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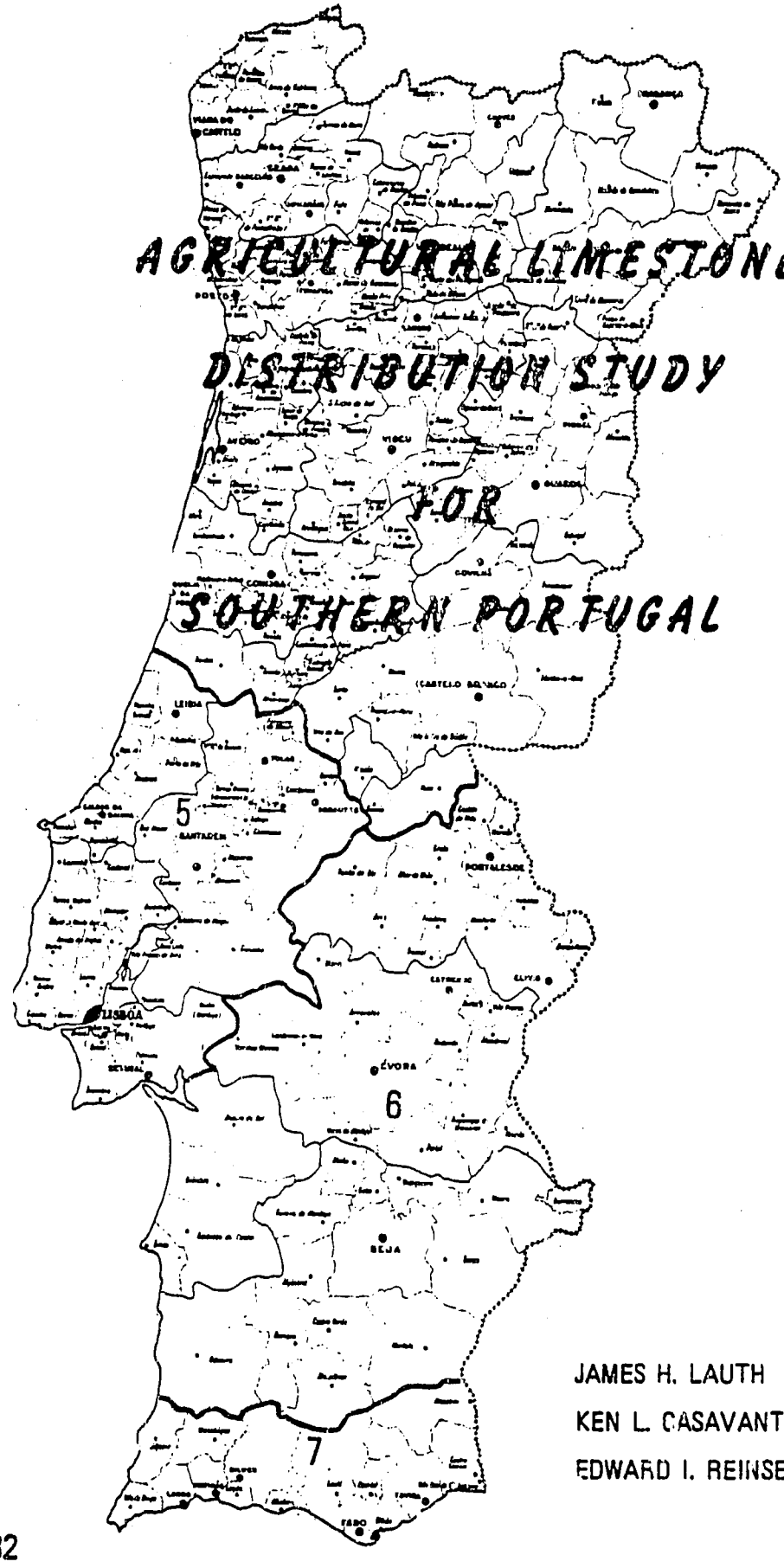
AGRICULTURAL LIMESTONE DISTRIBUTION STUDY FOR SOUTHERN PORTUGAL



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JULY, 1982

AGRICULTURAL LIMESTONE

DISTRIBUTION STUDY

FOR

SOUTHERN PORTUGAL

Prepared for: U.S. Department of Agriculture
Office of International Cooperation
and Development

U.S. Agency for International Development

PROCALFER Coordinating Group
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July 1982

July 30, 1982.

Dr. Glenn Purnell
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OICD/USDA
Lisbon,
Portugal

Dear Dr. Purnell:

In accordance with the Scope of Services of Contract Numbers 53-319R-2-179, 53-319R-2-193 and 53-319R-2-185 for Workplan No. 202610030006, we are pleased to submit twenty copies of our Final Report, Agricultural Limestone Distribution Study for Southern Portugal.

We wish to take this opportunity to extend our sincere thanks to the personnel of your office, the Ministry of Agriculture and all those who provided us with their continued cooperation and valuable assistance throughout our work.

Sincerely yours,

James H. Lauth Ken L. Casavant Edward I. Reinsel

ACKNOWLEDGEMENTS

The consultants gratefully acknowledge the excellent cooperation provided by officials and employees of the Ministry of Agriculture, including the Regional Services in Regions 5, 6 and 7, limestone producers, local cooperatives, the CP Railroad, the Portuguese Highway Department, trucking companies, and transportation associations.

Special acknowledgement is due Eng. Almeida Alves, Chairman, PROCALFER Coordinating Group, Eng. Victor Oliveira, transportation specialist for the Coordinating Group and MAP, Mr. James Black of USDA's PROCALFER team, João Araújo, interpretor and driver for PROCALFER, and to Sónia Santos and Maria Gomes who typed the draft and Final Report and who provided secretarial and interpretor support. These people particularly provided invaluable assistance to us during our work in Portugal.

PREFACE

USDA/OICD contracted individually with Mr. James H. Lauth and Dr. Ken L. Casavant and, through agreement with Economic Research Service, with Dr. Edward I. Reinsel, for their services to conduct an agricultural limestone distribution study for southern Portugal (Regions 5, 6 and 7).

Using production cost data and recommended plant technology developed from Limestone Production In Southern Portugal James Smith, June 1982, and limestone need and demand estimates developed by MAP this distribution study was to:

1. Develop and analyze transport and handling costs related to alternative sites, including existing or expanded plants in Region 3, considering location of quarry and plant, the distribution area(s) and the availability of transport and distribution facilities in the vicinity of each site;

2. Assess the current and projected transport capabilities and relative advantages of alternative transport modes from plant(s) to intermediate storage to farms or from plant(s) direct to farms;

3. Determine the costs of limestone storage in different areas for current and projected volumes of limestone;

4. Provide an overall analysis of alternative plant numbers, sizes and types, and alternative transportation/distribution systems considering production costs, total distribution costs, and operating feasibility for current operations

and project longer term volume;

5. Recommend the least cost system of limestone plant numbers, sizes and types and transport/distribution system, identifying additional plants, storage, transport, or handling facilities necessary with a suggested timetable for acquisition and operation;

6. Recommend alternative means and costs of GOP subsidies for limestone in order to deliver limestone at a uniform price to farmers, considering the existing limestone program and subsidy structure in northern Portugal;

7. Recommend appropriate credit, and/or pricing incentives to stimulate increased private sector participation in the production, sale, distribution, and/or storage of limestone; and,

8. Recommend the administrative organization and techniques seen necessary to manage the production and distribution system proposed, considering the structure being used for the northern Portugal limestone program.

The work was accomplished in June and July 1982, in Portugal. The final draft study was submitted in Lisbon on July 30 to USDA/OICD and AID officials.

EXECUTIVE SUMMARY

This agricultural limestone distribution study for southern Portugal (Regions 5, 6 and 7) is designed to support the technical and economic performance of the agricultural sector of Portugal's economy. The question of limestone distribution in the south was complex because the size of farms is significantly different from the north, little or no limestone is presently being applied, no specific information was available on either the sources of (supply) and need for (demand) limestone, and the cropping pattern is presently undergoing change in the regions, especially the Alentejo (Region 6).

The need or demand for limestone in the south is uncertain. Estimates of limestone use during 1983-86 were developed in cooperation with the Regional Services staff for each of the three regions. Projected use is around 64,000 tons in 1983 and 220,000 tons in 1986. The region of Alentejo is expected to become the major user of agricultural limestone, accounting for close to 90 percent of the anticipated use in the South. For the entire region, close to 85 percent of the hectares to be treated would be in subterranean clover, a crop that is integral to the new farming system that is being developed. If this attempt to significantly change the farming system is not successful, need for limestone will be less.

Southern Portugal has ample supplies of agricultural limestone being produced to meet anticipated demands. These supplies arise from a different limestone production technology than in the north; residual product from ongoing rock crushing activities is further crushed and sieved to meet minimum government standards. These activities are projected to result in available supplies of 270,000 tons in 1983 and more than a million tons in 1986.

Because of necessary assembly, handling and delivery costs, rail costs were found to be higher than bulk truck costs for movements of less than 300 kilometers. Thus, the expected system is one of bulk delivery by limestone producer trucks, usually directly to the farm from the limestone production plant. Truck rates of 5 escudos per ton kilometer were greater than costs, especially on the larger 34 ton GVW truck whose estimated costs were 3.68 escudos per ton kilometer. This rate/cost relationship, as well as potential cost savings, suggest that development of a trucking cooperative would be economically feasible.

Spreading on the farm would be done by small 750 kilograms spreaders attached to tractors. These spreaders already exist on most farms since they are presently used for fertilizer and seed application. Spreading costs were estimated to be 230 escudos per ton.

The least cost system for agricultural limestone distribution in the south was developed for 1983 and 1986. In 1983, no new limestone plant investment was assumed in 1986, thus allowing flexibility in the system. Analysis of the residual Pó de Pedra was done using an equivalency table. Results indicated that use of this material, which does not meet existing minimum government standards, was not economically feasible at this time. Thus, the least cost system used only production plants that produced a product meeting government standards.

In 1983 the Sesimbra area will provide over 54 percent of the production; Loulé, Serpa and Santiago do Cacém would provide about 14 percent each. In 1986, Sesimbra would distribute about 46 percent, 102,000 tons. Alenquer and Portalegre will come into production, producing 39,000 tons and 35,000. Fátima and Serpa would no longer be least cost production sources.

Region 5 (Ribatejo e Oeste) receives most of its shipments from Sesimbra in 1983 but also from Alenquer in 1986. Alentejo (Region 6) receives shipments from Sesimbra, Serpa and Loulé in 1983 and Portalegre will become an important source in 1986. The Algarve (Region 7) is served by Loulé plants in both years. The average length of haul in 1983 is 84 kilometers, decreasing to 72 kilometers in 1986.

The delivered price for agricultural limestone is expected to decrease from 713 escudos per ton in 1983 to 555 escudos per ton in 1986. Transportation costs are the main reason for this decrease, going from 447 escudos per ton in 1983 to 273 escudos per ton in 1986. These costs decline because distances are shorter as new plants are developed. Also, the cost per ton kilometer decreases from 4.4 to 3.68 escudos as new larger trucks are used in 1986. Plant price increases slightly from 266 escudos to 282 escudos over the time period.

The marketing of agricultural limestone will be done mainly by existing cooperatives in the south. They would handle the purchasing and order processing with the limestone being physically delivered directly to the farm.

There are strong differences existing between the distribution systems of the north and south. The average per ton plant price and transportation costs were 758 escudos and 1005 escudos in the north, compared to 266 escudos and 447 escudos in the south. Average delivered price was 1763 escudos in the north and 713 escudos in the south. Even under the existing subsidy program the farm price would be 1200 escudos per ton in the north compared to 800 escudos in the south.

There will be interactions between the two systems where they meet. Shipments of bulk product from Portalegre which is

in the south may go into the north. Shipments from Fátima to those southern farms that need bagged limestone because of small, inaccessible fields will occur. The interaction of the South and North purchases may cause northern plants to increase production, putting downward pressure on bulk and bag limestone prices in the North, and providing price competition to southern plants.

It does appear that no subsidy, other than that for bagged limestone in the South, is necessary. Further, financial support for construction of limestone plants is not necessary. However, because of its value to the smaller farms needing a supply of crushed limestone in bags, the Quisselgur plant is needed. Approval of any credit for the Portalegre plant should be contingent upon the development of need for limestone in the area. Other specific recommendations are offered in the report.

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I INTRODUCTION

This agricultural limestone distribution study in southern Portugal (Region 5, 6 and 7) is designed, as other related and concurrent studies, to achieve higher technical and economic performance from the agricultural sector of Portugal's economy. The past stagnation of agricultural production in Portugal has recently received the attention of the Government of Portugal (GOP) and resulted in a specific program to bring about an increase in productivity. Specific activities relate to soil correction and fertilization, forages and livestock production, and related development of research and extension capabilities.

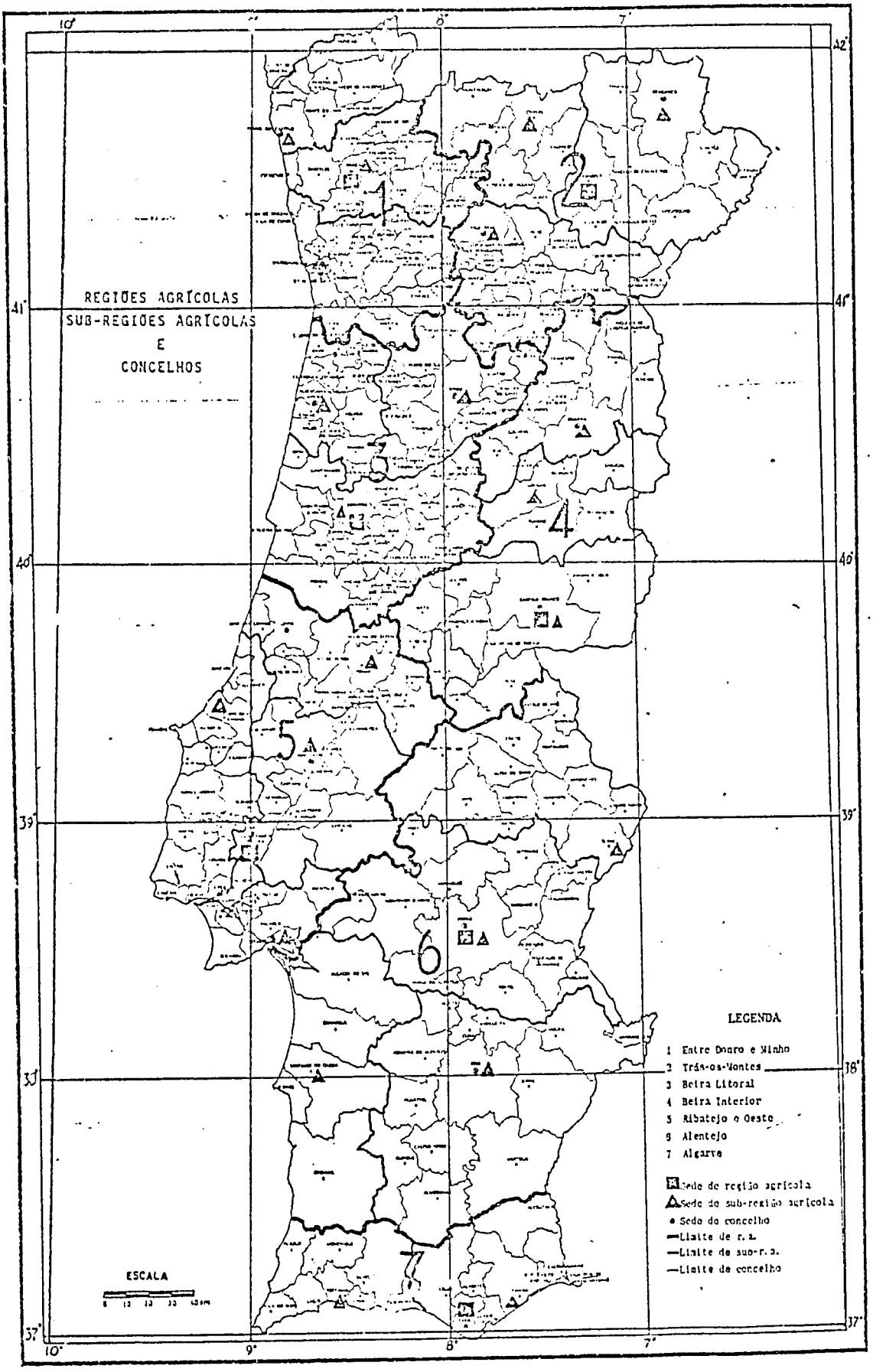
An initial study in this program was a limestone distribution system designed for the northern four regions of Portugal (Regions 1, 2, 3 and 4) 1/. See Map 1 for the area of Portugal covered by each region. That study resulted in a proposed least cost production and distribution system for 1981 through 1986. It provided a transitional plan for distributing 50,000 tons of agricultural limestone in the spring of 1981 to a system to handle 380,000 tons in 1986, all in the four northern regions. This study proposes a system to achieve the logistical and economic performance desired from limestone distribution in southern Portugal as part of the total technical and economic agricultural development effort underway in the country.

The question of limestone distribution in the southern three regions was complex because the size of farms is significantly different from the north, little or no limestone was presently being utilized, no specific information was available

1/ Agricultural Limestone Distribution Study for Northern Portugal, Lauth, Snitzler, Tosterud. February, 1981.

CONTINENTE

MAP 1.



on either sources of (supply) or need for (demand) limestone, and the cropping pattern is presently undergoing change in the regions, especially the Alentejo. These factors, while allowing the study design to follow the previous work in the north, forced a detailed examination of the southern regions, particularly of limestone production.

The specific objectives of this study were to: (1) design an efficient, cost minimizing system for production, transportation, marketing and distribution of agricultural limestone; (2) develop a system that is flexible enough to respond effectively to changes in conditions of supply, demand, or governmental policies; (3) evaluate government policies and/or programs, e.g. credit or subsidies, that would encourage use of agricultural limestone and cause attendant increases in agricultural production, and; (4) recommend the system components, marketing options, and governmental actions that would achieve these three prior objectives.

The objectives of this study are based on a given need and demand for agricultural limestone in the three southern regions. That is, that certain soils growing specific crops need limestone to maintain growth and/or increase yield at a determined rate of application and that farmers will buy certain amounts at given prices to fulfil their soil and crop needs. The consultants were unable to find sufficient data or research on the need or demand for limestone in the south to develop a judgement on the amounts needed to be produced and transported over a period of time. Thus, the consultants have used estimates of use of limestone, 1983-1986, made by the Regional Services. We believe these to be the best estimates available but, because of their uncertainty, the proposed supply system must be considered tentative. Flexibility has been a key ingredient in our development of the proposed system in order to provide for the uncertain need and demand.

Available to the consultants for this study was a report on limestone production done by Mr. James Smith [1/]. This report provided considerable information on limestone production and technology which was not available for the northern study.

1/ Report on Production of Agricultural Limestone in Southern Portugal, Smith. June 1982.

II METHODOLOGY

The overall approach to designing an agricultural limestone distribution system for the three regions of the south was to identify the least cost structure while allowing for flexibility in the recommended system. Sequential steps in the analytical procedure included the following:

1) The estimated demand for limestone in the south was evaluated and categorized by location and timing. Information was obtained on physical need and rationale for limestone usage, acceptance by agricultural producers, changing cropping patterns, location of use and proposed timing of the use during the 1983 - 1986 period.

2) An inventory of supply of limestone was undertaken. The location of limestone producers was examined relative to potential annual volume, timing of production during 1983-1986 time period, reserve supply, limestone physical and chemical properties, product source (primary agricultural limestone production or residual product), cost of production, and potential selling price.

3) Truck costs were synthesized and capacity of highway infrastructure (roads and bridges) was ascertained Potential congestion bottlenecks were identified and any impacts were included in the truck cost functions. Truck costs were developed for different sizes, backhaul frequency percentages, and ownership alternatives.

4) Rail costs were calculated and capability of the rail system in the south investigated. Cost of alternative carrier systems were determined.

5) The distance at which rail costs and truck costs equalize was calculated for alternative origin and destination distances. Then, competitive variables affecting this interaction in the south, such as rates, equipment availability, handling charges, and service differences were combined to determine the recommended transportation modes.

6) The recommended system was then specified, with number and location of production sources, associated trade and distribution areas, transportation modes and production/consumption expected during the 1983 - 1988 time period being identified.

7) The costs of the physical distribution system were then calculated, identifying delivered price to alternative demand areas.

8) The estimated amount of equipment required to efficiently move the specified volume of agricultural limestone was evaluated based on vehicle capacity and resultant number of truck or rail trips.

9) Alternative marketing and/or promotional arrangements such as cooperative handling, credit lines, subsidy to farmers, etc. were then examined.

10) Recommendations were made, based on analysis of the efficient system design, but modified by institutional considerations.

A concurrent objective of the analysis was to design a flexible system for agricultural limestone distribution as well as an efficient, minimum cost one. This secondary objective entailed the following steps:

1) Evaluation of potential GOP policy changes and resulting program characteristics relative to effects on system design.

2) Evaluation of the demand for agricultural limestone in the south. Undetermined at the time of the study were physical need for agricultural limestone, the degree of producer acceptance of the physical need, the financial ability of the producer to participate in the program, and the results from research and extension programs. All of these require a physical distribution system capable of reacting to either drastic increases in demand for agricultural limestone or little active demand in the early years of the 1983 - 1986 time period.

3) The supply system for agricultural limestone, as specified in the study, could vary significantly in cost of production and market prices, depending on potential competition among producers, the multiproduct characteristics of rock quarries, physical capability of alternative production sites, etc. These variables were evaluated relative to need for flexibility in the system design.

The data sources for this study consisted of the previous agricultural limestone distribution study for northern Portugal and field trips, both in the north and the south. Specific interviews were held with government officials, trucking fleet operators, limestone producers, trade officials, railroad personnel, Regional Service specialists, World Bank Project, Extension Specialists, and farmers.

III LIMESTONE PRODUCTION, TRANSPORTATION AND DISTRIBUTION IN NORTHERN PORTUGAL

In 1981, a program for agricultural limestone production, transportation and distribution was implemented by the GOP to introduce the application of agricultural limestone by farmers to neutralize soil acidity in northern Portugal (Regions 1, 2, 3 and 4). As part of the PROCALFER program, the goal of this project was to promote soil correction by the use of agricultural limestone on northern soils used in corn and forage production.

Goals were established for the tonnage of limestone to be applied over a 6 year period. The original goals 1/ of limestone application, in tons, were:

1981	1982	1983	1984	1985	1986
95 000	219 000	266 000	302 000	340 000	380 000

In November, 1981 these goals were revised as follows:

1981	1982	1983	1984	1985	1986
52 500	90 000	150 000	250 000	350 000	380 000

1/ Based on application to 50% of the corn hectares in Regions 1, 2, 3 and 4 and 50% of the pastures in Regions 2 and 4. The average application rate is 5 tons the first year, 5 tons the 2nd year, and one ton each succeeding year.

To create an initial demand from those farmers unwilling or unable to incur the full cost of agricultural limestone the GOP began a six year phased out subsidy program for the purchase of limestone. The subsidy funds approved for 1981 were based on 50 percent of the estimated average delivered price, or 700 esc/ton [2/]. Subsequent subsidies were proposed to be 50 percent in 1982, 40 percent in 1983, 30 percent in 1984, 20 percent in 1985 and none in 1986.

The first shipments under the government's subsidy program began the first of March, 1981. A uniform price to all farmers in the north was set at 1200 esc/ton in plastic bags [3/]. This uniform price was calculated from estimated delivered prices from plants to representative regional destinations, weighted by expected tonnages to each region, which resulted in an estimated weighted average delivered price of 1886 esc/ton.

Marketing of the limestone under the subsidy program is accomplished through 4 Unions of Cooperatives: Ucanorte in region 1, Corcoop in region 2, and Unicentro and Agroscoop in regions 3 and 4. The Unions buy limestone and arrange for its transportation to local cooperatives, paying all bills and incurring some administrative expense. The farmer buys the limestone from the local cooperatives, paying 1200 esc/ton. The Unions are then reimbursed monthly for

2/ Derived from an estimated 1353 esc/ton delivered price obtained from the Lauth, Snitzler, Tosterud study, February, 1981

3/ A price of 1100 esc/ton was later established for agricultural limestone in paper bags and 1300 esc/ton for dolomitic limestone.

the difference between the delivered prices to the cooperatives and 1200 esc/ton less a handling charge for the local cooperative. A quazi-government organization, named Codical, has been chartered to administer and account for the subsidy funds. Chart 1. is a diagram of the structure of the limestone subsidy program in northern Portugal.

In addition to the purchase price subsidy for agricultural limestone in the north, credit lines were also authorized in 1981 by the government for the purchase of limestone (9.5% interest), the construction of warehouses for limestone (12% interest) and the construction or expansion of limestone plants (13.75% interest) While these credit line subsidies were authorized for all of Portugal their use has been heavily concentrated in the four northern regions.

The quantity of limestone delivered to the four northern regions in 1981 were 52,500 tons, of which 36,458 were delivered under the subsidy program. This tonnage compares to an estimated 20,000 tons delivered to these regions in 1980. The average delivered price was 1763 esc/ton, ranging from 1410 esc/ton to region 3 to 1996 esc/ton to region 2. Limestone plant prices averaged 758 esc/ton, or 42% of the delivered price. Transportation costs averaged 1005 esc/ton or 55% of the delivered price. Administrative costs added another 54 esc/ton to the delivered price making a total average delivered price of 1817 esc/ton. The average subsidy cost was then 759 esc/ton, or 41% of the total delivered price, and ranged from 495 esc/ton for region 3 to 990 esc/ton for region 2.

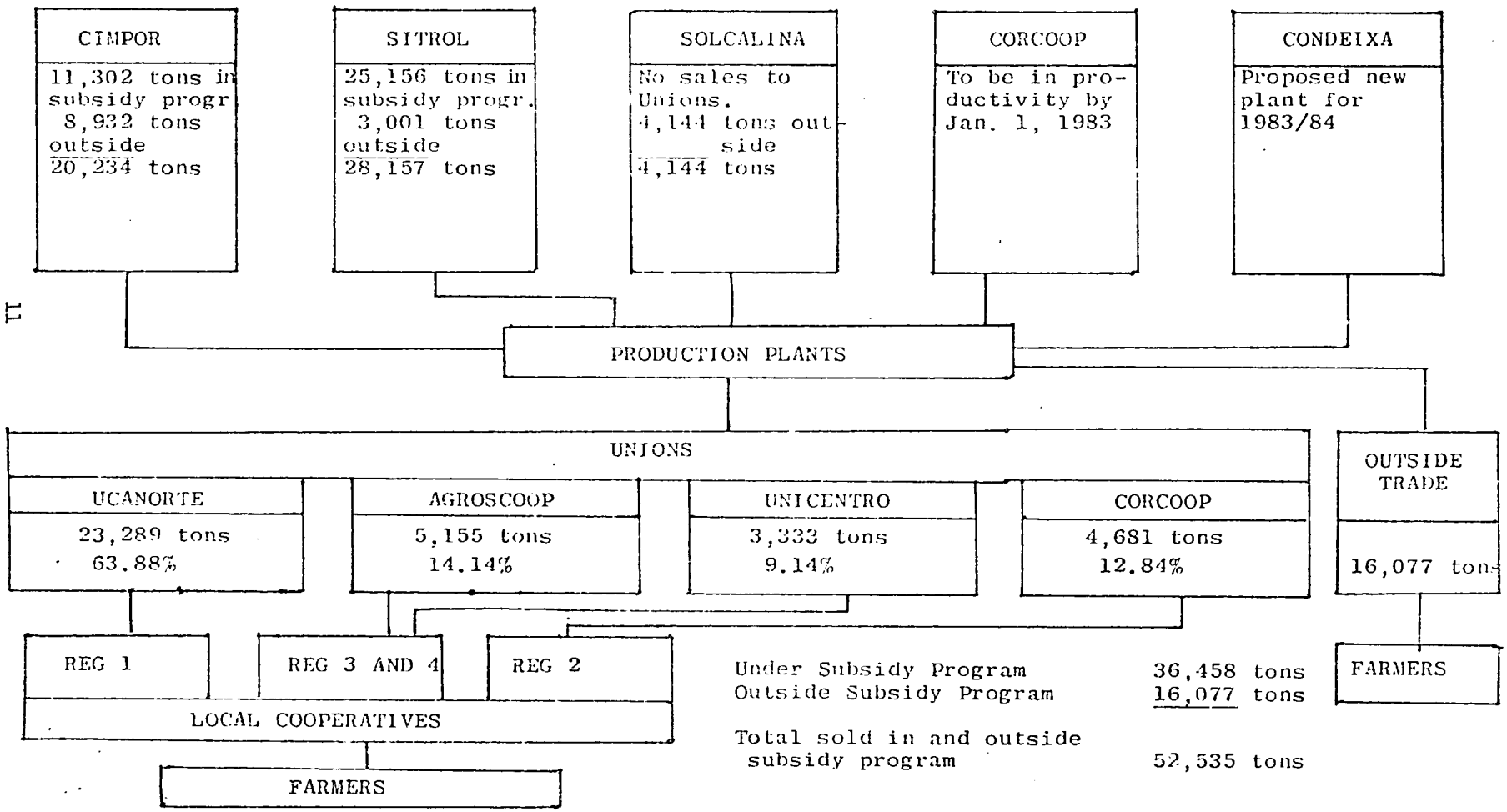
Production plants used under the subsidy program are plants which produced agricultural limestone prior to the program. None of these plants produce agricultural limestone from a residual product but rather as a by-product or joint product of their limestone rock crushing operation. All of these plants

CHART 1.

NORTHERN PORTUGAL

1981

AGRICULTURAL LIMESTONE DISTRIBUTION SYSTEM



Under Subsidy Program	36,458 tons
Outside Subsidy Program	16,077 tons
Total sold in and outside subsidy program	52,535 tons

produce an agricultural limestone product which meets minimum government standards for chemical and physical properties. Plans are underway for the construction fo plants which produce only agricultural limestone near Vila Real and Condeixa, with the aid of government credit. There is one project proposal for government credit of the expansion of a plant which will process a residual product (Pó de Pedra) into an agricultural limestone product which will meet the minimum standards 4/.

All of the limestone sold under the subsidy program is shipped and delivered to the farmer by truck in bags (paper or plastic) because of the small size of farms, the division of farms into small parcels, and, in some instances, difficult assess to the farms. Plans are underway to gain advantages of bulk delivery by construction of regional warehouses where bulk limestone can be received in bulk transport equipment, bagged, and then distributed locally in bags 5/.

Based on shipments through May 1982, preliminary estimates for 1982 can be obtianed for operation of the subsidy program in northern Portugal. Shipments under the subsidy program totaled 25,776 tons through June 1, despite lack of subsidy funds for the Unions during April and May. Assuming the same rate of shipment during the last 7 months in 1982 as occurred in 1981, and adjusting for the first two months in 1981, when no shipments were made, the 1982 yearly tonnage would be about 76,000 tons 6/, compared to 36,000 tons in 1981. Shipments outside the subsidy program during 1981 added about 25 percent 7/ to the total shipped so that 100,000 tons is an estimate of the total limestone to be shipped

4/ Quisselgur, near Fátima.

5/ For example, the planned warehouse by Ucanorte at Maia.

6/ 70 percent of 1981 shipments were made in June-December.

7/ Discounting the Quimigal shipments made in January, February and March, 1981 leaves a balance of 9500 tons shipped outside the program in 1981.

to the four northern regions in 1982. The average subsidy for the first five months was 868 esc/ton, up from the 1981 average of 759 esc/ton. The increase is due principally to an increase in the plant price for Sitrol limestone from 820 esc/ton to 980 esc/ton 8/. The Sitrol plant during the first five months supplied 65% of the limestone to the four Unions. Offsetting this plant price increase to some extent were purchases from Tudipedra 9/, a new supplier, at 850 esc/ton. Negotiations are underway by Codical with other plants at the 850 esc/ton price level 10/

Characteristics, prices and costs of the northern Portugal agricultural limestone production, transportation and distribution system may be summarized as follows, with particular relevancy to a southern system.

1. The price at the farm level for limestone is subsidized by the government at a uniform price of 1200 esc/ton regardless of distance from the limestone plant. During the first year of the program the subsidy averaged 759 esc/ton, or 41 percent of the delivered price to the farmer. For the first five months of 1982 the average subsidy was 868 esc/ton. The subsidy is to gradually decline from 50% in 1981 and 1982 to zero in 1986.

2. Government assistance is further available through low interest credit to farmers for the purchase of limestone and construction and/or expansion of

8/ Effective January 1, 1982
9/ Near Alcanede
10/ Quisselgur and Solcalina

Limestone plants and warehouses.

3. Purchases are from limestone plants where the agricultural limestone is produced as a by-product or joint product from limestone crushing operations. None is currently being purchased from rock crushing plants as a residual product or at plants which have a residual product which could be further processed into agricultural limestone.

4. All agricultural limestone purchased under the subsidy program meets minimum government standards for chemical and physical properties.

5. Marketing of agricultural limestone is accomplished through Unions of cooperatives with delivery to the farmer at the local cooperative.

6. All shipments are by truck and are in bags.

7. The average delivered price to local cooperatives was 1763 esc/ton in 1981, ranging from 1410 esc/ton to 1996 esc/ton. Transportation accounted for an average of 1005 esc/ton or 57% while the purchase price at the plant averaged 758 esc/ton, or 43%.

8. Truckers are offering rates below their long run variable costs under negotiation by the Unions (see Lauth Report, July 1982).

9. Consumption is increasing under the subsidy program. Shipments were 20,000 tons in 1980 without the subsidy program and 52,000 tons in 1981 under the subsidy program. Estimated 1982 shipments are 100,000 tons.

IV LIMESTONE NEED AND DEMAND

While use of limestone is known to improve crop production on many soils, whether it is needed and amounts that should be used are not easily determined. In general, the goal in applying limestone is to raise soil pH levels. The level of pH 7.0 is neutral and as that level is approached limestone is generally not required. Further, moderately acid soils frequently have little or no impact on yields. For example, the following data illustrate minimum pH levels for "optimum" production of some typical crops. Little, if any, negative impact on yields would be expected from acidity at pH levels above those shown.

	"Minimum Optimum pH" 1/
Oats	5.0
Potatoes	5.0
Rye	5.0
Grapes	5.0
Corn	5.5
Tomatoes	5.5
Olives	6.0
Sunflower	6.0
Wheat	6.0
Barley	6.5

1/ Da Silva, Rebelo, Guia Prático de Fertilização, Laboratório Quimico Agrícola, Ministério da Agricultura e Pescas, Direcção-Geral de Extensão Rural.

Relationship Between Soil Class and Need

Soils in Portugal are rated by use capacity for agriculture. Soils classified A and B are those most adapted to agriculture; those classified D and E are least adapted to agriculture and are commonly utilized as pasture and forest. In the Alentejo, the region thought to need most of the limestone, 15 percent of the soils are in classes A and B, less than 20 percent in class C, and nearly two-thirds are in classes D and E (Table 1). According to the report Projecto de Calagem, Fertilização e Forragens 1981-85, A and B soils generally do not require agricultural limestone because they are alkaline. Half of the C soils are acid and need such treatment. All D and E soils are said to need limestone to correct acidity.

Soil Test Summaries as Indicators of Need

Soil test summaries for southern Portugal also show some soils to be relatively acid and in probable need of limestone. For example, in the subregion Santiago do Cacém of the Alentejo, more than two-fifths of the soils for which soil tests summaries are available for 1981 showed pH of 5.5 or lower (Table 2). Even in that subregion with relatively acid soils more than 6 percent of the soils tested pH 6.6 or higher. In Beja subregion, however, only 18 percent of the summarized soil tests showed pH levels as low as 5.5 and close to half those tested had pH levels of 6.6 or higher. Over all a higher percentage of soils in Ribatejo e Oeste than in the Alentejo were at pH levels of 6.6 or higher (Table 3). However, even in the Santarém and Setúbal subregions of the Ribatejo, soils showing pH levels of 5.5 or lower accounted

TABLE 2

Soil Test Summary Data from

The Alentejo, by sub Region, 1981

Sub. Region	Number of Samples	pH (H_2O) 4.5 or lower	4.6 to 5.5	5.6 to 6.5	6.6 to 7.5	7.6 or higher
		..... percentage				
Santiago do Cacém	171	1.8	40.9	50.9	4.1	2.3
Portalegre	574	0.7	24.0	37.4	18.6	19.3
Évora	520	0.2	20.0	49.6	22.1	8.1
Beja	368	---	18.4	32.3	27.7	21.6

SOURCE: Soil tests conducted in laboratory of the Regional Director of Agriculture, Alentejo.

TABLE 1 USE CAPACITY OF SOILS IN THE ALENTEJO 1/

SUB-REGION	USE CLASS A	B	C	D	E	TOTAL 3/
Portalegre 2/	15413	33724	59474	113004	107254	328869
Evora 2/	13363	60374	140332	123349	172653	510071
S. Cacém	8609	21847	49846	160840	268966	510108
Beja	60552	106606	147078	163886	365684	843806
TOTAL	97937	222551	396730	561079	914557	2192854

1/ Source: Direcção Regional do Alentejo,
Ministério da Agricultura e Pescas,
Projecto de Calagem, Fertilização e Forragens, 1981-1985 - Julho 1981,
Pagina 3.

2/ Estimated

3/ Excludes Towns and Villages

for about 30 percent of those tested.

The purpose of soil tests is to determine the amount of lime required to raise the pH of the soil to a given level for production of a certain crop. However, soil tests do not "...necessarily determine whether or not a crop will respond to an application of lime on a particular soil..." 1/. This lack of response on some soils suggests that experimental work with particular crops on specific soils is essential in fully understanding how given crop yields are likely to be affected.

Nonetheless, soil tests and other data suggest that production could be improved in southern Portugal by application of limestone on some soils. But, because required soil pH levels vary by crop, consideration must be given to crops that are to be produced as well as to pH levels.

Profitable use of limestone in southern Portugal will generally require significant changes from traditional cultural practices and farming systems according to extension personnel, representatives from the World Bank project and others who are knowledgeable about agriculture in the region. For example, traditional crop rotations may include 2 years of cereals such as wheat and oats, followed by unseeded natural pastures for 2 to 5 years or longer. These natural pastures require almost no purchased inputs and farming risks are minimal. Under such a traditional extensive cropping system, neither the cereals nor the natural pastures have been shown to respond significantly to limestone. Thus its use would not be expected to be profitable

1/ Dahnke, William C. Report to PROCALFER Coordinating Committee, 1981, p. 11.

TABLE 3

Soil Test Summary Data from

Ribatejo e Oeste, by Sub Region, 1981

Sub Region	Number of Samples	pH (H_2O) 4.5 or lower	4.6 to 5.5	5.6 to 6.5	6.6 to 7.5	7.6 or higher
		..... percentage				
Caldas Rainha	1014	1.8	17.8	20.9	21.0	33.5
Santarém	1647	1.4	30.6	25.9	8.4	33.7
Setúbal	499	---	29.9	36.5	19.0	14.6
Tomar	881	2.5	24.2	21.1	14.4	37.8

SOURCE: Soil tests conducted in laboratory of the Regional Director of Agriculture, Ribatejo e Oeste.

and would not increase. Demand for limestone would likely remain near zero.

Currently, efforts are underway to introduce changes in farming systems that involve greater use of improved pastures, especially subterranean clover. This change would allow more livestock (perhaps double or triple current levels). Some farms that have not had livestock could support them under the improved farming systems. Also, because the subterranean clover is a legume it can add to soil nitrogen and improve soil fertility. Where soils are relatively acid, introduction of subterranean clover has been shown on demonstration plots to benefit from or even require use of limestone. Thus, as pastures are improved limestone demand is expected to grow.

Because use of limestone allows major changes in production practices, farm budgets show substantial change with the addition of subterranean clover. An example farm budget for a farm in the concelho de Barroncos indicated that receipts would be nearly 1300 contos higher while expenses would increase by less than 740 contos. Thus, there would be a gain of about 560 contos for the farm. It should be noted, however, that the expected gain required both improvement of pastures and addition of cattle. Limestone use without other changes would not be expected to be profitable.

Demand for Limestone

Determination of the need for limestone to improve crop yields, as has been suggested, is extremely complicated. Moreover, some understanding of yield response is implied in estimating

demand. But the question of demand--amounts that would be purchased at various limestone price levels--includes even more difficult questions.

Farmers can generally be expected to use limestone to the extent that it pays them to do so in an economic sense. That is, the value of additional output due to the use of limestone must exceed the cost of obtaining, transporting and spreading it. And to the extent that funds are limited, the farmer must choose from among all factors of production (lime, fertilizer, improved seeds, new machines, improved breeding stock, etc.) those that provide the greatest return per unit of cost. His choices are even greater and more complicated when possibilities for major changes in production systems are involved, as they are in Portugal. He may also wish to relate his farm production decisions to his family consumption decisions. Further, the many uncertainties faced by farmers in choosing the most profitable actions can be expected to cause them to use less limestone than might otherwise appear to be profitable.

Current Use of Agricultural Limestone

Despite evidence of acid soils and the potential for yield increases, little limestone is used in southern Portugal. Visits to limestone plants generally confirm that demand has been quite limited. The Montemor-o-Novo plant sold 800 tons of agricultural limestone and 500 tons were sold from the Santiago do Cacém plant in 1981. Other plants may have sold small amounts, but the totals would be extremely small in relation to the areas that might be treated.

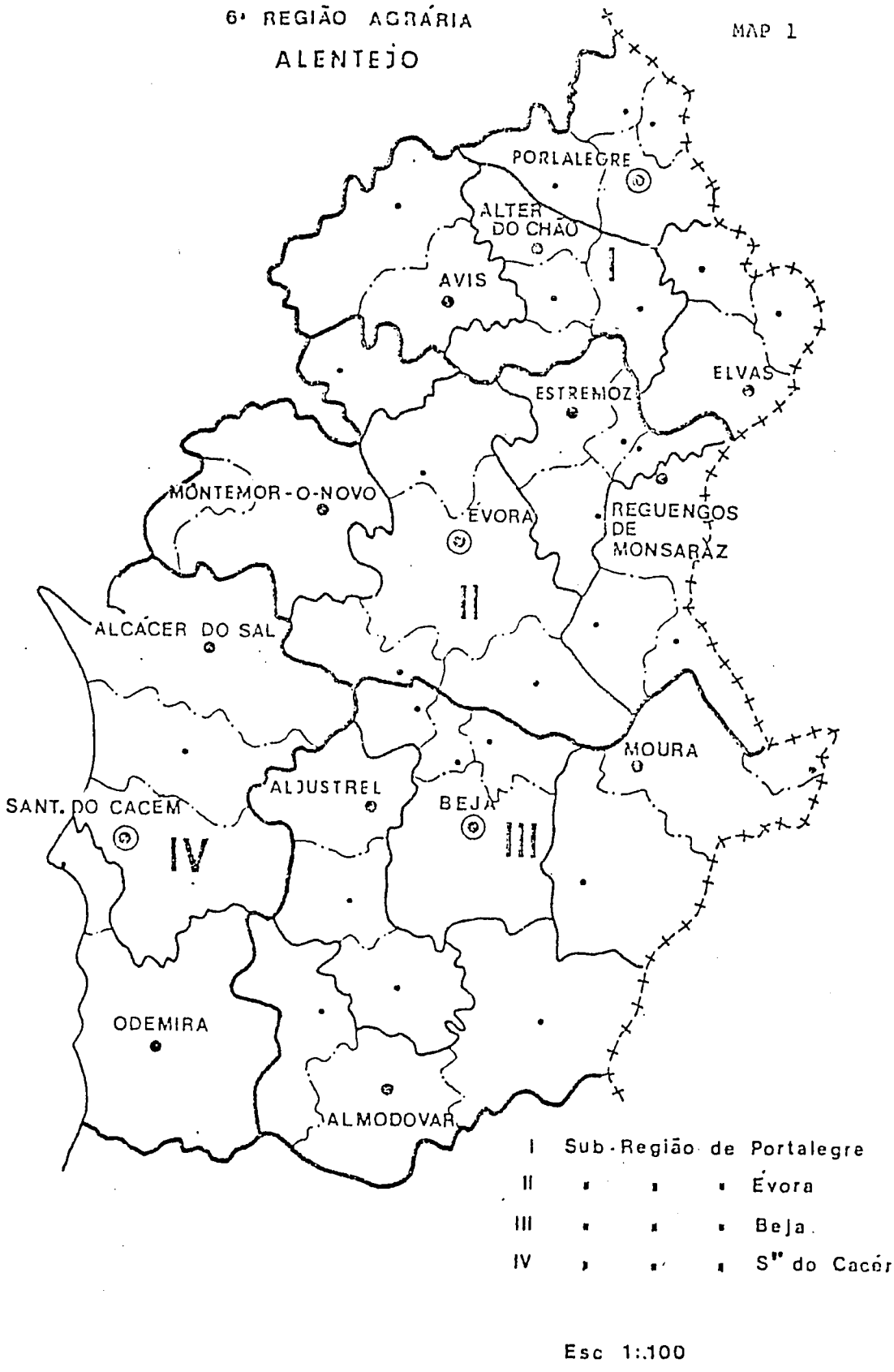
Besides use of agricultural limestone one example of use of residual Pó de Pedra from limestone rock crushing was found. This sale of 152 tons of Pó de Pedra from the firm of José Marques Gomes Galo, Lda. in Sesimbra, identified as being for agricultural use, was to a 1300 hectare agricultural production cooperative in the Alentejo. The cooperative was contacted to determine crops on which the limestone was used, how the material was delivered and spread, and at what rates.

The cooperatve had used soil tests to determine need. One area tested pH 5.9 and was treated. Other areas all tested pH 6.6 or higher and were not treated. The liming material was delivered to the cooperative by the limestone plant and two tons per hectare were spread with a centrifugal spreader mounted on the back of the cooperative's farm tractor. Crops being produced on treated soils were subterranean clover, corn and sorghum. The product was purchased at a plant price of 50esc/ton. Transportation for 220 kilometers to the farm added 650esc/ton, for a delivered price of 700esc/ton.

Anticipated Use of Agricultural Limestone

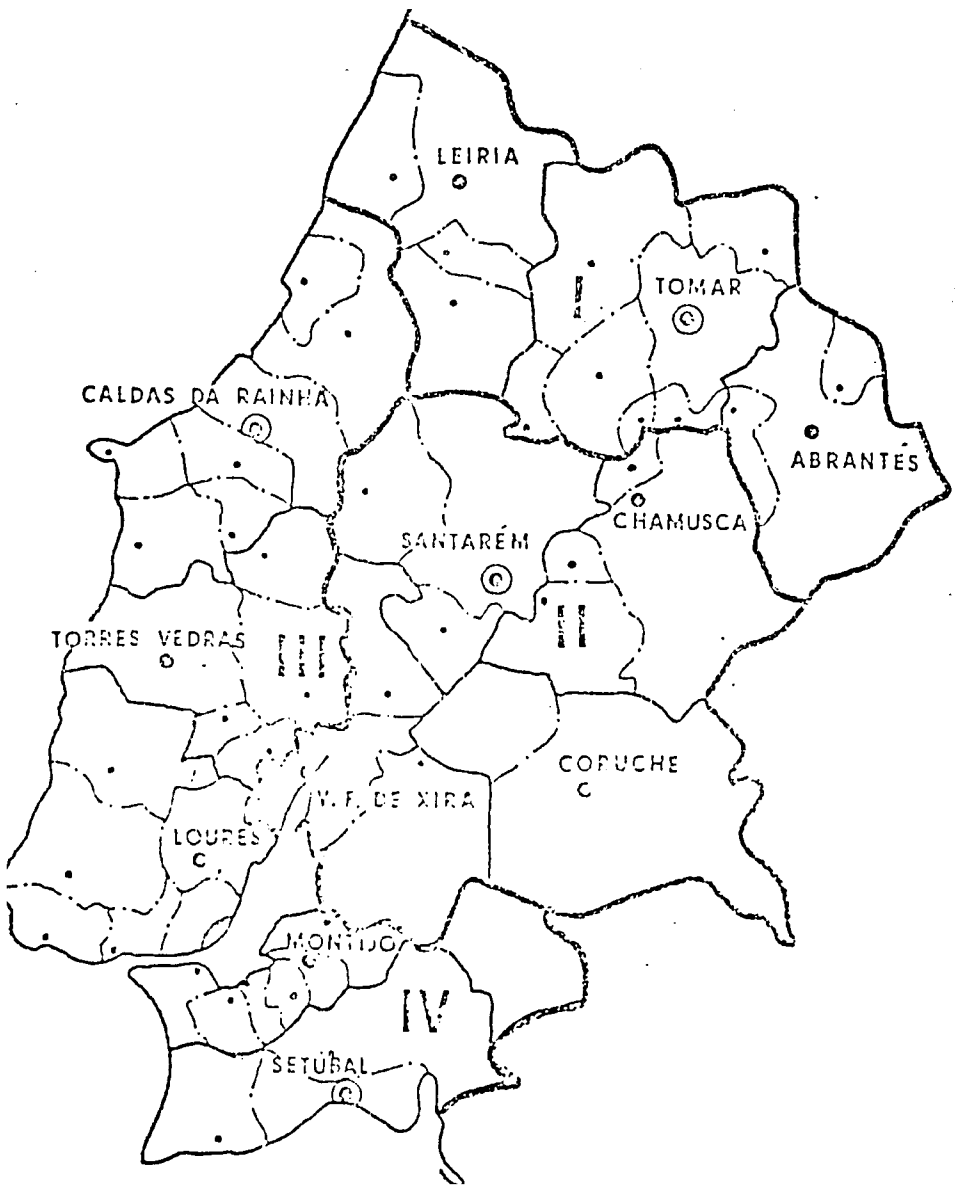
Estimates of limestone use during 1983-86 were developed in cooperation with Regional Services Staff for each of the three regions of southern Portugal - The Alentejo, Ribatejo e Oeste, and the Algarve (Maps 1, 2 and 3). The estimates revise those made earlier as shown in the report Programa de Calagem, Fertilização e Forragens 1/. These later estimates take into account

1/ PROCALFER, Aid Agriculture Program 1981-1985 - Part 2


6ª REGIÃO AGRÁRIA
ALENTEJO
MAP 1
PORTALEGRE
ALTER DO CHÃO
AVIS
ELVAS
ESTREMOZ
MONTEMOR-O-NOVO
ÉVORA
REGUENGOS DE MONSARAZ
ALCACER DO SAL
MOURA
ALJUSTREL
BEJA
SANT. DO CACEM
ODEMIRA
ALMODOVAR
I
II
III
IV
I Sub-Região de Portalegre
II " " " Évora
III " " " Beja
IV " " " S^to do Cacém
Esc 1:100

5ª REGIÃO AGRÁRIA MAP 2

RIBATEJO E OESTE



I Sub-Região de Tomar

II " " " Santarém

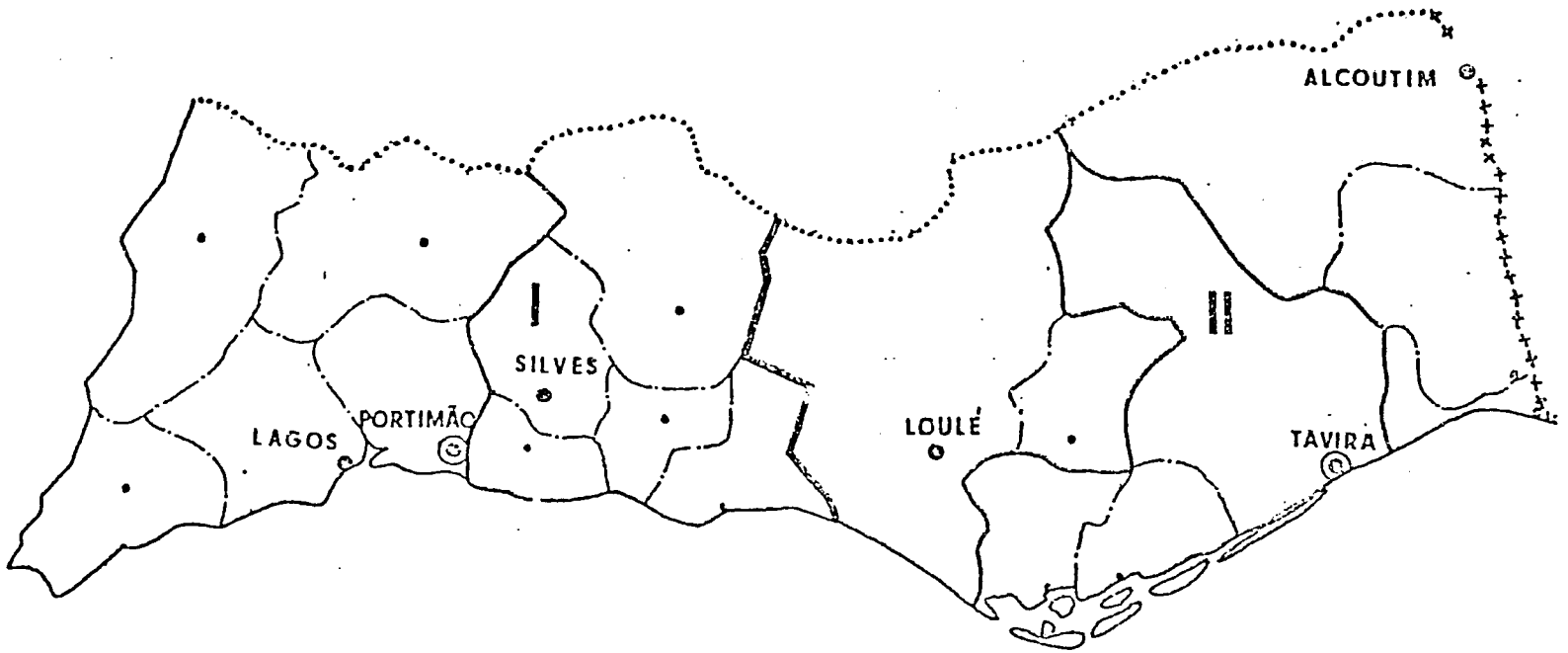
III " " " Caldas da Rainha

IV " " " Setúbal

Esc. 1:100

MAP 3.

7ª REGIÃO AGRÁRIA
ALGARVE



I Barlavento

II Sotavento

Esc. 1:100

the status of the limestone program and developments since the earlier ones were prepared. Consideration was given by Regional Services to various factors including crops and forages to be produced on treated land, predominant soils in the area, the need for and availability of extension education programs, and necessary changes in farming systems.

The region of Alentejo is expected to become the major user of agricultural limestone--accounting for close to 90 percent of anticipated use in the south. Within the Alentejo, improvement of forage production is clearly the primary objective. For the entire region, close to 85 percent of the hectares to be treated would be in subterranean clover (Table 4). Subterranean clover in the Évora subregion is seen as accounting for about 95 percent of treated land. In Santiago do Cacém, a region of more acid soils, corn and grain sorghum are expected to account for one-fourth and subterranean clover three-fourth of treated hectares.

Use of limestone in both the Ribatejo e Oeste and the Algarve would also emphasize forage production. While less important than forages, some lands used for cereals would be treated in the Ribatejo. In the Algarve, essentially all limestone use would be on forages.

The development of subterranean clover as an alternative to traditional forages is being encouraged by use of demonstration plots in the several subregions. Several of these were visited by the consultants. The goal of the demonstration plots is to provide farmers in the nearby areas evidence of benefits to be gained by production of this clover in combination with soil correction through use of limestone and proper fertilization. To the extent that this demonstration program is successful, use of limestone is expected to increase more where demonstration

TABLE 4

ESTIMATE OF AREAS TO RECEIVE LIMESTONE AND FERTILIZER TREATMENT
ALENTEJO, 1983-86 1/

Sub-region and Crop	Year 1983	1984	1985	1986
	..... Ha			
Évora				
Corn	310	480	650	925
Grain Sorghum	260	480	650	925
Subterranean Clover	9 680	19 370	29 023	38 684
TOTAL	10 250	20 330	30 323	40 534
Beja				
Corn	1 050	2 200	4 050	6 250
Grain Sorghum	500	1 200	2 600	4 500
Subterranean Clover	12 450	25 000	42 800	50 000
TOTAL	14 000	28 400	49 450	60 750
Portalegre				
Corn	1 050	1 725	2 400	2 900
Grain Sorghum	400	850	1 200	1 600
Subterranean Clover	6 650	13 300	19 750	26 600
TOTAL	8 100	15 875	23 350	31 100
Santiago do Cacém				
Corn	1 175	2 800	5 000	7 000
Grain Sorghum	800	1 600	4 000	6 000
Subterranean Clover	9 288	18 564	27 863	37 151
TOTAL	11 263	22 964	36 863	50 151
TOTAL	43 613	87 569	139 986	182 535

1/ Based on Programa de Calagem, Fertilização e Forragens (PROCALFER) AID Agriculture Production Program 1981-85, Quadro 4-3

programs are established. The consultants were told by Regional Service staff that this relationship was considered in estimating limestone use.

Geographical Distribution of Use

Anticipated quantities of agricultural limestone use in each of the regions were allocated by subregion to permit development of a distribution system by subregion (Table 5). For the Alentejo, the subregion distribution was based on hectares of crops and forages to be treated (Table 4). About one-third of total use in the region would be in Beja, one-fourth each in Santiago do Cacém and Évora and the remainder in Portalegre.

The subregion distribution for the Ribatejo e Oeste was based on that shown in Quadro 8-1, Projecto de Calagem, Fertilização e Forragens, 1981-85. That report showed use without reference to specific crops. In the Ribatejo, close to half of use is expected to be in the Santarém subregion and one third in the Tomar subregion. Finally, the relatively small tonnages to be applied in the Algarve were divided between the two subregions according to percentages of pasture areas in the respective subregions. This distribution is shown in Quadro 3-1, of the report identified above.

TABLE 5

ANTICIPATED AGRICULTURAL LIMESTONE USE BY REGION, SUB-REGION, AND YEAR 1/

	YEAR			
	1983	1984	1985	1986
	Metric Tons			
Alentejo				
Santiago do Cacém	14820	27560	39000	51220
Portalegre	10260	19080	27000	35460
Évora	13110	24380	34500	45310
Beja	18810	34980	49500	65010
TOTAL	57000	106000	150000	197000
Ribatejo e Oeste				
Tomar	2380	5100	6120	6800
Santarém	3220	6900	8280	9200
Setúbal	1260	2700	3240	3600
Caldas da Raínha	140	300	360	400
TOTAL	7000	15000	18000	20000
ALGARVE				
Barlavento	50	340	980	1490
Sotavento	70	440	1240	1890
TOTAL	120	780	2220	3380
TOTAL (All Regions)	64,120	121,780	170,220	220,380

1/ Based on limestone use as estimated by Regional Services for each region. Estimates were moved forward and up dated because of time clapsed since the early estimates were made. Distribution by sub-region in the Alentejo were made using areas of crops to be treated (Table 4). In the Ribatejo e Oeste the distribution was based on that shown in Quadro 8-1, Projecto de Calagem, Fertilização e Forragens, 1981-85, July 1981. The distribution of Pastures to be treated in the Algarve were distributed between the two regions as shown in Quadro 3-1, Projecto de Calagem, Fertilização e Forragens 1981-85, July 1981.

V LIMESTONE PRODUCTION

Southern Portugal appears to have ample supplies of limestone rock which could be used in correction of soil acidity. However, until now, little use has been made of agricultural limestone, even though crushed limestone is produced and used widely in construction. The existing limestone rock crushing plants represent a potentially valuable source of limestone for agriculture.

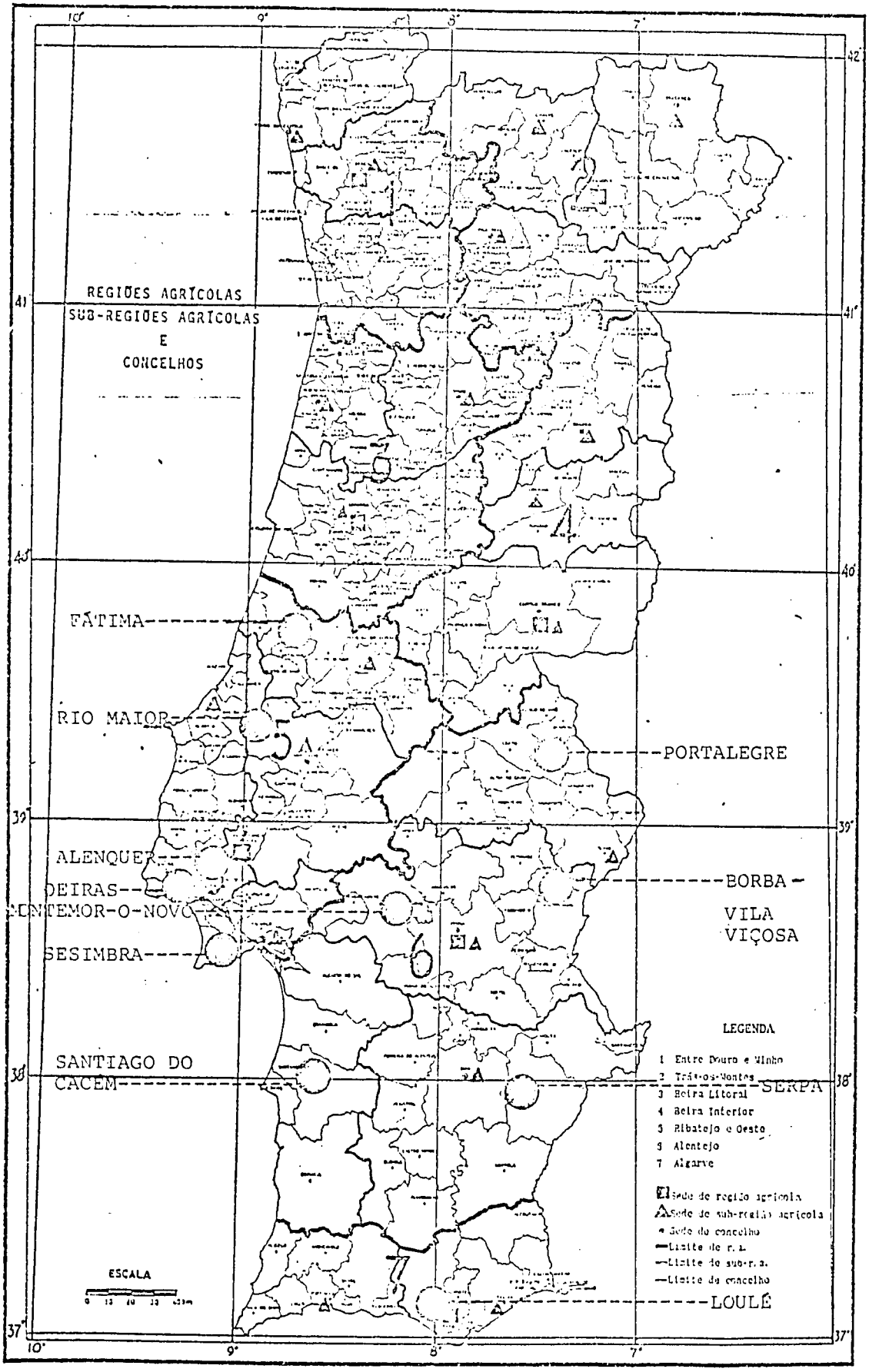
Location of Production

Most of the crushed limestone rock production lies in a band along the western part of the country (Map 1.). Three particularly important limestone rock crushing areas are Sesimbra, to the south of Lisbon, Alenquer, to the north of Lisbon, and Loulé in the Algarve, near the southern coast. In addition to these major areas, a number of other existing crushing plants could help meet the need. Also, several proposals have been made for construction of additional limestone and marble crushing operations. One large producer of construction aggregate from limestone indicated that Sesimbra and Alenquer areas--areas which could supply much of the south--alone account for half the country's production of crushed limestone rock.

Along with the general adequacy of the supply of limestone rock there is evidence that it is of high quality as indicated by chemical analyses (agricultural limestone must be at least 85 percent $CaCO_3$). In particular, a series of analyses of limestone samples conducted in a laboratory of the Direcção-Geral de Extensão Rural, at the request of the consultants on limestone distribution, showed neutralizing values between 95.4 and 107.9 (Appendix 1). Also, independent analyses supplied by crushed rock producers

LOCATION OF POTENTIAL AGRICULTURE LIMESTONE PLANTS TO SERVE REGIONS 5,6 AND 7

MAP 1



generally showed the chemical quality to be quite good (Appendix 2).

Sesimbra Area

In the Santana - Sesimbra and Zambujal - Sesimbra areas there are at least 12 firms that produce crushed limestone for highway and other construction. Nine of the largest of these have formed a consortium (Britasul) for marketing purposes. Sales statistics maintained for the nine firms show 917,000 cubic meters of aggregate sold through the consortium in 1981 (Table 1). Assuming 1.4 tons per cubic meter, this would amount to 1,283,000 tons of crushed aggregate of various sizes including the residual--Pó de Pedra. A Britasul price list is provided (Appendix 3).

It is understood that limestone material used directly in construction activities of the consortium members is not included in Britasul statistics on sales. This view was confirmed in visits to two Britasul member firms. Those visits also provide evidence of types of liming materials that will be available.

Teodoro Gomes Alho & Filhos, Lda.

This firm, which is in the Santana-Sesimbra area, is a member of Britasul and is a major producer of crushed limestone. Marketing is generally within 50 to 70 km of the plant but the company will supply outside that area. The firm uses its own truck fleet for delivery. Current production capacity is about 540,000 tons/year of crushed rock. While 7 to 8 percent residual is also produced, much of this is utilized in construction activities of

TABLE 1

MAPA COMPARATIVO DA. VENDAS DAS AGRUPADAS DURANTE O ANO DE 1981

UNIDADE: M3

AGRUPADAS	JANEIRO 81	FEVER. 81	MARÇO 81	ABRIL 81	MAIO 81	JUNHO 81	JULHO 81	AGOT. 81	SETEMB. 81	OUTUB. 81	NOVEMB 81	DEZEMB 81	M^3 TOTAIS 1981	TOTAIS/80	1981-1980
José L.B. Canteiro	13.309	9.602	10.006	11.546	12.318	16.922	7.028	15.258	26.512	9.024	10.660	8.055	150.246	102.942	+47.304
José M.B. Ludovico	4.273	3.610	5.536	3.929	5.590	6.219	11.273	6.951	8.900	7.803	4.961	6.669	75.714	74.972	+ 742
José M.G. Gelo, Ltda.	7.081	4.950	5.414	4.980	4.079	5.122	7.329	6.493	6.505	5.861	6.083	4.566	69.363	103.199	-33.836
Júlio C. S Fes., Ltda.	9.485	6.310	10.001	9.289	12.437	16.691	10.603	6.434	10.957	10.028	5.990	4.498	113.332	140.559	-27.227
Pérmotos Comércio, SARL	10.394	7.340	7.237	12.420	5.287	6.011	10.056	8.097	10.862	9.530	8.409	7.762	103.405	105.297	- 1.892
Sabiesul, SARL	8.203	7.061	7.357	9.116	8.971	9.415	9.477	13.179	14.827	11.082	10.277	7.100	116.065	128.808	-12.743
Teixeirita, Ltda.	8.653	7.031	6.310	9.755	9.265	11.930	12.522	7.815	9.215	11.884	7.494	6.697	108.578	105.380	+ 3.198
Ferro Alm. e Fes.	6.840	5.533	7.212	7.342	6.530	5.101	8.396	4.801	3.089	6.604	7.829	4.965	74.232	97.421	-23.189
Gelb. Sesimbrense, Ltda	6.786	7.757	9.517	6.396	10.227	11.637	10.546	9.950	13.838	7.562	8.925	3.322	106.478	102.461	+ 4.017
TOTAIS	75.015	59.201	68.590	75.472	75.304	89.053	87.230	78.978	104.715	79.378	70.538	53.934	917.408	961.039	-43.631

Santana, 08 de Março de 1982

the firm. A pile of this residual, estimated by an engineer at the plant to amount to 15,000 tons, was observed by the consultants. The residual product is currently priced at 75 escudos/m3 (54 escudos per ton). Discussion at this plant indicated that a new line with capacity of 50 tons/hour is to be completed within 10 to 12 months. It is expected to produce an extremely fine product for feeds, paints and other uses. Because it is also expected to meet the particle size and chemical requirements for agricultural limestone, it can be viewed as a potential source. The price for this product has not been established but it may be available for about 310 escudos/m^3 (221 escudos/ton).

José Marques Gomes Galo, Lda.

Another member of Britasul, this firm is in the Zambujal-Sesimbra area. Like other firms in the area, it has access to vast quantities of high grade limestone--in this case several hundred meters deep. The aggregate is used in construction engaged in by the firm, as well as being sold through Britasul. Delivery of aggregate may range up to 200 km in company owned trucks. Production of residual Pó de Pedra was said to amount to as much as 20 percent, but it is utilized as much as possible and stocks are limited to 10,000 m^3. Observation of the maintenance shop, equipment, and other phases of the business suggests that the operation is up to date and efficiently operated. A new line is under construction with a target completion date of late October 1982. While the goal of producing construction aggregate remains primary, the new line is expected to produce 300 m^3 (about 420 tons) per day of limestone that will meet agricultural limestone fineness standards. No increase from the current 75 escudos/m^3 (54 escudos per ton) price is seen at this time. Even with some increase in price, this material offers a potential source which will become available in the immediate future.

Other Sesimbra Area Production

The Galo and Alho firms, both with substantial limestone crushing capability, are two of the smallest members of Britasul--when measured by sales through the consortium. Together they represent less than 16 percent of sales for the nine members. To the extent that the types of operation of these two firms that were visited are similar to the other limestone crushing operations in the area, production capacity for aggregate would be impressive--possibly in the four million ton range or higher. Also, while only the finer limestone material to be produced from the new lines of these two firms has been considered it is quite likely that additional production capacity for such products exists or is being constructed by other firms in the Sesimbra area.

At least three smaller firms are known to exist in addition to the member firms of Britasul. Because no information was developed for them they have not been included in the analysis nor in estimates of limestone crushing capacity. Again this tends to provide conservative estimates of supply.

Alenquer Area

Alenquer is an extremely important area in production of crushed limestone for highway and other construction. Local limestone producers estimate total production in the area of some three million cubic meters (About 4.2 million tons) by three large and four smaller firms.

Calbrita 1/, located at Alenquer, is one of the three largest crushed aggregate producers in the area, producing an estimated 1.4 million tons per year of limestone aggregate. Production is from two quarries located 4 kilometers apart. Prices, at the plant, for these products range from 245 escudos/m^3 to 290 escudos/m^3. Appendix 3 shows the prices of all Calbrita's products. The normal delivery area for shipments is within 50 km of the plant. Shipments are made with 31 company owned trucks.

Calbrita is a large producer of residual Pó de Pedra, producing about 20 percent of total production in that product, or about 280,000 tons per year. This product sells for 120 escudos/m^3 (86 escudos/ton). About 50 percent of the residual Pó de Pedra is sold, mostly for use in highway construction, but there are about 50,000 m^3 on hand.

Small quantities of the residual Pó de Pedra have been sold to Produtora de Silica at Bucelas 2/. This firm buys Pó de Pedra from Calbrita and, through the use of a hammermill and pneumatic sieve, produces two limestone products differing only in fineness. These products are sold as agricultural limestone or to the animal feed industry. The coarser product (Agripó) sells for 980 escudos/ton; the finer product (Agrical) for 1,000 escudos/ton. Sales of these products in 1981 amounted to about 3,300 tons.

1/ Sociedade de Britas de Ricardo Pereira & Filhos, Lda.

2/ This firm has submitted to the PROCALFER Coordinating Group and IFADAP a joint project proposal with Solubema to produce agricultural limestone from marble waste in the Vila Viçosa-Borba - Estremoz area. For discussion of this proposed pl. t see page 43.

Visits at the Calbrita plant showed that seams of limestone being mined were mixed with subsoil which may affect the quality of residual material. However, chemical analyses requested by the consultants failed to show any real difference from those in other areas of the country (See discussion on page 50). Calbrita estimates a selling price of about 240 escudos/m^3 (172 escudos/ton), if a hammermill were added to the plant to produce agricultural limestone meeting the minimum fineness tests.

Loulé Area

Another major limestone aggregate production area with considerable potential is Loulé. At least three limestone aggregate producers are in this area. If the material is or can be made into a product of satisfactory quality the area can, in the future, meet the relatively small agricultural limestone needs of the Algarve and may have the potential--depending on transportation costs--of supplying liming materials to the Alentejo.

To avoid overestimation only the three firms known to be producing in this area will be described and later used in estimating potential availability of liming materials.

Betecna

Betecna is the largest concrete producer in Portugal. Its operation at Loulé is a new plant with capacity of about 500,000 m^3 per year (about 700,000 tons). The plant is currently testing its newly constructed plant. Although there are no plans

to produce agricultural limestone, the plant may have the capability to produce at relativaly low cost 3/.

ECOB (Empresa Comercial de Oleos e Bagaços, Lda.)

This plant, with limestone aggregate production capacity of about 288,000 tons per year, currently produces no agricultural limestone. However, a chemical analysis of a sample of residual Pó de Pedra from the plant compared favorably with that from other major producing areas. The potential interest in the plant is in utilizing some of the extremely large stocks of Pó de Pedra as liming materials either in its current form or with further processing. No local market exists and available stocks are growing 4/.

José Marques Gomes Galo, Lda.

The Galo plant, owned and operated by one of the firms that also crushes limestone rock in the Sesimbra area, is smaller than some of the others. According to Eng. Galo, the plant is producing about 100 m^3 (140 tons) of residual material per day that was said to meet minimum standards. This product is currently available at 50 escudos per m^3 (See Appendix 3 for a complete price list).

3/ See James Smith report to PROCALFER, June 1982.

4/ The Smith report indicates production of Pó de Pedra at rate of 600 tons/day.

Rio Maior Area

Because of its limestone reserves, existing limestone crushing operations, and location, the Rio Maior area supplies limestone to the North and is being considered for its potential of also supplying to the South.

Sitrol

This plant produces limestone for the glass and feed industries, and is a major supplier of bagged agricultural limestone to the North at a current price of 980 escudos per ton. Assuming a cost difference of around 330 escudos per ton for bagging, the plant price for bulk limestone would be near 650 escudos per ton.

Betecna

Betecna has developed limestone quarry and crushing operations in the Rio Máior area as a source of material for cement. At Rio Maior, the firm has production capacity of 200,000 m^3 year (280,000 tons) of crushed rock. Most of the residual Pó de Pedra is utilized in concrete production. Thus, current reserves are limited to about 10,000 m^3 (14,000 tons). While supplies are not large relative to other plants, the residual product is available at 350 escudos m^3 (250 escudos/ton).

Oeiras

Betecna

Betecna, the large concrete firm that operates in the Rio Maior and Loulé areas, has a limestone rock crushing plant at Oeiras with capacity of 200,000 m^3/year (280,000 ton/year). Residual materials, which are mostly used in cement, are priced at 350 escudos m^3 (250 escudos/ton).

Fátima

The Quisselgur plant produces and sells construction aggregate for 380 escudos/m^3 or 317 escudos per ton. Production of crushed rock is estimated at 600 to 800 tons per day, one third of which is now considered to be residual waste. In January 1982, an 80 ton per day operation was established to process the waste into agricultural limestone. Annual production capacity is about 21,000 tons per year. Sales of 7,000 tons during January - April 1982 have been to farmers and one cooperative within 50 km of the plant.

A separate company, Quisselgur "B", has been established to produce agricultural limestone using waste product from the limestone rock crushing operation of Quisselgur "A". The waste product is sold to Quisselgur "B" for 60 escudos/m^3 or 50 escudos per ton. Although no bulk limestone has been sold, it is priced at 800 escudos per ton. Bagged limestone is priced at 900 escudos per ton. Plans exist to expand the Quisselgur "B" operation to produce 105,000 tons per year of agricultural limestone.

Montemor-o-Novo

The José Manuel dos Santos Bibe plant near Montemor (Santiago do Escoural), though relatively small, is situated near areas of potential demand. The plant can crush about 240 m^3 of limestone rock per day but weather and quarry conditions limit limestone aggregate production to 135 days per year or 32,400 m^3 annually (about 45,000 tons). One fourth of this, about 11,000 tons, is screened residual. In 1981, 800 tons of this material, which is available at 759 escudos and 506 escudos per ton in two grades of fineness, were sold. Results of screening tests conducted at the request of the consultants showed the finest of these materials to essentially meet Portuguese agricultural limestone fineness standards--the closest of any residual product sampled. The consultants were told that production of screened limestone could be increased by reducing output of construction aggregate. Stocks of residual materials amount to about 8,000 to 9,000 tons. Delivery of products is generally in company trucks within 50 km of the plant.

Serpa

This marble crushing plant is used primarily for production of limestone to improve forage production on forest lands. It could supplement other suppliers in the near-term by 10,000 or more tons of limestone per year. However, because of its age and condition, the plant probably does not represent a reliable source in the longrun unless significant investment is made. The limestone is priced at 400 escudos/ton.

Santiago do Cacém

This plant produces a small quantity of agricultural limestone, although the main emphasis is on production of construction aggregate. The agricultural limestone is priced at 400 escudos per ton. Production capacity is about 8,000 tons per year. However, only about 500 tons of agricultural limestone were sold in 1981.

Portalegre

This proposed plant could produce either calcitic or dolmitic limestone. It would produce construction aggregate as well as agricultural limestone. The agricultural limestone would be produced from residual of the construction aggregate production which is priced at 240 escudos per ton. Although 800 escudos per ton for agricultural limestone has been suggested, there is reason to believe that a lower price might be more appropriate. The consultants estimated a price of 400 escudos/ton based on the aggregate price of 240 escudos per ton plus 160 escudos for additional processing. Capacity of 300,000 tons per year of agricultural limestone is estimated.

Vila Viçosa - Borba

This proposed plant would crush marble waste into limestone with production increasing to 289,000 tons by the seventh year. Because of high fixed costs, prices were seen

declining as production increases 5/

Year	Agricultural Limestone Tons	Price (escudos)
1	19	710
2	46	660
3	93	415
4	185	310
5	227	295
6	256	285
7	289	247

The James Smith report to PROCALFER expressed the view that the plant was well designed but that, because the market is small, quantities were likely to be lower than anticipated and prices would not decline as much as indicated.

Estimation of Quantities and Prices of Liming Material

The estimated prices and quantities of liming material available were developed from information obtained during visits at production plants. These visits included a wide range of limestone crushing plant sizes and types. The most typical types of production plants were included in the survey. The consultants have, in this report, attempted to provide conservative production

5/ Quantities and prices were obtained from the study of feasibility of this plant Projecto de Produção de Pó de Calcáreo no Alto Alentejo Para Utilizacão Como Correctivo Agrícola, December, 1981.

estimates. A summary of these estimates is shown in table 2 for the three major production areas of Sesimbra, Alenquer, and Loulé, where there are several plants, as well as for individual plants at other locations.

Details on the estimates for the Sesimbra, Alenquer and Loulé areas follow:

Sesimbra Area

A. Price:

Residual Pó de Pedra = 75 escudos/m^3
at 1.4 tons/m^3 = 54 escudos/ton
(see Britasul price list, Appendix 3)

Fine limestone material 310 escudos/m^3
(Approximation by plant operator)
at 1.4 tons/m^3 = 221 escudos/ton

B. Estimated production:

- Information from Firm of Teodoro Gomes Alho & Filhos, Lda.

Production of residual Pó de Pedra:
250 tons/hour x 9 hour day
240 days per year
= 540,000 ton/year Crushed Rock
Assuming 10 percent Pó de Pedra
= 54,000 tons per year

TABLE 2

PRICES, PRODUCTION AND STOCKS OF LIMING MATERIALS

SOURCE OF SUPPLY	PRICE		PRODUCTION		STOCKS
	RESIDUAL (PÓ DE PEDRA)	LIMESTONE	RESIDUAL (PÓ DE PEDRA)	LIMESTONE	PÓ DE PEDRA
	ESC/TON		TONS		TONS
Sesimbra area	54	221	420 000	209 000	75 000
Alenquer area	86	-	210 000	-	70 000
Loulé area	60	-	133 000	-	100 000
Rio Maior	250	650	28 000	-	14 000
Ceiras	250	-	28 000	-	14 000
Montemor-o-Novo	506	759 1/	11 000	-	8 000
Fátima	50	800	-	9 000 - 18 000 105 000 by 1983	60 000 100 000
Serpa	-	400	-	10 000	
Santiago do Cacém	-	400	-	8 000	

1/ This product essentially meets limestone standard. A share of the 11 000 tons of residual could be in this form.

SOURCE: Visits by consultants to limestone plants.

- Information from Firm of José Marques Gomes Galo, Lda.

  Production of residual Pó de Pedra:
  112 tons/hour x 11 hour day
  240 days per year
  = 295,680 tons/year crushed rock
  Assuming 10 percent Pó de Pedra
  = 30,000 tons per year

- Combining for above firms

  54,000 tons + 30,000 tons
  = 84,000 tons Pó de Pedra

Sales of above two firms through Britasul in 1981 = 143,595 m^3

Total sales through Britasul = 917,408 m^3 (See table 1)

Thus: $\frac{143,595}{917,408}$ = 15.6 percent of Britasul production

Conservatively these firms are assumed to account for 20 percent of Britasul production. If they account for 84,000 tons Pó de Pedra then:

$\frac{84,000}{.20}$ = 420,000 tons estimated Pó de Pedra from Britasul.

This estimate should be conservative because:

1. It ignores 3 small firms.
2. The assumption of 10 percent residual Pó de Pedra from crushing limestone may be low.

Production of limestone meeting standard:
(100 percent less than 2 mm; 75 percent less than o.71 mm)

Potential production when new lines are installed:

Alho plant (within 10-12 months):
50 ton/hour
250 9 hour days/year
= 108,000 tons/year

Galo plant (October 1982)
420 tons/day
101,000 tons/year

Total limestone production 2 plants only
108,000 + 101,000 = 209,000 tons/year

Stocks of residual Pó de Pedra estimated at 75,000 tons including only observed stocks at three locations.

Alenquer Area

A. Price:

Residual Pó de Pedra = 120 escudos/m^3
at 1.4 tons/m^3 = 86 escudos/ton
(see Calbrita price list Appendix 3)

B. Estimated Production:

- Information from firm of Calbrita

Production:
5,600 ton/day (Assumes 1.4 tons/m^3)
250 days per year
= 1,400,000 tons/year crushed rock
Assume 10 percent Pó de Pedra
= 140,000 tons/year

Calbrita plus other companies in Alenquer are said by local producers to account for three million m^3 (4.2 million tons/year). Assuming 10 percent Pó de Pedra = 420,000 tons/year. Calbrita product may include materials other than limestone and would thus be of lower quality. It would therefore need to be tested. Also because other uses exist the price for Pó de Pedra is somewhat higher.
Stocks of residual at Calbrita were estimated by plant officials at 50,000 m^3 (70,000 tons).

Loulé Area

A. Price:

Residual Pó de Pedra = 60 escudos per ton
At the Galo plant the present price is 38 escudos (Appendix 3).

B. Estimated Production:

Production includes that of three firms - BETECNA, ECOB, and GALO.

BETECNA estimated production at 500,000 m^3 per year; at 1.4 tons/m^3 that is 700,000 tons. At 10 percent production of Pó de Pedra = 70,000 tons/year.

ECOB (Empresa Comercial de Oleos e Bagaços, Lda.). Production was estimated at 1200 tons per day or 288,000 tons per year. (James Smith report to PROCALFER). Assuming 10 percent Pó de Pedra ≐ 29,000 tons per year.

JOSÉ MARQUES GOMES GALO, Lda. Production plant at Loulé. Production was at the rate of 100 m^3 per day of Pó de Pedra. Assuming 1.4 tons/m^3, this would amount to 34,000 tons per year.

Sum of three firms

70,000 + 29,000 + 34,000 = 133,000 tons/year.

Stocks of residual were conservatively estimated based on consultants observation at ECOB plant plus estimate by plant operator.

Alternative Liming Materials

Because of the extremely large quantities of residual Pó de Pedra available in Southern Portugal, the question was considered of whether this residual might be used in larger amounts to provide the same soil neutralizing effect as limestone meeting the standard (100 percent < 2 mm; 75 percent < 0.71 mm). Eight samples were taken for analysis. Both screen size and chemical analyses were done (Table 3). All of the samples rated well in the chemical analysis as indicated by the neutralizing index provided by the laboratory exceeding 95 percent for all samples. Thus, if ground sufficiently fine all would be expected to be satisfactory liming materials.

Materials ground finer than the standard may have greater neutralizing effects than the standard and can therefore be used in smaller quantities.

One of the samples, a screened residual from the Montemor-o-Novo plant, essentially met the limestone quality standard. All others included higher proportions of large particles and would require further processing. Alternatively, more of the residual product per hectare might be used.

To estimate additional quantities of residual limestone materials that might be required the AGLIME CONVERSION TABLE included with the James Smith report was adopted (Table 4). Lime quality indexes were computed for the eight samples (last column table 3). These indexes provide an estimate of amounts to the various products that might be required 6/. For example, the one sample that essentially met the Portuguese limestone standard had an index of 1.0, suggesting that for each ton of limestone required to correct soil acidity only one ton of this screened residual would be required. In contrast, several samples had a computed index of 1.4. These would require 1.4 tons to produce results similar to one ton of the finer product.

6/ Although the AGLIME CONVERSION TABLE was developed for the United States it appears to provide a good approximation for Portuguese standards. For more precise analyses, the consultants suggest that a similar index be developed relative to Portuguese limestone standards.

TABLE 3

SUMMARY OF TESTS OF RESIDUAL (PÓ DE PEDRA) 1/

Limestone Plant	Screen Size 1/				Neutralizing Index 1/	Lime Quality Index 2/
	10	10 - 25	25 - 60	60 Mesh		
	Percent					
Montemor-o-Novo (Sample 1)	17.6	33.2	21.0	28.2	96.4	1.4
Montemor-o-Novo (Sample 2)	2.9	22.6	26.1	48.4	96.4	1.0
Loulé ECOB	6.3	43.8	25.5	24.4	105.0	1.4
Alenquer Calbrita (Sample 1)	30.5	36.6	14.9	18.0	104.4	1.6 3/
Alenquer Calbrita (Sample 2)	27.6	32.1	15.8	24.5	103.4	1.4
Sesimbra Alho	32.4	34.0	21.2	12.4	95.4	1.6 3/
Sesimbra Galo	19.5	29.9	20.4	30.2	106.4	1.4

Cont. ...

Limestone Plant	Screen Size 1/				Neutralizing Index 1/	Lime Quality Index 2/
	10	10 - 25	25 - 60	60 Mesh		
	Percent					
Oeiras Betecna	49.5	21.9	6.7	21.9	107.9	1.6 3/

1/ Tests at request of Consultants by laboratory of Direcção-Geral de Extensão Rural (See Appendix 1 , for actual test results).

2/ Based on "AGLIME CONVERSION TABLE" (Table 4).

3/ Approximations.

TABLE 4

AGLIME CONVERSION TABLE FOR DIFFERENT LIME QUALITY INDEX ZONES

Lime Recommendation (tons/A.)	Zones of Lime Quality According to "Lime Quality Index" Values						
	40-49	50-59	60-69	70-79	80-89	90-99	100-109+
1	1.4	1.2	1.0	0.9	0.8	0.7	0.6
2	2.9	2.4	2.0	1.7	1.5	1.4	1.2
3	4.3	3.5	3.0	2.6	2.3	2.1	1.9
4	5.8	4.7	4.0	3.5	3.1	2.7	2.5
5	7.2	5.9	5.0	4.3	3.8	3.4	3.1
6	8.7	7.1	6.0	5.2	4.6	4.1	3.7
7	10.1	8.3	7.0	6.1	5.4	4.8	4.3
8	11.6	9.5	8.0	6.9	6.1	5.5	5.0
9	13.0	10.6	9.0	7.8	6.9	6.2	5.6
10	14.4	11.8	10.0	8.7	7.6	6.8	6.2

Lime Quality = [(8-20 mesh x 0.2) + (20-60 mesh x 0.6) + (less than 60 mesh x 1.0)] x [%$CaCO_3$]

The soil tests report tonnage of lime to apply for lime having a lime quality index zone of 60-69. To determine the equivalent of lime material above or below this zone, shift to the left or the right on the same lime on the conversion table.

For example: Soil Test Report says; Lime need is 6.0 Tons/Ha. For lime materials in 60-69 lime quality index zone apply 6.0 Tons/Ha. For lime in the 50-59 lime quality index zone 7.1 tons should be applied and for lime in the 70-79 lime quality index zone apply 5.2 Tons/Hectare.

Adapted from table provided in James Smith report to Procalfer, June 1982.

Bulk Delivery System

The organization of agriculture in Southern Portugal, the topography, the relative ease of truck transportation and access to farms, availability of spreading equipment and reduced production and handling costs, all suggest the possibility of a bulk agricultural limestone production and distribution system. Such a bulk system would contrast with the bagged system in use in the North. The limestone distribution study for the North proposed the bagged system now in use "...due to the small size and difficult accessibility to isolated farms..." 7/.

In contrast with the North where farms are mostly very small and difficult to reach by truck, much of the south is in larger units. Although the fields are not always level, southern farms are more frequently accessible by truck. Besides the relative ease of access, the larger farms in the South can more often utilize limestone in truckloads rather than the smaller quantities that might be obtained in bags. Further, discussions with farmers and Extension personnel not only indicated their preference for bulk agricultural limestone but also suggested that equipment is generally available for spreading 8/.

7/ Lauth, James H. and others, Agricultural Distribution Study for Northern Portugal, February 1981.

8/ The consultants observed farmer owned equipment of two types; (1) Tractor mounted 750 kilo spreaders, and (2) four ton trailer type spreaders for use behind farm tractors. Spreaders were also observed at local machinery dealers.

Use of bulk limestone also eliminates bagging costs of 250 escudos to 350 escudos per ton and allows use of dump trucks which can be gravity loaded at production plants and dumped at destinations, with handling costs near zero.

VI TRANSPORTATION SYSTEM

Truck Cost And Capacity

The efficient transportation of agricultural limestone by truck in the south will be dependent on both the highway infrastructure, its quality and location, and the motor carrier fleet itself. The operating characteristics of this mode are based on costs of operation, the capacity of the trucking industry, and the tariffs or rates charged by the truckers. The performance is further dependent on the incidence of backhaul, amount of annual mileage attained by the trucking firm and competition among truckers as well as with the railroad.

This section will analyze the capacity and cost structure underlying the trucking industry in southern Portugal. The capacity will be evaluated by examining the highway infrastructure and the existing trucking fleet. Costs will be computed and evaluated relative to rates existing in the south and then compared to the northern experience. Specific attention is paid to the impact of increased backhaul, annual mileage or variable cost pricing on the cost/rate structure. Potential benefits of shipper or cooperatively owned equipment are then considered.

Both financial and economic costs of transportation are developed. Financial costs include duties and taxes paid while economic costs ignore these items as being transfers within the national economy. As indicated earlier, movement by bulk is expected to be the overriding characteristic in the south and is a basic assumption of this analysis.

Highway Infrastructure

The highway infrastructure in southern Portugal (Regions 5, 6 and 7) is undergoing some improvements and changes that may improve the capability of the highway system to move increasing amounts of traffic. The existing system is summarized in Table 1. Continental Portugal had over 50,700 kilometers of roads of all types existing as of 1978, the last year of complete data available to the consultants at the time of this study. Of those roads, 19,316 kilometers or 38.1 percent are located in the southern three regions.

Forest roads are not very important to the southern area since over 87 percent of the forest roads are located in the north. On all other road types the south has a fairly consistent 36-44 percent share of the country's roads. Forty-four percent of the national highways are located in the southern area. It does appear that the southern region and its subregions have a fairly well distributed road system.

Operating speeds achieved by trucks are affected by land use around the road, alignment and pavement type. 'A survey trip showed the terrain in the south is rolling with most traffic expected to be on paved roads. This results in identified average truck speeds of 70 kilometers per hour in the Ribatejo e Oeste and Alentejo (Regions 5 and 6). The sharper alignment and different pavement condition in the Algarve cause operating speeds to be 55-60 kilometers per hour in that region.

Map 1. indicates the existing highway system, the projects under construction, and those that are under study for construction. The map is for 1979 but, according to highway planning officials, it still reflects the current direction of construction efforts. The

HIGHWAY INFRASTRUCTURE

MAP 1.

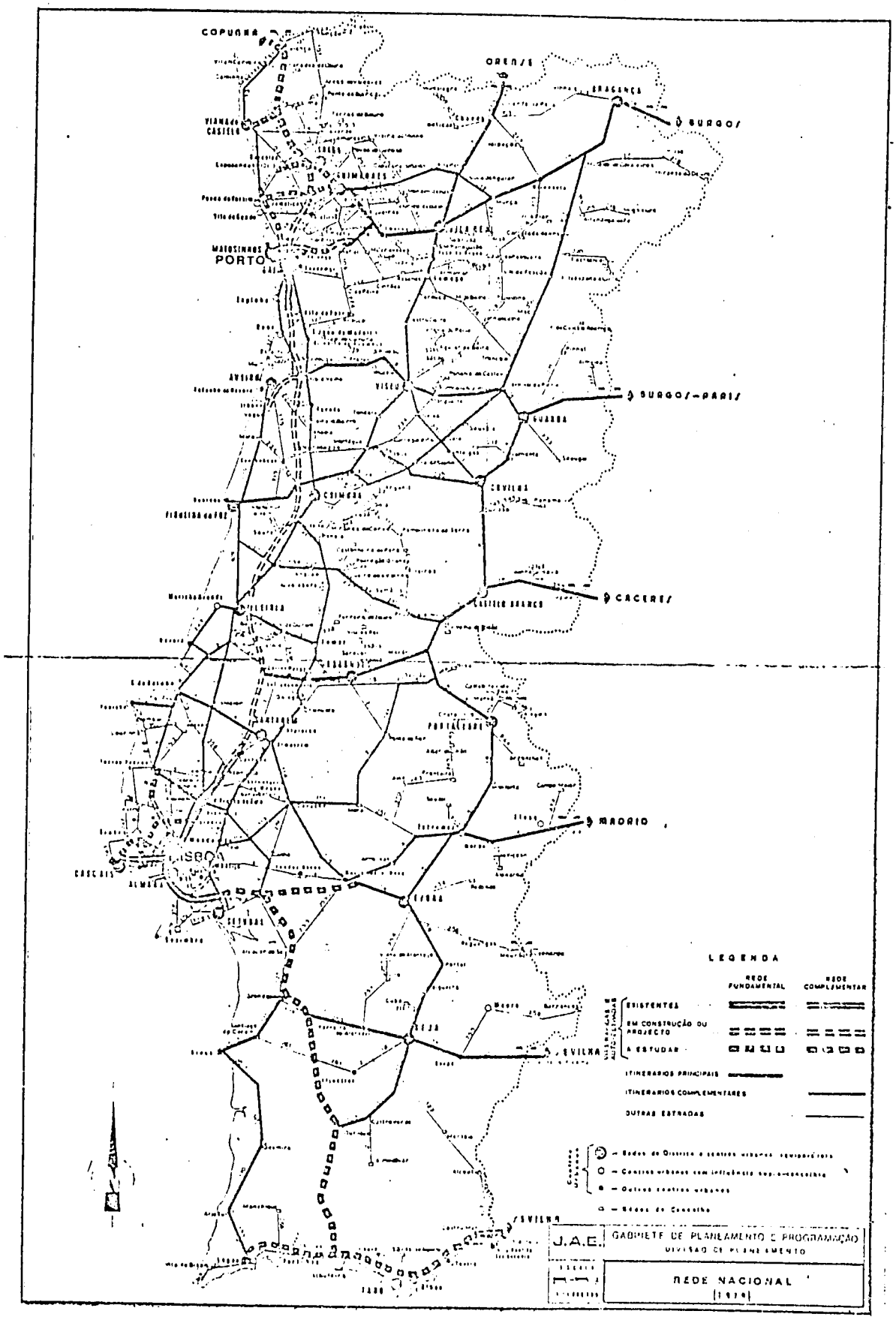


TABLE 1

HIGHWAY NETWORK OF SOUTHERN PORTUGAL, BY ROAD TYPE AND DISTRICT, 1978

DISTRICT	HIGHWAY NATIONAL	(ESTRADA) MUNICIPAL	TOTAL	MUNICIPAL ROADS (CAMINHOS MUNICIPAIS)	FOREST ROADS (VIAS FLORESTAIS)	TOTAL ALL ROADS
			(KILOMETERS)			
Beja	1 332	706	2 038	746	62	2 846
Évora	972	557	1 529	508	13	2·050
Faro	848	548	1 396	62	39	2 059
Leiria	921	585	1 506	694	256	2 456
Lisboa	1 048	839	1 887	556	140	2 583
Portalegre	915	503	1 418	814	25	2 257
Santárém	1 254	1 179	2 433	729	37	3 199
Setúbal	1 023	418	1 441	394	31	1 866
TOTAL - SOUTHERN PORTUGAL	8 313	5 335	13 648	5 065	603	19 316
TOTAL - CONTINENTAL PORTUGAL	18 685	14 949	33 634	12 326	4 749	50 709
PERCENT	44.5	35.7	40.6	41.1	12.7	38.1

SOURCE: Data calculated from Estatísticas dos Transportes e Comunicações, 1979, issued by the Instituto Nacional de Estatística, p.18.

principal activities on construction in the south are a bypass around Grândola and significant improvement to the Loulé - Ourique highway segment. Additionally, Montemor-o-Novo and Estremoz are receiving new bypasses as well as substantial upgrading of the highway east toward Madrid.

Other constraints exist on some of the potential origin - destination combinations for limestone movements. On movements from the Sesimbra area the entire town of Santana is a critical bottleneck to traffic flow as well as having several 120 - 160 degree turns necessary to access the freeway. Although a bypass is presently under consideration by officials in the Santana area, it will probably not be in existence by 1986.

Unfortunately, no information, other than truck cost estimates, was made available to the consultants from the Kampsax National Transportation study, the National Highway Plan by Freeman Fox Associates, or the Railroad Feasibility Plan by Canadian Pacific Consulting Services, Ltd. Thus, the identified highway improvement projects had to be verbally obtained from planning officials in a rather piecemeal fashion. If and when these three studies are accepted by GOP and made public, consultants have been promised that they will receive copies and background documentation.

In any case, the marginal impact of agricultural limestone movement on traffic densities should not be large. For example, in the Montemor-o-Novo area, shipments of 10,000 tons could be originated. With an average of 25 tons per truck, 400 truck trips would be required or less than 2 a day during the year. In the Sesimbra area, a possible movement of 150,000 tons could be expected by 1986. Assuming the same load factor, 6,000 truck trips might be necessary to move this tonnage. Even this large volume out of one specific area would only generate about

3 truck movements per hour. When traffic densities on specific origin destinations are made available from those recent studies identified earlier, more precise analysis of traffic congestion will be possible. In total, the marginal effect is expected to be small.

Trucking Fleet in Portugal

In addition to evaluating the physical capacity of the highway infrastructure in Portugal, it is also necessary to evaluate the capability of the trucking fleet in Portugal to move agricultural limestone. Precise estimates of the number of trucks are not available, but licensing records of the Direcção Geral de Transportes Terrestres can be used in an aggregate fashion [1/]. These operating permits identify the radius of operation and whether the truck operates as a commercial public (for-hire) truck or as a commercial private truck. Most trucks in Portugal (96 percent) are registered as private vehicles even though they sometimes are active as for-hire carriers.

The total truck fleet in Portugal was estimated, in October 1980, to be about 185,000 with an additional 57,600 trailers (see Table 2). Private vehicles are principally small in licensed weight, less than 5,000 kilograms, while the for-hire carriers are larger, generally over 7,000 kilograms.

1/ For a complete discussion, see Agricultural Limestone Distribution Study for Northern Portugal, Lauth, Snitzler, and Tosterud, February 9, 1981, pp. 109-113.

TABLE 2

PORTUGAL TRUCK FLEET SIZE, PRIVATE AND PUBLIC, BY RADIUS OF OPERATION

OCTOBER 1980

Type and Radius of operation	CARGO CAPACITY			
	Up to 5,000 Kgs.	5,001 7,000 Kgs.	Over 7,000 Kgs.	TOTAL
TRUCK				
PRIVATE:				
Radius-30 km	11,298	2,246	2,552	16,096
50 km	38,748	3,684	5,448	47,880
100 km	27,387	2,829	5,243	35,459
No limit	70,284	2,318	5,469	78,071
TOTAL	147,717	11,077	18,712	177,506 1/
PUBLIC:				
Radius-30 km	548	142	379	1,064
50 km	733	155	571	1,459
100 km	1,228	320	1,593	3,141
No limit	471	135	1,160	1,766
TOTAL	2,980	752	3,698	7,430 2/
PRIVATE & PUBLIC:				
Radius-30 km	11,846	2,388	2,931	17,160
50 km	39,481	3,839	6,019	49,339
100 km	28,615	3,149	6,836	38,600
No limit	70,755	2,453	6,629	79,837
TOTAL	150,697	11,829	22,415	184,936 6/
TRAILER				
PRIVATE:	51,673	3,575	1,329	56,577 3/
PUBLIC	22	109	710	841 4/
TOTAL	51,695	3,684	2,039	57,418 5/

1/ Excludes 825 trucks with capacity unknown.
2/ Excludes 314 trucks with capacity unknown.
3/ Excludes 117 trailers with capacity unknown.
4/ Excludes 30 trailers with capacity unknown.
5/ Excludes 147 trailers with capacity unknown.
6/ Exclude 1,139 trucks with capacity unknown.

SOURCE: Agricultural Limestone Distribution Study for Northern Portugal, Lauth, Snitzler, and Tosterud, February 9, 1981, p.110.

The truck fleet size has increased over time, from 81,700 in 1974 to about 186,000 in 1980 [2/]. The distribution of these trucks is quite even throughout the country. The three southern regions had 52 percent of the total truck fleet, about 93,000 trucks and 29,400 trailers in 1980.

The steady growth in trucking capacity in the country indicates that the trucking industry should be able to respond to demands for additional transportation generated by the movement of agricultural limestone. The general information did potentially suggest that bulk movement in the south may require additional purchases of large bulk trucks. However, a survey of limestone producers in the southern three regions indicated that a large number of private vehicles are available, vehicles that are presently carrying highway aggregate or construction material. Additionally, most producers stated that for-hire vehicles could be contracted with no difficulty. The exception was in the northern part of the southern region, near Fátima, where it has been traditional to carry limestone, bagged, on flat bed trucks. This firm had experienced a shortage of bulk trucks in the short run and had responded by initiating the purchase of two new bulk vehicles.

It then appears that agricultural limestone transportation in the south of Portugal may be different from the north but should have no capacity problems. The transportation of agricultural limestone in the south will be by private commercial trucks operated by the limestone producers as contrasted to the north where public (for-hire) owner-operators do most of the hauling. The ratio of rates to costs of operation for private carriage by consumers or cooperatives are specifically analyzed later in this study.

2/ Agricultural Limestone Distribution Study for Northern Portugal, Lauth, Snitzler, and Tosterud, February 9, 1981, pp. 109-113.

Truck Operating Costs

The data utilized in developing the financial and economic operating costs were principally obtained from a survey of agricultural limestone producers in the south. Additional information was received from the Associação Nacional de Transportadores Públicos Rodoviários de Mercadorias and the Rodoviária Nacional. Some of the cost items were verified and modified by the cost functions in the Freeman Fox and Partners report. Several of the cost relationships developed by Juan de Weille in Quantification of Road use Savings were used as assumptions in this study.

The basic approach is the economic-engineering method of firm cost analysis, essentially a synthesizing of costs for typical firm sizes. The primary assumptions used in the analysis were operating speeds in the southern regions of 55-70 kilometers per hour, movement by bulk and not by bags, and typical truck sizes of 34 tons and 22 tons gross vehicle weight (GVW) with respective payloads of 25 tons and 15 tons.

Selection of the two truck sizes and types utilized was made, by the consultants, based on the survey of limestone producers. These producers had over 190 trucks in total. The predominant make was Volvo, followed by Scania. Truck sizes used in limestone movement ranged from 4 ton GVW to 50 ton GVW. The two dominant sizes were 12-16 tons and 30-35 tons and were all bulk carriers. The general characteristics of the truck types chosen as representative are summarized in Table 3.

TABLE 3

GENERAL CHARACTERISTICS OF TRUCK TYPES

	I	II
Gross Vehicle Weight	22	34
Payload in tons	15	25
Number of axles	3	5
Number of tires	10	18
Vehicle life in years	8	10
Annual Kilometers	100,000	100,000
Purchase Price (esc.)	5,000 contos	8,000 contos
Tire cost (18+spare)	253 contos	(10+spare) 437 contos
Depreciable Value:		
with taxes	4,747 contos	7,563 contos
without taxes	4,415 contos	7,033 contos

SOURCE: Survey of limestone producers operating truck fleets in Southern Portugal, July 1982.

Development of Cost Items

Cost items can be separated into those that are directly related to, and vary with, the level of production (in the case of transportation this is usually considered as annual mileage), and those costs that do not vary with mileage. In the short run, these latter costs are considered fixed and the others as variable. In the long run all costs will be variable. Short run fixed costs are depreciation, interest charges or return on equity, and insurance. Variable costs or as commonly called, out-of-pocket costs, include fuel, oil, tires, maintenance, and driver's wages.

Fuel

These two trucks use diesel fuel which, in July of 1982, was being sold for 32 escudos per liter at the fuel pump. This is the financial cost. The economic cost would be 27.17 escudos per liter (32 escudos minus 4.83 escudos tax).

Diesel consumption by the representative trucks in this study was estimated at 35-45 liters per 100 kilometers for the 22 ton GVW truck and 40-60 liters per 100 kilometers for the larger 34 ton GVW truck (see Table 4.) In this study the midpoints of 40 and 50 liters per kilometer were used for the two sizes of trucks. This consumption results in annual consumption of 40,000 liters and 50,000 liters. This is equivalent to a vehicle cost (financial) per kilometer of 12.8 escudos for the smaller truck and 16.0 escudos for the 34 ton GVW. The economic cost per kilometer is 10.87 and 13.59 escudos, respectively.

TABLE 4

FUEL CONSUMPTION AND COSTS

	22 ton GVW	34 ton GVW
Liters per 100 kms	35-45	40-60
average	40	50
Annual consumption in liters	40,000	50,000
Annual fuel cost (financial)	1,280 contos	1,600 contos
Annual fuel cost (economic)	1,087 contos	1,359 contos
Escudos per vehicle km		
(financial)	12.8	16.0
(economic)	10.87	13.59

Engine Oil

The average cost of engine oil was 85 escudos per liter in July of 1982. Without tax it is about 57 escudos per liter. This price, surprisingly, was the same as quoted in December, 1980 in the study of northern Portugal. Costs probably did not increase because the limestone firms operating in the south operate large fleets of trucks and can therefore obtain volume discounts on oil purchases.

Oil consumption was based on 20 liters per oil change and oil was changed every 6,000 miles for the 22 ton GVW truck and every 5,000 miles for the 34 GVW truck. Additionally, 10 liters are assumed to be added between oil changes for the larger vehicle and 5 liters for the smaller truck. This results in total consumption of 4.2 liters and 6 liters per 1000 kilometers for the 22 ton GVW and 34 ton GVW trucks, respectively. Escudos per kilometer for oil consumption were then the following:

Truck	Financial (escudos)	Economic (escudos)
22 ton GVW	.36	.24
34 ton GVW	.51	.34

Tires

Tires for the trucks were estimated to cost 23,500 escudos for each tire with taxes and 22,045 escudos without taxes. The 22 ton GVW truck requires 10 tires so total tire and tube costs for this truck are 230 contos with taxes and 220 contos without taxes. Total costs of tires and tubes for the 34 ton GVW truck, which has 18 tires, are 423 contos (financial) and 397 contos (economic).

Tire wear was estimated from the Juan de Weille study to be:

	22 ton GVW	34 ton GVW
Lifetime speed	48	48
Tire wear*	6.7	9.5
equivalent lifetime Kilometers per tire	150 000	190 000

* Total tire wear of the vehicle as wear of 1 tire per 1,000 km.

Tire costs were then calculated in the following manner:

-Financial:

(22 ton GVW)

.067 x 100,000 = 6.7 tires per year worn out.

6.7 tires x 23.5 contos = 157,450 esc.
÷ 100,000 annual kilometers = 1.58 esc./km

(34 ton GVW)

.095 x 100,000 = 9.5 tires per year worn out.

9.5 tires x 23.5 contos = 223,600 esc.
÷ 100,000 annual kilometers = 2.23 esc./km

-Economic-

(22 ton GVW)

.067 x 100,000 = 6.7 tires per year worn out

6.7 tires x 22.0 contos = 148 contos ÷ 100,000 annual kilometers = 1.48 esc./km

(34 ton GVW)

.095 x 100,000 = 9.5 tires per year worn out

9.5 tires x 22.0 contos = 209 contos ÷ 100,000 annual kilometers = 2.09 esc./km

Depreciation

As indicated in Table 3, the financial depreciable value for the 22 ton GVW and 34 ton GVW was 4,747 and 7,563 contos, respectively. The corresponding economic depreciable values were 4,435 and 7.063 contos. These result in the following depreciation costs per kilometer.

-Financial-

(22 ton GVW)

4,747 contos ÷ 8 years = 593,375 esc. ÷ 100,000 annual kilometers = 5.93 esc. per kilometer.

(34 ton GVW)

7,563 contos ÷ 10 years = 756,300 esc. ÷ 100,000 annual kilometers = 7.56 esc. per kilometer.

-Economic-

(22 ton GVW)

4,435 contos ÷ 8 years = 554,357 esc. ÷ 100,000 annual kilometers = 5.54 esc. per kilometer

(34 ton GVW)

7,063 contos ÷ 10 years = 706,000 esc. ÷ 100,000 annual kilometers = 7.06 esc. per kilometer.

Maintenance

Specific estimates of maintenance costs of trucks continue to be very difficult, if not impossible, to obtain in Portugal. The method of deriving maintenance costs for this study was to update the costs identified in the northern Portugal limestone study, then modify them according to the new estimates made available to the consultants from the Freeman Fox report. This procedure resulted in the following estimates:

	Financial	Economic
(22 ton GVW)	4.6 esc/kilometer	4.1 esc/kilometer
(34 ton GVW)	5.4 esc/kilometer	5.0 esc/kilometer

Driver Time

Average wages and benefits for truck drivers do not vary since a national contract has been established. Deviations in monthly salary only arise as a result of the amount of overtime worked each month. Based on a 45 hour week with an average of two hours overtime, nine hours per

day, the average wages and social benefits paid to a driver was 37,000 esc per month. Since the average monthly kilometers was 8,333 for both truck types, the cost was 4.44 esc per kilometer. This figure was double checked by taking an average kilometers per hour of 47, including loading and unloading time, times 4.44 escudos. This estimate was 208.68 escudos per hour, very close to the 205 escudos per hour, figured on a monthly basis.

Interest

Debt capital must be borrowed and interest paid on this capital. Equity capital requires a rate of return comparable to other investment opportunities. In this study, the market rate of 25 percent was used for both debt and equity capital, based on a range of 23-26 percent in responses from fleet operators.

Interest rates were charged against one half the depreciable value of the vehicle since that would be the average value borrowed or invested during the lifetime of the truck. The financial and economic costs were calculated in the following manner:

-Financial-

(22 ton GVW)

4,747 contos x .5 = 2,373.5 contos x .25 = 593,375 esc. per year ÷ 100,000 annual kilometers = 5.93 esc. per kilometer

(34 ton GVW)

7,563 contos x .5 = 3,781.5 contos x .25 = 945,375 esc per year ÷ 100,000 annual kilometers = 9.45 esc. per kilometer

-Economic-

(22 ton GVW)

4,434 contos x .5 = 2,217 contos x .25 = 554,250 esc. per year ÷ 100,000 annual kilometers = 5.54 esc. per kilometer

(34 ton GVW)

7, 067 contos x .5 = 3,533.6 contos x .25 = 883,403 esc. per year ÷ 100,000 annual kilometers = 8.83 esc. per kilometer

Insurance

Most limestone producers operating trucks in southern Portugal do not carry cargo or collision insurance but are self-insurers due to the high cost of this insurance and the relatively low-value cargo being carried. Annual liability insurance per vehicle was estimated by truck fleet operators as 30,000 escudos per year. Economic costs were estimated as 93 percent of these financial costs. These estimates were the same for both sizes of vehicles, .3 escudos per kilometer (financial) and .28 escudos per kilometer (economic).

Total Truck Costs

The total costs of operating these vehicles to carry agricultural limestone in the southern regions of Portugal are presented in Table 5. The financial costs for the 22 ton GVW truck are 35.94 escudos per vehicle kilometer and 45.89 escudos for the 34 ton GVW truck. The economic costs are estimated to be 32.49 and 41.63 escudos per vehicle kilometer for the 22 and 34 ton vehicle respectively. Thus, economic costs are about 90.5

TABLE 5

FINANCIAL AND ECONOMIC TRUCK OPERATING COSTS IN SOUTHERN PORTUGAL, JULY,

Financial:	TRUCK TYPES	
Cost Items (esc.)	22 Ton GVW	34 Ton GVW
Fuel	12.80	16.00
Engine Oil	.36	.51
Tires	1.58	2.23
Depreciation	5.93	7.56
Maintenance	4.60	5.40
Driver Time	4.44	4.44
Interest	5.93	9.45
Insurance	.30	.30
TOTAL (Esc. per veh/km)	35.94	45.89
Payload in tons	(15)	(25)
TOTAL (Esc. per ton/km)	2.40	1.84
Economic:		
Fuel	10.87	13.59
Engine Oil	.24	.34
Tires	1.48	2.09
Depreciation	5.54	7.06
Maintenance	4.10	5.00
Time	4.44	4.44
Interest	5.54	8.83
Insurance	.28	.28
TOTAL (Esc. per veh/km)	32.49	41.63
Payload in Tons	(15)	(25)
TOTAL (Esc. per ton/km)	2.17	1.67

percent of financial costs.

The cost per ton kilometer is also shown. The financial costs are 2.4 escudos and 1.84 escudos for the 22 and 34 ton GVW vehicles, compared to economic costs of 2.17 and 1.67 escudos, respectively. The larger payload of the 34 ton GVW truck, 25 metric tons, generates greater efficiency and causes this vehicle to be the least costly to operate on a ton per kilometer basis.

Truck Rate/Cost Relationships

Rates charged or revenues received by operators of a trucking fleet must cover all costs if capital is expected to be reinvested into the operation over time. The rate can also reflect the need for transportation and the existence of competition; collectively, this is the rationale for rate making based on value of service, but many other variables also affect the rate and cost relationship. Distance of the movement, size of load, potential backhaul on the return movement; all of these can affect the cost experienced and rate charged.

Under pressure from shippers or desire to maximize sales, truck operators could economically offer rates just barely covering short run or out-of-pocket costs. The variability of truck rates is indicated in Table 6. When only short run variable costs are considered, the floor for economically justified rate making can be identified. This variable cost is 66 and 62 percent of the total cost or 23.78 and 28.58 escudos per vehicle kilometer for the 22 ton GVW and 34 ton GVW, respectively. The total cost for a two-way movement would be 4.8 escudos and 3.68 escudos per ton kilometer, but if short run variable costs are considered, the floor for rate-making can be as low as

TABLE 6

TRUCK COST VARIABILITY

	22 TON GVW	34 TON GVW
	(Escudos)	
Long run Variable Cost per Vehicle km	35.94	45.89
Short run Variable 1/ (Out of pocket) Costs per Vehicle km	23.78	28.58
Percentage	66	62
Long run Variable Costs per ton km	2.4	1.84
Total Cost for two-way movement	4.8	3.68
Out of Pocket Cost for two-way movement	3.17	2.28

1/ Costs excluded are depreciation, interest and insurance.

3.17 and 2.28 escudos per ton kilometer for the 22 ton and 34 ton GVW trucks, respectively.

Truck Rates

Rate tariffs were obtained by consultants during the survey of limestone producers in the south. Rates are customarily expressed in amount per ton on the one-way distance. The weighted average of these rates was 5 escudos per ton kilometer for one way kilometers. However, the range was quite wide, from 3.0 to 10 escudos per ton kilometer, indicating that some managers may be variable cost pricing to aid sales of limestone while others are trying to realize a profit on both limestone and transportation service sales. These rates, with the exception of the plant at Montemor-o-Novo, fell into the 4.2 to 5.0 escudo range.

Rate And Cost Comparison

Truck rates and costs are summarized in Table 7. The cost per ton kilometer for a two way movement is 4.8 escudos for the smaller vehicle, and 3.68 escudos if the larger vehicle is utilized. The survey of the producers indicated that roughly 60 percent of the existing trucks were of the 22 ton GVW size and 40 percent were of the larger size. A weighted average long run variable cost of 4.34 escudos per ton kilometer for a two-way movement was derived. This can be compared to the existing average rate of 5 escudos for the same movement; thus, rates, as quoted in the survey, are slightly above costs.

The relationship of these rates to costs over distance is detailed in Table 8 and Graph 1. The difference or possible

TABLE 7

TRUCK RATE AND COSTS PER TON/KM

(escudos)

	GVW	Payload	Cost/km	Cost/ton/km 1/	Rate/ton/km 1/
	22	15	35.94	4.80	5.0
	34	25	45.89	3.68	5.0
Weighted Average in South				4.34 2/	

1/ Rates and costs are doubled to reflect the vehicle return trip with no backhaul.

2/ A survey of limestone producers indicated that about 60 percent of existing vehicles were of the 22 ton GVW size and 40 percent were of the 34 ton GVW. Thus, the average cost of operating trucks in the south is around 4.34, again, for a two-way movement.

TABLE 8

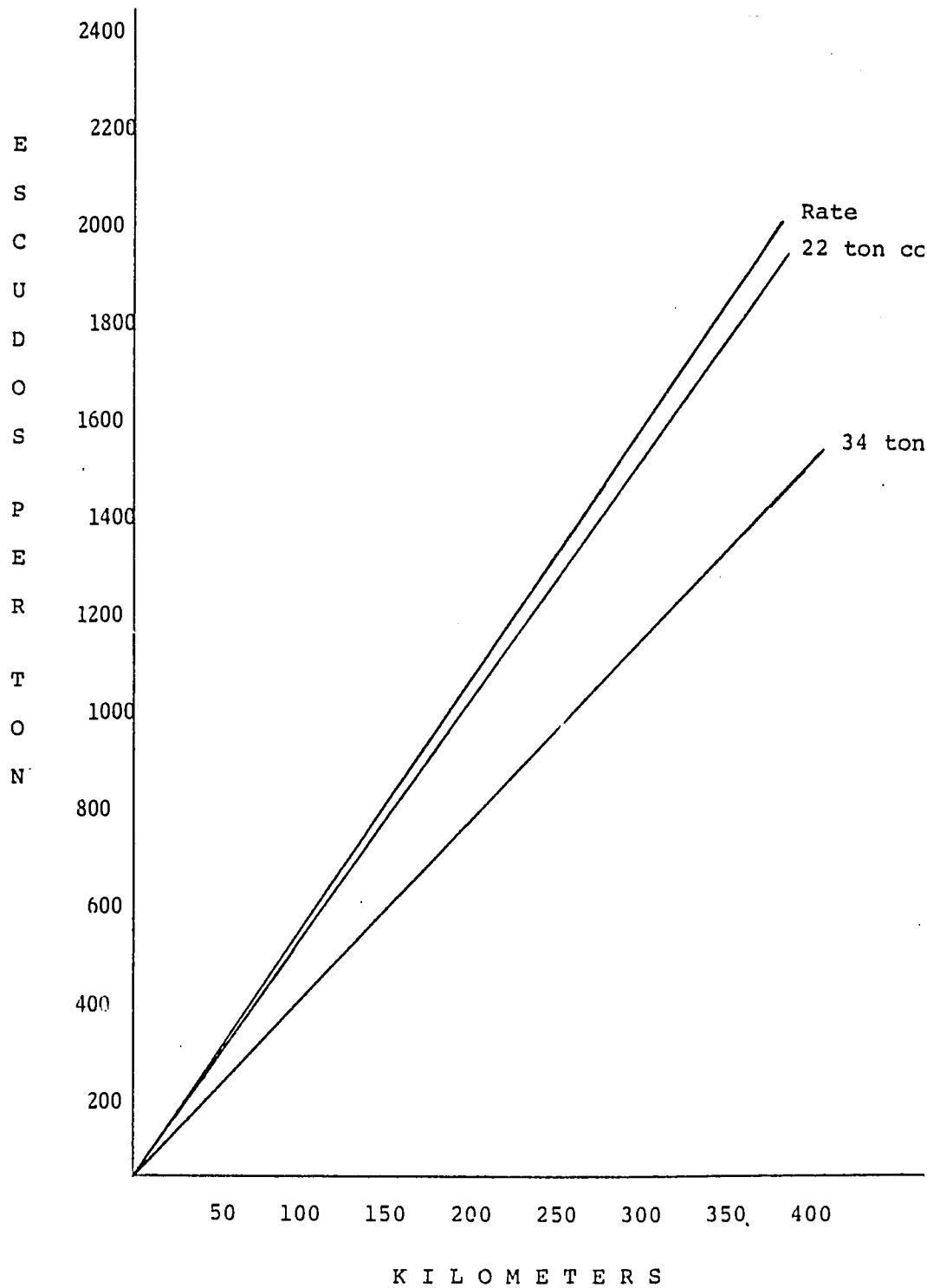
TRUCK COSTS AND RATES AT VARYING DISTANCES

(escudos per ton)

One-way Distance (km)	Cost 22 ton	Cost 34 ton	Rate (escudos)	Difference 22 ton	Difference 34 ton
50	240	184	250	10	66
100	480	368	500	20	132
150	720	552	750	30	198
200	960	736	1000	40	264
250	1200	920	1250	50	330
300	1440	1104	1500	60	396
350	1680	1288	1750	70	462
400	1920	1472	2000	80	528

GRAPH 1

RATE AND COST RELATIONSHIPS TO DISTANCE



profit between rates and costs increases from 66 escudos at 50 kilometers to 528 escudos at 400 kilometers for the 34 ton GVW truck. For the 22 ton GVW truck, the rates and costs are quite close with only 80 escudos difference, even at 400 kilometers.

This relationship of rates to costs appears to be different from that in the northern regions of Portugal. In the north, rates for agricultural limestone, in bags, appear to be below long run variable costs and above out-of-pocket costs. In the south, it appears rates are at or slightly above industry average costs. But, as suggested earlier, many variables affect rate-cost relationships. Type of truck ownership (private versus for-hire) and backhaul possibility do appear different between northern and southern Portugal.

In summary, it is the consultants' judgement that the level of information about the future rate structure for agricultural limestone in the south is very low at this time. Most of the rate tariffs were for trade areas of 50 kilometers radius or less and little experience exists on longer hauls of agricultural limestone. It is expected that future rates will reflect distance of haul and size of truck, with rates on longer, heavier movements being lowered on a ton per kilometer basis. In any case, it appears that rates may follow long run variable costs more closely in the south than in the north.

Backhaul And Cost Relationships

Rates are typically for a two-way movement of the vehicle since the vehicle has to return to its origin. Thus a 100 kilometer movement has a rate reflecting 200 kilometers of operational costs. But, such a rate tariff reflects no loads on the return movement, and therefore, no revenue other than the original fronthaul. If a return load can be achieved, total

costs can be spread over both loads. This increases the possibility, if not necessarily the probability, of rates being lowered on the front haul commodity, in this case, agricultural limestone.

The effect and importance of success in obtaining a backhaul is indicated in table 9 below.

TABLE 9

EFFECT OF BACKHAUL ON COSTS AND RATE/COST RELATIONSHIPS, ESC/TON/KM

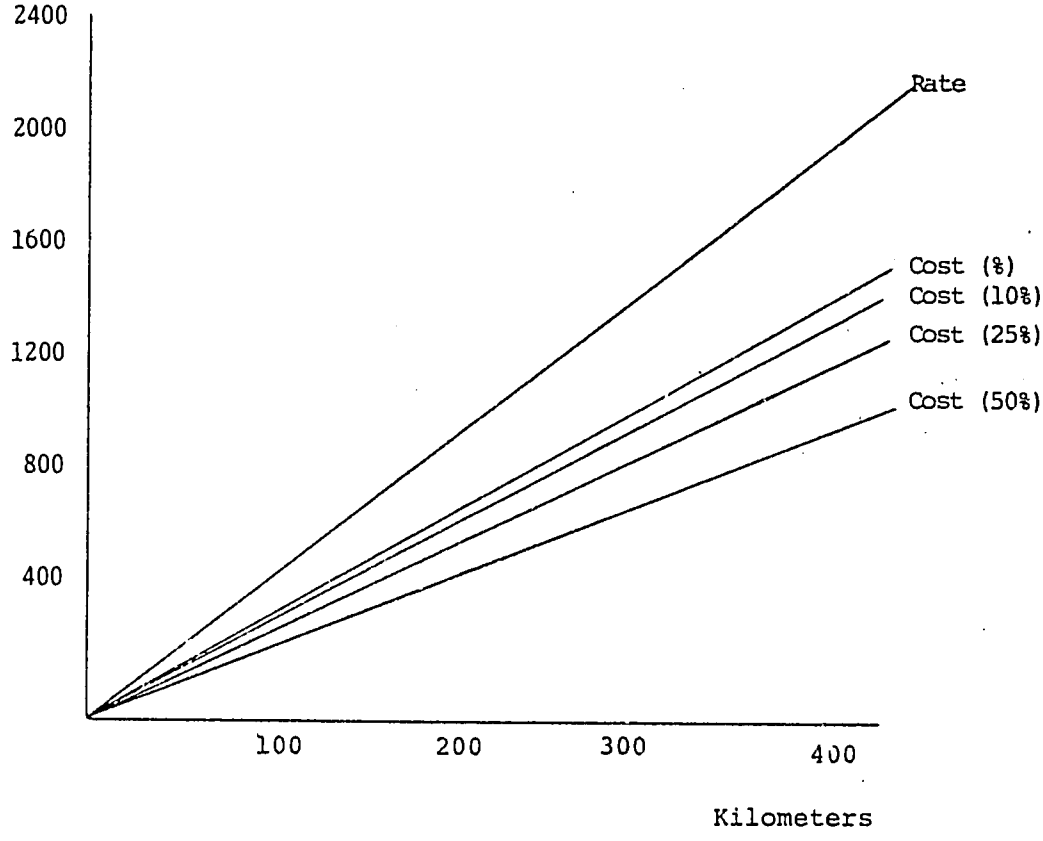
BACKHAUL FREQUENCY	COSTS (22 TON GVW)	COSTS (34 TON GVW)	ESTIMATED RATE	DIFFERENCE (22 TON GVW)	DIFFERENCE (34 TON GVW)
%					
0	4.8	3.68	5.0	.20	1.32
10	4.56	3.50	5.0	.44	1.50
25	4.2	3.22	5.0	.80	1.78
50	3.8	2.76	5.0	1.20	2.24

as the backhaul frequency increases from 0 to 50 percent, the costs per ton kilometer drop from 3.68 escudos to 2.76 escudos for the 34 ton GVW vehicle and drop from 4.8 escudos to 3.8 escudos for the 22 ton GVW truck. Comparing this to estimated rates shows clearly why rates have a possibility of dropping when backhaul is achieved. The net difference (profit) for a kilometer increases from .20 escudos to 1.20 escudos for the 22 ton GVW and from 1.32 escudos to 2.24 escudos as the backhaul frequency increases. The difference is shown in graph 2.

In the southern region of Portugal a very low backhaul frequency is expected. The movements are expected to be fairly short distances, in bulk trucks, that return directly to the limestone plant. But some opportunities do exist, such as bulk trucks

GRAPH 2

BACKHAUL PERCENTAGE AND RATE/COST RELATIONSHIPS,
ESC/TON/KM FOR 34 TON GVW



going empty to Evora from Rio Maior to pick up a product for Rio Maior to be refined for glass production. Movements of wheat may also serve as return haul movements. So, if and when any cooperative, shipper or limestone producer is successful in obtaining a consistent return haul, the cost savings and rate level changes for agricultural limestone movement could be substantial.

Shipper or Cooperatively Owned Equipment

It appears significant differences exist between the north and south regions of Portugal relative to trucking activities and performance. Trucks in the north are predominantly public for-hire carriers, using flat bed or low side vehicles with some backhaul; in contrast, trucks in the south are principally private commercial vehicles owned by the limestone producers, using bul dump trucks with little identified backhaul. Further, the rates in the north appear to be below long run variable costs while the rates in the south tentatively appea to be near long run variable costs for the 22 ton GVW vehicle and significantly above costs for the 34 ton GVW vehicle.

These factors suggest that conditions exist that would make shipper owned equipment economically viable in the south. Potential benefits do exist, such as lower operating costs, the use of costs rather than rates, increased flexibility in service, etc. This section will evaluate potential economies available from shipper owned and operated equipment. Particular attention will be paid to cost or rate saving arising from annual vehicular mileage, backhaul, and labor/financial efficiencies.

Annual Mileage

Cooperatively or shipper owned trucking could improve on the annual kilometers of a vehicle by dedicating their volume

of agricultural limestone to their own vehicle. The potential impact of greater annual kilometers can be identified in the following table:

TABLE 10

ANNUAL KILOMETER AND TRUCKING COSTS

(34 TON GVW)

NUMBER OF ANNUAL KILOMETERS	TOTAL COSTS PER KILOMETER
80 000	$\frac{80\ 000\ (28.58\ \text{esc.}) + 1\ 731\ \text{contos}}{80\ 000} = 50.22\ \text{esc.}$
100 000	$\frac{100\ 000\ (28.58\ \text{esc.}) + 1\ 731\ \text{contos}}{100\ 000} = 45.89\ \text{esc.}$
120 000	$\frac{120\ 000\ (28.58\ \text{esc.}) + 1\ 731\ \text{contos}}{120\ 000} = 43.01\ \text{esc.}$
140 000	$\frac{140\ 000\ (28.58\ \text{esc.}) + 1\ 731\ \text{contos}}{140\ 000} = 40.95\ \text{esc.}$

The short-run variable costs or out-of-pocket expenses in this example are 28.58 escudos per kilometer, consisting of fuel, oil, tires, maintenance and driver time. The fixed costs are 1,731 contos per year, consisting of depreciation, interest and insurance. Total per kilometer costs decrease as the annual kilometers increase, going from 50.22 escudos per vehicle kilometer if a vehicle is operated 80 000 kilometers per year, to 40.95 escudos if the vehicle is able to achieve 140,000 kilometers per year, a savings of 18.5 percent in costs of operation.

If the average trip length is 150 kilometers one way, then the number of trips necessary to reach 100 000 annual kilometers is 333 as shown below in Table 11.

TABLE 11

VOLUME OF LIMESTONE REQUIRED TO ACHIEVE VARIOUS ANNUAL KILOMETERS, 150 KILOMETER ONE-WAY TRIPS

ANNUAL KILOMETERS	NUMBER OF TRIPS	CARGO-WEIGHT TONS	TOTAL LIMESTONE MOVED (TONS)
80 000	267	25	6 675
100 000	333	25	8 325
120 000	400	25	10 000
140 000	467	25	11 675

This means that a cooperative or shipper would have to move 8,325 tons in order to achieve the average costs per kilometer identified in this study for a 34 ton GVW vehicle. If the shipper could move 11,675 tons in a year, costs per vehicle kilome could be lowered from 45.89 escudos to 40.95 escudos.

Backhaul

As developed earlier in this report, any revenue generated on the return movement reduces costs to be allocated to the fronthaul traffic. The impact on those costs of even a 20 percent loaded backhaul is significant. (See Table 9). The manager of a cooperatively owned and operated truck could work to become the focal point for any shipments moving out of the area towards the limestone production areas. Since most of these limestone sources are at, or near, population centers there may be local produce or production available for movement towards those centers.

Low Interest Loans

Cooperatives in Portugal may have available to them

either lower cost government financing or local financing sources offering lower interest than to a private individual. In either case, the interest charges may be lower, causing the costs of operation to decrease. An example is shown in Table 12 below.

TABLE 12

INTEREST LEVELS AND TRUCK COSTS, 34 TON GVW, ESCUDOS

INTEREST PERCENT	ANNUAL INTEREST	KILOMETER INTEREST COST	TOTAL VEHICLE COST
25	945,375	9.45	45.89
20	756,300	7.56	44.00
15	567,225	5.67	42.11
10	378,150	3.78	40.22

For every 5 percent decrease in cost of borrowing capital, a 1.89 escudos decrease in vehicular costs per kilometer occurs. Thus, interest charges drop from 9.45 escudos per kilometer to 3.78 escudos per kilometer as the interest rate paid decreases from 25 percent to 10 percent. Total costs decrease from 45.89 escudos to 40.22 escudos per vehicle kilometer, a decrease of over 12 percent, due only to a change in interest paid as a result of being a cooperative or in some manner qualifying for a low interest loan.

Cooperative Efficiencies

Some efficiencies may also be possible if the cooperative trucking fleet is administratively combined with an ongoing cooperative. The manager of the cooperative might serve as the manager of the trucking activities as well. Mechanics and labor could be used for both operations as truck drivers or equipment operators in times of seasonal demand. Also, a larger cooperative purchasing

materials for several operations may receive volume discounts. Thus, costs would decrease.

Rate/Cost Relationships

The above discussion emphasized potential decreases in costs of operation of shipper owned equipment. The largest savings may simply be that there would be no difference between rates paid and costs of operation of the truck. As presently estimated in the southern regions of Portugal, rates exceed costs, significantly, for the 34 ton GVW. Shipper owned and operated equipment, even if none of the potential cost economies identified above are realized, will guarantee that rates (tariffs paid) are at least as low as costs of truck operation. Further, operating one truck will give the cooperatives knowledge about what the costs of operation are and they will then be able to critically evaluate rates being charged by the limestone producers.

Implications

Without a doubt there are definite benefits to a cooperative or shipper of owning his own equipment. Rate increases or levels may be minimized by the availability of this competitive alternative. It is evident that a cooperative should evaluate its market relative to investing in trucking equipment. Such an investment could be made by one cooperative or several cooperatives joining together to form a transportation cooperative. Specifically, if the following situations individually hold, or some combination of them are available, a cooperative should actively consider acquiring trucking equipment.

1) If annual kilometers per vehicle will be over 100,000. This is obtainable by a volume of around 8,000-9,000 tons annually.

2) If any loads for the return movement can be identified. Even a small percentage of 10 percent loaded return hauls lowers the total cost by 5 percent.

3) If low interest loans are made available. A savings of more than 12 percent in total costs of truck operation is attainable if a 10 percent interest rate is received.

4) If existing labor can be used in the trucking operation, thus increasing the productivity of that labor.

5) If rates of for-hire carriers on limestone producers are above the estimated costs of operation. Provision of shipper owned equipment will decrease the transportation bill to at least costs of operation.

Rail Cost and Capability

The railroad system offers a high capacity, low variable cost alternative to move agricultural limestone in the south. This section will evaluate the physical capability of the railroad by reviewing its infrastructure and fleet characteristics. The economic capability will then be examined by identifying costs of operation, probable rates, and rate/cost relationships.

Railroad Infrastructure

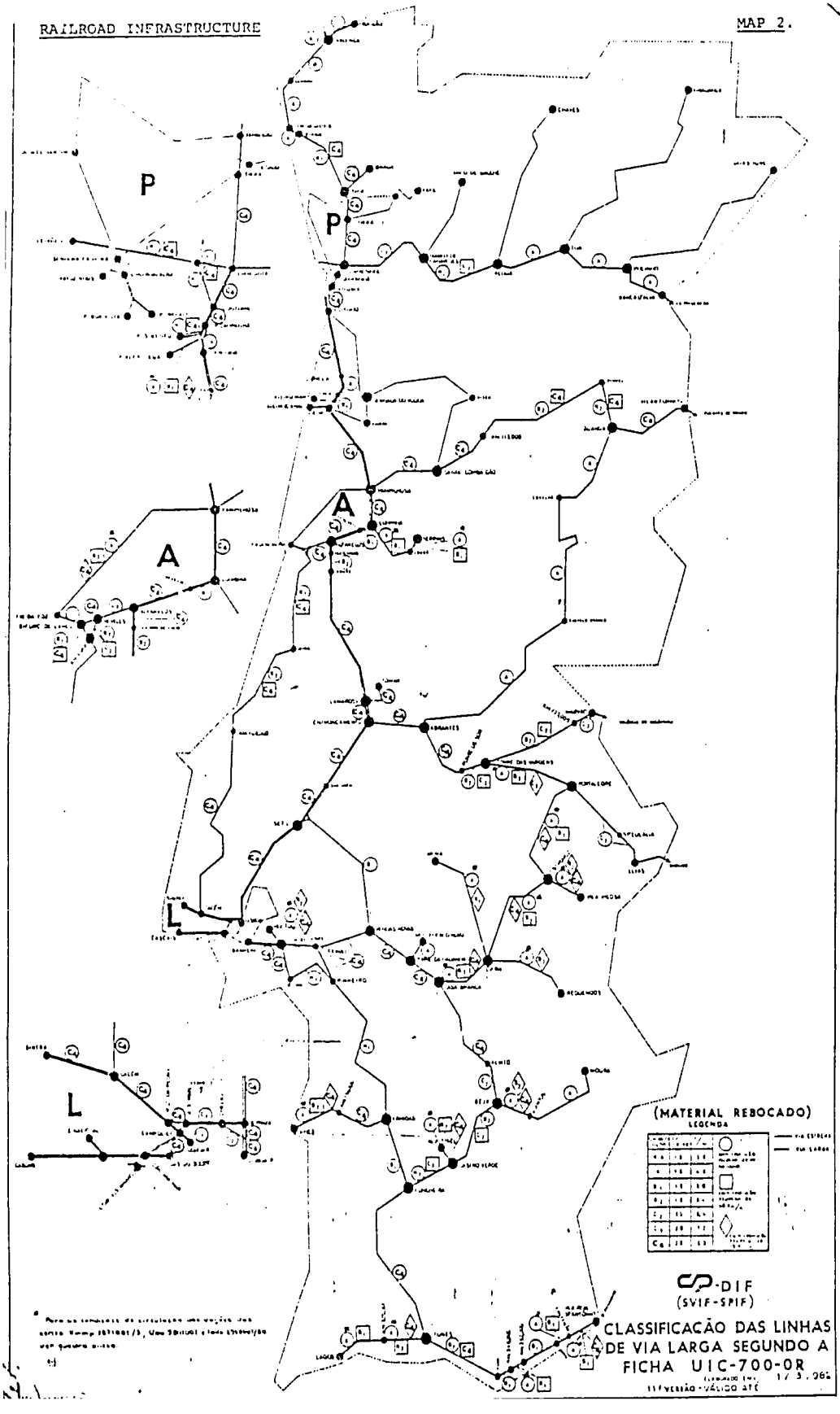
The CP has a program of upgrading trackage to 54.4km/m rail. Yet, over 1200 kilometers of the track is still lighter, older and worn. Some bridges also exist that cannot carry 20 ton axle loads.

The resultant weight restrictions constrain the weight per axle to 20 tons gross weight and lower. As indicated in map 2, some areas in the south are subject to either 18 or 16 tons per axle limits. But, in most origin-destinations tentatively identified for agricultural limestone shipments, at least an 18 ton axle weight is permitted. The only segment where the 16 ton axle limit is imposed in the south is into Montemor-o-Novo from the mainline.

The wagon fleet of CP totaled 6,367 wagons as of September, 1981. These wagons are assigned to service in each region as follows:

RAILROAD INFRASTRUCTURE

MAP 2.



	WAGONS	
	OPEN	CLOSED
Northern Region	578	578
Centre Region	1 908	1 784
Southern Region	558	970
	3 044	3 332

Of these 6 367 wagons, 4 020 are in commercial service. Others are only used in service for CP renovation or maintenance, are under repair, or are scheduled for retirement. Wagons owned by shippers such as Quimigal, Cimpor, Mobil, Sacor, etc. supplement the CP fleet by another 225 wagons.

It is expected that agricultural limestone in the south will be shipped in bulk in open top gondolas. Specifically, the L510 (2 axle) and EAOS 596 (4 axle) gondola will be the type of wagon used. The CP has, 1982, 200 of the 2 axle gondolas and about 300 of the 4 axle wagons. The 2 axle gondolas are presently used to haul coal and the 4 axle gondolas are typically used to carry wood to Spain but excess capacity is judged to be available 2/.

The 1981 freight traffic commodity distribution of the CP is indicated in Table 13. Table 14 shows the pattern in 1979. In 1981, the top ten commodities by tonnage comprised 73 percent of the volume, down slightly from 74 percent in 1979. The total tonnage has remained fairly steady, about 3.1 million tons in both years. Cement and fertilizer are the most important commodities, comprising 37 percent in 1979, increasing to 45 percent in 1981. If even moderate projections of agricultural lime-

2/ Based on Interview with CP officials

TABLE 13

FREIGHT COMMODITY STATISTICS, CP RAILROAD, 1981

Commodity No.	Commodity	Number of Wagons	Tons	Average tons per Wagon	Average length of Haul	Rank in tons
63	Cement	36,473	897,629	24.61	249	1
74	Fertilizer	27,196	501,740	18.45	314	2
01-5	Grain	20,507	377,831	18.43	285	3
30,31	Bulk Petroleum	4,376	120,235	27.47	180	4
35-37	Bulk Wood	5,208	112,804	21.66	339	5
58	Iron and Steel	4,429	83,622	18.90	362	6
26	Animal Feed	3,797	80,090	21.09	316	7
06	Flour	3,216	51,203	15.92	265	8
45-48	Minerals	1,187	36,182	30.48	140	9
11,12	Beer and Mineral Water	223	3,373	15.13	299	10
	TOTAL, top 10 Commodities	106,612	2,264,709	21.24	275	
	Percent of Total	61	72			
	All other Commodities	67,498	865,716	12.8		
	TOTAL, all Commodities	174,110	3,130,425	18.0	273	

SOURCE: Freight Commodity Statistics, 1981, CP Railroad

TABLE 14

FREIGHT COMMODITY STATISTICS, CP RAILROAD, 1979

Commodity No.	Commodity	Number of Wagons	Tons	Average Tons Per Wagons	Average Length of Haul	Rank in Tons
63	Cement	24,567	623,284	25.37	293	1
74	Fertilizer	28,282	548,414	19.39	293	2
45-48	Minerals	10,152	367,058	36.16	215	3
1-5	Grain	16,647	307,279	18.45	243	4
30,31	Bulk Petroleum	4,186	126,989	30.34	171	5
58	Iron and Steel	6,123	113,943	18.61	200	6
35-37	Bulk Wood	4,262	82,539	19.36	244	7
6	Flour	4,708	60,672	12,89	255	8
49-52	Crushed Rock	3,017	58,557	19.41	123	9
26	Animal Feed	2,979	56,644	19.01	323	10
	TOTAL, top 10 Commodities	104,923	2,345,923	22.35	257	
	Percent of Total	63	74			
	All Other Commodities	60,701	807,123	13.30	-	
	TOTAL, All Commodities	165,624	3,152,590	19.30	257	

SOURCE: Freight Commodity Statistics, 1979, CP Railroad

stone movements are achieved, that is, 150,000-250,000 tons annually, limestone would be in the top ten, and possibly the top 5 commodities in CP volume.

Generally, it appears that adequate track and fleet capacity exist in Portugal to handle the proposed movements. However, weight limit restrictions may affect the costs of agricultural limestone transportaton.

RAIL COSTS

Rail costs, developed for July 1982, are the result of the physical capability discussed earlier in this report. The methodology consisted of updating and modifying the original rail cost estimates of the CPCS, as reconstructed in the northern Portugal limestone distribution study 1/ . The gondola wagon was chosen by the consultants for bulk movement of limestone and costs were developed for this type of movement.

Cost Adjustments

The following cost adjustments and assumptions were made to the 1980 cost functions:

1) "Maintenance of wagons", "System level general overhead", "On company service - non revenue freight", "Shunting costs", "Station employees

1/ Plano de Reabilitação Ferroviária, CPCS, 1978 and Agricultural Limestone Distribution Study for Northern Portugal, Lauth, Snitzler and Tosterud, 1981

and expenses", and "Train cost per kilometer", were all increased 33 percent to reflect the 18 month time period between cost estimates.

2) "Wagon portion of train" was increased from 4/45 for bulk wagons to 4/66 to reflect a train that would have 17 wagons with 2 axles (34 axles total) and 8 wagons with 4 axles (32 axles total). This train composition was based on the distribution of the wagon fleet owned by the CP.

3) "Wagon days loading and unloading" was increased from 2.7 to 5 days per shipment to reflect the slow loading and unloading by a front-end loader and/or a backhoe.

4) "Wagon days per kilometer" was increased to .0135 based on an average distance hauled of 100 km/day.

5) "Car ownership (replacement value)" was set at 2,600 contos for a gondola wagon with no pneumatic equipment. The cost of capital was increased from 20 to 25 percent to better reflect current interest rates.

6) The movement in the south was expected to be on non-electric lines.

7) The consultants accepted the 35 year life with no salvage value for depreciation purposes and accepted the 100 percent empty return movement (ERM).

These cost items were used in tables 15 and 16 to develop the following rail cost estimating equation:

$$\text{Total wagonload cost} = 8{,}185.04 + 67.36k$$

where k = number of kilometers

TABLE 15

JULY 1982 RAIL COSTS - GONDOLA WAGON: 40 TON PAYLOAD

Cost Item (escudos)	Cost
1) Maintenance of wagons	179.23
2) System level general overhead (line 1 x .12407)	22.23
3) On Company Service - Non-Revenue freight(1 + 2 x .03444)	6.94
4) Sub-total (lines 1-3)	208.40

5) Car ownership (replacement value, 2,600 contos)

A) Depreciation Rate = 1/35 = 2.86%

Depreciation Expense = 2,600 contos x .0286 = = 74,360 escudos

B) Cost of Capital = Average Net Investment x cost of capital = .5 x 25% = 12.5%
2,600 contos x .125 = 325,000 escudos

C) Ownership Cost/Day = $\frac{74,360 + 325,000}{365}$ = 1,094.14

6) 1982 Wagon costs/day (Lines 4 and C) =	1,302.54
7) 1982 Wagon costs 1,302.54 x 5 days =	6,512.70
8) Shunting costs	567.83
9) Station employees and expenses	1,104.51
10) TOTAL (Lines 7-9)	8,185.04

TABLE 16

TRAIN COSTS

COST ITEM (BROAD TRACK)			(escudos)	COST
a)	i)	Train cost/km		265.61
	ii)	Wagon portion of train		4/66
	iii)	Train cost/wagon km (i x ii)		16.10
b)	i)	Cost/wagon day		1,302.54
	ii)	Wagon days/km		.0135
	iii)	Wagon cost/wagon km (i x ii)		17.58
c)		TOTAL Cost/wagon km (a iii + b iii)		33.68
d)		Empty return mileage (%)		100.0
e)		TOTAL cost/loaded wagon km (2 x c x d)		67.36

In order to estimate per ton rail costs the average payload must be divided into the cost function coefficients. The specific cost per ton is very sensitive to the size of the payload. Two possible payload coefficients were used.

(50 Ton payload)

If only 4 axle cars are used, and these cars only move on tracks that allow axle weights of 18 tons or greater, the possible payload is 50 tons.

4 axles x 18 ton limit = 72 ton GVW - 22 tare weight = 50 tons possible payload

(40 Ton payload)

If both 2 axle cars and 4 axle cars are used, in their proportion of the entire car fleet, and these cars are only moved on tracks that allow axle weights of 18 tons or greater, the possible average payload is 40 tons.

4 axle x 18 ton limit = 72 ton GVW - 22 ton tare weight = 50 tons

2 axle x 18 ton limit = 36 ton GVW - 12 ton tare weight = 24 tons

thus: 50 tons x 300 4 axle cars in fleet = 15 000
24 tons x 200 2 axle cars in fleet = 4 800

15 000 + 4,800 ÷ 500 cars = 39.6 tons average payload

These two payload possibilities result in the following per ton cost functions:

<u>40 ton</u>	204.63 + 1.68 k
<u>50 ton</u>	163.70 + 1.35 k

These cost equations result in the costs at alternative distances in Table 17 below.

TABLE 17

JULY, 1982 RAIL COSTS PER TON, VARIOUS DISTANCES

Distances (kilometers)	40 ton payload	50 ton payload
	(escudos)	
50	288.63	231.20
100	372.63	298.70
150	456.63	366.20
200	540.63	433.70
250	624.63	501.20
300	708.63	568.70

Assembly, Handling and Delivery Costs

Since none of the probable production sources of agricultural limestone are located on rail sidings, any movement by rail will necessitate some truck movement as well. In fact, rail shipments will have to be assembled by truck, loaded at the origin, unloaded at the destination, and delivered by truck. Thus, the total cost of rail shipments must include not only the cost of the rail movement but also the necessary assembly, handling and delivery costs. This section will develop these costs.

Assembly by Truck

It was assumed that a 34 ton GVW truck would be utilized from the limestone plant to the rail siding. This entails a cost of 3.68 escudos per ton kilometer. A survey of production sources indicated an average

of 15 kilometers would be the distance from production source to railhead. This resulted in an assembly cost at origin of 55.20 escudos per ton.

Delivery by Truck

Truck delivery, from rail siding to farm, was also assumed to be by 34 ton GVW truck at 3.68 escudos per kilometer. The estimated delivery distance, if only 10 destinations in the southern region are used, was an average of 50 kilometers. This results in a delivery cost per ton of 184.20 escudos.

Loading and Unloading Costs

In order to load the bulk limestone into the open top gondola wagon a front-end loader is necessary. At the destination point it becomes necessary to use a backhoe to clean the gondola cars and load the trucks for delivery to the farms. This requires a backhoe at every destination rail siding and a front-end loader at every origin rail siding.

Purchase price estimates were obtained and a combination front end loader and backhoe was chosen to be used at every handling point. Machines that were only backhoes were more expensive, 6 million escudos, compared to the smaller, more popular combination machine at 3.5 million escudos. This machine has a 60-70 horse power engine, a reach of 6-7 meters, and a 5 year life expectancy. The depreciation costs on this equipment would be 700,000 escudos per year and interest, at 25 percent annually, would be 437,500 escudos per year, for a total ownership cost per year of 1,137,500 escudos.

The ownership cost per ton is very sensitive to the annual volume handled by each machine. For 1986, the

expected agricultural limestone movement was 220,000 tons. Since truck movement is expected on the short hauls, it was assumed that 60 percent or 132,000 tons of limestone would be moved by rail, if it were cost effective to do so. It was further assumed that 3 origins in the southern regions would be used to move limestone to 10 destinations in the consumption regions. This results in an average volume at origin of 44,000 tons and at destination 13,2000 tons, or an ownership cost at origin of 25.85 escudos and at destination, 86.17 escudos per ton.

In addition to ownership costs, labor and operating costs for the backhoe/frontend loader would occur. Operating cost per ton, principally gas, oil and maintenance, was estimated to be 10 escudos per ton. A machine operator would load or unload a 50 ton payload wagon in two hours at an estimated labor cost of 200 escudos per hour. This results in an estimated labor cost of 8 escudos per ton.

Combining the ownership, operating and labor costs at origin results in a loading cost of 43.85 escudos per ton. At the destination areas, where volume is lower, the unloading costs are estimated at 104.17 escudos per ton.

Total assembly, handling and distribution costs are then estimated as follows:

a)	Assembly-truck	55.20
b)	loading	43.85
c)	unloading	104.17
d)	delivery-truck	184.20
	Total handling cost	387.42 escudos

While the consultants feel this is a reasonable estimate of total handling costs, they are aware that several

critical assumptions have been made:

1. These costs are based on 1986 traffic volumes, thus at smaller volumes in earlier years the loading and unloading costs may increase.

2. It was assumed that rail would only capture 60 percent of the movement. If more limestone were to move by rail, handling costs would decrease as the fixed ownerships costs of the front end loader/backhoe are spread out over more tons.

3. A brief analysis of the impact of different numbers of origins, destinations and delivery distance was done. Increasing the destinations to 20 areas with shorter delivery distances only marginally affected costs since lower truck delivery costs were mostly offset by higher unloading costs. If more than three origins are used, loading costs would increase significantly.

Total Rail Costs

The costs of rail movement are combined with the assembly, handling and delivery costs in table 18 below.

TABLE 18

TOTAL RAIL COSTS PER TON, INCLUDING HANDLING COSTS

Distance (Kilometer)	40 Ton Payload	50 Ton Payload
	(escudos)	
50	676.05	618.62
100	760.05	686.12
150	844.05	753.62
200	928.05	821.12
250	1,012.05	888.62
300	1,096.05	956.12

Both 40 ton and 50 ton cost functions are indicated. It is apparent that the impact of the handling costs is to simply increase the base charge in escudos from 204.63 to 592.05 for the 40 ton payload and from 163.70 to 551.12 for the 50 ton payload.

Railroad Rates

Prices (rates) charged by the CP for shipments by rail are published in tariffs available from the CP. Commodities are classified according to their physical transportation characteristics and assigned to a specific rate scale table. These tables specify rates in escudos per ton for length of haul and cargo weight per wagon.

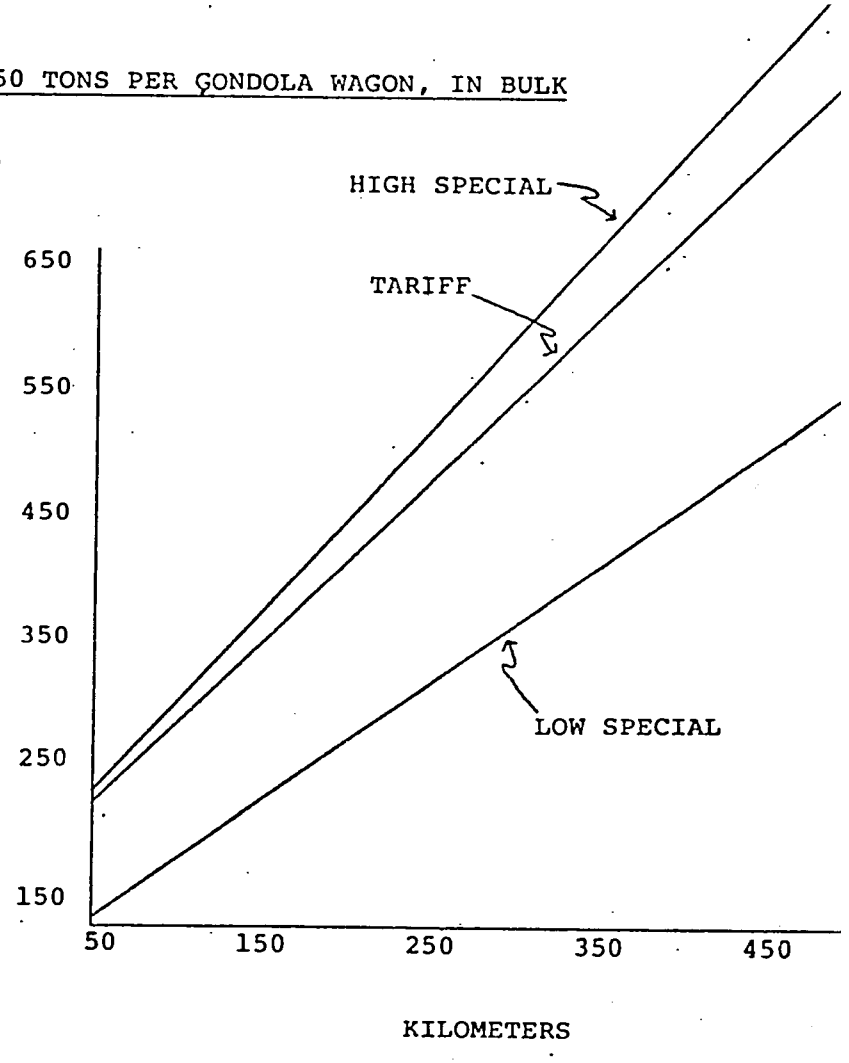
Since no crushed limestone is now moving by rail in bulk, crushed limestone has not been assigned a rate scale table. CP officials, unofficially, judged that Table 601 would likely fit the characteristics of bulk crushed limestone. However, rate scale tables serve principally as a base from which to calculate rates to be charged. Conditions such as truck competition, number of wagons per day or per week, number of wagons per train, type of wagon, seasonality of movements, annual volume, expected turn-around time, market competition, and shipper or carrier owned equipment are considered in each instance to determine the amount of the reduction to be given under the published applicable rate in the tariff.

For crushed limestone, in bulk, in 4 axle gondolas, in shipments ranging from 66,000 ton per year to 220,000 tons per year, at 40 to 50 tons per wagon, in railroad equipment, and moving seasonally, CP officials estimated the range of special rates which might be offered. Table 19 presents the published tariff rate for crushed limestone and the high and low of special rates which could be expected. The low range of

RAILROAD RATES FOR CRUSHED LIMESTONE, 40-50 TONS PER GONDOLA WAGON, IN BULK

(ESC. PER TON)

KILOMETERS	TARIFF RATE 1/	HIGH SPECIAL RATE 2/	LOW SPECIAL RATE 2/
50	225	218	153
100	293	284	198
150	361	350	247
200	428	424	302
250	496	467	330
300	551	540	378
350	632	591	416
400	686	680	476
500	822	790	555



1/ Table 601, CP Tarifa Geral de Transportes Part II, Mercadorias, effective January 1, 1982.

2/ Obtained from interview with CP officials as estimated range of special rates on specific shipments of crushed limestone.

rates average about 30 percent below the published rate. This table also shows how distance affects the special rates. The tariff rate increases linearly with distance while the special rates increase at a decreasing rate as distance increases. This reflects the cost characteristics anticipated when establishing the special rates.

Rail Rate/Cost Relationships

A comparison of rail rates and costs at varying distances is shown in table 20. The costs are those derived from the cost estimating equation for a 50 ton payload and reflect long run variable costs. The tariff estimates obtained from the CP are also presented in the table.

Rail costs and rail rates follow each other almost equally at each of the distances. The tariff rate is about 97-99 percent of the total costs. The high special rate indentified for probable future movements of limestone follows the rate by 95-99 percent. The low special rate appears to be about 66-71 percent of the tariff rate.

It appears to the consultants that the rates quoted by the CP follow costs quite closely. Further it appears that the tariff and high special rates closely approximate fully distributed costs of rail operation and the low special rate is based on out-of-pocket or incremental costs.

This latter relationship was examined by deriving 70 percent of total rail costs (a common estimate of out-of-pocket costs in the transportation literature) in table 20.

TABLE 20

RAIL COSTS AND RATES, VARYING DISTANCES, JULY 1982

(Escudos per Ton)

Distance (Kilometers)	Costs 50 ton payload	Costs 70%	Rates tariff	Rates High Special	Rates Low Special
50	231	162	225	218	153
100	299	209	293	284	198
150	366	256	361	350	247
200	434	304	428	424	302
250	501	351	496	467	330
300	569	398	551	540	378

The 70 percent costs are extremely close approximations of the low special rate. Thus, the low special rate is a proxy for out-of-pocket cost pricing. Note also that as distance increases this low special rate increases more slowly.

Truck/Rail Cost Comparison

Determination of the least cost method of transporting agricultural limestone can be done by comparing the long run variable costs of rail to truck. Rail costs include the assembly, handling and truck delivery costs of 387.42 escudos per ton. These cost estimates are developed in Table 21.

It is evident that truck transport has a cost advantage over rail up to at least 160 kilometers (see Graph 3 and Table 22) and could have a cost advantage up to 296 kilometers. The

TABLE 21

TRUCK/RAIL COST ESTIMATES, VARYING DISTANCES

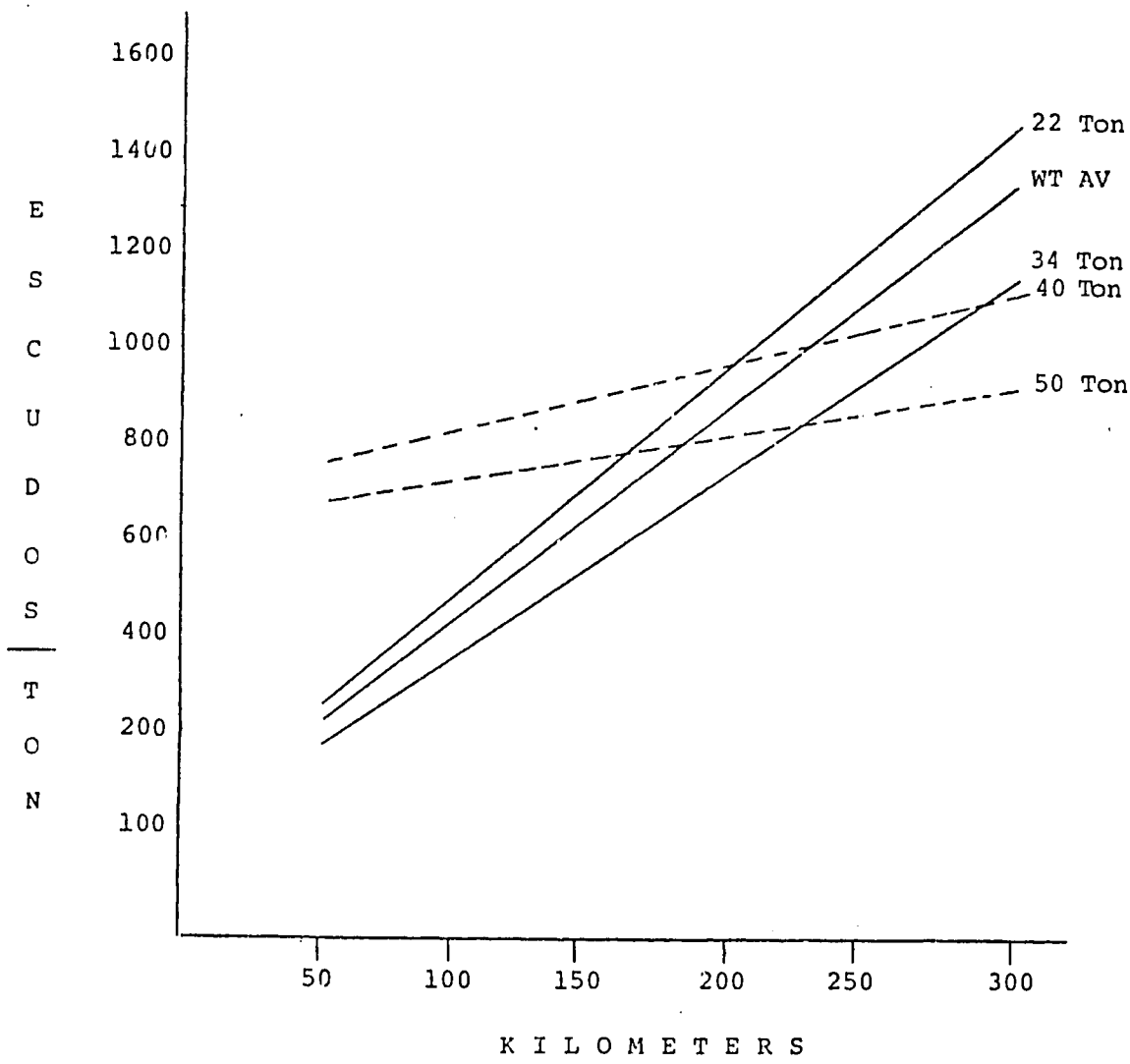
(in Escudos per ton)

	Rail Total Costs 1/		Truck Costs		
Distance (kilometers)	50 ton Payload	40 ton Payload	34 ton	Weighted Average	22 ton
50	619	676	184	220	240
100	686	760	368	440	480
150	754	844	552	660	720
200	821	928	736	880	960
250	889	1,012	920	1,100	1,200
300	956	1,096	1,104	1,320	1,440

1/ This cost estimate includes rail costs plus assembly, handling, and delivery costs of 387.42 escudos per ton.

GRAPH 3

TRUCK/RAIL COST EQUATIONS



Truck

Rail

TABLE 22

BREAK EVEN DISTANCES - TRUCK/RAIL

Cost Estimates

Rail		Truck	Kilometers
50 ton	vs	22 ton	160
50 ton	vs	weighted average	181
50 ton	vs	34 ton	236
40 ton	vs	22 ton	190
40 ton	vs	weighted average	218
40 ton	vs	34 ton	296

shortest break-even point would occur when the most efficient rail cost, 50 ton payload, is contrasted with the least efficient truck cost, 22 ton GVW. The longest distance that truck transport has an advantage over rail is 296 kilometers, based on the 40 ton average payload for rail and use of the larger 34 ton GVW vehicle. It is likely that limestone will move in rail gondolas averaging 40 tons and in the larger trucks so that, realistically, trucks will have a cost advantage up to nearly 300 kilometers.

Additional Distribution Costs

The previous analysis examined the costs of delivering the agricultural limestone from the production source to the farm. It is expected that the limestone will be dumped on a level area, possibly on a plastic sheet in the open, by a bulk truck to be later spread on the fields by the farmer. This spreading operation is an additional expense associated with distributing agricultural limestone in the south.

The present means of applying limestone and fertilizer in the south is by a small rotary apreader attached to a tractor. These 750 kilogram spreaders are currently available to most farmers in the region, according to a survey of Regional Services agents by the consultants, since they are now being used for fertilizer and seed applications. Also available in some areas are 4 ton spreaders that could be rented or purchased from existing owners.

These small existing spreaders attached to or pulled by tractors will be the initial system for applying limestone to the fields. In the future, bulk spreaders attached to the trucks might be used on the larger, more accessible fields. Such a vehicle could be owned by either the limestone producer

or a local cooperative. However, since the individual farmer is expected to still own a small spreader for fertilizer and seed application, some limestone will probably continue to be applied in this manner. It does suggest caution to any bulk distributor considering capital investment in a bulk truck spreader.

The cost of utilizing the existing spreader system is about 230 escudos per ton of agricultural limestone. This cost estimate consists mostly of labor costs with some depreciation, interest and fuel charge for tractor/spreader operation. These costs were derived by updating the cost estimates in the northern limestone distribution study by Lauth, Snitzler and Tosterud, and the project paper, Portugal: Agricultural Production Program.

VII SYSTEM ANALYSIS

The development of a least cost distribution system for limestone in Southern Portugal will now proceed from the various elements related to demand, available supplies, and the transportation system.

System Demand

Before beginning the more formal analysis leading to a least-cost distribution system, estimates of anticipated limestone use for each subregion in 1983 and 1986 were brought forward from Chapter IV (Table 1.). The 1983 data allow analysis for the immediate future whereas the 1986 estimates permit an intermediate term view.

System Production

Information on quantities and prices of liming materials that had been obtained from limestone production plants and discussed in chapter V were then assessed to determine those which could be expected to prevail in 1983 and 1986. Particular note was taken of major supply questions, restrictions and anticipated changes at individual plants that could potentially affect price or quantities available.

For example, the possible use of the residual Pó de Pedra which was found to be available in large quantities could greatly change analysis. Thus, the economic feasibility of its use was a major issue . That issue is considered below.

TABLE 1

SUMMARY OF ANTICIPATED AGRICULTURAL LIMESTONE USE

BY SUBREGION 1983 AND 1986

		1983	1986
		----------tons----------	
Alentejo			
	Santiago do Cacém	14820	51220
	Portalegre	10260	35460
	Évora	13110	45310
	Beja	18810	65010
	TOTAL	57000	197000
Ribatejo e Oeste			
	Tomar	2380	6800
	Santarém	3220	9200
	Setúbal	1260	3600
	Caldas da Rainha	140	400
	TOTAL	7000	20000
Algarve			
	Barlavento	50	1490
	Sotavento	70	1890
	TOTAL	120	3380
TOTAL	(All Regions)	64120	220380

Adapted from Table 5, Chapter 4.

The amount of agricultural limestone available for distribution is dependent on type of product as well as location and production volume. The residual Pó de Pedra available in Southern Portugal offered the possibility, at least in the near term, of using more of this product per hectare to achieve the same soil neutralizing effect as limestone meeting government standards. Analysis of samples, discussed earlier in this study, indicated that about 1.4 tons of this material would be needed to achieve results similar to one ton of the finer product.

If the residual material is used, additonal costs will be incurred. Forty-percent more product would need to be purchased, transported and spread on the fields. The potential impact on costs is shown in Table 2 for differing distances from the production point. The plant price of 60 escudos per ton for the Pó de Pedra is based on the survey conducted by the consultants. The transportation cost by truck is 4.4 escudos per ton/kilometer, the weighted average presently existing in the industry. Spreading costs for the tractor mounted spreader, identified earlier in this study, were 230 escudos per ton.

At 50 kilometers from the limestone plant the residual product at 1.4 tons per hectar has an equivalent cost of 714 escudos per ton, 204 escudos more than the one ton application. This suggests that as long as plant price for a product meeting government standard is less than 264 escudos it would make economic sense to <u>not</u> use the Pó de Pedra at the higher application levels. This means that, even near the plants, sale prices of 264 escudos or less will prevent Pó de Pedra from being economically feasible.

TABLE 2

COST COMPARISON, PÓ DE PEDRA vs

PRODUCT MEETING GOVERNMENT STANDARDS

(escudos)

	50 km		100 km		150 km	
	1 ton	1.4 tons	1 ton	1.4 tons	1 ton	1.4 tons
Plant Price	60	84	60	84	60	84
Transportation	220	308	440	616	660	924
Spreading	230	322	230	322	230	322
Total Cost	510	714	730	1022	950	1330
Difference	204		292		380	
Plant Price could go to:	264		352		440	

As distance from the plant increases, the equivalent or break-even price increases steadily due to greater transportation costs. At 100 kilometers the sales price of material meeting government standards would need to be greater than 440 escudos per ton before it would pay to use Pó de Pedra. Since the production sources for agricultural limestone include expected prices of less than 264 escudos per ton, little use of residual materials is expected, except immediately around the limestone plant. Further, the plants that have sizeable amounts of residual material, e.g., Sesimbra, Loulé, and Alenquer, are not generally located close to farming areas.

This analysis is sensitive to transportation costs, equivalency ratios, and spreading costs. Therefore, continued monitoring of this alternative is appropriate. Moreover, the equivalency rates used here only reflect an average of the samples taken by the consultants at six plants. Analysis of the chemical and physical properties of specific plant products may give differing ratios.

For 1983, it was assumed that the Sesimbra area could provide 101,000 tons from the Galo plant which is scheduled to be in production by late October 1982 (Table 3). The added capacity for 1986 from that area would come from the Alho plant which is actually expected to be in production by late 1983. Addition of a hammermill and seive at Alenquer would allow use of the residual Pó de Pedra but that addition was assumed to come after 1983. Both the Vila Viçosa-Borba marble crushing operation and the Portalegre plants are proposals which require investments. Thus, neither is considered as a potential source in 1983. Because the materials which are treated as residual at other plants are fully utilized in construction activities of these firms at the Betecna, Rio Maior and Oeiras plants, and the prices were relatively high, neither was included in the formal analysis.

TABLE 3

SUMMARY OF EXPECTED LIMESTONE PRICES

AND QUANTITIES IN 1983 AND 1986

Source	1983		1986	
	Plant Price esc	Quantity tons	Plant Price esc	Quantity tons
Sesimbra	220 1/	101,000 2/	260 3/	209,000 4/
Loulé	60 5/	130,000 6/	260 5/	130,000 6/
Alenquer	-	-	260	210,000
Fátima	800 6/	18,000 6/	800 6/	105,000 6/
Montemor-o-Novo	760 6/	11,000 6/	760 6/	11,000 6/
Vila Viçosa - Borba	-	-	415 7/	93,000 7/
Portalegre	-	-	400 8/	300,000 6/
Serpa	400 6/	10,000 6/	-	- 9/

SOURCE: Summarized from information presented in Chapter V.

1/ Based on expected price at Alho plant for material meeting standard.

2/ Based on utilization of material from new line under construction at Galo plant which is to be available in late October, 1982.

3/ Based on development of alternative markets for residual materials.

4/ Quantities to be available by late 1983 from the Alho and Galo plants.

5/ This price from the ECOB plant was used because it was more representative of the market than the 38 escudos price quoted for the Galo plant. The consultants were told that the residual Pó de Pedra from the Galo plant would meet limestone standards. Nevertheless, for 1983, it was assumed that 110 percent as much of the residual would be required. By 1986, it was assumed that the residual would be processed further at a cost of 200 esc/ton.

6/ Based on information obtained at the production plant (See Chapter V).

7/ Assumes that the size of the market for limestone will hold production down and keep the price relatively high.

8/ The 400 escudos price was adopted based on the James Smith report to PROCALFER.

9/ Because of its current age and condition the Serpa plant was not included as a longer term supplier.

System Findings

The method of determining a least cost distribution system for agricultural limestone in the south is quite straight-forward. The system was analyzed in two time periods, 1983 and 1986. It was determined that the production and distribution system presently existing would essentially be the system existing in 1983. By 1986 other investments and production changes could be available; thus, analysis of a system for this time period incorporated more flexibility.

The previously identified production sources, volumes and prices were then combined with transportation costs to the identified subregions to generate a potential delivered plant price at each demand location from each of the production sources. In total, potential production volume greatly exceeded the estimated need for both 1983 and 1986.

A transportation cost of 4.4 escudos per ton kilometer was used in the 1983 analysis; this cost reflects the weighted average cost of the existing truck fleet. In 1986 the cost of 3.68 escudos per ton kilometer was used; this reflects the fact that enough time exists for the trucking fleet to undergo change towards the larger sized vehicles. Truck, rather than rail, was used because only potential movements of extreme distance were of a length, in kilometers, greater than the distance where the cost advantage of truck over rail disappears. Subsequent analysis reinforced this assumption.

Supplies were then allocated to demand areas on a least cost delivery price basis. The findings of the analysis are summarized in Table 4 for 1983 and Table 5 for 1986. In 1983, Sesimbra is the highest volume shipper, moving almost 35 thousand tons or about 54 percent of total movements. These

TABLE 4

ORIGIN - DESTINATION LEAST COST SHIPMENTS, 1983

Origin	Destination	Volume (tons)	% of total	Delivered price (esc/ton)
Sesimbra	Santarém	3,220		669
	Setúbal	1,260		334
	Caldas da Rainha	140		788
	Santiago do Cacém	6,820		590
	Portalegre	10,260		1,126
	Évora	13,110		788
(Total-Sesimbra)		34,810	54.3	
Loulé 1/	Beja	8,810		757
	Barlavento	50		258
	Sotavento	70		60
(Total-Loulé)		8,930	13.9	
(Total-Serpa)	Beja	10,000	15.6	532
(Total-Fátima)	Tomar	2,380	3.7	800
(Total-Santiago do Cacém)	Santiago do Cacém	8,000	12.5	400
	TOTAL	64,120	100%	

1/ Because of uncertainty about whether this product fully meets government standards, calculations are based on a factor of 1.1 to achieve the same neutralizing effect on soils as a product meeting minimum government standards.

TABLE 5

ORIGIN - DESTINATION LEAST COST SHIPMENTS, 1986

Origin 3/	Destination	Volume (tons)		% of Total	Delivered Price (esc/ton)
Sesimbra	Setúbal	3,600			356
	Santiago do Cacém	43,220			569
	Évora 1/	22,655			735
	Beja 2/	32,505			749
(Total-Sesimbra)			101,980	46.3	
Alenquer	Tomar	6,800			654
	Santarém	9,200			415
	Caldas da Rainha	400			422
	Évora 1/	22,655			749
(Total-Alenquer)			39,055	17.7	
Loulé	Beja 2/	32,505			757
	Barlavento	1,490			426
	Sotavento	1,890			260
(Total-Loulé)			35,885	16.3	
(Total-Portalegre)	Portalegre		35,460	16.1	521
(Total-Santiago do Cacém	Santiago do Cacém		8,000	3.6	260
	TOTAL		220,380	100%	

1/ Because of the extreme closeness in delivered price the demand from the Évora sugbregion was divided equally between Sesimbra and Alenquer.

2/ Because of the extreme closeness in delivered price the demand from the Beja subregion was divided equally between Sesimbra and Loulé.

3/ The proposed plant at Vila Viçosa-Borba was initially used in the analysis at a plant price of 415 esc/ton for production of 93,000 tons. However, the analysis showed that this plant would be able to market only 45,310 tons at this price. In further analysis at the plant price of 660 esc/ton for 45,000 tons of production, this plant was not a least cost plant for any demand.

shipments are heavily in the north, with the exception of Tomar's small need of 2,380 tons which is served by the existing plant at Fátima. The remaining supply is spread quite evenly among Serpa, Loulé and Santiago do Cacém who each have about 12-15 percent of the total shipments.

The least cost distribution system for 1986 is quite similar (see Table 5) with Sesimbra supplying about 102,000 tons or slightly over 46 percent of the 220,380 annual ton requirement for southern Portugal. Alenquer, which was not in existence in 1983, will provide about 39,000 tons or 17.7 percent in 1986. Loulé and Portalegre are expected to both have markets available to them for around 36,000 tons, 16 percent. Santiago do Cacém continues to provide production for its local regional needs. Serpa is expected to drop out of production by 1986 because of its antiquated and obsolete equipment.

The Ribatejo e Oeste region (number 5) receives, in 1983, most of its agricultural limestone from Sesimbra. Only Tomar does not receive shipment from Sesimbra since it is served by its local production at Fátima.

The subregions of the Alentejo also receive some shipments from Sesimbra but use more widely dispersed production areas. Both Portalegre and Evora are served by the Sesimbra area limestone plants while Santiago do Cacém is served by local production. The Beja subregion will receive limestone from both Serpa and Loulé in 1983. Serpa is the least cost supplier but does not have enough volume to meet the estimated demands in Beja; thus, Loulé is expected to provide almost 9,000 tons.

The demand for agricultural limestone in the Algar-

ve is only 120 tons in 1983. This quantity is obtained from the Loulé area.

The least cost distribution system in 1986 has some significant changes from 1983. Setubal in Ribatejo e Oeste still receives its limestone from the Sesimbra plants. However, Tomar, Santarém, and Caldas da Rainha areas will be purchasing their limestone supplies from the plants at Alenquer.

In the Alentejo in 1986 significant shifts in distribution are expected. Only Santiago do Cacém will continue with the same purchase as in 1983, namely, buying from the local plants. The new plant at Portalegre will eliminate the Sesimbra shipments to the Portalegre region. The new plants at Alenquer will be able to service about half of the Evora demand; the other half will continue to be purchased from Sesimbra. Much of the Beja volume that originally was received from the Serpa facility in 1983 will be purchased from Sesimbra, with Loulé also increasing in volume in 1986.

The length of haul for the least cost movements is indicated in Table 6. In 1983 most movements were either less than 50 kilometers or between 100 and 150 kilometers. The longest distance was 206 kilometers and the weighted average was 84 kilometers. In 1986 the average distance had decreased to 72 kilometers and the longest movement had dropped to 135 kilometers. Again, most least cost movements will be less than 50 kilometers or between 100 and 150 kilometers. These findings support the assumption of utilizing trucks rather than rail as the least cost carrier.

It is also evident that the high plant prices at Montemor, Fátima and Vila Viçosa overide the locational advantages

TABLE 6

NUMBER OF LEAST COST SHIPMENTS, VARIOUS DISTANCES

Distance	1983	1986
< 50 km	6	7
51-100 km	1	1
101-150 km	4	5
> 151 km	1	0
Longest Distance	206	135
Weighted Average	84	72

of these firms. If plant prices can not be lowered, the competitive activity of other production areas may eliminate these firms from agricultural limestone marketing.

The delivered price and its components, plant price and transport costs, are weighted by volume and summarized in Table 7 for both time periods. The delivered price for agricultural limestone is expected to decrease from 713 escudos per ton in 1983 to 555 escudos per ton in 1986. The Algarve experiences an increase in delivered prices because of significant increases in plant prices unbalanced by decreases in transportation costs. The other two regions have decreases in transportation costs that override the increases in plant prices. As a result, delivered price decreases for these two regions.

Transportation costs decrease for two reasons. First the average length of haul decreases since more centrally located plants will be in existence at that time. Secondly, the cost per ton kilometer decreases from 4.4 to 3.68 escudos as investment in new, larger 34 ton trucks occurs.

Several concerns about the assumptions of this analysis should be identified. First, the 1986 system includes firms that are not yet totally in existence. Second, average transport costs per ton may be slightly understated since it was assumed that, for a firm serving its local area, no transportation occurred. Third, this system is based on cost effectiveness of plant price, transportation cost and resultant delivered price in deciding purchase decisions. If other non-cost factors are part of the decision process, deviations from this system may be seen. For example, to increase sales, some limestone producers could absorb some of the transportation costs. This could shift the distribution pattern.

TABLE 7

LEAST COST MOVEMENTS AND WEIGHTED PRICE AND COST, BY REGION, 1983 AND 1986

Price Item	Ribatejo e Oeste	Alentejo	Algarve	Total
(1983)				
Volume (tons)	7,000	57,000	120	64,120
Plant Price (esc/ton)	417	252	60	266
Transport Cost (esc/ton)	239	469	83	447
Delivered Price (esc/ton)	656	721	143	713
(1986)				
Volume (tons)	20,000	197,000	3,380	220,380
Plant Price (esc/ton)	260	285	260	282
Transport Cost (esc/ton)	162	286	73	273
Delivered Price (esc/ton)	422	571	333	555

Marketing of Agricultural Limestone

The consultants considered several methods of marketing bulk agricultural limestone to farms in the South. As used here marketing consists of two functions: 1) the physical shipment and handling of the product; 2) the selling, advertising, promotion, purchasing, order processing and payment for the product. This latter function we refer to as purchasing and order processing.

Methods of marketing which appear to have merit in the South are grouped below by their marketing function.

Physical Movement and handling	Purchasing and Order Processing
1. Direct to farms	By local cooperatives
	By individual firms
	By limestone plants
2. Through a local distribution point with either farmer pick-up or delivery to farms including spreading	By local cooperatives
	By individual firms

Initially, farmers may buy direct from the limestone plant with direct shipments to the farm, but as volume increases efficiency will be gained by consolidation and coordination of the physical movement and purchasing and order processing. Further, local outlets can provide "hands-on" information and technical assistance service to the farmer in his purchase of limestone.

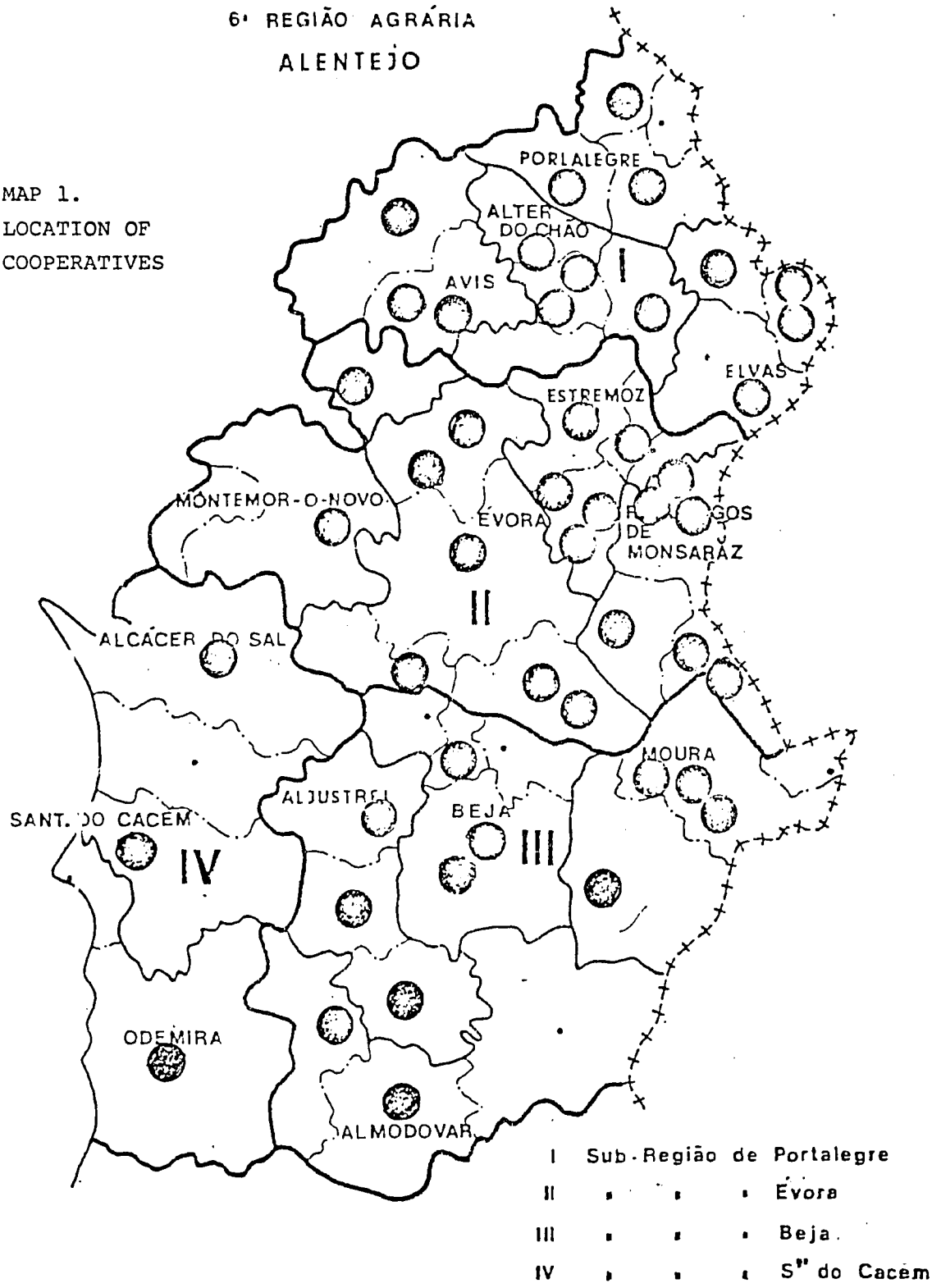
As volume begins to increase, marketing should be accomplished through a local system already in existence. This is particularly appropriate since demand is uncertain, making it important to keep the system flexible. Agricultural cooperatives, particularly farm supply cooperatives, offer an existing service to farmers in their area which could generally be expanded to include agricultural limestone.

Although some cooperative may not be in a position to act as local limestone suppliers their numbers appear to be sufficiently large to meet needs. In Portugal at the end of 1979, there were about 85 farm supply cooperative and 160 cooperatives engaged in both supplying inputs to farm production and in buying farm products 1/. Of these, some forty-eight were in the Alentejo -- the region where most of the agricultural limestone is expected to be used. The distribution of these cooperatives within the Alentejo appears to be well suited to a system such as has been described (Map 1.). The Ribatejo e Oeste and the Algarve also have numerous cooperatives which could serve those regions 2/

1/ Segurado, José, Breves considerações sobre as Cooperativas Agrícolas de Compra e Venda, Ministério de Agricultura e Pescas, Direcção-Geral de Extenção Rural. FEV 1980; and, Sampaio, Maria Ernestina Pato Melo, Cooperativas Agrícolas do Alentejo, Direcção-Geral de Extensão Rural, Direcção de Serviços do Associativismo Agrícola, 1980.

2/ Lists of Agricultural cooperatives were obtained from Direcção Geral de Extensão Rural.

MAP 1.
LOCATION OF
COOPERATIVES



These cooperatives, as well as production cooperatives and farm product marketing cooperatives, could serve as limestone purchasing agents for farmers with the limestone moving in bulk directly to the farms. As envisioned, the local cooperative would take orders, consolidate them, and provide them to limestone producers. Delivery would ordinarily be direct to farms in bulk trucks provided by the limestone production plants, by the cooperative, or by for-hire truckers. The cooperative would retain a small percentage of sales to cover its costs of taking orders and making payments.

This system could operate in much the same way for smaller farmers who might require less than a truck load, except that delivery would be to the cooperative rather than directly to the farm. The farmer would then obtain the limestone, in the quantity desired, at the cooperative.

In the longer term, if consumption increases as projected, local cooperatives may consider joining together in their purchase of limestone to achieve greater efficiencies in arranging for purchases, consolidation of orders, and order processing. Such joining together would also fit into cooperative spreading operations on the larger farms and cooperative owned trucks for over-the-road transport and local delivery to the smaller farms.

North And South Interactions

Comparisons

Comparison of the proposed limestone production, transportation and distribution system for Southern Portugal with the existing system in Northern Portugal reveals sharp

contrasts. The following table illustrates the differences.

	NORTH 1/	SOUTH 2/
	(esc/ton)	
1. Weighted Average Plant Price	758	266
2. Weighted Average Transport cost	1005	447
3. Weighted Average Delivered Price	1763	713
4. Weighted Average Subsidy Price	705	none expected
5. Price to farmer	1200	800 3/

Each of the components of plant prices and transport costs are substantially higher in the north, even in 1981 as compared to the proposed 1983 system for the south. A discussion of why these differences exists follows:

Plant Prices

The product purchased in the South is principally from large highway and construction aggregate plants processing

1/ 1981 figure for 36,089 tons. Delivered to local cooperatives.

2/ 1983 figure for 64,000 tons. Delivered to farms.

3/ Includes a handling margin for local cooperatives to act as purchasing and order processing agents.

a residual (waste) product into agricultural limestone meeting government standards. The product is shipped in bulk. Thus the agricultural limestone produced bears little of the joint costs of producing crushed limestone rock products and there is no bagging cost. Plants in use in the north are producing agricultural limestone, in bags, as a joint product in their limestone crushing operations. Consequently in the north agricultural limestone is bearing its share of total costs of producing crushed limestone rock products and the cost of bagging at the plant - an estimated 350 esc/ton.

It is noted, however, that if a significant market is found for the residual product, as has occurred in some cases at plants in the south (for highway construction, for example) total costs are likely to be reallocated towards the agricultural limestone, and the selling price set to meet the market.

Considerable limestone rock crushing plants producing highway and construction aggregate exist in the north, generally in the area bounded by Rio Maior on the south, Coimbra on the north, Leiria on the west, and Tomar on the east. Most of these plants would have a residual product capable of being further processed into agricultural limestone. One such plant, Quisselgur, located at Fátima, is currently processing residual product into agricultural limestone meeting government standards and has submitted a credit project for expansion. This plant's price for agricultural limestone is 850 esc/ton, reflecting the current subsidized northern market rather than production costs. Production costs would be estimated at 260 esc/ton for residual product processed into agricultural limestone plus 350 esc/ton for bagging for a cost of 610 esc/ton.

These types of plants would be expected to produce agricultural limestone by processing residual product, depending on the volume of agricultural limestone requested by northern and southern farmers.

Transport Costs

The difference in transport cost between the north and south is due to shorter distances in the south than in the north. The average distance for the proposed southern system is 84 kilometers while the average distance for northern shipments is estimated at over 200 kilometers. Both areas use trucks for transportation. The estimated truck costs for the north are 3.87 esc/ton with prices running just below that, while in the south truck costs are estimated at 4.4 esc/ton with prices slightly higher.

Farmer Prices

The difference in farm price between the north and the south is estimated at 400 escudos per ton. It is, in fact, slightly more than this since the 800 escudos price in the south is a price delivered on the farm whereas the 1200 escudos price in the north is the price of agricultural limestone delivered to the local cooperative. The limestone must then be distributed to the farm, increasing further its delivered farm price.

Moreover, the 1200 esc/ton price to the farmer in the north is one that all farmers in the north pay regardless of distance from the limestone plant. Farmers in the south will pay a market price for their agricultural limestone which will consider

distance from the plant. Thus, while the average price to the farmer in the south will be an estimated 800 esc/ton, farmers will pay from 160 esc/ton to 808 esc/ton depending upon the distance their farm is from the limestone plant.

Interactions

Obviously, there is no Maginot line between northern Portugal and southern Portugal. Shipments of agricultural limestone can move readily between the two areas. But, because of beginning the program first in the north, with its identified difference, two systems that have different structures have developed. Thus, there will continue to be some imbalances until the two systems are merged.

Some potential interaction between the areas are seen. For example, at Portalegre, shipments to the north will probably occur, especially into regions 3 and 4. Conversely, shipments of bagged agricultural limestone to the south will occur from Fátima area plants to those farms that need bagged limestone because of small, inaccessible fields.

Other imbalances may result. The subsidy in the north is designed to achieve a 1,200 escudos delivered price to the farm. It would appear natural for this 1,200 escudos farm price to also be available in the south. And, since delivered farm price is relatively low in the south, no actual subsidy by the government would be necessary.

However, the subsidy could be difficult to control because the southern bulk limestone price, as developed by the

agricultural limestone producers, would tend to gravitate toward the subsidy level, thus requiring subsidies. Such payments would be direct subsidies to limestone producers and would not be aiding farmers or lowering their effective farm price. One method of avoiding this problem might be to provide a subsidy that is related to the bagged limestone needed by some of the smaller farmers in region 5. This potential problem suggests that early phase out of the subsidy program would lessen these imbalances.

On the positive side, efforts by northern farmers to obtain bagged and bulk limestone at lower prices will provide economic incentives to northern plants to produce agricultural limestone from residual products, putting downward pressure on bagged and bulk limestone prices in the north, and provinding price competition to southern plants.

VIII RECOMMENDATIONS AND IMPLEMENTATION PLAN

1. The findings of this study suggest that, at this time, the role of the Government of Portugal in the South should be one of education, information provision, and monitoring, not one of formal participation in the limestone production and distribution process, as is done in the North. Delivered prices to farmers in the South are below prices in the North. Demand for limestone is presently uncertain and supply appears adequate. The consultants therefore recommend that no subsidy be given in the price to the farmer in southern Portugal, except in the purchase price of bagged limestone to small farm near the northern region.

2. Given the relatively large limestone crushing capacity in the South compared with the current limited demand, considerable caution is recommended concerning efforts to expand production of limestone to avoid building production capacity beyond probable demand. Financial support for construction of limestone production plants is not recommended for most of the South. However, because of its value to both the northern and southern porgrams in supply of crushed limestone in bags, support for the Quisselgur plant expansion is recommended. With respect to the Portalegre plant, approval should be granted when demand warrants. Financing should then be provided in proportion to the production of agricultural limestone relative to highway aggregate.

3. The potential direct use of Pó de Pedra, the residual product from limestone crushing activities, as agricultural limestone needs further investigation. An equivalency table, similar to the one presented by James Smith and adapted with

minor modification for this study, should be developed for the soils of Portugal. Such a table should indicate decreased amounts for those products that are above the current minimum government standards as well as indicating increased amounts needed of lower grade materials. This table should be developed by Portuguese soils technicians at the soil testing laboratory of Direcção-Geral de Extensão Rural.

A more detailed analysis of the economic feasibility at the farm level should be done. This analysis should include specific product plant prices, updated transportation costs, and refined spreading cost estimates. Only if such analysis, based on an equivalency table tailored for Portuguese soils, indicates economic feasibility for the farmer, should requests for changing of government standards be generated. This analysis should be done by Eng. Victor Oliveira of MACP.

4. An evaluation of the North and South limestone program, and the interactions, ahould be undertaken. Implications from each area program to the other exist in credit, subsidies, consumption, and price structure. This evaluation would require the aid of a consultant serving as a policy and technical advisor on distribution matters in both the North and South. This study should be initiated in the Spring of 1983 when more data are available and investment decisions (by private and public bodies) have been made. It should be combined with the analysis of trucking rates and costs in the south.

5. A record keeping system that will allow monitoring of limestone use in the south, and evaluation of the distribution program, is needed. The consultants suggest that invoices from the Cooperatives showing the chemical and physical nature of the product, the source, plant price and transportation charge, be supplied to the Regional Services. These should be summarized each quarter and analyzed be Eng. Victor Oliveira of MACP. They

would also be used by Regional Services Extension personnel to advise farmers on particular application of the equivalency table to their soils. A directive from MACP to the limestone plants may be necessary to achieve inclusion of chemical and physical properties of the product on each invoice. The need for this suggested recommended record system should be reviewed periodically.

6. Because the need for agricultural limestone and thus the expected demand are extremely difficult to assess, the consultants recommend that considerably more work be done in this area. For example, full use should be made of existing agronomic information from summary data from soil testing laboratories. These data will allow a detailed geographical mapping of soil pH in Portugal and indicate how the pH changes over time with limestone use. This information can then provide a basis for analyzing program directions and suggesting modifications. The Coordinating Group could arrange with PROCALFER to contract this work.

7. Greater use of experimental plots is recommended to provide improved understanding of probable yield response to limestone application, either alone or in combination with fertilizers on various types and classes of soils. Demonstration plots which are established as Extension tools should not be considered as substitutes for statistically designed experimental plots.

8. To encourage the development of a market in agricultural limestone, the consultants recommend that information on plants producing agricultural limestone be provided to cooperatives and farmers. We also recommend that producers of agricultural limestone be kept fully informed on actions to increase limestone use, on quantities being used, and on marketing agents

such as cooperatives. Two mailing lists of producers and cooperatives should be developed to facilitate information exchange. This should be done by Regional Services, coordinated by Eng. Victor Oliveira.

9. Increased extension activities with Cooperatives and farmers to stimulate limestone use is encouraged. Extension workers should be provided training as needed to help them work with individual farmers in assessing the expected gain in revenue from use of limestone alone or in combination with changes in fertilization, rotations, and other aspects of the farming system being used. Specific training in farm management and in use of the equivalency table to be developed for Portugal is recommended.

10. To aid in the information exchange, and increase market awareness of the agricultural limestone program, a continuing effort in further refining the costs of limestone production and inventory of production sources, as developed by James Smith and consultants, is recommended. Further identification of plant process costs, probably utilizing the economic-engineering approach, should include the possibility of the use of screening as a low investment method of producing an acceptable agricultural limestone product.

The inventory of production sources should also receive further attention as a means of generating limestone supply and competitive pressure on plant prices. Additional samples should be taken to determine the physical and chemical properties of the product at each site.

These activities can be undertaken by Regional Service personnel and the transportation technician of MACP. Consultants may be used to guide the effort next spring by providing technical assistance to the Portuguese officials in the above activities.

11. Further study of trucking rates and costs should be initiated. Rates thus far are "paper" rates since few actual shipments have been made at these rates. Because the rate/cost relationship in the South appears high, the potential benefits of "real" rate and cost relationships to cooperatives and farmers is great. This monitoring activity would allow modification and updating of the cost equations, developed in this study, to provide timely information for cooperative or shipper use.

12. Serious consideration should be given by the cooperatives in the south to development of some trucking capacity, probably in the form of a truck cooperative. The published tariffs for truck delivery by limestone producers appear to be substantially above the costs of operation, especially on large trucks. In addition to possible rate savings realized by cooperative trucking, potential economies are available, e.g. backhaul, annual mileage, interest, flexibility, etc., which could further lower costs of trucking. Therefore, as agricultural limestone movements develop in the south, and as actual rate/cost relationships are identified, it is recommended that cooperatives either form a trucking cooperative or purchase their own trucks.

13. The distribution system for agricultural limestone should be based on existing cooperatives, probably those already engaged in farm supply, and should use existing marketing channels to the extent possible. Such cooperatives would handle the order processing but little physical handling would be done, except for very small farms. No government agency, equivalent to Codical in the North, is recommended. No union of all the cooperatives exists in the south and such a union is not necessary for implementation of the recommendations of this study.

14. The consultants recommend a truck delivery system in the south utilizing open dump trucks and production plant to farm delivery. Because the supply of for-hire and limestone plant trucks appear adequate, no financial or other incentives should be necessary at this time.

15. The training program of Eng. Victor Oliveira should be continued. His performance as technical advisor to the Coordinating Group and Codical has been strong but his future activities will be greatly aided by increased training. Suggested subject areas are transportation economics, economic cost methodology, survey techniques, limestone and fertilizer production, logistics management, agricultural marketing and governmental relations. It is recommended that such training be in the United States, probably in early fall of 1982.

16. The consultants recommend that the Agricultural Limestone Distribution Study for Southern Portugal be translated into Portuguese and made generally available to PROCALFER, Regional Services Coordinators in the North and the South of Portugal, Extension personnel, and the Ministry of Agriculture. The executive summary and recommendations should be immediatly translated and distributed. Such distribution would encourage comments by knowledgeable persons. These comments could lead to improved solutions to issues related to providing limestone to areas where needed. To assure that all comments which are received are given full consideration, the Coordinating Group should have responsibility for summarizing contents received. Subsequent reevaluations of the limestone program could consider both the Southern report and these comments.

IMPLEMENTATION PLAN

	Activity	Date	Personnel	Resources
P	- Translation and Distribution of Study (Rec. 16)	Fall, 82	USDA/OICD PROCALFER Team	4 weeks
P	- Quisselgur Decision (Rec.5)	Fall, 82	Coordinating Group	---
P	- Soil Test Summary and Analysis (Rec.6)	Fall, 82	Soil Scientists (Portuguese)	Continuous
A	- Training of Eng. Victor Oliveira (Rec. 15)	Fall, 82	Lauth Casavant, Smith (Consultants)	4-6 weeks
A	- Distribution Review and Implementation 1/	Spring, 83	Casavant (Consultant)	4 weeks
	1) Truck Cooperative Feasibility (Rec. 10)			
	2) Rate/cost Update (Rec. 9)			
	3) North/South Interaction Analysis (Rec. 14)			
	4) Review and Analyze Current Production and Distribution and recommend changes			

1/ To be coordinated with Lauth review and implementation of Northern program scheduled for Spring, 1983.

	Activity	Date	Personnel	Resource
P/A	- Production Plant Inventory and Cost update (Rec.13)	Spring, 83	Victor Oliveira Regional Services Casavant	4 weeks
P	- Analysis of Limestone Equivalence Table and Development of program for use. Training of Extension (Rec.6,8)	Fall, 82 Through Spring Spring, 83 Continuous Training	Laboratório Rebelo da Silva Regional Services Extension Regional Services Coordinator	6 month Continuous
P	- Portalegre Decision (Rec.1,5)	83-85	Coordinating Group	---
P	- Record System (Rec. 12)	Fall, 82 to develop	Coordinating Group Regional Extension Service Regional Coordinators Victor Oliveira	8 weeks
P/A	- Extension Training Farm Management Short Course (Rec. 2)	83-85 Fall, 82	Extension Services Farm Management (Consultants)	Continuous 4-6 weeks
P/A	- Crop Response Experimental Plots (Rec. 11)	83-85	Research Services (Consultants)	6-8 weeks
P	Information (Rec. 3)	Fall, 83 Continuous	Regional Services Victor Oliveira	4 weeks

P - Program Actions

A - Advisory Actions

P/A - Combined Program and Advisory Actions

A P P E N D I X I

Livro N.º 258

MINISTÉRIO DA AGRICULTURA E PESCAS
SECRETARIA DE ESTADO DO FOMENTO AGRÁRIO
DIRECÇÃO-GERAL DE EXTENSÃO RURAL

N.º 13

Análise QUANTITATIVA da amostra n.º 2879 a 2881, apresentada por PROGRAMA DE CALAGEM FERTILIZAÇÃO E FORRAGENS "PROCALFER"

residente em

Natureza da substância CALCÁRIO Proveniência

Acondicionamento da amostra SACOS DE PLÁSTICO

Indicações do rótulo

RESULTADO

REG: 2879, AMOSTRA Nº 1:				
	GRANULOMETRIA:			
Bibe	> 2 mm (US STANDARD 10 mesh)	17	60	%
Montemor	< 0,71 mm (US STANDARD 25 mesh)	49	22	%
O-Nova	VALOR NEUTRALIZANTE	96	4	
REG: 2880, AMOSTRA Nº 2				
	GRANULOMETRIA			
Bibe	> 2 mm (US STANDARD 10 mesh)	2	92	%
Montemor	< 0,71 mm (US STANDARD 25 mesh)	74	45	%
O-Nova	VALOR NEUTRALIZANTE	96	4	
REG: 2881, AMOSTRA Nº 3:				
	GRANULOMETRIA:			
	> 2 mm (US STANDARD 10 mesh)	6	33	%
ECOB	< 0,71 mm (US STANDARD 25 mesh)	49	87	%
Soule	VALOR NEUTRALIZANTE	105	0	

Importa esta análise em EFICIAZ

Apreciação:

O ANALISTA

Em 16 de Julho de 1982

VISTO

Mod. 16 — 200 cart. 2x100 — 3-79 — S. & M., Lda.

210 x 297

Livro N.º 356

MINISTÉRIO DA AGRICULTURA E PESCAS
SECRETARIA DE ESTADO DO FOMENTO AGRÁRIO
DIRECÇÃO-GERAL DE EXTENSÃO RURAL

N.º 14

Análise QUANTITATIVA da amostra n.º 2882 a 2884, apresentada por PROGRAMA DE CALAGEM FERTILIZAÇÃO E FORRAGEM "PROCALFER"

residente em

Natureza da substância CALCÁRIO Proveniência

Acondicionamento da amostra SACOS DE PLÁSTICO

Indicações do rótulo AMOSTRA Nº 5 - CALBRITA; PEDREIRA GTª DA NOITA - 9/7/82

RESULTADO

REG: 2882 AMOSTRA Nº 4			
GRANULOMETRIA			
Calbrita >2 mm (US STANDARD) 10 mesh)	30	51	%
<0,71 mm (US STANDARD) 25 mesh)	32	97	%
VALOR NEUTRALIZANTE	104	4	
REG: 2883; AMOSTRA Nº 5			
GRANULOMETRIA			
Calbrita >2 mm (US STANDARD) 10 mesh)	27	59	%
<0,71 mm (US STANDARD) 25 mesh)	40	30	%
VALOR NEUTRALIZANTE	103	4	
REG: 2884; AMOSTRA Nº 6			
GRANULOMETRIA			
>2 mm (US STANDARD) 10 mesh)	32	41	%
ALHO <0,71 mm (US STANDARD) 25 mesh)	33	56	%
VALOR NEUTRALIZANTE	95	4	
Santana			
Desimbra			

Importa esta análise em OFICIAL

Apreciação:

O ANALISTA

Em 14 de JULHO de 1982

VISTO

Mod. 18 — 200 ex. 2-100

Livro N.º 206

MINISTÉRIO DA AGRICULTURA E PESCAS
SECRETARIA DE ESTADO DO FOMENTO AGRÁRIO
DIRECÇÃO-GERAL DE EXTENSÃO RURAL

N.º 165

Análise QUANTITATIVA da amostra n.º 2885 A 2886 apresentada por PROGRAMA DE CALAGEM, FERTILIZAÇÃO E FORRAGENS "PROCALFE

Residente em

Natureza da substância CALCÁRIO Proveniência

Acondicionamento da amostra SACOS DE PLÁSTICO

Indicações do rótulo

RESULTADO

REG 2885; AMOSTRA Nº 7			
GRANULOMETRIA			
>2 mm (US STANDARD) 10 mesh	19	54	%
<0,71 mm (US STANDARD) 25 mesh	50	60	%
VALOR NEUTRALIZANTE	106	4	
REG 2886; AMOSTRA Nº 8			
GRANULOMETRIA:			
>2 mm (US STANDARD) 10 mesh	49	49	%
<0,71 mm (US STANDARD) 25 mesh	28	60	%
VALOR NEUTRALIZANTE	107	9	

Importa esta análise em OFICIAL

Apreciação :

O ANALISTA

Em 16 de JULHO de 1982

VISTO

146

Mod. 16 — 200 cart. 2x105 — 3.79 — S. A. M., Lda.

210 x 297

To provide more complete information the eight samples were screened with a 60 Mesh Screen with the following results:

Amostra 2879 - nº 1	0,25 mm US Standard 60mesh	- 28,21%
Amostra 2880 - nº 2	0,25 mm US Standard 60mesh	- 48,33%
Amostra 2881 - nº 3	0,25 mm US Standard 60mesh	- 24,37%
Amostra 2882 - nº 4	0,25 mm US Standard 60mesh	- 18,00%
Amostra 2883 - nº 5	0,25 mm US Standard 60mesh	- 24,50%
Amostra 2884 - nº 6	0,25 mm US Standard 60mesh	- 12,40%
Amostra 2885 - nº 7	0,25 mm US Standard 60mesh	- 30,20%
Amostra 2886 - nº 8	0,25 mm US Standard 60mesh	- 21,92%

A P P E N D I X II

SANTANA - CESIMBRA

PEDREIRA TEODORO GOMES ALHO

Carbonates (Co_3 Ca)	95/98
Perda ao Rubro	42/43
Sílica (SiO_2)	08/10
Alumina (Al_2O_3)	02
" + TiO_2	03/10
Ferro (Fe_2O_3)	01/02
Cálcio (CaO)	55/56
Magnésio (MgO)	05/06
Alcalis (Na,K)	
(Na_2O)	002
(K_2O)	008

Outros resultados:

Desgaste de "LOS ANGELES"	32/34
Resistência	350/400 Kg/Cm2

Instituto Superior Técnico

LISBOA

Laboratório do Serviço de Análises

Telefone 801346

Boletim N.º 34709-:

Em 27 de Novembro de 197 9

O Ex.mo Sr. Yuang Portugues

remeteu a este Laboratório 1 amostra

de calcareo, que vinha encerrada

em saco de plástico devidamente vedado

com os sinais indicados

Dizeres do rótulo: amostra nº

José Miguel Gomes Gaio

Certifica-se que a análise da referida amostra conduziu aos seguintes resultados:

(no calcáreo seco a 1000C):

Perda ao rubro	43,19
Sílica (SiO_2)	1,01
Alumínio (Al_2O_3)	0,12
Ferro (Fe_2O_3)	0,0[illegible]
Cálcio (CaO)	55,31
Magnésio (MgO)	0,67

O Director do Laboratório,

Lisboa, 27 de Novembro de 197 9

MINISTÉRIO DA AGRICULTURA E PESCAS
SECRETARIA DE ESTADO DO FOMENTO AGRÁRIO
DIRECÇÃO-GERAL DE EXTENSÃO RURAL

.....

dise CALCAREIA da amostra n.º 5795-D apresentada por Direcção Regional do Ribatejo e Oeste — Sub-Região de Tomar

idente em TOMAR

tureza da substância CALCARIO Proveniência Chão de Maçãs — Gaia

ondicionamento da amostra SACO PLÁSTICO

ticações do rótulo DIRECÇÃO REGIONAL RIBATEJO E OESTE — SUB-REGIÃO TOMAR — QUISELEUR LDA — AMOSTRA CALCÁREO INT. D.º

RESULTADO

CÁLCIO (CaO)	50,05	%
MAGNÉSIO (MgO)	0,26	%
CÁLCIO (CaCO3)	89,37	%
MAGNÉSIO (MgCO3)	0,54	%
CARBONATO TOTAL (CaCO3)	90,92	%
GRANULOMETRIA		
> 2 mm	5,20	%
< 0,71 mm	72,30	%

porta esta análise em OFICIAL

nicação: Em relação à sua carta com referência 6/F, dentro dos termos indicados na Norma NP-183, informo o amostra não cumpre o que respeita à sua granulometria (> 2 mm = 0%).

O ANALISTA

Em 28 de Janeiro de 1982

VISTO

151

A P P E N D I X III

CALBRITA

SOCIEDADE DE BRITAS DE RICARDO PEREIRA & FILHOS, LDA.

SEDE: CASAL DOS FORTES — ALENQUER
PEDREIRAS: CARAPINHA, QUINTA DA MOITA E SANGUE REAL
TELEFS.: 72140 - 72426 - 72471 (PPC) APART. 4 - 2580 ALENQUER

TABELA DE PREÇOS

NA PEDREIRA

TIPO		SOBRE CAMIÃO NA PEDREIRA GRANULOMETRIAS m/m	PREÇO M3
BRITA Nº 1	(bago de arroz)	4-6	290$00
BRITA Nº 1		6-10	290$00
BRITA Nº 1		6-15	290$00
BRITA Nº 2		15-25	290$00
BRITA Nº 3		25-35	290$00
BRITA Nº 4		35-45	290$00
BRITA Nº 5	(cascalho grosso)	45-70	265$00
ENROCAMENTO		———	265$00
ENROCAMENTO	(de máquina)	———	265$00
ALVENARIA		———	265$00
TOUT-VENANT		———	245$00
RESIDUOS		———	120$00
PÓ DE PEDRA		———	120$00

ESTES PREÇOS SÃO ACRESCIDOS DE 15% I.T.

ESTA TABELA ENTRA EM VIGOR NO DIA 1-2-982

ESTA TABELA ANULA A ANTERIOR

A P P E N D I X IV

CASA GALO

PEDREIRA DA RUCHINHA — BOLIQUEIME — LOULE

TABELA DE PREÇOS A PARTIR DE 15/9/81

VENDA NA PEDREIRA

BAGO DE ARROZ	CUSTO CADA M³	350$00
BRITA Nº. 1	CUSTO CADA M³	330$00
BRITA Nº. 2	CUSTO CADA M³	330$00
BRITA Nº. 3	CUSTO CADA M³	320$00
BRITA Nº. 4	CUSTO CADA M³	300$00
1/2 CASCALHO	CUSTO CADA M³	300$00
TOUT VENANT	CUSTO CADA M³	290$00
MATAÇÕES OU TOT	CUSTO CADA M³	290$00
PÓ DE PEDRA	CUSTO CADA M³	50$00
DETRITOS PEDREIRA	CUSTO CADA M³	30$00

ESTES PREÇOS TEÊM UM ACRESCIMO DE 15% DE I.T.

BOLIQUEIME, 15 de SETEMBRO DE 1981

Britasul - A. C. E.

CONSÓRCIO DOS INDUSTRIAIS DE BRITAS DO DISTRITO DE SETÚBAL
TELEFONES 2231 362 / 2231 030 / 2231 570
APARTADO 19
ESTRADA NACIONAL 375
SANTANA — 2970 SESIMBRA

CIRCULAR 23

Teodoro Gomes Alho & Filhos
EMPREITEIROS
Telef. 223 11 51/2/3
SANTANA — SESIMBRA

Exmo.(ª) Senhor (ªs):

Devido ao agravamento do custo da produção, bem contra a nossa vontade, somos obrigados a fazer uma ligeira rectificação dos preços de venda dos nossos produtos, com o prévio conhecimento da Direcção Geral dos Produtos Não Alimentares. Assim, a partir de 01/4/82 os preços de venda na pedreira passam a ser os seguintes:

5 a 8 m/m	*Bago de Arroz*	*360$00/m3*
8 a 14 m/m	*Brita n.º 1*	*360$00/m3*
14 a 20 m/m	*Brita n.º 2*	*360$00/m3*
20 a 35 m/m	*Brita n.º 3*	*340$00/m3*
	Brita n.º 4	*340$00/m3*
	1/2 Cascalho	*340$00/m3*
	Cascalho Grosso	*340$00/m3*
	Enrocamento	*340$00/m3*
	Tout-Venant 1.ª	*340$00/m3*
	Tout-Venant 2.ª	*260$00/m3*
	Matacões ou T.O.T.	*260$00/m3*
	Refugos de Britas	*200$00/m3*
0 a 5 m/m	*Pó de Pedra*	*75$00/m3*
	Detritos de Pedreira	*40$00/m3*

Estes preços não incluem o Imposto de Transacções.

Agradecendo desde já a melhor compreensão de V. Exa.(ª), subscrevemo-nos com particular estima e consideração

BRITASUL - A. C. E.

A Gerência

José Marques Gomes Galo, Lda.

INDUSTRIAIS, PROPRIETÁRIOS
E EMPREITEIROS DE OBRAS PÚBLICAS

Pedreiras de Britagens Mecânicas em Setúbal e Sesimbra
Máquinas para Escavações - Terraplanagens - Abre Valas
Camions Basculantes - Compressores - Dumpers - Cilindros
Materiais de Construção Civil

ZAMBUJAL - 2970 - SESIMBRA

TELEFONES
ESCRITÓRIO - 2231144 - 2230285
RESIDÊNCIA - 2231532

CASA GAL

Exmo.(ª) Senhor (ᵉˢ):

Devido ao agravamento do custo da produção, bem contra a nossa vontade, somos obrigados a fazer uma ligeira rectificação dos preços de venda dos nossos produtos, com o prévio conhecimento da Direcção Geral dos Produtos Não Alimentares. Assim, a partir de 01/4/82 os preços de venda na pedreira passam a ser os seguintes:

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Brita n.º 2	*360$00 m3*
Brita n.º 3	*340$00 m3*
Brita n.º 4	*340$00 m3*
1/2 Cascalho	*340$00/m3*
Cascalho Grosso	*340$00 m3*
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Tout-Venant 2.ª	*260$00 m3*
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Agradecendo desde já a melhor compreensão de V. Exa.(ª), subscrevemo-nos com particular estima e consideração

José Manuel dos Santos Bibe

OBRAS PÚBLICAS - PEDREIRAS

Telefones: Escritório 82183 • Pedreira 83177
Largo Machado dos Santos, 7 — 7050 MONTEMOR-O-NOVO

TABELA DE PREÇOS

PRODUTO	PREÇO NA PEDREIRA	PREÇO NO RAIO DE 40 KM	PREÇO PARA ALÉM DE 40 KM a 100 KM
CALCÁRIO FINO	759$00/T	1 159$00/T	1 375$00/T
CALCÁRIO GROSSO	506$00/T	906$00/T	1 122$00/T

- Entra em vigor em 23.6.82
- Anula as tabelas anteriores

Montemor-o-Novo, 23 de Junho de 1982

José Manuel dos Santos Bibe

OBRAS PÚBLICAS - PEDREIRAS

Telefones: Escritório 82193 • Pedreira 85177
Largo Manuel dos Santos, 1 — 7050 MONTEMOR-O-NOVO

TABELA DE PREÇOS

PREÇOS NA PEDREIRA

BRITA 1	.....	380$00 + 15%	=	437$00/
" 2	.....	380$00 + 15%	=	437$00/
" 3	.....	380$00 + 15%	=	437$00/
" 4	.....	380$00 + 15%	=	437$00/
" 5	.....	380$00 + 15%	=	437$00/
TOUT VENANT	.....	300$00 + 15%	=	345$00/
RACHÃO	.....	360$00 + 15%	=	414$00/
PÓ	.....	240$00 + 15%	=	276$00/

PREÇO DO TRANSPORTE PARA:

ALCÁCER DO SAL	.....	250$00/m3
ARRAIOLOS	.....	300$00/m3
CABRELA	.....	300$00/m3
CIDORRO	.....	300$00/m3
ESCOURAL	.....	100$00/m3
ÉVORA	.....	230$00/m3
LAVRE	.....	300$00/m3
MONTEMOR	.....	230$00/m3
S. CRISTÓVÃO	.....	250$00/m3
S. Geraldo	.....	260$00/m3
S. SEBASTIÃO	.....	120$00/m3
TORRÃO	.....	300$00/m3
VENDAS NOVAS	.....	300$00/m3
VIANA	.....	260$00/m3

- Esta tabela anula as anteriores
- Entrou em vigor no dia 1 de Junho de 1982