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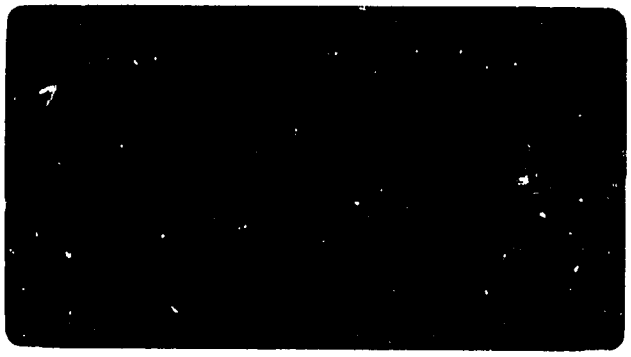

Resources Development Associates

SOILS AND AGRICULTURAL DEVELOPMENT IN NORTHERN PORTUGAL

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APPENDIX 1: EQUIPMENT NEEDED FOR THE SOILS LABORATORY

1.0 SUMMARY

At the request of the Government of Portugal and the Agency for International Development, a Senior Resources Analyst from Resources Development Associates travelled to Northern Portugal in September 1979 to assist the Universitario de Tras Os Montes e Alto Douro of Vila Real in the review and development of plans for a program of soil classification, soil testing, fertility mapping and a program of advisory support or extension services for farmers in the region. This report presents a summary of the existing situation, action taken, and recommendations made.

The constraints on improving agricultural production for traditional farmers in northern Portugal will not be solved quickly. Innovations provided through technical assistance and agricultural extension programs are needed at this time. The University at Vila Real will play a key role in increasing the farmers capability for crop production. The University will grow in experience and capability to meet the challenge.

The region has a broad variety of climatic zones which would lend itself to a great variety of crops. Hot dry summers are a limiting factor to crop production, therefore development of irrigation systems is desirable. Irrigation requirements will be specific for each farmer, with the exception of the larger valleys where an existing irrigation system can be expanded. Soil conservation measures are critical to crop production on a sustained yield basis. The kinds of conservation practices that are presently being considered are crop rotations, winter planting, all facets of terracing, and water diversion channels.

Crop production is generally low. Crops are well tended but the nutrient needs of the soils have been traditionally ignored. The farmers have demonstrated the ability to grow crops on marginal lands (steep and rocky soils) by building rock terraces to retard soil losses and by developing rudimentary drainage and irrigation systems to control surface water. However, a major constraint to increasing crop production on these marginal lands is their low fertility. Preparation of organic matter compost

and a program for measuring and distributing appropriate fertilizers has been recommended.

Winter forage is an important part of the conservation plan and also in the expansion of a high quality livestock industry.

Various species and varieties for improving crop diversity were examined and suggestions were provided on who else might be contacted for other seed sources and technologies that might be helpful.

Methodologies for fruit tree fertilizer needs, fertilizer responses, and drainage techniques were examined as well as some disease control procedures for establishing new orchards in old orchard stands.

The research program at the University was reviewed. Several recommendations were made for applied research activities to increase soil fertility, crop production, crop diversity, and industrial development in the agricultural sector.

Direction has been given to the University on how to acquire soils data and soils maps:

1. through the search for recommendations given on similar crops under similar conditions outside of the region;
2. by a program for collecting soil samples and crop production data from the farmers to develop a data base and problem solving approach for the conditions indigenous to northern Portugal;
3. by an agricultural survey sample design to collect data on soil fertility and crop responses and be processed by computer to facilitate analysis and distribution of results;
4. by designing a stepwise procedure to resolve generalized problems first and then focus on those problems which require more intensive study.

In terms of the soil survey, the soil scientist should map slope, texture, depth and internal drainage for the region as a tool to assist planners in making land use interpretations because these are the primary soil characteristics that assist in

making most of the land use decisions. Such a soil survey is needed and should be conducted by the National Soil Survey located in Lisbon. However, during this project, assistance was provided to the University soils personnel on photointerpretation techniques and soil classification procedures.

The soil laboratories were reviewed with the objective of improving analytical procedures for processing soil samples as quickly and efficiently as possible.

The soil chemistry laboratory needs automatic dispensers and a larger shaker to perform their analyses. They should estimate texture and organic matter by hand and sight to reduce time and costs associated with this analysis technique. More bottles and beakers are needed so the lab can handle up to 60 samples per day. The soil chemistry laboratory needs to develop a procedure in micronutrients because there are micronutrient problems in the region. This laboratory has trouble ordering chemicals. They must go through a third party and oftentimes chemicals may be six months to one year in delivery. The soil chemistry lab could use more automatic filling and dispensing pipettes and large self measuring containers for chemicals that are used and measured frequently. The chemistry laboratory should become prepared to do water analysis both for agricultural purposes and to maintain water quality for health needs and for light industry expansion.

The soil physics laboratory was reviewed and they need a large drying stove because samples, especially in the winter, take too long to dry and moisture content varies too much. The soil physics laboratory also needs a better capability in soil mineralogy, particularly in x-ray defraction for identifying the minerals in clays and silts. This may be available to them in Lisbon through two institutions there.

At least five extension agents should be sent to the northern region of Portugal so that the University can engage in a cooperative agricultural extension service for direct contact with the farmer.

Deficiencies, obstacles to development, and opportunities are summarized below:

1. A good soils map must be prepared for the region.
2. A good microclimate map is also essential.
3. A full hydrologic study is needed to establish the water available for irrigation.
4. A cadastral survey is necessary so property boundaries are clearly established. This will improve the sale and renting of land.
5. The development of high return crops should be encouraged.
6. A large industry could develop around highly processed foods. This does not conflict with land ownership and should provide outside income for the small farmers who have the necessary labor for vegetable and fruit crops.
7. The area could develop a service industry.
8. Other light industry might also be considered. This would stem the probable emigration to larger cities.
9. Better markets for farm produce need to be developed.
10. An effective distribution system needs to be developed for incoming and outgoing goods.
11. The institute needs the assistance of the extension service.
12. The University could develop more social, athletic, intellectual and creative programs for the faculty, staff, students and community.
13. The faculty need advice on how to further their education.
14. More contacts with other governmental and educational institutions would be helpful.

2.0 INTRODUCTION

This is a report of the technical assistance and recommendations provided to the Universitario de Tras Os Montes e Alto Douro, Vila Real, Portugal. The work was performed from September 22 to December 8, 1979, by Joseph E. Goebel, Senior Resources Analyst, Resources Development Associates.

2.1 Objective

The stated objective of the technical assistance grant was to assist the University in program development for soil classification, soil testing and fertility mapping in addition to an advisory program for support or extension services to farmers in the northern region of Portugal.

2.2 Physical Characteristics of the Region

The area to be affected by the proposed extension services provided by the University at Vila Real is the northern region of Portugal (Figure 1).

2.2.1 Climate

The climate of the area is a mixture of maritime and continental influences, which create an intricate complex of microclimates that are in part nearly subtropical and temporal in nature. The winters are cold and wet and frosts are common. The summers are hot and dry during the effective growing season. Because of the maritime and continental climates and the orogenic influence of the mountains, there are several kinds of microclimates in the region. The microclimates have a major affect on the adaptability and the varieties of edible crops that can be produced in the region.

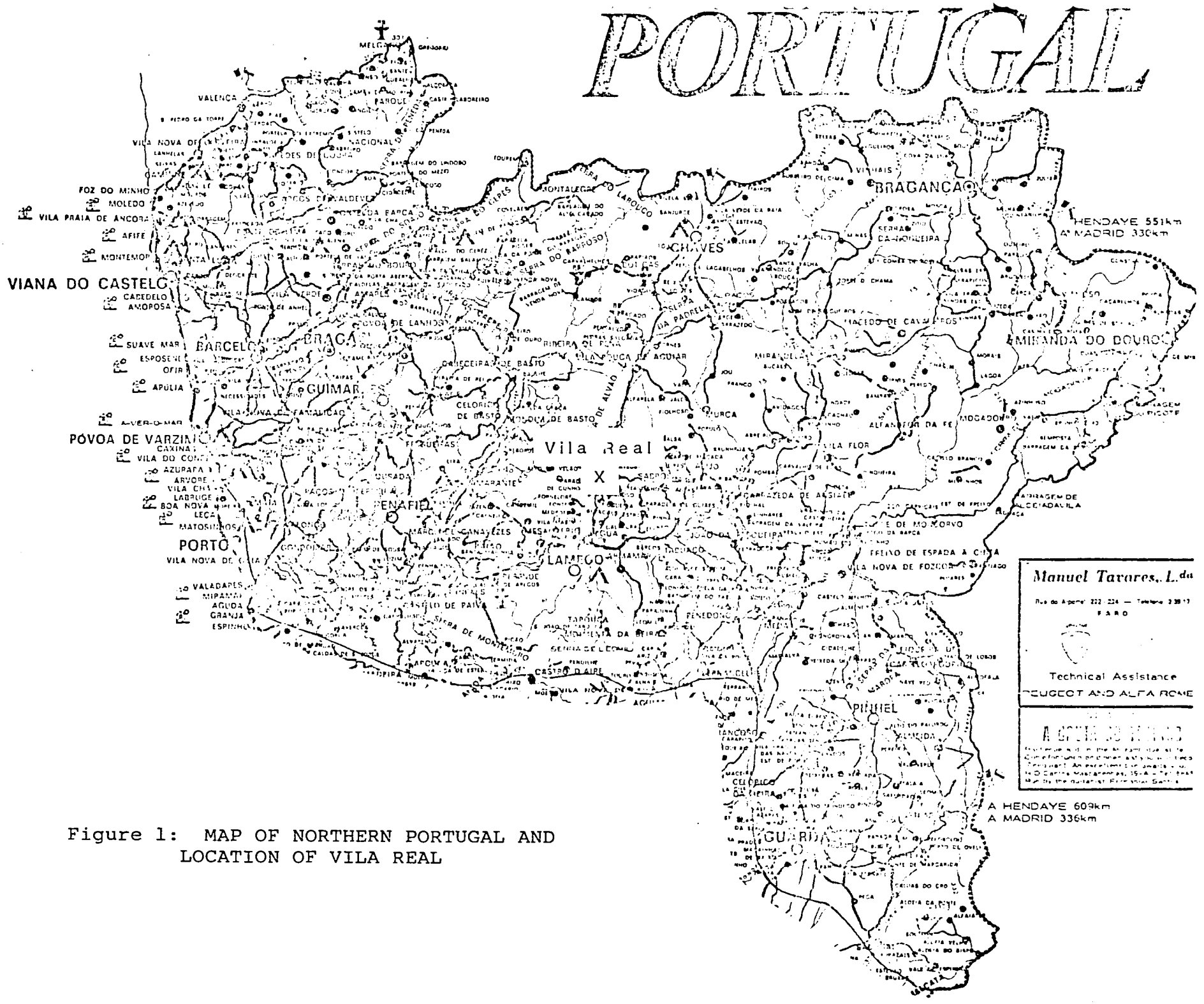

Figure 1: MAP OF NORTHERN PORTUGAL AND LOCATION OF VILA REAL

2.2.2 Soils and Topography

The area is dominated by low mountains and narrow valleys. The important soils are alluvium along the major rivers and the very minor streams with colluvium along the side slopes. There are gently rolling to steeply rolling hills along the mountain tops. The terraced lands on steep slopes are valuable for wine crop production.

Slopes are generally steep or moderately steep and erosion is a constant problem. Historically, erosion assisted in the formation of good soils after the farmers built rock wall terraces to contain the soil movement. The soils have little vegetative protection in the wet winters and the vegetation is sparse near the end of the summer, the first heavy fall rains cause serious erosion, thus reducting soil fertility and productivity.

The soils are usually either steep, shallow and rocky or they are moderately deep and poorly drained with moderate slopes. They are frequently acid soils. The soils that occur on the mountain tops usually abound with rock outcrops. They are thin young soils with poor drainage and often have high organic matter content. In the high inter-mountain regions with intermediate slopes the soils are moderately thick with argillic horizons. They are usually wet in the spring and dry in the summer. The steep slopes are thin colluvium with little soil development. The soils are usually better drained in the region and are sought for agricultural expansion at this time. The thicker colluvium along the lower slopes represent thicker and mixed poorly drained with well drained soils. Across the region, there is a division between those soils formed on granite and those formed on schist parent material and distinct from those soils formed on alluvium and terraces. The alluvial soils are more fertile. The granite soils are low in potassium and phosphorous and the schist soils are high in potassium but low in phosphorous. Nearly all of the soils are very acid. Because of the wet, cool winters, the soils are frequently poorly drained and saturated in the spring.

2.3 The Farming Community

The area has been cultivated for hundreds of years. The region supports a large population which is scattered in many small towns. Land holdings are small and ownership is often scattered. The farming community has developed a rich tradition in agricultural practices.

2.3.1 The People

The greatest resource in the region is the people with their long tradition in agriculture. They are determined to farm the land and are probable capable of doing so throughout the entire region. The area is economically depressed but not underdeveloped.

The rural people of northern Portugal are mature, serious and conservative. The farmers are experienced and rely on a very long farming tradition and in a traditional manner. The farmers are interested in new solutions and assistance with their problems. They have a good idea of what will work for them. This community is also older and ownership will likely change quickly in the next ten or more years.

2.3.2 Traditional Farming

The farmers ability to understand farming, and his willingness to dedicate himself to this purpose, is the region's greatest attribute. The region's farmers are knowledgeable about all facets of agricultural production from horticulture through forage types and tree crops. Basically the Portugese farmers in this region are highly skilled at tending bush and tree crops, an unusual characteristic because most farmers in the world tend grass crops.

The crop types grown in the area are: grapes, especially the port grape; potatoes; wheat; rye; oats; barley; olives; almonds; chestnuts; fruits; pasture and forests. Production is generally low. Crops are well tended, but the nutrient needs of the soils have traditionally been ignored. Reduction in production was a slow and imperceptible process. The soils were not naturally balanced in nutrients, being high in potasium and low in phosphorous as well as being very acid. Since the people have demonstrated the ability to terrace and irrigate steeply sloping land, the region can be considered to have a greater soil resource than was available in the past. To maintain productivity, however, these soils do require careful husbandry and technical improvements. Portugal is in a position to lead in the technology of applying intensive agriculture to marginal agricultural lands. For many years, the farmers have eradicated any plants that compete with their crops. In the cultivated fields this has resulted in eliminating a large bulk of organic matter production. Little by little the production was diminished without the people being aware of it as the organic matter was lost during the hot summer months. Therefore, most of the soils that have been farmed for a long time are very low in organic matter.

A true legacy of the region is the contour rock wall terraces constructed over hundreds of years. These need to be maintained but they are an obstacle to mechanization. The walled terraces probably originally began as a way of ridding the surface of rocks when the erosion exposed them. The placement of the terraces probably depended on the convenience of carrying rocks by hand a limited distance up and down slope. The rocks were definitely in the way for tending the vineyard. As a result, year by year, they added rocks to the terrace and it grew in height. As it got higher the soils accumulated until the terrace became effectively level with the base of the next terrace upslope. The placement of the contour of the land was probably a function of watching where the wall failed in the beginning due to water accumulation and changing the position of

the wall until it was able to hold the water back. This procedure, which is an indigenous response to conditions, seems to have been very effective. It was the response of the people four and five hundred years ago to the need to conserve their land and also farm grapes on steep slopes. The method should be encouraged for promoting rock wall terraces because they seem to represent a method for securing long term agricultural production.

2.3.3 Present Level of Technology

The agribusiness community is rudimentary and somewhat unorganized with the exception of the port wine industry. The organization for the production and sale of port wine should serve as a good example to the people of the region.

The people in the region have the capability and desire to intensify their efforts in making higher production from the agricultural resources available to them. The farmers have achieved the highest level of production that they can possibly achieve given the constraints of soil, climate, and knowledge of traditional practices. Technical assistance to the farmers is now necessary because the problems they face for increasing production are greater than they can solve with their own resources. In regard to the technical assistance approach, it is important to observe carefully the present technology level in the agricultural sector so that the experience gained in traditional agricultural practices over the many years is not lost in the eagerness to adapt new technology.

2.4 The University

The Universitario de Tras Os Montes e Alto Douro is located at Vila Real in Northern Portugal (Figure 1). The University status was recently achieved from the former Instituto Politecnico of Vila Real. Figure 2 is a partial view of the University. The fields below the wall are planted to grapes and vegetables.

2.4.1 Institutional Goals

The University philosophy is to study and teach agriculture in cooperation with the farmer and the agricultural community. This is important if the region is going to break the technological barrier and significantly increase agricultural production.

The University is now an established institution with broad community support. The population size and educational background of the region requires a large university and enrollment will probably grow to tens of thousands of students.

The agricultural school is well constructed and it is already exercising most of the functions of an American Land Grant College. Agriculture and forestry are the primary courses taught. Research is conducted on the University farm and on private farms. Crop diseases are diagnosed and tested. The Univerity is awaiting extension specialists so they will have a communication link with the farmer.

The University administration is dedicated to education for both the agricultural specialist and the farming community. The University appears to be capable and well motivated to extend their expertise to the farming community. The staff and faculty have demonstrated that they are enthusiastic, dedicated and well educated. However, some of the faculty will need to further their education (advanced degrees) since the school's role

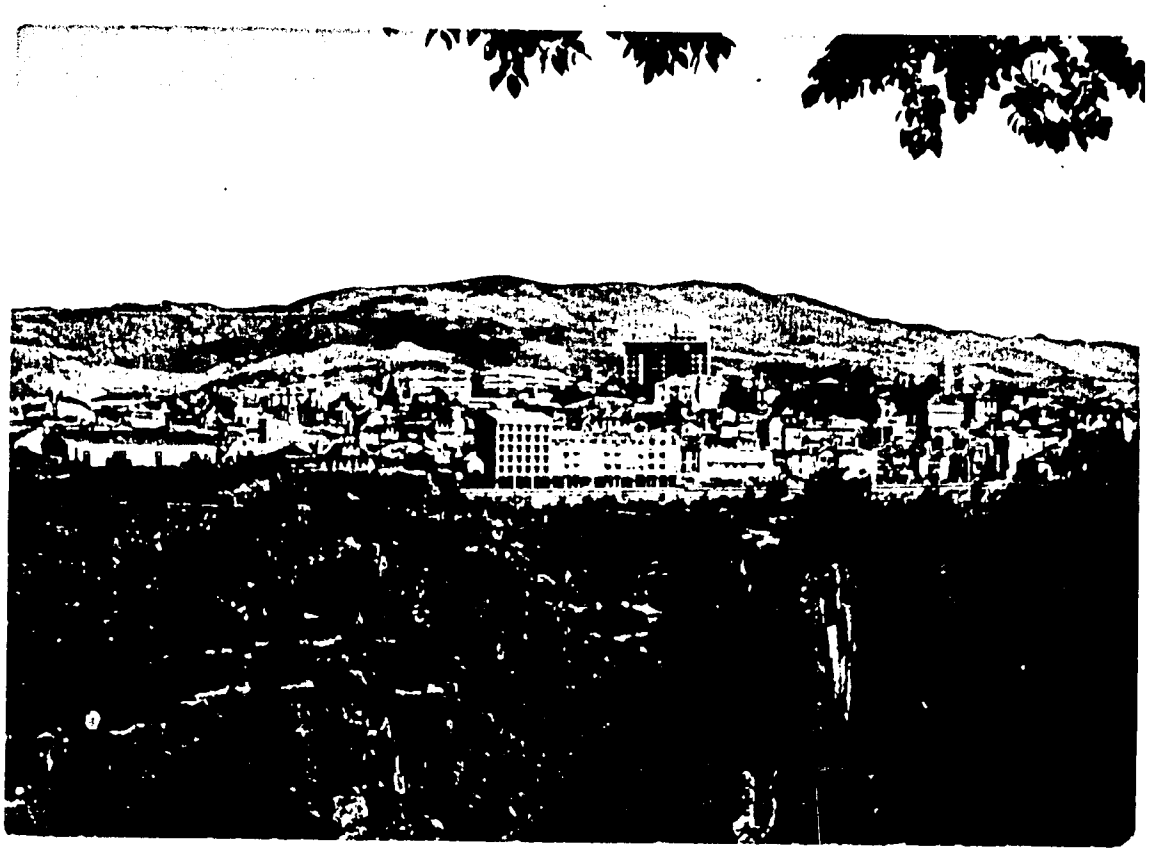

Figure 2: THE UNIVERSITARIO DE TRAS OS MONTES e ALTO DOURO AT VILA REAL, PORTUGAL

changed to university status. The University can be considered an important contribution to the people involved in agriculture in the region.

The University staff and faculty is well balanced technically and they respect each other personally and professionally. They are eager to pool their specialties and work together to solve problems. They understand how each one relies on the capabilities of the other. They are gaining the respect of their colleagues and institutions outside of the University.

Other institutions of Portugal have a substantial capability to support the research and investigative effort of agricultural resources in northern Portugal for education, inventories and detailed research, so that if the problems are identified, the national support is able to respond.

2.4.2 The Need for Extension Services and Research to Improve Farmer Productivity

The community has explored most of the solutions to problems related to agronomic production which are available to the individual farmer. However, agriculture is now expanding onto soils that are more difficult to manage for intensive uses. To guide crop production practices from this point on, the area needs imaginative and new solutions of a highly technical nature from qualified technical people.

More sophisticated technical assistance is required from crop production specialists and larger institutions. The infrastructure is available but not adequate to meet all the needs of the farming community.

Agricultural resources are difficult to change and for this reason alternatives to the resource cannot be presented easily. The major recommendation for increasing agricultural production is the growing and processing of horticultural and fruit crops, as well as the grape. Development of the food industry in the

area would tap the farming capability and utilized the small parcels of land while creating an added opportunity for the population to work. The region is already developed agriculturally and in the process of developing new solutions on marginal lands.

The region needs better adapted crops and more varieties of the same crops. Too frequently the market is innundated with the same crops at the same time of the year. Given the variety of microclimates and soils, improvements in crop diversity and supply, throughout the year, could provide a more balanced diet for the Portugese people. For this reason, research pertaining to horticultural and fruit crops varietal species adapted to soil and microclimatic regions would be useful for making the maximum and most intensive use of the agricultural resource. Further, in those lands not suitable to horticulture, the use of multiple and dual cropping practices would be advantageous. In some cases, with intensive crops, it may be necessary to plant grasses for erosion control to protect the soil in the winter season when the land is not actively supporting a crop.

Through the identification of areas with distinct microclimates and the application of appropriate cultural improvements, the region should be able to produce a greater variety of crops over a greater portion of the year. This is especially true if the irrigation and drainage needs are met. For this reason, studies are needed to identify ameliorating drainage practices. The soils become very dry in the summer, thus indicating a need to explore local sources of water for irrigation. Given these conditions, surficial and subsurface hydrologic studies would be very useful in the area. The agriculture use in this region is very intensive and will continue to grow, therefore, alternative solutions to the problem associated with increasing the agricultural production should be investigated at this time.

Overall, there is a good agricultural resource provided the farmers are given sound advice and technical assistance to maximize the intensive production on each area. The University in Vila Real is already expanding into the technical assistance role. Because of the need for outside technical assistance to the farmer, this University serves as a important source of agricultural information. The university is demonstrating the willingness to develop a new level of agricultural technology for resolving problems associated with climate and soils; e.g., drainage, irrigation, fertility, crop practices and crop species.

3.0 SOIL CONSERVATION, SOIL FERTILITY AND AGRICULTURAL PRODUCTION ON MARGINAL LANDS

Soil conservation is one of the more serious questions in Northern Portugal because marginal agricultural land is presently being farmed and the expansion will continue into those regions. Conservation studies should be a large portion of the investigations and recommendations to come from the University. The soil conservation section is dealing with the problems as they relate to the region, but their job will be more difficult as agriculture moves into more marginal land.

Almost all aspects of soil conservation need to be employed. The conservation practices will depend on the kind of land under use. This becomes a farm specific project. The farmer needs technical assistance on his own personal farm to solve his own personal problems. This is a case where a conservation technician in association with the exension agent would be very helpful by contacting the individual farmer and discussing his needs, then laying out the conservation program which would best suit him.

Soil erosion is particularly a problem at the end of the dry season when crops are either harvested or spent. During the rainy season the soils are saturated and subject to erosion. A common practice has been the establishment of rock wall terraces or diversion channels cut to the length of the slope with the use of roads that direct the overflow of water to established drainage ways.

The land needs some protective cover at the end of the dry season. It may be mulch or an old crop that has not been removed so that the first rains do not have the intensive erosive capability. Frequently a good cobblestone cover serves well as a mulch. This can be very helpful in crops like grapes where cultivation is minimal and the slopes are steep.

Farmers also need to be careful to do their tillage practices when the soil is at its best tilth. Some soils are on the clayey side and clodding and compaction become a problem if

the soil is too wet. Some of them are very difficult to handle when they are too dry. One of the important thing to consider is reducing the amount of all tillage by the practice of minimum tillage or no tillage. This would include the use of crops for weed control. It would include use of herbicides and the use of equipment capable of passing over the land only once.

They need to consider winter cover, since the major rain falls in the winter when plant growth is retarded. The employment of cereal and grain crops like wheat, rye and oats, which do in fact grow through the cool winters, can give them some protection against erosion and hopefully help to reduce weeds as well as supply a green manure crop for the spring planting. These crops may be helpful in removing some of the water in the early spring on the highly saturated soils.

The organic matter has been seriously reduced in the area through weeding and burning. Returning organic matter to the soil is a high priority in all cropping systems. The soil must be fed to feed the people.

The first kind of technical agricultural assistance should be given in terms of dry land farming because irrigation has not been highly developed nor is it clearly understood. It will be some time before farmers can make the conversion to irrigated agriculture.

3.1 Rockwall Terraces

Land manipulation is excessive in Northern Portugal. The farmers are willing to plow, and frequently do plow the land to one and one-half meters deep. The purpose is either to mix rotten rock into the soil to give it a more effective depth or to mix clay layers to increase permeability. The farmers also do land smoothing, rock removal and cultivation for weed control. The traditional agriculture has necessitated the use of rock walls for property boundaries and as a place to store the rocks

as they are exposed through erosion. This in turn has accumulated deep soils behind the rock walls (Figure 3). On first appearance, it seems that this technique is too expensive for modern technology. It certainly is an inhibitor to the use of equipment. Rock wall construction was dependent on hand labor and later animal labor and therefore was not designed for the purpose of machinery. The overall view shows that this technique has been used very effectively in expanding the amount of agricultural land available and also preventing erosion. The silt and clays simply are not moving into the surficial water systems.

Earthen terraces do not control brush on the steep terrace slopes. The brush tends to use moisture from the grape and the grapes suffer severe drought in the summer. At this time, the earthen terraces are not a practical solution to the erosion and management problems.

3.2 Organic Matter

Composting can increase organic matter and is an important facet in improving productivity of soils in the region. Organic matter not only increases the fertility, but will reduce the amount of air pollution because the plant refuse is presently extracted from the fields and burned. Burning is much too popular at this time. The effect has been to reduce the organic matter level and subsequently the fertility of the soils.

Composting in particular promotes the same kind of sanitation as burning because the composting procedure kills most of the pathological diseases and converts the organic material to a more usable form for the plants. Compost stores fertility during the winter months and permits the farmer to place the organic matter where it will be most useful.

Figure 3: ROCK WALL TERRACE: A TRADITIONAL METHOD TO REDUCE EROSION AND PRODUCE CROPS ON MARGINAL LANDS

3.3 Irrigation and Drainage

Presently the only real source of irrigation water that is being seriously considered is surface water retained behind major dams. Because of the excess rainfall in the winter, and the time lapse for the internal drainage in the subsoil, or in the rocks beneath, there is a good probability that there is other water more immediately available to the landowners. First of all, streams are already being utilized. The water is channeled from the small local streams to nearby slopes and valleys to increase pasture production. This practice has established the water rights and irrigation channel networks which could be utilized more efficiently.

Below many of the poorly drained soils there is a high water table which could be utilized with a low pressure small irrigation system. This, in fact, has been done by many of the farmers in the region. Another source of irrigation water could conceivably be taken from drainage tiles because the many soils need drainage as well as irrigation. The drainage tiles would provide the capability of increasing the effective permeability of the system, thus tapping this water source. The large surface area of the drainage tile would permit the delivery of high volumes of water. These could be coupled with the irrigation systems that use lesser amounts of water such as drip irrigation or subsurface irrigation or certain sprinkler types. The question of irrigation is going to be very complex and simple answers cannot be given. Many kinds of irrigation techniques may be applicable and probably are going to be used.

Ground water for irrigation is available under the higher interfluvial regions in fractured schist or granite. If a well is placed in a highly fractured zone it should prove to be high yielding. For this reason, a good hydrologic study is necessary so that the amount of water available and its probable accessibility can be evaluated. With alternative sources of water the land owner would be given the opportunity to decide how he is going to take advantage of that water resource. Generally,

the high country streams run all year long into the valleys which indicates a good source of subsurface water.

3.4 Fruit Tree Production

Fruit trees and horticultural crops probably offer the greatest opportunity for the region to further intensify its agriculture and increase the rate of return per hectare. Fruit tree fertilization and nutrient need were diagnosed through plant tissue tests and soil tests. Also, methods for reestablishing a new fruit tree stand without contaminating the new stock with diseases of the old stock were examined. Interplanting new trees between the old ones, later removing the old trees, or if necessary burning the diseased trees before planting new stock was recommended. If the disease is too well established, it may be necessary to change tree species for five or ten years before returning to the original species. Fruit trees should be measured to determine yield rates and yield per soil class.

A method for draining saturated soils for fruit trees entails breaking up any clay horizon or impermeable layer with a trench of gravel to permit the infiltration of water, seasonally trapped by these conditions, into the lower more permeable subsoil to be carried off by the drainage tile. Simultaneously, this sort of system should also serve, if properly installed, to supply local irrigation water for the plant during some of the dry season by taking the irrigation water out of the drainage tile itself. Tree crops would lend themselves to drip irrigation which uses less water under less pressure. Some vegetable crops would also lend themselves to irrigation with drainage water during the dry season.

3.5 Grape Production

The planting and management of grapes in vertical rows on steep slopes was a subject of great interest to the Portugese. Vineyards were visited that had been planted 20 years ago, some planted eight years ago and some three years ago. The horizontal rows were planted right beside the vertical rows on the same slopes and soils. Because the vines occupy such a minor part of the surface area, the configuration of the plants in rows does not appear to be a significant factor in erosion control. Vertical tillage does not tend to increase the downward creep of the soil as much as horizontal tillage. The practice of ridging the row on steep slopes is not a satisfactory method to retain water. In fact, the effectiveness of vertical rows seemed to be more dependent on the cobble pavement. By maintaining a good cover of cobble (providing the machinery can still function) effective erosion control is possible on horizontal or vertical rows. It is also important that the slopes be cut in their effective length. In this case, the placement of roads for the machinery that will handle the cable driven equipment is appropriate for the vertical plantings. Trenches or earthen terraces in the center of the field reduces the slope gradient. Erosion occurs on the natural slope whether planting by the horizontal or vertical system. The soils erode at nearly the same rate, holding other factors constant. Erosion on these slopes is a natural phenomenon and for this reason the soils are rocky and thin.

The use of the rocks at the surface following cultivation and erosion could be used for rock wall terraces that would retain the soil. This is a traditional method to reduce erosion and to preserve the agricultural resource. Soil and crop management is a personal decision of the farmer, however given factual information he can make wise decisions.

There are other regions where the soil may be as deep as one meter to one and one-half meters, quite clayey, well saturated in the spring with few rocks in the solum. These soils present a

different management problem. They need to be drained in the spring and care must be taken that the water does not accumulate along the roads and channels used to control the water disposal. In this event, erosion will be higher because there is little rock mulch to protect the soil.

To reduce the amount of cultivation and land preparation, without the use of herbicides, the possibility of burning alcohol was suggested (which the area is capable of producing) to eradicate emergent weeds. This would eliminate the problem of cultivating. Farmers plow the rocky ground when they cultivate grapes and this effectively prunes the roots back to the plant. If they could avoid turning the soil the grapes probably would be in a better position to utilize the fertility and nutrients in the row area of the vineyard.

3.6 Forage and Pastures

Both improved and established pastures are needed. In some cases they need to be of a permanent nature. In other cases they can become part of the regular cropping system to take advantage of grass cover for conservation needs. There is a serious problem of finding a large body of plant materials which survive under the extreme conditions. The dry season conditions in the summer time need to be modified by the use of irrigation water.

The question of pastures was examined. Cattle, sheep and goats are important for converting forages to edible products. Some lands are unsuitable for cropping because large boulders exist and the climate is unfavorable, especially in the upper mountains where frosts are common in summer, thus limiting the growth of most crops. Few grasses and legumes can tolerate the acid soils, dry summers and cold winters. The planting of subterranean clover, red clover and crimson clover with rye grass has been practiced with good results. Practices that can reduce cost for establishing grasses and methods of brush control

include the use of goats, hand labor by shepherds, and mowers if sufficient rocks are removed. In mountain pastures, rocks can be removed and placed as terraces for the purpose of restricting eroding soils. In other cases the forage may be planted to be harvested as silage or hay. Better quality forages are necessary for wintering livestock, but the serious limitation in developing the livestock industry is the animal health problem with tuberculosis and brucelosis.

The intensive use of livestock in agriculture includes maximizing the efficiency of an animal to convert forages to milk and unless the milk is healthy (free of diseases) the potential of high return on forages is restricted. Therefore, a national campaign is recommended to eradicate bovine tuberculosis and brucelosis in the best interest of public health.

In regard to range grasses, a need exists to reduce the amount of land preparation so that the cost of establishment is reduced considerably. This sort of pasture is usually imposed on land that is relatively low in productivity. The number of animals maintained per hectare is considerably less than on improved pastures.

The use of pasture combined with forestry is possible,but it requires reducing tree basal area and the forage production. This could be a method of providing both trees and livestock and also allow the farmers to have some annual return from the land until the trees are large enough to sell.

3.7 Forestry

On many soils there is serious competition between grass and forest. Pine is not a well adapted species to the region because moisture is a limiting factor in the dry summers. Oak or chestnut is better adapted than pine and there is a need for afforestation on lands less suitable for agriculture. National, provincial and common lands usually occupy larger parcels on

lesser quality agricultural lands. Therefore, these lands would be suited for forests or parks. Interplanting of trees and crops, trees along fence rows, and trees along streams for stream bank protection (especially the more valuable hardwood species) should be considered. In this way there could be some production from the nuts or olives . The wood could be utilized for products used in the region. The foresters have a good concept of how the trees can fit into the natural agricultural complex. Large sections had been converted to forest and some people destroy the trees in an attempt to establish pastures. Sometimes the pasture may be more suitable for the land; in other cases, it may not be. The communities need to be educated as to what the real role of trees can be in terms of maximizing the use of their soil resource.

4.0 OPERATIONAL AND ANALYTICAL PROCEDURES RECOMMENDED FOR THE AGRICULTURAL-EXTENSION PROGRAM

The Senior Resources Analyst spent several days with each of the University departments involved in agronomy programs. Their programs were reviewed and advice was provided on how to proceed. The Senior Resources Analyst traveled to review the soils and agricultural conditions near the cities of: Lamego; Vila Real; Mirandela; Mira poca Vale; Miranda do Douro; Braganza; Chaves; Braga; and Viseau. These trips proved useful and helpful in understanding the settings in which the University at Vila Real was functioning.

4.1 Soils Laboratory

The soils investigation section was visited first. Soils mapping is the responsibility of another national office and that responsibility should remain with that office. There was a meeting with some of the people who would be involved in the soils mapping and who could influence the decision to map the soils in the northern region. They agreed to send a team of soil scientists to the northern region, if needed. The arrangements would be easier to organize if the University would give administrative as well as some logistic support. This point was conveyed to the Director of the University. In the meantime, instructions on mapping slope, texture, depth and the drainage of soils were provided as these are the most important characteristics in making land use decisions. Some guidance is needed by non-soils specialists on how to proceed with their specialties in terms of the constraints placed on them by a lack of knowldge about the soils.

Other instruction was provided on how to collect and organize soils information about the region, including: data collection procedures; how to classify soils; and where to acquire the classification systems used by other countries.

On the visit with the soil scientist in Lisbon, the Senior Resources Analyst found that the agronomy department in Lisbon is very capable of doing soils investigations and could serve as a support unit for the University at Vila Real. Soil testing and soil research is rather advanced throughout the country, thus setting high standards for the University. The agronomy institute will offer excellent support for the University of Vila Real. The group of men who mapped Angolan soils are available and that capability can be mobilized to do a semi-detailed soils survey of northern Portugal.

There are two institutes in Lisbon with the capability of doing soil mineralogy and clay analyses. The National Agricultural Service (NAS) is doing in-depth studies in trace elements, soil physics, and mineralogy. The soil scientist at the University of Vila Real had previously spent time at NAS and was familiar with their procedures. The National Soils Testing Laboratory has ten years' experience testing soil fertility and offered to supply all results from their tests of northern Portugal.

The soil chemistry laboratory at Vila Real was reviewed to see what procedures were being used and how production could be increased. The laboratory is functional and the people are competent. The flow of samples was impeded by the lack of a drying stove, a large shaker, automatic measuring devices and a more direct contact for purchasing equipment and chemicals. For example, a common salt was not delivered until six months after being ordered. The laboratory, with present space and personnel, should be able to handle up to 60 soil fertility samples per day. It is important that lab personnel achieve the capability to do micronutrient analysis on the soils and plants because there are some problems in the regions with boron, copper, molybdenum, manganese and selenium.

The equipment needed by the soils chemistry laboratory to increase their productivity and to achieve capability in doing microelemental analyses is provided in Appendix 1.

A method was recommended for entering the lab results into the computer so that the data would be more available for computations.

The soils physics laboratory was reviewed. This unit seemed to be functioning very well. The people are experienced. Suggestions were made to estimate the texture and organic matter content by hand, because both of these tests are time consuming and expensive for routine soil fertility analysis. Some advice on equipment for soil moisture tension requirements was also provided.

The climatology section is headed by a very competent person. Discussions focused on the macro and microclimates in the region. The Senior Resources Analyst suggested the use of tree ring studies, soil temperature and botanical adaptations to extend climatic information from the weather station to areas with little or no record. This is necessary since the region needs a microclimatic map and the number of weather stations necessary to do a definitive study of this sort would be prohibitive. Therefore, indicators for significant changes in microclimate need to be noted and evaluated so that they can be brought to bear in a mapping procedure.

4.2 Soil Suitability Mapping

Another conservation problem concerning the agricultural resources in the area is the encroachment of both housing and industry on major agricultural soils. The area is limited in good agricultural soils and construction could profitably utilize unproductive areas. Traditionally, the farmers have built their houses and their towns on the least productive areas of the region. The use of agricultural land by housing and industry needs to be curtailed quickly. Unfortunately, soils maps are not available to guide building construction, but a slope map could serve this useful purpose. A technician could use a slope map and planning criteria to select appropriate sites for agriculture

or non-agricultural use. Given only one criterion on which to pass judgement, the slope map would probably be the best until a good soils map can be prepared with its proper interpretation on agriculture and other land uses.

4.3 Soil Fertility Program

The region has some inherent fertility problems which include phosphorous deficiencies. Generally, all the soils are low in phosphorous. Almost all of the soils have low pH, that is, acid soils. Most of the region suffers deficiency in water during the summer months. Other parts of the region have problems of too much water in the soils during the winter and early spring. In limited areas soils are even saturated during the summer months.

The people responsible for crop yield recommendations were visited. There is little or no experience on the response of any of the crops to fertilizer application on the soils of the region. For one reason there are no soils maps to serve as a basis for crop yield response. Second, they have no yield data on how the crop is responding to the recommended fertilization. The crop yield personnel are making recommendations on the basis of recommendations made elsewhere in the world for similar crops under somewhat similar conditions. They seem to be making reasonable recommendations given existing knowledge.

4.3.1 Application and Distribution of Fertilizers

There are several factors which affect the use of fertilizers in northern Portugal. The soils are naturally low in phosphorous and many soils are acid. Potassium varies considerably. Some natural soils are high in potassium while soils that have been cropped a long time may be low. Nitrogen

also varies and is usually related to the presence of organic matter which often has been depleted due to cropping.

Fertilizer use has been hampered by the lack of a good soil testing program designed for the region. There is little yield data related to soil test results.

The actual application of proper fertilizers has been hampered by the fact that often the recommended fertilizer mix was not available to the farmer at the point of purchase. The farmer, thereupon, had to either choose a substitute or abandon fertilizer. If he chose a substitute it was frequently the wrong mix for there was little guidance on how to achieve the proper balance of nutrients. This usually resulted in purchasing too much of one nutrient and not enough of another.

There is a standard list of about 17 mixes supposedly available. These standard mixes were derived mostly for conditions in southern Portugal where more fertilizer is used. As a result the farmers in the North find it difficult to locate properly mixed fertilizer.

Upon purchasing the fertilizer the farmer is faced with two problems. The roads are often steep and in poor condition and the fertilizer often does not arrive to the many small fields. If the farmer does reach the small fields with the proper allocation of fertilizer, he often has no means to properly apply it. Therefore, the fertilizer is frequently broadcast by hand and achieving an even distribution and application rate is very difficult. Some farmers do have small fertilizer spreaders, but most farmers have little access to information about the timing of the application or the placement of the fertilizer.

Many farmers have obtained poor results for their efforts. Further, the availability of loans and the high interest rates, which is often one of the first considerations in a fertilizer program, are both prohibitive. There are probably other factors such as severely dry weather or heavy rains which reduce crop yield and reduce the return on the investment for fertilizer use, thus causing some farmers to avoid the practice altogether. The

success of any fertilizer program in the North will depend on a good extension service. The area is already committed to intensive agriculture and the farmers are interested in high return crops. To obtain a high return on crops requires very careful and very specific fertilizer requirements. The farmer needs good technical advice on how to proceed with a fertilization program.

Besides developing a body of information on crop responses to fertilizer recommendations for various crops on the soils of the region, consideration should be given to the distribution of fertilizers. If N, P and K are delivered to the local distributor in bulk as uniform pellets and separated into three bins, the distributor can then mix and bag the fertilizer according to the soil test recommendations. This should reduce the complications of distributing 17 kinds of fertilizers. It permits the company more expediency in restocking the distributor during the rush season. And it reduces handling costs. The distributor reduces inventory costs. And the farmer receives the proper fertilizer.

Calcium is deficient in nearly all of the soils. The pH is also low in most soils. In some soils the cost of neutralizing the soil is probably cost prohibitive. The recommendations for calcium for crops raised on these soils is being based on the needs for acid tolerant crops. In other cases either the pH is high enough or the crop is worth enough to recommend neutralizing the soil. Care should be taken to locate calcium sources in the region and some are already known. It is important to reduce transportation costs for lime or else it quickly becomes cost prohibitive. A method for financing low interest rate loans on lime application based on technical recommendations would be essential.

Trace elements represent another problem. Some are deficient and others are at toxic levels. In the case of baron and copper toxicity has been culturally induced. There needs to be control on the proper application and treatment of these conditions for the public health.

The efficient use of all of the fertilizers is dependent on an active project for management of organic matter. Both green manure and barnyard manure need to be incorporated into the fertility program. The organic matter is often severely depleted. The soils are usually coarse textured and many are thin. Under these conditions organic matter offers the best alternative to retaining unused fertilizer and also increases its availability to plants in addition to its many other benefits.

With the rising cost of petroleum, farmer should be encouraged to use legumes as a source of nitrogen. They may be planted either for forage, ground cover, or for green manure.

Erosion is a problem on the slopes in the northern mountainous region because of the intense rains at the end of the summer dry season and during winter when there is little vegetative growth. Erosion must be controlled to save on fertilizer costs and increase their effectiveness.

Past weed control measures have reduced organic matter and fertility. Increasing fertility will also increase the problem of weed control. Increased weeds will reduce returns on the fertilizer investment. It is important to make the farmer aware of this fact.

The technology of applying fertilizer on small steep fields with proper crop selection and other items addressed in this section need to be examined thoroughly. The area needs to drastically increase its use of balanced fertilizers and lime. Technical assistance must be provided to increase the farmer's capability to adequately manage the soils for crop production.

4.3.2 Soil Data Collection

The University personnel are eager to interact with the farmers to learn if their recommendations can help the farmers increase production. Therefore, a program was designed that would: 1) receive samples from the farmer, and 2) receive data

from the farmer concerning crop production so the crop yield division can determine if their model is predictive of actual yield. An adequate crop yield model is needed to correspond with their laboratory techniques and the soils in the region, which is the only way soil fertilizer recommendations can be made. Instructions were prepared on how to take soil samples and prepare questionnaires to provide data on: crop yield, the type of crop in the previous year, size of the land parcel, and any fertilizers that were applied. The laboratory is making the assumption that the status of the fertility of the soil was somewhat similar between the previous year to the current analysis.

The data from the soil fertility analysis will be entered in the computer so that the team making the recommendations will be able to access this data bank and start to evaluate the fertility conditions in the area. The geographic location of the parcel will be based on the political location of the farms because geopolitically the area is subdivided into rather small parcels. The objective for collecting soil samples from the farmer is to determine what yields can be expected from various crops. Also, this method will enable the laboratory to determine what level of phosphorous and potash applications should be recommended to increase crop yields.

A soil bag with minimal instructions for soil sampling will be supplied to the farmers and an identification tag that reveals the location of the farm, farmer's name, information on the previous crop and fertilizers used, and the size of the parcel. They will take this bag and the instructions to a Junta Fragacia (middle-level government unit) and locate four individuals who would be interested in distributing the bags and collecting the soil samples. Among those being considered were the local priest, a member of the Junta Fragacia, someone in the almecen (local general store), or a leading farmer in the community. The team will return in two weeks to collect the soils and to talk over the critique which the farmers gave these four individuals

concerning the instructions and procedures. These samples will then be evaluated and within one month, five Junta Fragacias across the region will be selected. The sampling procedure will be reported by taking a limited number of soil bags and incorporating the revised instructions for data collection. Once the logistics and procedures are operational, the data collection teams will be ready to launch a regional campaign to collect soil samples for fertility analyses. This should take somewhere between six and eight months.

After about two years of collecting data of this sort, the University will have a large enough data bank to begin to refine their own recommendations and be more specific to the particular farmer's needs. At the same time the laboratories should be geared up to deal with large numbers of samples. Many of the recommendations to the farmers should be already automated on the computer so the bulk of recommendations which are routine can be processed automatically.

4.3.3 Soil Data Processing

The University possesses a small Wang computer with BASIC language programming, but the specialists have not been utilizing the computer as an effective tool for coping with the massive amount of data that they must process. The computer section is going to grow very quickly within the next few years. The agronomist needs to enter yield data into the computer to increase access to the test results to enable the various University departments to interpret the data in terms of their own discipline. The program was set up such that a sample is numbered, localized mostly by its political settings and its owner's name. Then all of the possible analyses or tests that would be applied are labelled and catalogued so the specialist may enter into, for example, the soil chemistry file and extract the results on the particular sample of interest for a given soil test result. As soon as they get more results from this data

bank, they will find themselves more comfortable making recommendations and arriving at solutions to the agricultural problem in the region.

The people are well educated and capable. Their confusion and concern stem more from the fact that they do not know what resource they are working with because it has not been inventoried. The data is not available for solving problems. So they look to other institutions and they look to other experienced people to answer questions for them which in fact cannot be answered until the facts of the region have been established.

One of the largest sets of data banks that will be developed, for making decisions concerning assistance to the farmer, will be the results from the soil fertility tests. This aspect was critically reviewed so that the data will be as useful as possible. Questions were included in the data collection forms about the previous crop and its production and the fertilizers applied. In this way, the specialists would have some indication of crop productivity. The final test of the data collection and processing procedures is the yield received by the farmer based on the University's recommendations. This includes not only fertility recommendations but also conservation and cropping system recommendations, etc.

4.3.4 Soil Fertility Experimentation

The data bank on fertility analysis is an important source of information to monitor the effectiveness of field recommendations. Therefore, six steps were outlined that would be useful for determining what kind of research is necessary and how much effort needs to be placed on that research. This should pricritize their research and to put their first effort in those projects which will give the maximum return. The six steps were:

1. Review the data from the fertility analysis to get an idea of natural fertility for each soil type. Then determine how each of the crops are responding to present management from the limited data they have received from the farmer. They probably can solve many of the immediate problems on that basis alone. In the case that the data does not reflect an answer to the problem, they would;
2. Send out a questionnaire to those selected farmers who are having problems that do not lend themselves to answers based on the overall general trends. These are questionnaires specific to specific problems encountered. If these kind of questionnaires do not yield enough subsidiary information to solve a problem then they should;
3. Visit a portion of these farmers to determine the farm conditions.
4. They may enter into an agreement with the farmers to do some experimental planting so they can engage in a widely distributed test to measure some yields carefully so they get better control on why a crop is not responding to certain recommendations. If that does not solve the problems, they will
5. Plant the crop in the experimental farm and grow it under more specific constraints. If that still does not resolve the problem, it may be necessary to;
6. Conduct pot tests where the control is even more specific. Pot tests can also be used in the incipient testing at the beginning by establishing the major soils and setting up pot tests to help understand how these soils are responding to various fertilizer needs.

This stepwise procedure will allow them to solve the problems as quickly as possible as enough data becomes available. The procedure would help to avoid putting any more effort or money into the solution of the problem than is necessary. They seemed to respond favorably to this kind of problem solving.

Overall, the question of how to approach research and how to understand the resources at hand was overwhelming for the group. The problems are extensive. The kinds of data they need for solving the problems and giving assistance to the farmers is very deficient in the area. They were entering into various research programs based on what they happened to see or their own personal interests. The objective became one of breaking the major

research problem into smaller sections and into a stepwise procedure that was comprehensible. The idea was to focus the team effort on the problem so they could draw from each other's special capabilities.

4.3.4.1 Sample Design

The area does not need a reconnaisance level study of any sort at this time. Detailed studies are needed but they are time consuming. The agronomy department must have an accurate data set. Therefore a randomized inventory of the agricultural resources was recommended. A sample of 500 land parcels was drawn to be enumerated in the field by personnel with prepared questionnaires. Five hundred parcels of land would be analyzed very thoroughly and would provide useful information about the extent and distribution of crop conditions and problems that arise.

The purpose of the study was to acquire general information about the status of the agriculture in the region. It was designed to develop a body of knowledge on a technical level and also to focus attention on specific parcels of land where the specialists collective efforts could begin to make technical recommendations. The study should bring all of the specialistis together as a team. It should also establish a method for monitoring crop change and trends over time. This study will help the specialists to identify specific goals and would fill the void of deficient data quickly by getting more resources information. It is a way to get them on the farms to learn what the conditions are in the field. The inventory will provide the data necessary to prioritize and direct research. The sample is important because it will give the first indication of the status of agricultural resources. This inventory does not require a specific time limit and there are many ways in which the inventory can be conducted. The data base can be revised or expanded as the need arises. Inventory data can be used by all

the specialists. Thus it will be necessary for all users to contribute to the design of the questionnaire to insure that all pertinent data is collected.

4.3.4.2 Sample Methodology

A generalized soils map and a slope map based on the slope categories for the land capability classification was constructed. The general map of climates and a crop distribution map was also obtained. Nine thousand intersections of latitude and longitude were located on one minute intervals that occurred within the region under study. All of the coordinates were listed on individual pieces of paper the same size and were mixed in a container. A sample of 510 coordinates were drawn. The sample was listed in order of which they were drawn so the size of the sample can be reduced if necessary. In this way subsamples can be taken to compare against each other for statistical accuracy later on.

As a demonstration of the utility of this procedure samples were selected which occurred in the Duoro wine project region. More samples could be extracted from this same coordinate number base for the Duoro wine project to answer more detailed questions specific to the region. That is, questions which were not adequately answered by the initial 50 samples (in this case) that occurred.

The specialists from each section were escorted to one of the parcels of land that occurred in the random inventory to discuss what kind of data they should collect, what crop was on the land, and what kinds of measurements were needed. Thus, the specialists understand how this particular kind of information will be useful to them. The fact that the sample is only an estimate and not a substitute for mapping was emphasized. Mapping the resources provides specific interpretations for all of the region. It is also not a substitute for onsite specific

interpretations for the farmers. It is not a substitute for small unique important studies on limited problems. On the other hand, the sample can provide a broad range of data because of the amount of interrelated data collected from each specialist. Some of the data will be more precise, collected in this manner, than for example, data collected from a soils map. Further, this kind of study allows for generalization about what the conditions are in the area and permits monitoring over the years to see what changes are taking place. The alternatives for the region will be limited to those choices made by the larger agricultural community. The University will also be a leading factor in suggesting alternative courses.

5.0 RECOMMENDATIONS FOR APPLIED RESEARCH

A research program was reviewed with the soil conservationists to consider the amount of soil erosion that is taking place in three different climatic zones with four prominent slope groups and with three different management practices in northern Portugal.

A soil erosion formula was developed from incomplete data. The formula needs to be tested over a greater range of climatic and terrain variables to determine its predictive value.

Intensive agriculture with higher return crops is a long term goal. One of short term basis, the farmers need to be given alternative choice concerning the present cropping and agricultural practices. Among those choices are the introduction of more crop varieties that extend the effective seasons. Crop rotation systems are needed which will improve the fertility and production of the land and protect it against erosion. There is a need for introducing legumes in the rotation to raise the nitrogen level, increase fertility, and aid in soil conservation. Legumes can also be grazed by livestock.

Dairy animals, beef cattle, goats and sheep are important in northern Portugal. Brucelosis and tuberculosis in dairy and beef cattle must be controlled. Fertility, growth rates and production of livestock is low. Animal husbandry is a science that needs to be taught in the region.

The National Soils Survey should conduct a semi-detailed soil survey of the region. A microclimatology map of the region should be prepared to the scale of 1:50,000. There needs to be a cadastral survey so that ownership is understood and established. Ownership boundaries need to be clearly established so that land can pass hands either by rent or by purchase.

There should be a study of the infrastructure and the agricultural support institutes. There needs to be a hydrology study so that both the surface and subsurface water availability is carefully mapped and its utility made known. There needs to

be the entry into generalized information to sort out and solve the easier broader problems, then to begin to concentrate at lesser levels of generalization. The problems that are not as readily resolved should be isolated and more specific studies made. A randomized inventory of the agricultural resource should be conducted.

Horticulture and fruit crops in the region should be increased to complement the present wine growing industry. There is a vegetable canning factory at Cachoa. Given the technology of the farmers, the amount of fruits and vegetables raised presently and the high population density, the need for higher returns per unit of land, the small parcels of land, the amount of hand labor available, and the need for light industry; the region is in a good position to develop a food processing industry. This industry could develop the market for the product.

The farmer would concentrate his efforts and talents on high production crops such as cabbage, onions, carrots, potatoes, brocolli, asparagus, oranges, cherries, strawberries, rasberries, peaches, pears, apples, almonds, chestnuts, pecans, walnuts, etc., all high yielding, high return crops which the people know how to grow. It is important that many varieties--early and late maturing varieties--of horticultural crops be tested and evaluated as suitable for more extensive production. A survey of the local market indicated that farmers are selling and consumers are purchasing essentially the same products at the same time of the year on a feast or famine basis. Fall crops are simply not available in the later summer or in the early winter and visa versa. Spring crops are not seen or known in the fall and winter time though some of them would produce at this time of year.

Further, there is a need to study the Portugese plant materials. Not even the grape farmers are aware of the genetic capabilities of the grapes they grow. Olives in the northeastern section need to be frost resistant because of a thaw that occurs in January and apparently there are such varieties in Spain. The

varieties of fruits and vegetables that are grown are not recognized nor do the grape farmers discuss the planting of new and distinct varieties available from other places.

Experimental planting of wheat or rye between the vine rows in the fall was suggested as a method to provide a vegetative cover in the winter when the grapes were not growing. These planting would serve as an erosion control by stabilizing the slopes and would also help to dry the soils earlier in the spring because May is the month when this type of crop grows most vigorously. These two crops use a different class of herbicide than for grapes and therefore could be killed quickly when the grapes begin to grow effectively, leaving a mulch at the surface to protect against erratic rains in the summer and the first rains in the fall. The rye or wheat crop would help in reducing the weed problem because the active growth of the grain would overshadow the growth of weeds. The subsequent result would be to increase the organic matter in the subsurface by the decaying and it would also help to hold the fertility in plant and organic tissue so that it is not so readily mineralized and lost by leaching. This line of research and experimentation should be studied carefully to find out what the complications are with the kind of conservation practice.

6.0 RECOMMENDATIONS FOR STRENGTHENING THE INSTITUTIONAL CAPABILITIES OF THE UNIVERSITY

The University is an educational institution first and foremost. It educates agronomists and agricultural technicians, but it needs to consider continuing education for the farming community. It also needs to expand its public education and should dedicate itself to practical and basic research in the region so it can teach, instruct and lead the agricultural community. Seminars should be considered for the local agricultural community and for the specialists at the University and specialists in other institutions. Also, the University should consider a series of lectures to interested groups who have special agricultural production problems.

The University has developed, on its own, a project to research the agricultural capability in the Duoro wine region with the objective of quadrupling the production of port wine. This should be supported because it represents a first step in getting into farmer-University relationships and farm community-farmer-University relationships.

Because of the size of the job facing the University and because of its youth, there are till many items which need to be addressed. One such item is the appointment of a research coordinator who can review and direct research activities and exchange information among the participating departments. This should help the research take on a coordinated effort. The interrelationships between various department would be utilized.

The University staff needs a hydrologist and a hydrogeologist to locate surface and subsurface sources of irrigation water for the dry summer months.

Other aspects of the educational responsibility need to be stressed in addition to formal education and direct contact with farmers. This includes public education through the mass media, lectures to local groups, continuing education, seminars for the specialists in the community and seminars on the technical disciplines.

Because of the additional new responsibility of becoming a University, the teachers need advice on assistance available to further their education. They can also use moral support on job security during their training. The University has been very supportive in this aspect in the past.

The research objective seems to be well directed towards acquiring data needed to answer practical farming problems. Each of the staff are actively engaged in research. The research needed to complete higher degrees offers the University the opportunity to investigate important problems.

The educational and research efforts should be separated. The work load allocation should be arranged so that a person either attends to research or teaching because both demand full-time attention. It is good for the staff to engage in both research and teaching activities but it would be better if they were not done simultaneously.

The staff can, on occasion, use short courses to bolster certain deficiencies. The soil specialist can use time in another country with the staff of that country (for example, the Soil Conservation Service in the United States) to acquire a capability in interpreting soils for various uses. This is a kind of information that is not available from formal education. Some others may find it necessary (e.g., the fertilities specialist) to spend some time with a fertility laboratory in another country to see how the problems of soil fertility and fertilizers recommendations are resolved there.

APPENDIX 1

EQUIPMENT NEEDED FOR THE SOILS LABORATORY

LIST OF EQUIPMENT NEEDED FOR THE SOILS LABORATORY

MUFFLE, FURNACE, inside revested with silica refractory, for temperatures up to 1000°oC, chamber size about 17cm width x 10cm height x 27cm em depth, 220 Volts 1

TRAY, translucent silica, with a rim on three sides for using in the muffle furnace 3

HOT PLATE, with aluminum plate, about 12cm Ø, thermostatic control, 220 Volts 1

OVEN, aluminum made, range above ambiente to 120°C, mechanical convection, inner measurements about 100cm width x 95cm height x 66,5cm depth, 220 Volts 1

WILEY MILL, motorized, for bench mounting, complete, 220 Volts 1

MOTOR DRIVEN MORTAR GRINDER, mortar and pestle of agate, grain size max 10mm, mortar volume about 650cm3, with scraper, time switch and dustproof cover, 220 Volts 1

FUME HOOD, built-in exhaustor, for especially aggressive media, with acid-resistant tiles, laid on asbestos cement plates, about 150cm width x 100cm depth 1

WATER BATH, polyethylene or stainless/steel made, 6 places, 220 Volts 1

CRUCIBLES of platinum, high purity, with covers, 30ml 12

CRUCIBLE TONGS of stainless, steel, tips covered with platinum 1

CRUCIBLES of silica, squat form, 50ml 12

CENTRIFUGE, top speed 5,000 r.p.m., including angle heads, buckets and rubber, pads for 15 and 50ml tubes, 220 Volts 1

HOLLOW CATHOD LAMPS, Perkin-Elmer, for A.A.S., Intensitron

Aluminum 1
Molybdenum 1
Potassium 1
Sodium 1
Titanium 1

CONDUCTIVITY METER, digital readout, 0,1 - 200,000 umhos range, automatic temperatures compensation, electrode able to read conductivity of small amounts of liquid, complete 220 Volts 1

pH METER, digital readout, 0 - 14 pH range with a reproducibility and accuracy of ± 0,01, pH, manual and automatic temperature compensation with two combined electrodes and filling solution, ready for using, 220 Volts 1

KJELDAHL NITROGEN APARATUS, with a digestion system up to 20 samples, temperature control unit and accessories and automated distilling unit with accessories, 220 Volts . . . 1

ERLENMEYER FLASKS, 250ml, with open interchangeable reflux condensors of 50 cm length, free-boron glass 12

VOLUMETRIC FLASKS, free-boron glass . . . . . .

100 ml 12
1000 ml 2