insurance
         (Seguro)

      c. Taxes
         (Impuestos)

      d. Interest
         (Intereses)

      e. Fixed maintenance
         (Gastos fijos de mantenimiento)

      f. Supervisory labor
         (Trabajo de supervisión)

2. Variable Costs
(Costos variables)

   a. Labor
   (Mano de obra)

   b. Supplies and materials
   (Provisiones y materiales)

   c. Fuel and power
   (Combustible y fuerza)

   d. Repairs and variable maintenance
   (Reparaciones y mantenimiento vario)

   e. Insurance, interest and taxes on stocks
   (Seguro, intereses y los impuestos sobre existencias)

   f. Shrinkage and quality deterioration
   (Merma y deterioro de la calidad)

3. Overhead Costs
(Gastos generales fijos)

   a. Management salaries and expense
   (Sueldos y gastos de administración)

   b. Office fixed costs
   (Costos fijos de oficina

   c. Bookkeeping
   (Teneduría de libros)

   d. Office staff
   (Personal de oficina)

   e. Utilities
   (Servicios)

   f. Office supplies and miscellaneous
   (Provisiones, papelería, de oficina y varios)

C. Characteristics of Fixed Costs
(Caracteristicas de los costos fijos)

1. Apply to every cost center for marketing grain
(Aplicar a cada central de costos para mercadeo de grano)

2. Remain constant and must be paid regardless of volume
(Permanecer constante y hay que pagar sin tener en cuenta el volumen)

3. Mean that idle or underutilized facilities are costly
(Significa que las facilidades ociosas o subutilizadas son costosas)

4. Are a function of the design and original cost of the facilities
(Son una función del diseñe y del costo original de las facilidades)

5. Are lower per unit of volume with increased utilization, e. g.
(Son más bajos por unidad de volumen con mayor utilización, Ejj.)

   a. Ton-months, or ton-days, of storage
   (Tonelada-mes, o tonelada-dias, de almacenamiento)

   b. Tons handled, cleaned or dryed
   (Toneladas manajadas, limpiadas o secadas)

   c. Ton-kilometers transported
   (Tonelada-kilometros transportadas)

D. Characteristics of Variable Costs
(Caracteristicas de los Costos Variables)

1. Apply to every cost center for marketing grain
(Aplicar a cada central de costos para mercadeo de granos)

2. Are a direct function of volume; constant amount per ton, ton-month, ton-kilometers
(Son una función directa del volumen; cantidad constante per tonelada, tonelada-mes, tonelada-kilómetros)

3. Reduced by reorganization to reduce amount of labor, materials and other variables inputs required to do the same job, not by increasing volume
(Merman por reorganización para reducir cantidad de mano de obra, materiales y obros insumos variables necesarios para ejecutar el mismo trabajo, no por aumento del volumen)

E. Characteristics of Overhead Costs
(Caracteristicas de los Costos Generales)

1. Apply to the operation as a whole rather than to specific cost centers.
(Se aplica a la operación total más que a las centrales de costos)

2. Distributed to each function on the basis of the relative contribution of the function to the total operation
(Distribuidos a cada función en base a las contribución relative de la función a la operación total)

3. Reduced by improved organization of overhead activities
(Se reducen por majoramiento en la organización de las actividades generales)

4. Reduced per unit of volume by expansion and diversification
(Se reduce por unidad de volumen por medio de ampliación y diversificación)

F. Total Annual Cost for a Given Operation at a Given Location
(Costo total por año de una operación especifica en una localización especifica)

1. $F + VC + \frac{VO}{S} = T$, where

   F = total fixed costs for the operation
   V = total annual volume for the operation
   C = the per-unit variable cost for the operation
   O = the total overhead cost
   S = the sum of the volumes for all operations supporting the overhead costs

   ($F + VC + \frac{VO}{S} = T$, donde

   F = costos fijos totales por depreciación
   V = volumen total por ano para la operación
   C = el costo variable por unidad para la operación
   O = el total de los costos generales
   S = la suma de los volúmenes para todas las operaciones que cubren los costos generales)

2. Total unit cost for the operation: $T/V = U$
   (Costo total por unidad para la operación: $T/V = U$)

G. Setting Margins and Charges
(Fijar márgenes y recargos)

1. Geographic price differences to cover transportation costs
   (Diferencias de precios geográficos para cubrir costos de transporte)

2. Position price differences to cover handling margins
   (Diferencias de precios de posición para cubrir gastos de manejo)

3. Moisture discounts, dockage, to cover shrinkage and drying costs
   (Descuentos por humedad, muellaje, para cubrir merma y gastos de secadado)

4. Foreign material discounts, dockage, to cover shrinkage and cleaning costs
   (Descuentos por impurezas, muellaje, para cubrir merma y costos de limpieza)

5. Damage discounts to cover blending costs and lower value of damaged kernels
   (Descuento por danos para cubrir gastos de mezclado y menor valor por los granos dañados)

6. Storage charges and seasonal price differences to cover total storage costs.
   (Gastos de almacenamiento y diferencia de precios por estación para cubrir costos totales de almacenamiento)

7. Premiums for bulk or discounts for bagged grain to reflect differences in handling costs
(Prima para granel o descuentos para grano empacado para reflejar diferencias en costos de manejo)

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(5) Reducing Marketing Costs and Increasing Operating Efficiency
(Reducir Costos de Mercadeo y Aumentar Eficiencia de Operación)

A. Planning Number, Type and Location of Facilities
(Planear número, tipo y ubicación de las facilidades)

As discussed under topics No. 1, 2 and 3
(Según lo discutido en tópicos 1, 2 y 3)

B. Convert from Bag to Bulk Handling as soon as Possible
(Cambiar tan pronto como sea posible el manejo en sacos por manejo al granel)

1. More efficient and lower cost handling
(Manejo más eficiente a menor costo)

2. Savings of bag costs
(Economía en el costo de los costales)

3. Elimination of insect harbors
(Eliminación de albergue de insectos)

4. Lower cost transportation
(Más bajo cost de transporte)

a. Faster loading and unloading
(Cargue y descargue más rápido)

b. Saving of freight on bags
(Ahorro en fletes de los costales)

5. Necessary for commingle system of grain handling
(Necesario para sistema mixto de manejo de granos)

C. Keeping Facilities Busy
(Mantener ocupadas las facilidades)

1. Reducing unused capacity
(Reducir la capacidad desocupada)

2. Avoiding delays
(Evitar demoras)

3. Balancing equipment to eliminate bottlenecks
   (Equilibrar el equipo para evitar cuellos de botella)

4. Joint use of equipment
   (Uso conjunto del equipo)

D. Reducing Repair Costs
   (Reducir costos de reparación)

1. Effective maintenance program
   (Programa effectivo de mantenimiento)

2. Systematic replacement
   (Reemplazo sistemático)

3. Spare parts inventory
   (Inventario de repuestos)

4. Using qualified repair services
   (Utilizar servicios de reparación calificados)

E. Minimizing Insurance Costs
   (Reducir costos de seguro al mínimo)

F. Selecting Appropriate Depreciation Schedules
   (Seleccionar programas adecuados de depreciación)

G. Reducing Fuel and Power Costs
   (Reducir costos de combustible y energía)

1. Selecting economical source
   (Selección una fuente económica)

2. Avoiding unnecessary stopping and starting
   (Evitar paradas y arranques innecesarios)

3. Operating at optimum rates
   (Operar a niveles óptimos)

4. Avoiding waste
   (Evitar desperdicio)

H. Reducing Labor Costs through Effective Utilization
   (Reducir el costo de la mano de obra con utilización efectiva)

1. Effective work organization
   (Organización efectiva del trabajo)

2. Industrial engineering studies
   (Estudios de ingeniería industrial)

3. Maintaining spirit of productivity
   (Mantener espíritu de productividad)

I. Minimizing Shrinkage and Quality Deteriorating
(Reducir al mínimo las mermas y el deterioro de calidad)

1. Cleaning and drying grain for storage
(Limpiar y secar el grano para almacenario)

2. Proper use of aeration and temperature reading equipment
(Uso adecuado del aireador y del equipo para leer la temperatura)

3. Fumigation
(Fumigación)

4. Housekeeping
(Cuidado y mantenimiento de las facilidades)

5. Conversion to bulk handling
(Conversión a manajo a granel)

6. Blending and handling practices
(Prácticas de mezclado y manejo)

7. Systematic physical handling
(Manejo físicos sistemático)

J. Using an Effective Accounting System
(Utilizar un sistema efectivo de contabilidad)

1. For grain inventory control
(Para control de inventario de granos)

2. For operating cost control
(Para control de costos de operación)

3. For planning to reduce operating costs
(Para planear reducción de costos de operación)

K. Diversifying to Spread Overhead Costs
(Diversificar para esparcir los costos generales)

1. Complete grain handling services
(Completar servicios de manejo de granos)

2. Addition of related lines
(Adición de líneas relacionadas)

3. Development of a complete marketing system
(Desarrollar un sistema completo de mercadeo)

****

(6 and 7, 9, 11) Equipment Selection and Operation
(Selección y Operación del Equipo)

A. Grading Equipment
(Equipo clasificador)

1. Sampling - May use probes but may prefer to use a scoop if grain has much straw
(Muestreo - Puede usarse sondas pero podría ser preferible usar una pala o cucharón si el grano tiene mucha paja)

2. Grading screens required for all grains to be received
(Se requieren mallas clasificadoras para todos los granos que se reciban)

3. Electrical moisture testers are necessary but must be checked frequently. Country elevators and terminal elevators should have two testers to be checked against each other daily.
(Son necesarios los probadores eléctricos de humedad pero tienen que ser controlados con frecuencia. Los silos de campo así como los silos centrales deben tener dos probadores para comparar diariamente el uno con el otro)

4. Grading must be done quickly, perhaps a minimum of 10 minutes, to decide whether to buy the grain and where to dump it.
(La clasificación debe hacerse rápidamente, tal vez un máximo de 10 minutos, para decidir si comprar el grano y donde verterlo)

B. Weighing Equipment
(Equipo para pesar)

1. All scales should be checked at least once a week for accuracy by weighing test weights.
(Se deben chequear todas las básculas por lo menos una vez a la semana pesando pesos de prueba para precisión)

2. All scales should be checked by a scale maintenance mechanic at least once a year or more frequently if trouble is noticed.
(Se deben chequer todas las básculas por un mantenimiento por es menos una vez el año o mas frequentamente si pasan problemas.)

C. Receiving
(Recibo)

1. Bulk handling is badly needed to reduce labor and truck costs and the cost of bags.
(Se necesita con apremio el manejo al granel para reducir los costos de mano de obra, camiones y costo de los costales)

2. Most bag dumps can be converted to bulk dumps by installing a truck hoist or cable-powered scoop.
(La mayoría de los vertederos de bultos pueden convertirse a vertederos al granel instalando una grúa de camión o una pala movida por cable.)

3. Enough dump pits must be provided to reduce truck waiting time to a practical minimum.
(Deben hacerse suficientes vertederos para reducir el tiempo de espera de los camiones a un mínimo)

4. Calculations should provide an optimum (least) cost considering truck, rail or barge waiting time cost and the facility cost for the elevator. Generally, an unloading or loading facility should not be in use more than about half the time in order to reduce length of waiting lines.
(Se deben hacer cálculos para proveer un costo óptimo (mínimo) que tenga en cuenta costo del tiempo de camión ferrocarril o lanchón y el costo de los silos. Por lo general, una instalación para cargue o descargue no deberá permanecer en uso mas de la mitad del tiempo con el fin de reducir las colas de espera)

5. Some studies should be made, probably by industrial engineers, of arrival rates under Colombian conditions. This data is needed for optimum sizing of all the facilities.
(Se deben hacer algunos estudios, probablemente por in enieros industriales, de ratas de llegada bajo condiciones Colombianas. Estos estudios y sus datos se necesitan para decidir el tamano optimo de todas las instalaciones.)

D. Cleaning
(Limpieza)

1. All grain should be cleaned upon arrival at elevators and the clean grain should meet the standard trading grade.
(Todos los granos deben ser limpiados cuando se reciben en los silos y una vez limpios deberán llenar el grado standard de comercialización)

2. It would probably be best to provide one cleaner for each dump pit or receiving elevator.
(Probablemente sería mas conveniente tener un limpiador para cada vertedero o silo recibidor)

3. There are no good standards for grain cleaners - the specifications should include capacity and efficiency requirements.
(No existen buenos standards papa limpiadores de granos - las especificaciones deberán incluir requisitos de capacidad y eficiencia)

4. Provisions should be made to dispose of much of the material removed as an animal feed ingredient.
(Se deben tomar medidas para deshacerse de la mayor parte del material que se guita como ingrediente para frabricar alimento animal.)

E. Drying
(Secada)

1. May need some small dryers for bulk at many facilities.
(Es posible que se necesiten algunas secadoras pequeñas para granos al granel en muchas de las instalaciones)

2. Could consider some bins with perforated floors having capacities of 20-100 tons. These could be used for minor crops or when arrival rates are low.
(Se podrían considerar algunos depósitos de piso perforado con capacidades de 20-100 tonelades. Estos se podrían utilizar para cultivos menores o cuando las ratas de llegada son bajas.)

3. Drying temperatures should not be too high.
(Las temperaturas para secar no deben ser muy altas.)

4. Generally best not to remove over 4% moisture per pass except on feed grains.
(En general es mejor no extraer mas de un 4% de humedad por cada pasada excepto para granos de alimento animal.)

F. Storage
(Almacenamiento)

1. Consideration should be given to more use of flat storage.
(Se debe considerar el mayor uso de almacenamiento horizontal)

2. Tropical areas are very difficult and will require very careful handling of aeration equipment. Aeration rates may need to be much higher than in USA and air flow may be best if up.
(Las áreas tropicales son muy difíciles y requerirán un manejo cuidadoso del equipo de ventilación. Las tasas de ventilación es posible que deban ser mas altas que en los Estados Unidos y el flujo del aire puede ser mejor arriba.)

3. All instruments - psychrometers and thermocouples - must be checked for accuracy.
(Todos los intrumentos - psicrómetros y termocuples - deben ser controlados para precisión.)

4. Fumigation can be aided by aeration systems.
(La fuminación puede ser ayudada por sistemas de ventilación)

5. Housekeeping is very important for rodent and insect control.
(El mantenimiento de los edificios es muy importante para control de roedores e insectos.)

G. Transportation
(Transporte)

1. Much attention should be given to efficient use of trucks.
(Se debe prestar mucha atención al uso eficiente de los camiones.)

   a. Avoid delay time during loading and unloading.
   (Evitar demoras en el cargue y descargue.)

   b. Provide loads both ways if possible.
   (Tratar de que haya carga para los viajes de ida y regreso.)

2. May need to give some thought to how present trucks can be converted easily to bulk.
(Puede ser necesario pensar en cómo los camiones actuales se pueden convertir para cargue al granel)

3. Bulk railroad loading and unloading may require some changes but should not be difficult.
(Cargue y descargue al granel por ferrocarril puede necesitar algunos cambios pero éstos no deberían ser complicados.)

4. Bulk barge facilities will require considerable study but will be very economical.
(Las facilidades para cargue al granel en lanchones requerirán bastante estudio pero serían muy económicas.)

5. Ship loading and unloading will be very good at Santa Marta and should be used to reduce demurrage costs.
(Cargue y descargue por barco sería muy bueno en Santa Marta y deberá aumentarse para reducir costos por demora.)

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(8) Establishing Price Differentials for Quality
(Establecer diferenciales del precio por calidad)

A. Standardization as a basis for trading
(Estandarización como base para negocios)

1. Grain characteristics affecting value
(Características del grano que afectan el valor)

2. Characteristics of standardization
(Características de normalización)

a. Official grain grade standards
(Normas oficiales de calidad)

b. Inspection system for grain classification
(Sistema de inspección para clasificación de granos)

c. Sorting into lots according to standards
(Separación de lotes según normas)

3. Importance
(Importancia)

a. Price differentials for quality to producers
(Diferenciales de precio a los productores de calidad)

b. Handling and marketing on a commingle basis
(Manejo y mercadeo en base de grano mezclado)

c. Bulk storage and transportation
(Almacenamiento y transporte a granel)

d. Financing and trading on basis of warehouse receipts
(Financiación y negocios en base de certificados de depósito)

B. Basis for standards and grading
(Bases para normas y clasificacion)

1. Definition of classes
(Definición de clases)

2. Numerical or special grades within classes
(Grados especiales o de número dentro de clases)

3. Factors affecting weight and quality
(Los factores que afectan el peso y calidad)

a. Moisture content
(Humedad)

b. Foreign material content
(Impurezas)

c. Application of dockage system
(Aplicar el sistema de muellaje)

4. Factors affecting quality but not weight
(Los factores que afectan calidad pero no el peso)

a. Damaged kernels
(Granos dañados)

b. Heat-damaged kernels
(Granos dañados por calor)

c. Test weight
(Peso de prueba)

5. Special grade factors
(Factores especiales de calidad)

a. Weevils
(Gorgojos)

b. Smutty
(Tiznado)

c. Foreign odors
(Olores extraños)

d. Others
(Otros)

C. The Trading Grade
(El grado o norma de negocios)

1. Basis for price quotations
(Bases para cotizaciones de precios)

2. Normally a numerical grade, e.g. No. 2, by class
(Normalmente un grado numérico, como No. 2, por clase)

3. May have special requirements on one or more grade factors
(Se pueden tener requerimientos especiales para uno o masfactores de grado)

4. Good average quality which a large portion of crop meets
(Calidad buena promedia la cual incluye la mayor parte de la cosecha)

5. Exact specifications may vary slightly from year to year
(Las especificaciones exactas pueden variar ligeramente de año a año)

D. Discounts and premiums for quality
(Descuentos y premios por calidad)

1. Dockage
(Muellaje)

a. Applied to moisture and foreign material
(Aplicado a humedad e impurezas)

b. Adjustment in weight to the equivalent clean and dry basis
(Ajustar el peso al equivalente limpio y seco segun las especificaciones de las normas para negocio)

(1) Computed shrinkage
(Merma computada)

(2) Hidden shrinkage
(Merma oculta)

(3) Cleaning and drying costs
(Costos de limpieza y secamiento)

c. Separate dockage on each factor
(Muellaje distinto para cada factor)

2. Price discounts
(Descuentos del precio)

a. Adjustment in price of grain
(Ajustar el precio del grano)

b. Separate discounts for each factor
(Descuentos distintos para cada factor)

c. Damaged kernels most important factor in addition to moisture and foreign material
(Despúes de humedad e impurezas el grano dañado es el factor mas importante)

E. Setting appropriate price differentials
(Fijar las diferenciales apropiadas de precio)

1. For moisture content
(Para humedad)

2. For foreign material
(Para impurezas)

3. For damaged kernels
(Para grano dañado)

F. Reflecting price differentials to individual producers
(Reflejar las diferenciales de precio a los productores individuales)

1. Grading and pricing by first handler
(Clasificar y fijar el precio por el primer comprador)

2. Educational programs for producers
(Programas de educación para productores)

3. Reflection of differentials in price support programs
(Reflejar las diferenciales de precio en los programas de sustentación de precios)

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(10) Role of Government Agencies in Grain Marketing
(Papel de las Agencias del Gobierno en Mercadeo de Granos)

A. Essential Functions of Government in Grain Marketing
(Funciones Esenciales del Cobierno en Mercadeo de Granos)

1. Price support for grain producers
(Sustentación de precios para productores de granos)

2. Facilitating services for grain marketing
(Facilitar servicios para mercadeo de granos)

3. Regulations to prevent monopoly and excessive marketing charges
(Reglamentos para evitar monopolio y recargos excesivos de mercadeo)

B. Price Support for Grain Producers - See Discussion No. 12.
(Sustentación de precios para productores de granos. - Véase Discusión No. 12.)

C. Facilitating Services for Grain Marketing
(Facilitar servicios para mercadeo de granos)

1. Reporting of supply, demand and prices
(Información sobre oferta, demanda y precios)

a. Importance of accurate and timely information
(Importancia de información precisa y oportuna)

b. Assembling accurate information
(Recopilar información precisa)

c. Reconciling and tabulating information
(Reconciliar y tabular información)

d. Informing public of results
(Informar al público de los resultados)

2. Grade standards and grain inspection services
(Standards de calidad y servicio de inspección de granos)

a. Training and certifying licensed inspectors
(Entrenamiento y certificación de inspectores licenciados)

b. Checking official grades
(Chequeo de grados oficiales)

c. Official grades
(Grados oficiales)

d. Educational material and programs
(Material y programas educativos)

3. Weights and measures
(Pesas y medidas)

a. Standardization of weights and measures
(Uniformar pesas y medidas)

b. Checking and certification of scales
(Control y certificación de básculas)

(1) Original certification of new scales
(Certificación original de básculas nuevas)

(2) Unannounced periodic checking and certification
(Control periódico sorpresive y certificación)

4. Certification of licensed public warehouses
(Certificación de bodegas públicas autorizadas)

   a. Licensing requirements
   (Requisitos para registro)

   b. Bonding requirements
   (Requisitos para seguro)

   c. Unannounced checking of warehouses
   (Control sorpresivo de bodegas)

   d. Reporting requirements
   (Requerimientos para divulgación)

5. Supervision of transportation
(Supervisión del transporte)

   a. Requirements for licensing
   (Requerimientos para registro)

   b. Supervision and control of freight rates
   (Supervisión y control de las tarifas)

   c. Supervision of claims for losses and damage in transit
   (Supervisión de reclamos por pérdidas y daños en tránsito)

6. Supervision of imports and exports
(Supervisión de importaciones y exportaciones)

   a. Licensing of importers and exporters
   (Licencias a importadores y exportadores)

   b. Collection of duties
   (Recolección de impuestos)

   c. Issuing import and export permits
   (Expedir permisos de importación y exportación)

   d. Promotion of international trade
   (Promoción del comercio internacional)

7. Other facilitating services of government agencies
(Otros servicios de entidades del gobierno)

D. Regulation to Prevent Excessive Marketing Charges
(Reglamentos para evitar recargos excesivos de mercadeo)

1. Approval of rates and charges
(Aprobación de tarifas y recargos)

   a. Transportation rates
   (Tarifas de transporte)

b. Drying charges
(Recargos para secar)

c. Cleaning charges
(Recargos para limpieza)

d. Storage charges
(Recargos para almacenamiento)

e. Elevating and handling charges at ports
(Recargos por manejo en los puertos)

2. Licensing for handlers and processors
(Licencias para el personal de manejo y procesadores)

a. Licensing companies
(Licencias a compañías)

3. Maintenance of fair trade practices
(Mantener prácticas justas de comercialización)

a. Investigation and prosecution of violators
(Investigación y acusación a los infractores)

b. Anti-monopoly legislation and administration
(Legislación y administración anti-monopolio)

c. Education and public relations programs with grain industry
(Programas de educación y relaciones públicas con la industria cerealista)

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(12) Coordinating Price Support and Marketing Programs
(La coordinación de los programas de sustentación de Precios y los de Mercadeo)

A. Distinction in Objectives of Marketing System and Price Support Program
(Distinguir los objectivos del sistema de mercadeo y los de programas de sustentación de precios)

1. Objectives of marketing system - efficient and low-cost distribution of all cash grain from producer to final consumer
(El objetivo del sistema de mercadeo - la distribución eficas y al bajo costo de todo el grano comercial del productor al consumidor final)

2. Objectives of price support programs
(Los objectivos de programas de sustentación de precios)

a. Assure producers of prices sufficient to cover production costs (Garantizar a los productores los precios adecuados para cubrir los costos de producción)

b. Assure consumers of adequate supplies at reasonable costs (Asegurar a los consumidores suministros adecuados a un costo razonable.)

c. Prevent excessive year-to-year variations in production and prices (Evitar fluctuaciones anuales excesivas en producción y precios)

B. Relationships between marketing and price support programs. (Relaciones dentro de los programas de mercadeo y los de sustentación de precios)

1. Neither can accomplish objectives of the other (Uno no puede lograr los objectivos del otro)

2. Both types of programs are essential for economic development (Ambos tipos de programas son esenciales para el desarrollo económico)

3. Challenge is to operate each of the programs efficiently without adverse effects on the other (El desafio es operar eficazmente cada uno de los programas sin afectar adversamente al otro)

4. The two programs often become confused, particularly when the same government agencies are involved in both (Muchas veçes se confunden los dos tipos de programas, particularmente cuando la misma agencia del gobierno está comprometida en ambos.)

C. Essentials of the Colombian Price Support Program for Grains (Esenciales del Programa Colombiano de Sustentación de Precios para los Granos)

1. Establishing minimum guaranteed prices to producers (Establecer precios mínimos de garantía a los productores)

2. Buying and storing grain when market prices are below support prices (Compara y almacenar grano cuando los precios en el mercado esten por debajo de los de sustentación)

3. Selling grain from storage reserves to help prevent excessive price rises (Vender grano de las existencias almacenadas para ayudar a evitar alzas excesivas de los precios)

4. Regulating imports and exports to maintain adequate domestic supplies and help stabilize prices (Regular importaciones y exportaciones con el fin de mantener suministros domésticos adecuados y ayudar en la estabilización de precios)

D. Essentials of Grain Marketing in Colombia
(Esenciales del Mercadeo de Grano en Colombia)

1. See discussions No. 1, 2, 3, and 4.
(Vea discusiones Nos. 1, 2, 3 y 4)

2. Receive all cash grain from producers at harvest and pay a fair price for the quality delivered
(Recibir todo el grano al contado de los productores al cosecharlo y pagar un precio justo por la calidad entregada)

3. Dry, clean and store or ship the grain
(Secar, limpiar y almacenar o despachar el grano)

4. Distribute the grain to competing uses and locations at the time and place and in the quantity and form needed
(Distribuír el grano a los usos y lugares competitivos, al tiempo y lugar, y en las cantidades y formas requeridas)

5. Distribute to export outlets surplus grain not needed for domestic use
(Distribuír a los mercados en el exterior el grano en exceso de las necesidades domésticas)

6. Distribute imported grain to supply requirements over domestic production at the time and place and in the quantity and form needed.
(Distribuír grano importado para suministrar los requerimientos domésticos no llendos por la producción doméstica al tiempo y lugar y en las cantidades y formas requeridas.)

E. Role of Government-Owned Marketing Facilities
(El Papel de las Facilidades de Mercadeo del Gobierno)

1. Should be operated to perform these essential marketing functions with equal effectiveness for all grain marketed, whether delivered under the price support program or sold by producers to private handlers and processors
(Se deberán operar en una manera que desempeñen las funciones esenciales de mercadeo con la mismo eficacia para todo el grano mercado, si es entregado al gobierno en el programa de sustentación de precios, o es vendido por productores a los compradores o procesadores de empresa privada.)

2. Marketing of government-owned grain should be accomplished with equal effectiveness through privately owned marketing facilities and government owned marketing facilities.
(El mercadeo del grano que pertenece al gobierno deberá cumplirse con igual eficacia por las facilidades de mercadeo de la industria privada y las del gobierno)

F. Using Price Support Programs to Improve Marketing
(Utilizar los Programas de Sustentación de Precios para Mejorar Mercadeo)

1. Price differentials for quality
(Diferenciales de precio por calidad)

   a. Grading and discounts for delivery under price supports can be used to pioneer grading and buying practices for all grain
   (La clasificación y descuentos para entrega por los programas de sustentación de precios se podrán usar para introducir nuevas prácticas de clasificar y comprar granos generalmente)

2. Premiums for bulk delivery
(Premios para entrega al granel)

   a. Bulk premiums for delivery under price supports can be used to encourage bulk premiums on all marketings of grain
   (Premios para entrega al granel en programas de sustentación de precios podrán usarse para fomentar el uso de premios para el granel en todo mercadeo de grano)

3. Handling, drying, cleaning and storage charges
(Recargos para manejar, secar, limpiar y almacenar)

   a. Rates offered and paid for contract services on government grain can be used to establish precedent for the private trade
   (Las tarifas ofrecidas y pagadas por servicios contratados para grano del gobierno podrán usarse para establecer un precendente para el comercio privado)

4. Price differentials by area
(Diferenciales de precios por zona)

   a. Differential support price levels in surplus and deficit areas can be used to help stabilize price differentials by area on free market grain
   (Niveles diferenciales de los precios de sustentación en zonas de producción excedente y en las de déficit podrán usarse para ayudar estabilizar las diferenciales zonales de precios para grano en el mercado libre)

PERSONNEL TRAINING RECOMMENDATIONS

"Training Grain Handling Managers"

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 personnel 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.

In order for personnel to obtain the knowledge and skills necessary for the performance of their duties, an organized training course is recommended. The Food and Feed Grain Institute, Kansas State University, offers short course training in grain handling techniques. Instruction is directed for the warehouse and elevator manager or operator level and consists of lectures, discussions, laboratory work sessions, and field trips. Areas covered in the short course are shown in the following outline.

GRAIN STORAGE AND MARKETING SHORT COURSE

I. Introduction to Course

- A. Importance of Proper Grain Storage and Marketing
  1. Prevent loss of food and feed grains
  2. Provide stable prices for food and feed grains
- 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 participant's country)

- 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. Aeration
1. Air properties
2. Air-grain temperature relationships

D. Grain Drying
1. Principles of grain drying
a. Temperature-moisture relationships
b. Effect of 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

E. Equipment Maintenance

VI. Storage

A. Type of Structures
1. Farm storage
2. Warehouse storage
3. Elevators

B. Structural Maintenance

C. Storage Methods and Procedures
1. Warehousing
2. Elevators
a. Binning
b. Blending

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 condition
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. Economics of Marketing Management and Operations

A. Principles of Management
1. Organization within firm
a. Assignment of responsibility
b. Training of personnel
2. Organization to provide customer service
a. Importance of consumer
b. Educational services

B. Principles of Operation
1. Exchange
a. Buying
b. Selling
2. Economics of physical handling

(1) Cost of alternatives
(2) Location
(3) Type

b. Transportation
(1) Local
(2) National
(3) Export

c. Processing

3. Facilitating operations
a. Financing and risk taking
b. Information
(1) Price and demand
(2) Crop production
(3) Supplier
(4) Procedures for informing public
c. Standardization
(1) Establishing grades
(2) Licensing procedures
(3) Arbitration

4. Bookkeeping, accounting, inventory control

C. Government and Grain Marketing
1. Commercial regulations
2. Legal environment
3. Action programs
a. Farm
b. Non-farm
4. International programs and policies

D. Form of Business Organization
1. Individual proprietor
2. Partnership
3. Corporation
4. Cooperative
5. Government

IX. Tours of Local Facilities to Point Out and Demonstrate Course Material

X. Laboratories to Compliment 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

G. Business Procedures and Market Analysis Methods

GRAIN STORAGE TEST AT SANTA CRUZ

During the visit to Santa Cruz, Dr. Kelly of the British Tropical Investigations team offered to provide facilities to check the effects of the Santa Cruz climate on stored grain. It was suggested that corn would be available for storage tests. Based on this conversation, the following test is suggested in order to provide controlled data for storage analysis in the Santa Cruz area.

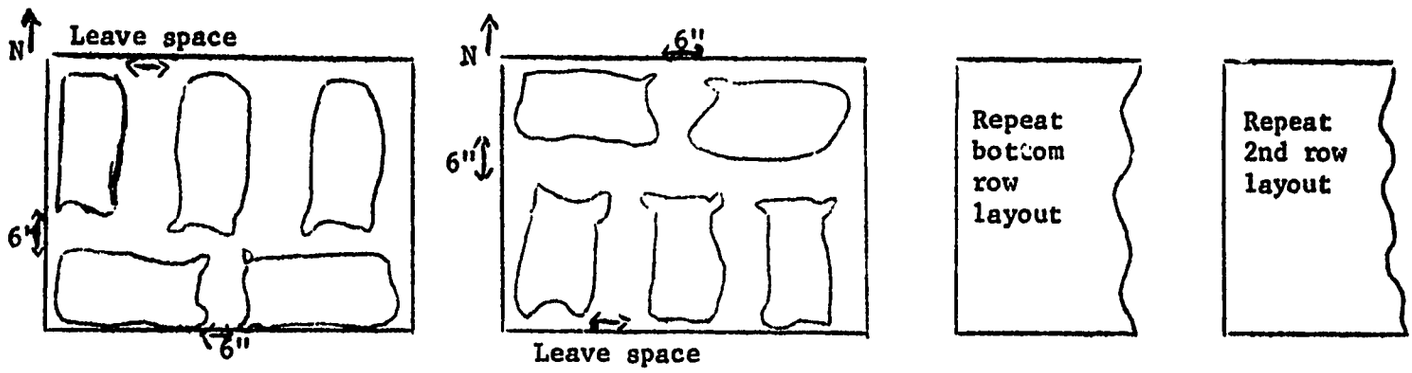
Materials Needed

1. Eight thousand pounds of corn. The corn is to be divided into two sample groups of 40 burlap or cotton 100-pound sacks.
2. Sufficient phostoxin fumigant to treat the corn for insect control prior to the test. Sufficient plastic sheets to cover the grain during fumigation.
3. Moisture meter, temperature measurement device, probe, screen for testing corn for live insects.

Procedure

1. Take the moisture and temperature of the corn before proceeding further. The moisture should not exceed 13 percent at a temperature within 10 degrees of the average daily temperature at the time of sampling. If the corn exceeds 13 percent, it should be dried to the 13 percent level. If the temperature is excessive, check for mold growth and insect formations. Use the grain screen to check samples for live insects. If the grain appears sound, record the date, starting moisture, temperature, and degree of insect contamination.
2. Divide the corn into two representative groups of 40 sacks each. If it is possible at this time, fumigate the corn with phostoxin. Dr. Haws of AID/USU has information on the proper procedure.
3. Arrange the corn sacks in two groups using the following guide for one group:

TOP VIEW



Bottom Row	2nd Row	3rd Row	4th Row
5 sacks	5 sacks	5th Row	6th Row
		7th Row	8th Row

For the second group, use any five- or six-bag stacking pattern, preferably one used locally.

4. If the two groups have not yet been fumigated, fumigate now using phostoxin with a plastic sheet covering the stack for best penetration.

5. Take corn samples from interior bags once a month. Do not disturb sacks if at all possible.

6. Run moisture, temperature, and screen for insects using the drawn samples. Record air temperature at time of sample. Example of data sheet is shown:

Grain _____ Investigator _____

Date	Grain Temperature	Air Temperature	Moisture Percent	Insects Noted	Mold Noted	Comments

Comments

1. If possible, prepare corn for storage by December so it can be under test conditions from January through June.

2. If live insects are seen in the samples taken, fumigate entire stack immediately with phostoxin.

3. If moisture reaches 16 percent and corn quality appears to start to deteriorate, the corn should be removed from storage and dried down to 13 percent.

4. Record starting and monthly data checks in a set sequence for the entire period.

APPENDIX IV

GRAIN STORAGE AND MARKETING

FOOD AND FEED GRAIN INSTITUTE
KANSAS STATE UNIVERSITY

SIZING OF GRAIN ELEVATOR FACILITIES

Dr. Harry B. Pfost

There is little literature available to use as general guides to decide upon the capacity of various components of a grain storage facility. Boulard (1) discusses the problem in detail and presents examples of rational solutions to the receiving problem as applied to U. S. (particularly hard red winter wheat area) conditions. Data which are required for other conditions are practically non-existant.

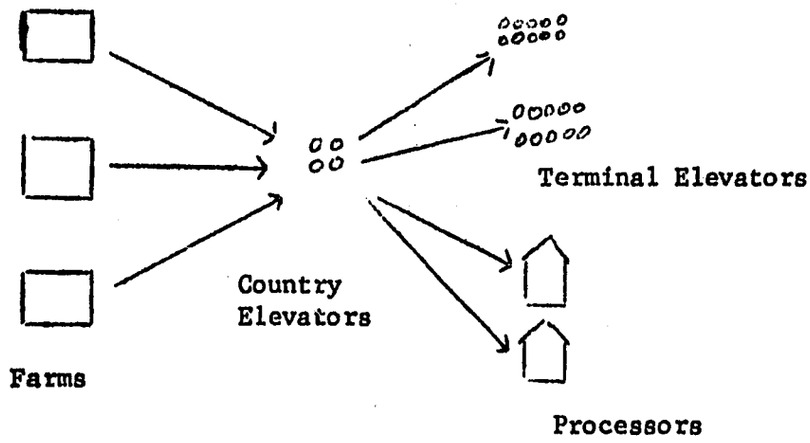
Three critical areas may have to be studied: receiving, storage, and loading out. However, the capacity of the receiving facilities and the storage facilities are probably the most critical under most conditions of normal grain elevator operation.

The first problem to be solved is that of the size of the territory to be served by a grain storage facility. Until this can be established there can be no solution to the other problems of sizing the grain storage facility.

In general in the U. S. and other major developed grain producing countries, the flow of grain is from farm to country elevator to processor or terminal elevator. There are, of course, exceptions; for example, large farms may have their own elevator facilities which ship direct to processors or terminal elevators. These large farm elevators have about the same problems of sizing equipment as the country elevator and the solution would proceed in about the same manner.

A typical flow chart of the grain marketing and storage system would appear as shown in Figure 1:

Fig. 1



Major items of cost which occur within the system are:

1. Processing costs including cleaning and drying
2. Transportation costs
3. Storage costs which include costs for the actual physical storage facilities, quality maintenance (aeration and insect and rodent control) and interest on the investment in the grain itself.
4. Handling in and out of storage
5. Buying and selling costs -- the costs of conducting the actual ownership exchange

Major functions which the grain storage and marketing system accomplish are the same as the costs items enumerated above. Where the various functions are to be performed offers the possibility of considerable flexibility. Some general considerations will be discussed.

Function of Farms. Most or all of the required functions may be performed by the farmer. In many countries, the farmer stores his grain until it is taken to a city market where it is sold directly to a consumer. (Sometimes this is considered to be an archaic system). In other countries, a large farmer will store his grain and then deliver directly to a processor. (Sometimes this is considered to be an advanced system). Thus, the farmer may take all responsibility for all the functions of a grain storage and marketing system. Some of the advantages are:

1. The farmer takes the responsibility for all functions of the storage and marketing system and should gain some profit from each function which he performs.
2. The value of the farm labor and equipment at harvest time may be more valuable than at other times and he will profit by holding the grain on the farm rather than delivering it to his market outlet.
3. Price increases may occur between harvest and time of sale.

Some disadvantages include:

1. Cleaning and drying costs may be high if done at the farm because of the limited use of facilities. For example, sun drying of rice may be relatively expensive compared to the cost of drying in a large heated air dryer or the overhead costs per ton dried of a dryer to be used on a single farm for a single crop may be much higher than that of a dryer located at an elevator where it might be used over a much longer period of time.
2. The cost of storage space per ton will usually be lower in larger units.
3. The farmer may have difficulty in maintaining quality; for example the control of mold or insects is quite difficult in some areas.
4. Transportation costs of small lots of grain over long distances may be high.

5. Many processors will prefer to purchase large lots of grain of a known quality so the farmer may have difficulty in selling a small lot to a large processor.
6. Major price declines may reduce potential profits.
7. The farmer may not wish to utilize his available capital to own grain.

Function of Country Elevators. The country elevator has the major role of providing a ready market for local grain, processing (cleaning, drying, and conditioning) for storage or sale, assembling of fairly large lots of more-or-less uniform quality, storage, selling to a larger elevator or processor. These functions may be more economically performed here than at other points in the system. In general, there are opposing forces which will dictate the optimum size of the country elevator. Small country elevators located close to grain-producing farms offer the following advantages:

1. Minimizes loss of farmer's time required for transport from farm to market.
2. Minimizes transport costs from farm to market.
3. Places the grain where quality maintenance may be more adequately supplied and supervised.
4. Can resell grain in the local community with a minimum of transport cost.

Functions of Terminal Elevators. Terminal elevators, as the term is used in the U. S., are large elevators which receive a large amount of their grain from country elevators, assemble large lots of grain of a given quality and generally ship to processors or export loading facilities. Generally, the terminal elevators have cleaning and drying equipment but depend more on the country elevators for this processing. Long-term storage may be provided, but much of the grain does not remain in storage for long periods. That is, a particular silo may be filled and emptied a few times per year with various types or grades of grain as grain is assembled, classified, and sold.

Functions of Processors. Processors may engage in all of the functions described above. Although most grain processors purchase grain from country or terminal elevators as needed, other processors find it profitable to purchase grain from farmers and provide the processing and storage functions that are normally provided in the traditional system by elevators.

Storing Grain on the Farm

Although it may be relatively expensive to process and store grain on the farm, the higher costs may be justified as an alternative to transporting the grain to a central facility for processing and storing. For example, many corn-producing farms in the U. S. feed most of the corn which they produce. If the grain is stored on the farm, the advantages are:

1. Transport costs to and from market for that part of the corn to be fed are avoided.
2. Two selling-buying transactions are avoided.
3. The farmer may avoid making a decision regarding how much of his supply to sell until months after harvest.
4. Since he may have an investment in drying, storage, and quality maintenance for the majority of his crop, he can use some of the same investment at no additional cost for his surplus.

As another example, in many areas of the world where subsistance agriculture exists, the family consumes most of the grain which is grown for food. The same advantages which were listed above for farm storage of feed grain apply here. A point often overlooked in developing countries when planning grain marketing and storage systems is that in areas of typical subsistance agriculture, the grain available for commercial markets is the surplus which a family can produce over-and-above the food needs of the family. Hence, the first consideration must be to that of aiding the farm to properly process and store grain at the farm so that there can be a surplus for sale. In some tropical areas, the problems of quality maintenance (protection from mold and insects) may be so difficult that farm storage is really not practical because of large losses which occur. In some of these cases, it may be much more economic to develop community drying and storage facilities where farmers can have grain dried and stored and withdraw the grain required by the family as it is needed.

A system of community storage now practiced in the U. S. is called "grain banking" and applied particularly to feed grains. The system operates basically as follows:

1. At harvest time, the farmer delivers his grain (which frequently must be dried) to a country elevator-feed dealer.
2. The grain is processed as required and stored with other grain, but the farmer retains ownership of a quantity of grain equal to that delivered and of a similar grade. Drying charges are made to cover drying costs.
3. When the farmer requires feed, the dealer grinds and mixes grain with a supplement and deducts an equal amount of grain from the farmer's "deposit" of grain. Since the sale of feed processing services and supplements may provide a fairly large profit, no handling or storage charges are usually made by the elevator.
4. If the farmer decides to sell, or withdraw, his grain rather than have it made into feed, he may do so but will then pay a service charge based upon the costs of handling the grain into and out of storage plus a per-month charge for the storage.

In the U. S., elevators which engage in "grain banking" are supervised by a state agency to see that the farmer's "deposit" is safe just as other state agencies supervise banks to see that a depositor's money will be returned.

Alternatives to Country Elevators

Some alternatives to country elevators exist in various forms.

In the U. S., farmers who are near large terminal elevators or processors may deliver, usually by truck, grain to the market at harvest time or later.

In some countries, itinerant truckers go to the farm, buy the grain, and then sell immediately or after a storage period. This system has developed in many areas where it is very expensive to transport grain to a market. Since the costs are high in this system, the difference between the price paid to farmers and the price for which the trucker sells the grain is large.

In one country (Costa Rica) with which the author is familiar, the national grain marketing agency sends trucks to small communities where farmers may sell their grain directly. These trucks return each day to a small collection point where grain may be partially cleaned and dried, stored a few days, and then transported by rail or truck to one of two national terminal elevators. The entire system is owned and operated by a government agency. The same agency maintains retail outlets in major cities where grain is sold directly to consumers, although most of the grain is sold to processors or other retail stores.

In Colombia, S.A., the National Grain Marketing Agency (IDEMA) and the National Farm Supply Agency (INAGRARIO) are cooperating to purchase grain in those areas where limited grain is for sale and where country elevators would not be economically feasible. The farm supply agency has a large number of stores where seed, fertilizer, and other farm supplies are sold. Rather well-trained personnel are in charge of these stores and with a little additional training can be taught to grade grain and purchase it. Since most of the grain purchased is in small lots and in sacks, it can be stored without too much difficulty or danger for a few days until a truck from the grain marketing agency can pick it up for transport to one of the grain elevators.

Obviously, the simplest widely used grain marketing system is that in which the farmer sells his grain directly to the consumer, usually at a city market. Although the transport and selling costs may appear high, this system may provide many economies where consumers process their own grain for food. It is not well adapted to situations where long transportation distances or large lots are involved.

Planning Storage at the Farm Level

In general, we will assume that the goal of a grain storage and marketing system is to minimize the cost of moving and storing grain between the time of harvest and the time when it is consumed as a food or feed. Local conditions will influence that nature of the overall system. Since labor and other costs vary so widely between different countries and little good cost data is available for many areas, it is impossible to give easy answers for all conditions.

Subsistance Farms. As the term is used here, a subsistance farm is one where most of the grain is used for food or feed on the farm on which it is produced. (It would also include the case where the producer sells directly to a nearby consumer, probably at a village public market.) Since the producer is also the consumer, there are three practical alternatives:

1. The farmer cleans and dries (if necessary) the grain, stores it on the farm and sells the surplus at whatever time he desires.
2. The farmer cleans, dries and stores the amount needed for home consumption and sells the surplus at harvest time.
3. The entire crop is sold (or grain banked) at harvest and the farmer repurchases for the family needs. This alternative must be very strongly considered in areas where maintenance of quality is difficult.

Costs which occur between harvest and time of consumption of that fraction used by the producer include:

1. Cleaning costs.
2. Drying costs. Natural drying by sun and air are frequently used and may require much labor but offer the advantage of low energy cost. Facility costs for natural drying are usually low. Artificial-heat driers are usually more expensive in terms of investment and energy but cheaper in terms of labor; artificial-heat driers usually require a higher level of operator competence. Community driers may offer a good compromise and be attractive.
3. Transportation costs. These will normally occur only if the grain is taken off the farm for drying or storage.
4. Storage costs. This includes:

   Depreciation, taxes, and interest on the investment. Since the fixed costs are high for storage, every effort should be made to minimize the investment by the use of local materials, local labor for construction, etc. Facilities should provide protection against rain, insects, and rodents. Where high humidity exists the moisture of well-dried grain may increase as moisture is absorbed from the atmosphere until it must be redried to prevent mold. It is very difficult to seal against this absorption of moisture. Some good and simple storages which are used include:

   Brick or sun-dried brick laid with mortar which will prevent the entrance of insects or rodents.

   Wood bins constructed to prevent the entrance of moisture or rodents.

   Underground silos are used in the drier sections of Northern Africa. These are simply holes dug in the ground, lined with mortar or clay, and covered to prevent the entrance of rain.

Metal bins in various sizes and types are used frequently where suitable native building materials are not available or construction costs are high. Sometimes old oil drums are available.

Plastic containers or liners for bins constructed of other materials may offer protection from moisture and insect; and some of those constructed of film are easily transported.

5. Quality deterioration costs. If grain is lost by molds or if it is destroyed or eaten by insects or rodents, this is a readily identifiable cost. Estimates of loss by insects and rodents are estimated to be as high as 25% under many conditions.
6. Quality maintenance costs. Protection from rodents is accomplished best by placing a brick, stone, concrete, or metal barrier around the grain. Poisons may be distributed and used in more developed areas.

   Insects are controlled by placing a protective barrier around the grain and by treating infested grain with an insecticide. Phostoxin has been found to be practical in many areas where one person in a community can be trained in its application.

   Mold can be prevented by keeping grain dry. Generally, if grain is dried well at harvest and if the average relative humidity of the air does not exceed 70% or if the temperature of the grain is below 10° C., then mold will not be a serious problem. Under many tropical conditions, grain must be redried if the storage period exceeds a few months.
7. Interest and insurance. Grain which is stored on the farm represents an investment which should properly return an interest. Since interest rates to farmers are very high in some areas, this may be a substantial cost. Insurance costs may be a hidden cost, but whether a farmer carries fire insurance or stands his own risk from losses such as flood or fire, there is a risk cost.

   Alternatives to be considered include:

   Farm processing and storage.

   Off-farm processing and farm storage.

   Off-farm processing and storage with the farmer retaining title to the grain but paying for processing and storage.

   Off-farm processing and storage with the farmer relinquishing title to the grain. (In this case, the farmer sells to a local elevator at harvest time and repurchases as needed.)

In general, if the processing and storage is done on the farm, the drying facility must be large enough to dry the farm production in the period between the beginning of harvest and the time when quality deterioration due to molding would begin to occur less the amount normally consumed or sold during this interval. The storage facility would normally be at least as large as that required for use on the farm during the period between harvests; a maximum size would be the maximum expected production.

If a dryer is constructed for the community and if the facilities can be used more or less uniformally over the harvest season, then the size can be minimized. If farmers are allowed to bring grain at a time of their own choosing and it must be dried for the farmer to take home, larger facilities will be required. Data regarding local desires would have to be gathered to obtain estimates of the required capacity.

Community storages, similar to "grain banks", should be as large as the estimated local consumption between harvest periods with allowance for staggering of harvests periods for various grains. For example, assume the following production and consumption of grains:

Crop	Time of harvest	Average production	Average local consumption/month
Wheat	July	11,000 Tons	60 Tons
Beans	September	300 Tons	20 Tons
Corn (Maize)	November	2,000 Tons	120 Tons

Figure 2 shows the total grain to be stored if it is assumed that the local consumption occurs uniformally over a 12-month period and that the surplus of a crop may not be sold until just before the next harvest of that same crop. Also assume that the harvest occurs uniformally during the months indicated as the time of harvest.

Obviously, in years of above-average production, the storage requirements will exceed the capacity of the storage if it is built for normal yields. This excess storage requirement may be met by selling some of the wheat and bean surplus just before or during corn harvest.

Although this type of community storage has not been widely used, strong consideration should be given to its use in areas where there is a large percentage of subsistance farms and weather or other conditions make it difficult to store grain on the farm. Some of the reasons are:

If home-stored grain suffers a high degree of quality deterioration, then there is little if any available surplus to feed the urban population.

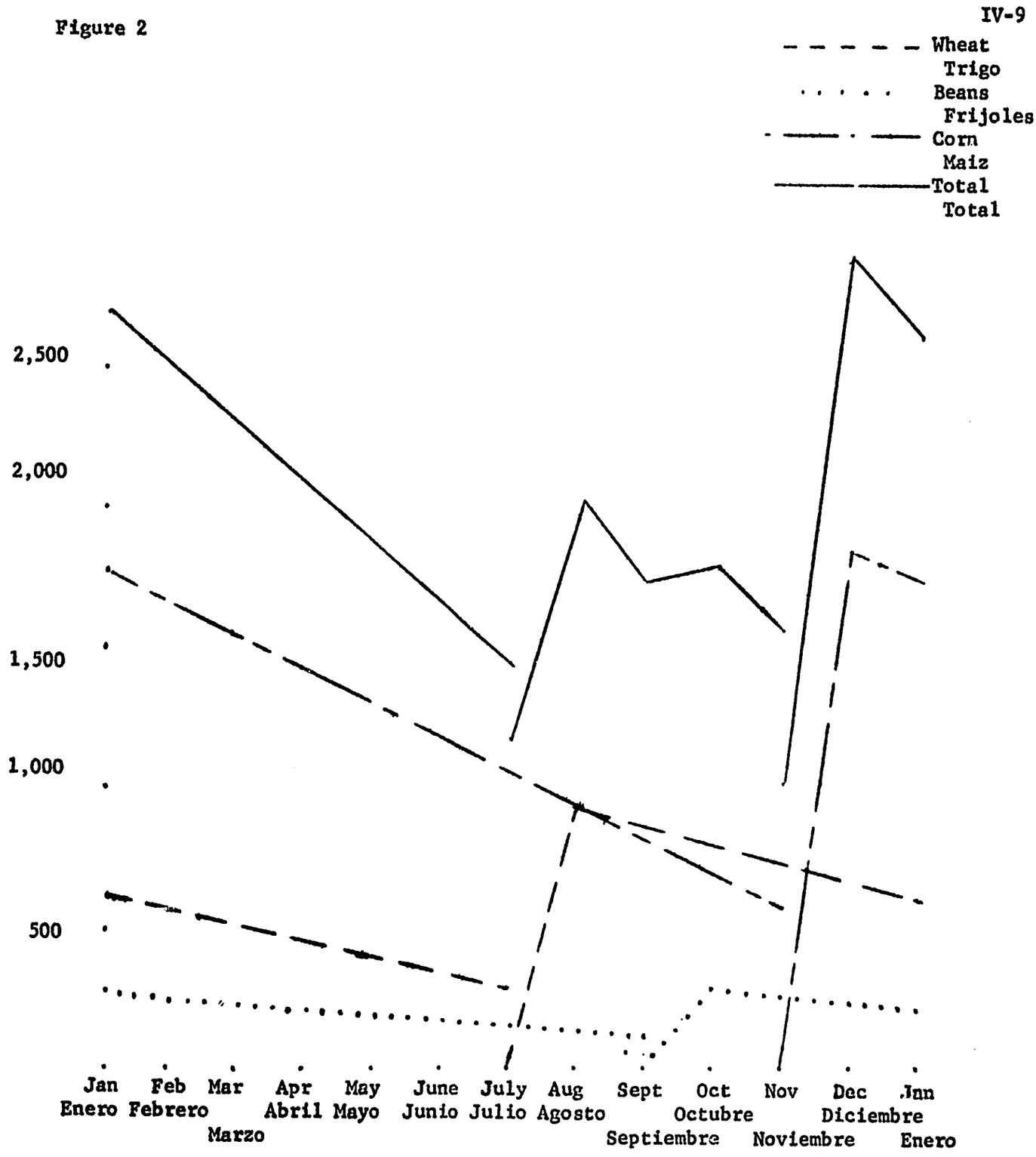
In years of low crop yields even the local population will be deficient in food supplies of quality deterioration is severe.

Advanced drying and insect control techniques may be much easier to introduce through a community storage rather than through the training and equipping of individual farmers.

The advantages of increased income through the sale of surplus agricultural products to this type of community is obvious.

Obtaining data on crop yields and consumption is very difficult in situations such as this. It must be done in the field on a community-by-community basis. Two sources of data are possible:

Figure 2


Wheat
Trigo
Beans
Frijoles
Corn
Maiz
Total
Total
2,500
2,000
1,500
1,000
500
Jan
Enero
Feb
Febrero
Mar
Marzo
Apr
Abril
May
Mayo
June
Junio
July
Julio
Aug
Agosto
Sept
Septiembre
Oct
Octubre
Nov
Noviembre
Dec
Diciembre
Jan
Enero

One may ask each family what it produces and consumes or as a check the acreage times estimated yield (as estimated by someone familiar with the region and crops) may be used to check production; consumption may be estimated by multiplying population by probable consumption of food.

It must be remembered that a community storage presents a type of risk not encountered in farm storage. If a community storage suffered a large loss of product through fire, flood, theft, etc., then the food supply for an entire community is lost. Some form of all-risk insurance should be available through a reliable (probably governmental) agency which would have the capability of promptly and completely reimbursing the loss.

Commercial Farms. Commercial farms will have a relatively large part of their grain production available for sale. Food grain used on the farm will not be of major consequence. Farms of this class will eventually sell most of their production and the question is only whether it will be marketed at harvest time or stored for sale after harvest.

Advantages of immediate sale include:
- The farmer need invest no money in drying or storage facilities.
- There are no risks from fire, quality deterioration, etc.
- Cash is available to reinvest in the next crop or other enterprises.

Advantages of storing include:
- Transporting the grain to a market at harvest may be more expensive than at a later time when the farmer and his equipment are not as busy.
- Prices are usually lowest at harvest; by storing, the increase in price should at least pay for most of the storage costs.
- If the farmer uses a considerable part of his crop for food or feed, he can delay a final decision on the fraction of the crop to sell until more information is available for a decision.

The United States Department of Agriculture has actively supported the practice of on-farm storage. Low-interest, high-repayment period loans have been made available to farmers to build storage structures and equip them with drying, aeration, and other necessary machines. Educational programs to teach fundamentals of proper storing and quality maintenance techniques are a part of the Agricultural Extension Service efforts.

Obviously, a farm storage need be no larger than the maximum expected production. However, since it would be filled only once in a few years, it may be more profitable to build a storage which will about meet the average requirements and sell any surplus at harvest or provide a cheap temporary storage when production is above normal.

Temporary storages of plastic film can be used to store most grain satisfactorily for short periods. Also, other farm building space may be pressed into temporary service without too much loss from insects and rodents during a short period.

Processing, particularly drying, equipment need be no larger than that required to dry the crop as it is harvested. Frequently if weather conditions are not too severe, the drying time can exceed the harvest time. For example, corn harvested in the fall in the corn belt area of the U. S. can be cooled and held at moisture contents of perhaps 17-18% during the winter months. This allows drying facilities to be used over a period of a few months before the corn is finally dried to the normal 13% moisture which will allow it to be kept safely during the hotter summer months. Research at Bogota, Colombia, S. A., shows that in that climate grain can be stored safely at 15-16% moisture when the grain is aerated each night to cool it; in this climate the night-time temperatures fall to about 20° C or lower. Local conditions must be studied, but if the grain moisture is not too high at harvest and if relative humidity conditions indicate a large proportion of days when the relative humidity falls below 70%, then natural air drying can be used and the drying time can be over a period of several weeks.

Country Elevator Sizing

Determining the optimum size and location of a country elevator involves many major factors including:

Density of grain production in the area to be served.
Proportion of the production which is available for sale.
Cost of transportation from the farm to the elevator.
Location of markets for the grain when it leaves the elevator.
Cost of transportation to the ultimate market.
Relative costs of constructing elevators of various sizes.
Relative costs of operating elevators of various sizes.

Obviously, a country elevator should have a minimum annual operating cost which will include such items as the manager's salary, fixed cost of weighing and grading equipment, fixed costs on equipment for receiving grain, etc.

If the volume of grain for sale in an area is not enough to cover the minimum costs within reasonable price limits, then alternatives (such as truck pick-up stations) should be considered.

When a proposed site for an elevator is being considered, one must first survey the surrounding region to obtain an accurate estimate of the total grain production and percent which will be sold.

The area to be surveyed will depend upon the transportation costs and other factors. For example, in the wheat region of the U. S. the total production within a 100-kilometer radius might be applicable. In an informal survey in Bolivia, S. A., the author determined that a farmer will probably not transport grain further than about 30 kilometers by animal transport; beyond 30 kilometers the transport costs begin to exceed the value which the grain would have for other purposes such as animal feed. (Animal products are usually cheaper to transport than the grain which the animals consume.)

Also, obviously, in an area where grain marketing systems exist, the influence of competitive market outlets must be considered. For example, if prices paid by two country elevators are equal, a farmer would tend to market at the one which offered the lower transport costs; or a farmer may sell grain to an itinerant trucker who picked up at the farm at a lower price than he would receive if he transported the grain 20 km. by burro or ox cart to a country elevator.

Production potential for most areas must be made by some person familiar with the are who can contact farmers and evaluate the accuracy of reported yields, proportion for sale, when the crop will be sold, etc.

The location for an elevator will be limited to some degree within the potential area; such limits are:

Transport facilities such as highways and railroads.
Trading or population centers. Elevators will normally be located in or near villages or towns where farmers tend to come to trade and where labor and utilities may be more readily available.

The planner will be able to reduce the number of alternatives which should logically be explored after some experience.

It will be logical to divide the areas around a proposed elevator if they differ significantly in such characteristics as crops produced, percent of crop to be sold, transportation costs to the elevator, etc. Possible markets for the grain must be analyzed to determine when the markets will need grain and in what quantities, transport costs to markets and finally prices to be expected at various times of the year.

Only after data is obtained regarding sources and markets can the problem of sizing the parts of an elevator be approached. Here we will be most interested in establishing the proper size or capacity of receiving facilities, drying facilities, and total storage space since these components represent most of the important variable investment costs in an elevator.

We will also assume that the goal is to provide the lowest total cost of marketing and storing grain whether the costs are actually borne by the elevator, the farmer, or the ultimate processor or consumer.

The first step then is to determine the quantity and time of supply from each of the supply areas being considered under the alternative. A table such as Figure 3 might be prepared.

Figure No. 3. Table to be used in predicting supply.

Elevator Location	_____		Alternative _____
Production Area	_____		Crop _____
Crop Year	_____		
Hectares harvested	_____		
Average yield	_____		
Total Expected Harvest	_____	Tons	
Percent of crop available for sale	_____		
Tons available for sale	_____		
Tons availabe for sale through elevator	_____		
Probable time and amount marketed:			
January	_____	Tons	
February	_____	Tons	
March	_____	Tons	
April	_____	Tons	
May	_____	Tons	
June	_____	Tons	
July	_____	Tons	
August	_____	Tons	
September	_____	Tons	
October	_____	Tons	
November	_____	Tons	
December	_____	Tons	
The week of greatest delivery will be	_____		
Tons marketed this week will be	_____		
The greatest amount expected to be delivered to the elevator in one day is	_____		
Moisture content during week of greatest delivery will be	_____		
Distance from elevator	_____	km.	
Transportation cost per ton			
at harvest	_____		
other times	_____		
Tons marketed			
at harvest	_____		
other times	_____		
Transport costs			
at harvest	_____		
other times	_____		
TOTAL	_____		

Some explanation of items needed in Figure 3. The total tons harvested will have to be obtained through a survey of the area in most cases. This may involve a visit to each or a large number of farms in the area under study to determine total crop area and yield as well as probable amount which will be sold and when. If the area is small, it may be possible to survey practically every farm. If the area is large, then some fraction of the total farms may be selected at random and surveyed. Sometimes it may be necessary to obtain the opinion of one, or a few people, such as the agricultural extension agent regarding the required information, but such information may be biased by various factors or the individual may not have the detailed information required.

The amount delivered during the week of greatest delivery is very important for use when designing the receiving and drying facilities and will be most difficult to obtain. Little data has been collected, but Table 1 shows the maximum percent of grain receipts which occur in any one week for some conditions in the U. S.

Table 1. Maximum receipts in one week under some U. S. conditions

Location and Grain	Maximum receipts as % of yearly receipts of that crop
Central Texas, grain sorghum	23
Central Kansas, wheat	45
Illinois, corn	10

When designing elevators for locations where a history of the marketing patterns is not available, it will be very difficult to estimate the maximum arrival rates. Probably few areas of the world would have an arrival rate exceeding the 45% shown in Table 1. Wheat in central Kansas is usually harvested during very favorable weather and the harvest is well mechanized so that the harvest period is very short. Also little grain is stored on the farm and sold later. In Illinois, much of the corn is stored on the farm and sold in the spring after the fall harvest; hence, the 10% marketed in any one week at harvest is probably a fairly low value and such a low value would seldom be found.

The data obtained in the U. S. indicates that during a concentrated fast harvest the receipts during the busiest day may be about 20% greater than the average daily receipts during the busiest week.

If transportation costs at harvest time are much higher than transportation costs at other times, then strong consideration should be given to aiding farmers in obtaining some farm storage.

If a considerable portion of the grain for sale has been sold locally, perhaps through a city market, then the elevator must not disrupt this local trade or must plan to sell at retail locally or resell to local merchants in order not to jeopardize the local food and feed supply.

After local needs have been supplied, any surplus must be disposed of through other channels such as terminal elevators or processors. Naturally, once an elevator has placed grain in storage, it is desirable to try to delay sale as long as possible in order to make maximum use of storage facilities. If the pricing system is operating properly, grain may be marketed as needed so that the elevator which sells relatively soon after harvest will have the same chance of profit as the one which stores for a long period -- perhaps until just before harvest. A worksheet similar to Figure 4 may be proposed for the disposal of grain.

Figure 4. Disposal of grain.

Elevator _____ Alternative _____

Crop _____

Market Location	Transport Costs to Market	Other Costs to Market	Marketing January			Marketing December		
			Tons	Price Differential	Total Margin	Tons	Price Differential	Total Margin

Total transport costs _____

Other marketing costs _____

Total marketing costs _____

Total marketed/month _____

Total margin/month _____

Total margin/year _____

Margin less total marketing costs _____

Summary tables may no be prepared to guide in the sizing of receiving, drying, and storage facilities. Figure 5 can be used as a guide to sizing receiving and drying equipment.

Figure 5. Summary sheet of purchases to aid in sizing of receiving and drying facilities.

Week of year	Grain _____		Grain _____		Grain _____	Total	
	Tons	Moisture	Tons	Moisture		Tons	Tons Dried
1. _____							
2. _____							
3. _____							
50. _____							
51. _____							
52. _____							

Figures 6 and 7 can be used as a guide to the preparation of a chart similar to Figure 2 to estimate total storage volumes required.

Figure 6. Amount of crop in storage

Elevator _____ Alternative
Grain _____

Month	Receipts	Sales	Net in Storage
Month of harvest.			
1st month after harvest . .			
2nd month after harvest . .			
3rd month after harvest . .			
4th month after harvest . .			
5th month after harvest . .			
6th month after harvest . .			
7th month after harvest . .			
8th month after harvest . .			
9th month after harvest . .			
10th month after harvest. .			
11th month after harvest. .			

Figure 7. Total storage requirements

Elevator _____ Alternative _____

Month	Tons in Storage			Total Storage, Tons
	Grain _____	Grain _____	Grain _____	
January. . .				
February . .				
March. . . .				
April. . . .				
May.				
June				
July				
August . . .				
September. .				
October. . .				
November . .				
December . .				

Sizing Receiving Facilities

There are three major steps in receiving grain. The first step is to weigh and grade the grain; the second is to dump it into a receiving pit or pile it in a warehouse so the supplier may leave; the third is to pay the supplier.

If grain is received by truck the grain is usually probed to obtain a representative sample as it is being weighed. Moisture and the quality tests are then made to determine where the grain will be placed in the elevator before it is unloaded. The truck may be delayed a few minutes while the grading is done. Usually the time required for weighing and grading is short compared to the unloading process so that this step is not a limiting factor. Seldom is more than one scale or one set of grading equipment required. If the operation becomes a point of major delay, then more persons may be added to speed the process.

If grain is received in very small lots, such as by animal transport, the weighing and grading operation may be an important factor. It is relatively inexpensive to add scales or grading equipment which can increase the capacity of the operation for small deliveries of sacked grain. No data is known on times required to receive grain from animal transport.

Most delays in receiving trucked grain occur where the grain is unloaded from the truck. Studies reported in (1) indicate the following times required to dump trucks of bulk wheat at country elevators in Kansas: 1-man crew, 3 min.; 2-man crew, 2.25 min.; 3-man crew, 1.75 min. The author has questioned elevator operators in Colombia who indicated that about 30 minutes is required for a 4-man crew to dump a 5-ton load of sacked grain. Obviously, for a given receiving capacity, trucks per-day, many more receiving dumps must be provided when grain is delivered in sacks.

If grain is received in bags and does not need to be cleaned or dried before storing, it may be stored in a bag warehouse according to class and grade. If it must later be cleaned and/or dried, it will usually be dumped, processed, and then stored in bulk or resacked. Under these conditions, the capacity of the cleaning and drying equipment can be reduced. Grain may be dried in sacks and this is frequently done if very small quantities of a particular grain type are received at one time; most bulk driers require a few tons of grain to fill them.

The time of day when trucks arrive is important in determining the number of receiving dumps. Figure 8 shows the arrival pattern of trucks at a country elevator during one harvest. Similar patterns were found at other elevators receiving wheat. The author has found similar hourly patterns during a milo harvest at Manhattan, Kansas. No data is known for the wide variety of conditions in other countries and will have to be gathered locally.

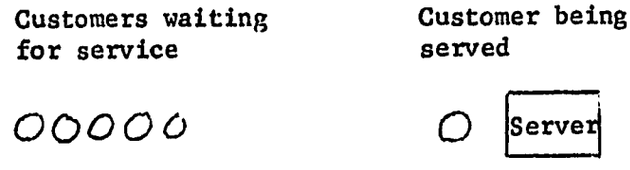
Long lines of trucks waiting to unload at elevators are a common sight in the U. S. and have been reported in other countries. This represents a cost which is borne by the farmer and can only be corrected by improving the design and operation of the elevator to provide faster service during receiving. The problem of providing service to prevent long lines of customers in "queues" waiting to be serviced has been studied extensively in recent years but has not been applied to the sizing of grain elevators as much as it should have.

The problem consists of obtaining information regarding arrival rates, service rates, and then reaching a balance between the cost of providing service against the cost of delay in being served to obtain the minimum overall cost.

Queueing Theory

Several common models of the queueing problem exist but only two will be discussed here. In the first model we will consider the case where there is one server and customers arriving for service will line up on a first-come-first-served basis to wait for service, as shown in Figure 9.

Figure 9. Simple single-server queue



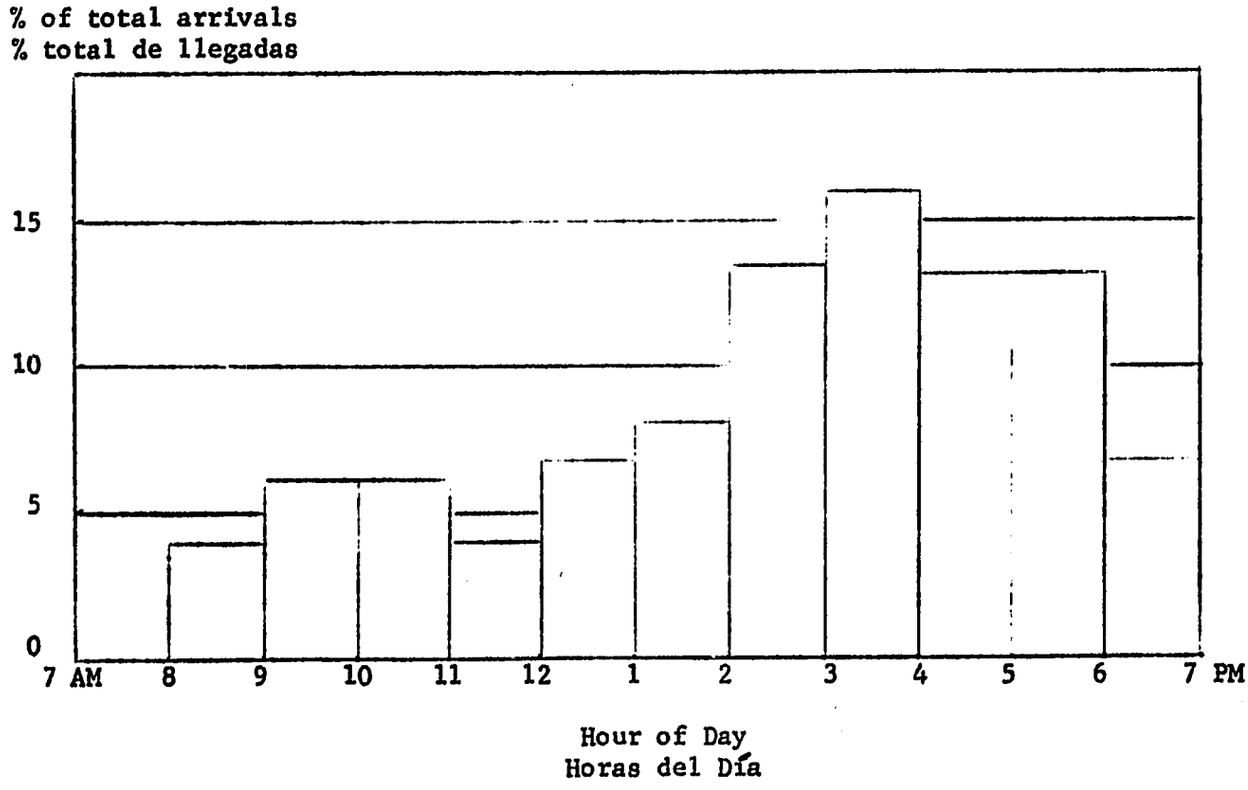
If there are very few customers and service is rapid, then there will seldom be anyone waiting in line. If there are many customers and the service is slow, the line will grow to be fairly long at times.

Figure 8

Gráfico Nº 8

DAILY PATTERN OF TRUCK ARRIVALS AT A COUNTRY ELEVATOR DURING 1961 GRAIN SORGHUM HARVEST, S. W. Kansas

FLUJO DIARIO DE LAS LLEGADAS DE CAMIONES A UN ELEVADOR (SILO) SUBTERMINAL DURANTE LA COSECHA DE SORGO EN 1961, S. O. Kansas



If it is assumed that the customers arrive at random and that service times are less than the time between arrivals, then certain characteristics of the queue can be calculated.

We first define "A" as the mean arrival rate where "A" is equal to the number of customer arrivals per unit time, e.g. customers/hour. We then define "S" as the service rate, that is, the mean number of customers serviced per unit time if the server is continuously busy. We further define "U" as the utilization factor where "U"$=\frac{A}{S}$.

If "U" is greater than unity, then the arrival rate is greater than the service rate and an infinitely long waiting line forms. We will consider only values of "U" less than unity.

The mean length of the queue, customers waiting for service, will be

$$Lq = \frac{U^2}{1-U}$$

The mean time required per customer, "W", while waiting in line and being serviced will be:

$$W = \frac{1}{S-A}$$

As an example consider a case where an elevator receives trucks at the rate of 8 per day and when using two men to dump sacks can dump one truck per hour or a maximum of 10 per day or when using 4 men to dump, can dump two trucks per hour or a maximum of 20 per 10-hour day. Further assume that a laborer to dump sacks can be employed for $1.00 per day and that it costs $3.00 per hour to have a truck standing idle. Will it be profitable to employ the other two men to dump sacks?

For the two cases then:

No. in dump crew	2.0	4.00
Arrival rate, "A"	.8	.80
Service rate, "S"	1.0	2.00
$U = \frac{A}{S}$	.8	.40
$Lq = \frac{U^2}{1-U}$	3.2	.27
Average time per truck, $W=\frac{1}{S-A}$	5 hours	.83
Average waiting cost/truck	$ 15	$ 2.50
Truck waiting cost/day	$120	$20.00
Labor cost per day	$ 2	$ 4.00
Total labor + truck	$122	$24.00

Hence, we see that we may reduce the total truck waiting plus labor cost from $122 to $24 by increasing the dumping crew from 2 to 4 men. Even if labor costs $1 hour, it would still be profitable to increase the size of the dumping crew.

Figure 10 shows another queueing model where customers form a single queue in front of "M" servers.

Figure 10. A multiple server single queue line where the customer at the head of the line goes to the first available server.

The solution of this problem is more difficult than that of the single server. However, if the utilization factor is large (near unity) then the average queue length is:

$$Lq = \frac{U'}{1-U'}$$

where U' is now defined as:

$$U' = \frac{A}{MS}$$

The total waiting time is now:

$$W = \frac{1}{MS-A} + \frac{1}{S}$$

As an example, consider the case of an elevator which will receive 40 trucks of bagged grain per day during a 20-day harvest season. Assume that each dump pit costs $3,000 annually including fixed and operating costs. How many dump pits should be provided?

As a possible solution, the cost to both customers and elevators will be investigated for the cases of 3 and 4 dump pits with 4 men dumping at each pit.

	3 dumps	4 dumps
M	3.	4.
A	4.	4.
S	2.	2.
U'	.67	.5
Lq = U'/1-U'	2.	1.
$W = \frac{1}{MS-A} + \frac{1}{S}$	1.	.75
Total trucks during season	800	800
Total truck waiting time	800	600
Total truck waiting costs	$ 2,400	$ 1,800
Total dump pit costs	9,000	12,000
Total annual	$11,400	$13,800

Thus, the optimum solution would be to install three pits.

In the above models it was assumed that trucks arrived uniformally during the day. The data available indicate that generally in the U. S. trucks tend to arrive more frequently during the late afternoon so that the simplified models are not as accurate as they should be in some cases. However, the more exact solution which would result from using the actual, non-uniform, arrival rates can only be practically solved by using a computer simulation solution. The details of this type of solution are too extensive to include here.

When designing an elevator where accurate data on arrival rates is not available, the best estimates of arrival rates should be used and if found to be inaccurate then additional dumps can usually be installed if properly allowed for in the original planning.

The size of the actual pit should be large enough to hold the majority of the loads which will be dumped. This will allow two or more dump pits to feed into one receiving elevator, cleaner, etc., when receiving sacked grain or will allow for the use of smaller conveying equipment when bulk grain is unloaded.

Conveying Equipment

Obviously, the receiving facilities of an elevator will tend to limit the maximum flow of grain into the remainder of the system. The receiving conveying equipment can fairly easily be sized by knowing the rate at which grain can be dumped.

Cleaning Equipment

Since it is common practice to place one cleaner in each set of receiving conveyors, the cleaners should have a capacity equal to that of the conveyor which supplies grain to it.

If grain is received and stored in bags, then the capacity of the cleaning equipment can be reduced much below the receiving rate. In this case, the work of cleaning may be spread over a period of weeks or even months.

Drying Equipment

The capacity of drying equipment can be less than that of receiving equipment because it will normally be profitable to operate the dryer over a 24-hour period rather than limiting operation to the normal 10-to-12 hour period when grain is received. Also grain which is not too wet may be held for days or weeks before drying without serious results.

Table 2 shows the maximum storage time for shelled corn at various moistures and temperatures. Data for other grains is not available but some work with grain sorghum indicates that storage times may be shorter. Wet grain which is to be stored for short periods should be placed in small bins where the temperatures can be monitored and where it can be aerated if trouble develops.

Table 2* Maximum time for storage of shelled corn at various corn moisture and air temperatures.

Storage air temperature (fahrenheit)	Corn moisture content			
	15%	20%	25%	30%
	Days	Days	Days	Days
75°	116	12.1	4.3	2.6
70°	155	16.1	5.8	3.5
65°	207	21.5	7.8	4.6
60°	259	27	9.6	5.8
55°	337	35	12.5	7.5
50°	466	48	17	10
45°	725	75	27	16
40°	906	94	34	20
35°	1,140	118	42	25

*From Guidelines for Mold Control in High-Moisture Corn. Farmers Bulletin No. 2238, U. S. Department of Agriculture, 1968.

As an example of how Table 2 may be used, consider the following case: Four thousand tons of corn will be delivered during a harvest period of 21 days and delivered with moisture contents ranging from 15 to 25% with an average moisture content of 20%. Assume that 1,000 tons will be delivered the first week, 2,000 tons the second week, and 1,000 tons the third week. Also, a reasonable practice would be to place all 15 to 20% moisture grain in one group and all 20-25% moisture grain in another group. For sake of safety, assume that all of the first group will be at 20% moisture and all of the second group at 25% moisture. Further, we will assume that nighttime temperatures will allow cooling the grain to 70°F by nighttime aeration (this can be done in most parts of the world).

Since it is undesirable to try to dry grain of this moisture in one pass (too much kernel cracking and breakage results), it would be best to dry the wetter fraction in three passes and the dryer fraction in two passes.

Assume that a dryer has the following capacities:

Tons/hour	Moisture change
6	15 to 12
5	20 to 15
5	25 to 20

How many of these dryers will be required?

Since there is some time lost while a dryer is changed from one lot to another, we will assume a 20-hour-per-day drying time.

Since grain at 15% moisture will keep for a fairly long period, we will attempt to get all grain dried to 15% as quickly as possible and then make the final drying after harvest, if necessary.

During the first week, all of the higher moisture grain can be dried to 20% as it is received. This will require:

$$\frac{500 \text{ tons}}{5 \text{ tons/hr}} = 50 \text{ hours dryer operation}$$

The 20% moisture grain can be dried to 15% as it is received, requiring:

$$\frac{500}{5} = 50 \text{ hours of dryer operation}$$

There are now 40 hours of dryer time which may be used to reduce the original wetter grain from 20 to 15% and 40x5=200 tons. At the end of the first week the status is:

700 tons 15% moisture grain which should be safe for several weeks
300 tons 20% moisture which should be dried to 12% moisture within less than about 16 days

During the second week only the wetter grain can be dried. For the wetter fraction 140x5=700 tons of grain will be reduced from 25 to 20% moisture as it is received and should be safe for about 16 days. At the end of the week there will be about 300 tons of 25% grain to be dried and this will require about 2 days of drying time.

During the third week 300 tons of the previous week's high-moisture corn will need to be dried plus 500 tons of the third week's high-moisture corn. Since only 700 tons can be dried, there will be a one-day carryover. At this point, the 20% moisture grain from the end of the first week and the 20% moisture grain from the beginning of the second week will be at the limit of its storage life. Obviously, the original dryer capacity was insufficient and a larger dryer or two dryers will have to be installed.

If two dryers are selected, then the schedule might be as follows:

During the first week 500 tons of 25% moisture can be dried to 20% and will require 500÷5=100 hours of drier time. Now there are 1,000 tons of 20% moisture grain of which 900 tons can be dried to 15% moisture in the remaining 180 hours of dryer time leaving 100 tons to be dryed within about 16 days.

During the second week, there will be 1,000 tons of 25% moisture grain which can be dried to 20% moisture while using 1,000÷5=200 hours of dryer time spread over the week. The next step will be to dry the remaining 100 tons from the first week which will require 20 hours of dryer time leaving 60 hours during which time 300 tons of 20% moisture grain from the second week can be dried to 15% moisture.

At the end of the second week, there will be 2,000-300=1,700 tons of 20% moisture grain to be dried. All of this was received during the second week and should be dried during the third week or early in the fourth week.

During the third week, there will be 500 tons of 25% moisture grain which will require 100 hours of drier time. The remaining 180 hours can be used to dry 900 tons of 20% moisture corn held over from the second week. At the end of the third week, there will be 800 tons of second-week corn that is nearing the end of its storage life if not dried and 1,000 tons of 20% moisture corn received during the third week and which must be dried before about 16 days.

During the fourth week, 160 hours of drier time will be required to dry the remainder of the second-week corn to 15%. The remaining 120 hours of dryer time can be used to dry 600 tons of the 20% moisture corn delivered during the third week.

At the end of the fourth week, there will be 400 tons of corn remaining to be dried to 15%.

During the fifth week, the first 80 hours of dryer time will be needed to complete the drying of the 20% moisture corn and the remaining time can be spent in drying 15% moisture corn to 12%. After the first four days of the fifth week, 4000÷6=667 hours of dryer time about 2½ weeks will be required to complete the drying process.

Since the use of the two dryers is just about the correct capacity leaving little margin of safety in case of breakdown, it may be wise to install three such dryers if it is difficult to obtain repairs. In general, it will always be safest to have a larger number of small machines than one large machine of the same capacity to provide some operating capability in case of machine failure. Usually the use of a large machine will not save on operating costs, such as fuel and electricity, and the additional investment in equipment can be partially offset by the insurance offered by multiple machines.

Storage Space

The planning of storage space requirements was discussed in some detail in the section on community elevators. Basically, the problem consists of making a survey to determine when grain will be received and when it will be sold. The solution will be found by making a summary of estimated receipts and sales during the year and determining the volume to be stored - particularly at the peak season.

If bag storage is being designed, the utilization of space can be quite flexible. That is, a given square meter of floor space can be used to store any of the grains available. It is not possible to fill the warehouse completely, however, because space must be left between piles to allow for traffic, bag placement and removal and access for insect and rodent control. A warehouse which is filled to more than about 66 to 75% of its total usable volume will be difficult to operate and manage.

Bulk storage is less flexible than bag storage. If a particular bin has only a small quantity of one class of grain in it, then the remaining empty space cannot be used for other classes of grain. No investigations have been made regarding the optimum number of bins to be provided in a storage structure. Bouland (1) recommends that at least three bins be provided for each class of grain. This is probably a safe rule and will allow considerable flexibility in the use of storage space in case of abnormal crop yields, variations in rate of sales, etc. Some savings in original investment may be possible if some thought is given to the exact use to which each bin will be put at various times of the year.

The exact size of each bin will also be influenced by the exact nature of the construction. For example, it is easier to provide a variety of sizes of bins if steel construction is used than if slipform concrete is used. In general, it is not common practice to provide more than two or three sizes of bins.

As an example of how total space requirements may be influenced by bin size, consider the following storage problem:

During the time of greatest storage requirements, the following quantities by type are expected to be:

White corn	2,000 T
Yellow corn	1,500 T
Red beans	300 T
Black beans	200 T
Paddy rice	500 T
Dryland rice	800 T
Total	5,300 T

Try two alternatives:

1. Use 1,000 T and 500 T bins
2. Use 1,000 T and 300 T and 100 T bins

Alternative 1 will require 3 bins of 1,000 T each plus 6 bins of 500 T each or a total of 6,000 T capacity.

Alternative 2 will require 3 bins of 1,000 T each, 5 bins of 300 T each and finally 8 bins of 100 T each for a total of 5,300 T capacity.

Based upon local construction costs, it would have to be determined whether the second alternative were cheaper. The second alternative does have the advantage of greater operating flexibility but no margin of safety if yields are higher than anticipated. Obviously, either alternative would be better than a simple solution of providing only 1,000 T bins.

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