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AGRICULTURAL POTENTIAL IN THE NORTHERN ANDES, PERU:
THE CAJAMARCA INTEGRATED RURAL DEVELOPMENT PROJECT

by

SANDRA FOGLIANI, B.A.

A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfillment of
the requirements for the degree of

Master of Arts

Department of Geography

Carleton University

Ottawa Ontario

January, 1997

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“AGRICULTURAL POTENTIAL IN THE NORTHERN ANDES, PERU:
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Thesis Supervisor

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January, 1997

ABSTRACT

The Cajamarca Integrated Rural Development Project aims to help a group of traditional Andean peasant farm communities, located in Cajamarca Province, Perú. The peasants lack the basic services of health care, electricity, and running water, on their 1-5 hectares farms. They must overcome rugged topography and other physical and economic challenges. Land degradation is a problem, as is an inequitable market system.

Physical conditions are major determinants of farm production, however market and farming practices are also discussed in order to understand the whole situation. Soil and landscape characteristics were examined and GIS was applied to data obtain from the CIRDP in order to differentiate within the regions according to slope, erosion, pH, drainage, and soil texture and depth. On the basis of these results, the potential for crop growth within each differentiated area was assessed as unfeasible, not recommended, marginal or good. Finally, applying the above, the growth limitations for barley and wheat, corn, and potato in each region were analyzed and the results were mapped. Conditions are unfavorable over most of the area, with slope being the major problem. It will be difficult to improve production but some recommendation are advanced.

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CHAPTER 1

INTRODUCTION

1.1 Definition and Purpose of the Research

The need to improve people's lives is dramatically clear in the so-called "developing" countries. Hundreds of development projects are being carried out by GOs (Governmental Organizations) and NGOs (Non Governmental Organizations) from all over the world. The Peruvian Andean Region is a silent witness of this movement, including the beneficiaries of the Cajamarca Integrated Rural Development Project (CIRDP).

The CIRDP is a project oriented towards the sustainable development of Andean peasant communities located in Cajamarca, Perú. The project aims to improve the productive system of these communities in an environmentally friendly manner as well as improve the living conditions of the peasant families. This thesis aims to be a contribution to that Project and a source of information for future development of research programs undertaken in the area. I argue that the factors related to crop production are part of a particular historical and cultural-political context, market and farming practices. Landscape and soil conditions such as altitude, slope, erosion, soil pH, soil texture and soil drainage are also very important elements.

The goal of this work is to generate an integrated document that will help understand the conditions of the CIRDP communities for planning purposes. It will assess the potential of crop growth for barley and wheat, corn and potato through the analysis of the biophysical characteristics of the region and will show through maps the most suitable areas for growing these crops. This research also will suggest viable strategies that will improve the peasant living

conditions. Therefore, the environmental factors that are discussed in this work are both physical and human; the links and relationship established between these factors are also very important.

This investigation is based on the analysis of literature related to the subject, research studies by the CIRDP and my field trip in the region (May-June 1993). The field trip in Cajamarca provided an opportunity to gather written information and figures, to interview people related to the Project, and to observe the area first hand. A month spent in Lima allowed collection of complementary written information and cartographic material such as figures and aerial photographs.

Throughout this work, the factors related to peasant agricultural production are first discussed as separate issues (e.g. soils, market, farming practices, etc.) in order to facilitate their analysis, and then an attempt is made to develop how they are interconnected.

This work is organized around four chapters besides the Introduction, which includes an overview of the CIRDP. Chapter two presents the theoretical framework of this thesis and discusses the key definitions of what this study is based on: concepts such as environment, sustainable development and sustainable agriculture. The basic principles for sustainable rural development strategies in Southern countries are also discussed.

The third chapter describes the actual situation of the communities which are the subjects of this study emphasizing the factors that affect agricultural production. Since these communities are located in the Andes of Perú, the chapter presents a summarized description of both the country and the region in order to understand the area. Then, the conditions of the

peasant communities are described including physical and human environments. This chapter represents, then, the description of the region.

Chapter four develop a framework analysis of the biophysical constraints to agriculture. The information is analyzed according to crop production in CIRDP. Climate and soil conditions, such as pH, texture and erosion, are considered as physical factors. Human factors that are discussed are the farming practices and the market. This chapter also analyzes the farming suitability conditions, by location, for barley and wheat, corn and potato in the study area. These analyses are based on field research done by the CIRDP on soil and landscape conditions and use a geographical information system (GIS) approach to facilitate interpretation.

Chapter five address the challenges for the peasant families and the CIRDP. It draws conclusions about and provides suggestions on the farming, economic, social, cultural and political aspects of the region as they relate to potential for improvement of the peasants' living conditions and the achievement of sustainable development in the CIRDP region. The GIS exercise done in the former chapter is described here as a model strategy for implementing the CIRDP.

The approach of the whole study is based on my belief that any research which affects or links the environment (and in the environment I always include people as one of its elements) must consider and use a holistic approach taking into account both the physical and human factors and their interrelationships.

1.2 The Cajamarca Integrated Rural Development Program

1.2.1 Organization of the Program

The Cajamarca Integrated Rural Development Program is a development project which commenced in May 1985 (Reyes, 1989:1) and works in small peasant communities around the city of Cajamarca, Peru. Phase I was completed in 1990 (Reyes, 1989), Phase II ended in June 1995 (Reyes, 1990). This Program is supported by the Canadian International Development Agency (CIDA) and administered by CUSO. Three Peruvian development research organizations at the Universidad Nacional de Cajamarca¹ (UNC) - Servicio Silvo Agropecuario² (SESA), Grupo Polivalente de Proyección Social³ Chim Shaullo, and Programa de Desarrollo Rural Integral de Jesús⁴ (PDRI-Jesús) - conducted the field work in each the three groups of communities.

CUSO staff at the UNC work with the three UNC organizations in order to have a coherent and integrated implementation of the Program. Each UNC organization has its own professional and technical staff, including an Organization Coordinator who acts as director.

The total Program includes 32 villages with approximately 12,760 people or 2 500 families (Reyes, 1990:4-5). The division of responsibility among the UNC organizations is presented in Table 1.1. Details concerning location and attributes of the communities are presented in Chapter 3.

¹ National University of Cajamarca

² Forestry and Farming Service

³ Polyvalent Group of Social Projection

⁴ Integral Rural Development Program of Jesús

Table 1.1
Area of Responsibility of the UNC Organizations

ORGANIZATION	COMMUNITIES	PEOPLE	HECTARES
SESA	14	4 760	9 000
Chim Shaullo	6	4 200	5 000
PDRI - Jesús	12	3 800	3 690
TOTAL	32	12 760	17 690

Source: Reyes 1990:7

1.2.2 Goals and Objectives of the CIRDP

The goal of the Program is:

"To help selected peasant communities to further develop and consolidate their productive systems, in order to generate sustainable development alternatives (ecodevelopment) through the ongoing program of the three rural development Centers of the UNC"(Reyes, 1990:3)

The purpose of the Program is:

"To improve the productive and organizational capacities of selected peasant communities in Cajamarca through soil and water conservation, agricultural support, animal husbandry, health and community development programs."(Reyes, 1990:3)

The specific objectives of the Program are:

- a) "To assist communities in containing and gradually reducing the extreme erosion of the region's hillsides which are the basis for the economic support of the peasant population ..., and which are essential for the environmental survival of the region.

- b) to assist rural communities to improve their living conditions through water gathering and soil conservation activities which have a direct impact on: drinking water availability, health, environmental sanitation, sustainable agricultural production, reforestation and other productive activities.
- c) To strengthen organizational and technical skills through the provision of complementary courses among peasant communities on environmental and agricultural development, primary health and other community development activities. These training activities will develop an awareness among them as to the importance of environmental protection and regeneration as the only means to protect their livelihood, as well as the ability to plan and implement concrete development activities.
- d) To incorporate women into the development efforts by carrying out special promotional and educational programs aimed at improving their productive capacities and skills while increasing their awareness of their role in society.
- e) To strengthen the University's ability to provide adequate training for professionals and technicians to address the ecological and rural development needs of the region."(Reyes, 1990:3-4)

Within this framework, the Program is oriented towards attaining self-sufficient communities while improving the environmental condition of the area. It also seeks to respect the culture and traditions of the Program's communities. The Program focuses on medium and long-term commitments to generate environmentally-sound development alternatives in order to protect the Andean ecosystem (Reyes, 1990). Thus, sustainable development that emphasizes conservation of the natural environment plus social development is the main component of the Program.

1.2.3 Strategies of the CIRDP

The Program strategies are based on the Ecodevelopment model proposed by the UNC which aims to provide the basis for sustainable agriculture through "...re-establishing an ecological balance among the ecosystem's elements..."(Reyes, 1989:24). The Program

stresses the importance of fostering community participation in the planning and implementation of activities and in the evaluation of the process as a basic strategy towards guaranteeing the Project's sustainability (Reyes, 1990:8). In order to ensure this participation, the rural community should be committed to the Program.

Because protection of the natural environment while improving the living standard of the peasant communities is the major task, the main strategies involve the definition of ecological problems and the promotion of ecologically-sound practices that will encourage a rational management of the ecosystem (Reyes, 1990: 8; Reyes, 1989: 14). An initial premise of the Program is that the current factors most limiting to the improvement of living standards of the region are the low agricultural production and the high levels of soil erosion (Reyes, 1989:7). In order to reverse land deterioration the Project strategy is:

"...maximizing the use of the available water, reforesting the slopes of the hills, building terraces to expand the productivity area, and introducing a water management system which will provide drinking water for domestic use, fish culture and irrigation."(Reyes, 1989:15)

To the above end, the initial step was to evaluate the resource potential of each community's territory. This was followed by the community defining their needs and potentials in collaboration with experts and technicians, and entering into discussion of possible solutions to the community's problems and how to organize the community in order to achieve their goals (Reyes, 1990:14-15). Examples of the implementation of this approach include the periodic internal evaluations of the Project through the "Annual General Assemblies"⁵, the Phase II Management plan which was a result of the team

⁵Project's staff and representatives of the communities participate in these meetings.

members' and villagers' concerns, and the contribution of labor and locally-available building materials for infrastructure work by the community (Reyes 1990:1,9). Other examples of community input include: the peasants' request for a simple approach to soil conservation which was taken into account in the Phase II Project Plan; the peasants' identification of seepage, canals and slow-formation terraces as being important; and the peasants' request that improved agricultural and small livestock production and marketing strategies be included in the Program (Reyes 1990:6,8,9).

A crucial concern of the Program is the lack of traditional community organization in the target area, which can lead to reduced community participation. Thus, an important strategy of the Program is to encourage community organization by setting up and enhancing organizational structures and training people to foster community development (Reyes 1990:6,9). One means to approach this task is the establishment of "Animation Centers" or "Community Centers" in each community. These centers "...are set up to rehabilitate the community infrastructure, services and activities which are presently unavailable or inaccessible to peasant families in the area." (Reyes, 1989:15). However, in many cases these Centers have not been established because the villages have other priorities, such as availability of land and water (Reyes 1989:23). An alternative approach to fostering community organization is applied when the communities request the benefit of any Project's activities. Following the request the Program encourages the creation of a

"Community Development Committee" (CDC) and:

"Each CDC is trained by the project's promoters to build a more general vision of development problems, the resource available and the institutions working on these issues. Later specific tasks are assigned to the members and sectors of the community along with the planning of further educational or development actions."(Reyes 1989:23)

The Program pays attention to the role that women play in their villages and recognizes the need to improve women's participation at all levels, including in the decision-making process (Reyes, 1990:9; Reyes, 1989:14). The main strategy used by the Program is education which enhances the participation of women in the village life through activities such as communal stores, health committees, parents' associations, craft production, community assemblies, etc.(Reyes, 1989:17).

The activities proposed by the Program are the following (Reyes, 1990:10-28):

- 1)Environmental Development
 - a) Soil conservation structures
 - b) Reforestation
- 2)Agricultural Development and Training
 - a) Irrigation
 - b) Crop improvement
 - c) Animal health
 - d) Credit and marketing
 - e) Training
- 3)Primary Health Care
 - a) Potable water systems
 - b) Community health services and training
- 4)Community Development
 - a) Baseline studies and social research
 - b) Handicraft production
 - c) Women's promotion
 - d) Community promotion and training
- 5)Technical Assistance
 - a) Technical advisors and professional training
 - b) Inter-University cooperation

In summary, the strategies used and promoted by the Cajamarca Integrated Rural Development Program are oriented towards increasing peasant production in an environmentally-friendly manner, encouraging community participation, organization and education "...so that people can initiate and control the process affecting their lives."(Reyes, 1989:10).

CHAPTER 2

SUSTAINABILITY

2.1 Environment

A description of the environment of the peasant communities involved on the CIRDP is required in order to understand the potential of crop production. However there are different definitions and approaches of what the environment is. The following presents the approach to environment that this work will be using.

According to Gilberto C. Gallopin:

"When you try to understand or observe an individual, population or any object of the universe (alive or not), the focus of interest is the object and the rest of the universe can be called its environment"(From Sunkel and Gligo, 1980:206)

This approach to defining the environment is not very helpful for research purposes because it will be extremely difficult to study and impractical to manage this "rest of the universe". For research purposes, a more restricted and useful definition of environment is:

"a group of factors, ...or variables which do not belong to the system under consideration and that interact with the elements of the mentioned system or with the system as a whole"(Ruíz Pereyra, 1987:6).

According to this definition the environment of an object is anything that closely interacts with the object in space and time. The environment of an object is limited to the web of close meaningful interrelationships established around the particular object. The chosen limits of any environmental system should be viewed as a porous boundary rather than a closed boundary. An object and its environment are in permanent and reciprocal relationship. Hence, a

change of any element of either, object or environment, modifies the whole system (Teitelbaum, 1978:10-11).

The human environment, is a broader concept:

"..., it is the group of physical, chemical and biological elements and social and cultural factors acting in reciprocal interaction with human beings or other living beings,..."(Teitelbaum, 1978:27)

Humans establish relations not only with tangible and sensorial variables, they also are influenced by abstract elements such as education. Therefore, environment not only includes the "natural" factors (biological and physical) but also, and equally important, the economic, political and socio-cultural aspects. As the Brundtland Commission in "Our Common Future" affirms:

"The environment does not exist as a sphere separate from human actions, ambitions and needs, and attempts to defend it in isolation from human concerns have given the very word 'environment' a connotation of naiveté in some political circles"(World Commission on Environment and Development (WCED), 1989:xi)

The environment under this perspective is a reality closely related with the men and women who contribute to shape it. Such reality is not static; on the contrary, it is dynamic because it changes and evolves as the result of the interaction of its elements. Thus, the environment depends on the different processes occurring through its relationship web, where men and women are not excluded.

For my present work I will be using use the conventional terms "human environment " for anything human built, and "natural or physical environment", for nature's creation. However, many conditions that will be classified as "natural or physical environment" such as

the physical and biological landscape, may have been strongly altered from an earlier state as a consequence of men/women's actions (e.g. deforestation, erosion, etc.).

2.2 Sustainable Development

The world's present condition is not an encouraging one as evidenced by an average annual deforestation (1981-90) of 16,900,000 ha., a total of human-induced land degradation (1945 to the late 80's) of 1,964.4 million ha., a total cereal aid (1989) of 10,044 million metric tons (World Resources Institute, 1992:286, 290 and 280). These circumstances exist despite many years of development strategies and projects having been carried out in many of the world's nations. As a consequence, a new development path is required: "...one that sustain human progress not just in a few places for a few years, but for the entire planet into the distant future"(Brundtland Commission (WCED), 1989:4). Such a new development path, which is strongly advocated nowadays, is called sustainable development.

The following discussion on sustainable development provides the context for understanding the goals of the CIRDP, its approach and the approach of this research. The definition of sustainable development presented by the Brundtland Commission is:

"...development that meets the needs of the present generation without compromising the ability of the future generations to meet their own needs,..."(Brundtland Commission (WCED), 1989:43)

In "Our Common Future"(1989:44), the Brundtland Commission also stressed that sustainable development must meet the basic needs of all, men and women without exception, and provide them the opportunity to fulfill their just aspirations. However, because needs and

aspirations are socially and cultural constructed, which are the ones that sustainable development must meet? The basic and most important condition is that the needs and aspirations to be met should be environmentally sound and reasonably possible to achieve for anybody (Adams, 1990; Brundtland Commission (WCED), 1989; Redclift, 1987).

The environmentally sound condition is the capstone for any strategy in sustainable development. The reason for this is quite obvious: if sustainable development is to meet human needs in a sustainable manner, the natural resources must be conserved and enhanced (Brundtland (WCED) Commission, 1989:57). This conservation of the natural resources should not be based on "protectionism" (i.e. protect the resource without using it) because people depend on the use of natural environments directly or indirectly. Many of the Northern conservation policies tend to be "protectionism", putting conservation values above the need of the people to use the natural resources (e.g. the European banning seal skin). In the protectionism approach the natural environment is protected for its own sake. From a Southern perspective the natural environment and its resources must be employed in order to survive. These two perspectives are not necessarily exclusive; they can and should be complementary. Sustainable development seeks this complementarity by stressing the need of using the natural resources in a rational manner, which means environmentally sound use that avoids depletion (Brundland Commission (WCED)1989, MacNeil, 1991) . This is clearly stated in "Agenda 21":

"While managing resources sustainably, an environmental policy that focuses mainly on the conservation and protection of resources must take due account of those who depend on the resources for their livelihoods."(UN, 1992:20).

Another important characteristic of sustainable development is that natural resource use should take into consideration both physical and human environments (UN, 1992:127). This means that how natural resources are used is determined by both the natural environment and the cultural, social and economic aspects of the human environment. Recognition of the linkages and interrelations among natural and human systems is extremely important. As MacNeil suggests (1991:48 and 50-51), policy agendas and institutions (including transnational corporations) should integrate the natural environment with such issues as growth, employment, trade, and be aware of and accountable for the environmental consequences of their actions. In a few words, economic and environmental issues should be integrated in the decision making process before the undertaking of any activity.

Sustainable development allows the use and transformation of the natural environment unless that use leads to the depletion of the resources and deterioration of the environment. That is the reason why sustainable development requires the use of environmentally sound technologies (Adams 1990, Brundtland Commission(WCED) 1989, Redclift 1987). These technologies are the ones that:

"...protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their waste and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substituted."(UN, 1992:453)

Thus, a requirement for sustainable development is access to environmentally sound technologies. In order to gain this access it is not only necessary to acquire the scientific knowledge that will create new environmentally sound technologies, but also to surpass the limitations to access imposed by our social structures (WCED, 1989:43). This is specially true

in Southern countries where access to new environmentally sound technologies is quite difficult. Three main reasons impose these limitations to access:

1. The initial investment in environmentally sound technologies usually is expensive so people stay with the technology already in use or they adopt another less expensive technology.
2. The transfer of technologies normally does not take into account the new environment where they will be applied, hence many of them do not work the way they were supposed to and they get rejected.
3. The creation of new technologies is expensive and if not viewed as a priority in Southern countries there are few investments and little support for it.

On the other hand, many of the indigenous technologies of Southern countries are environmentally sound (Vivian, 1992; Amador and Gliessman 1990:148-55; Redclift, 1987:132,160). However the people who use them are seen as poor and categorized in a low social status. In addition these environmentally sound indigenous technologies usually are not market oriented and, as a consequence tend to be abandoned and to be forgotten.

According to the Brundtland Commission (WCED1989:43) sustainable development should prioritize the needs of the poor, not only because they do not meet their basic requirements (e.g. food, health, education, etc.) but also because they put high pressure on the natural environment (Brundtland Commission (WCED), 1989:49). It is true that the economically poor people put pressure on the natural environment, for example by the agricultural use of marginal land. However, if it is determined what forces these economically poor people to overuse the natural resources, the blame will not be placed on them. It is possible to identify two main stages working on those forces. The first stage is the loss of access to land or other natural resources by the people who were dependent on them. This loss

usually occurs due to a high demand for a particular product (e.g. lumber, meat, etc.) by the Northern countries which directly or indirectly take power and control over the resources necessary to obtain that product. The second stage is the finding and use of the remaining land and natural resources by the people who used to depend on the appropriated resources. In order to survive, they cause a high stress to the natural environment. The problem here is that:

"... resource management decisions are taken over by those with insufficient stake in the local environment, and resources are extracted at unreplenishable levels in order to benefit other, often richer societies." (Vivian, 1992:72)

Therefore sustainable development should not only meet the needs of the poor but also should work on the social-cultural forces that have led to the overuse of different environments. As Redclift (1987:59) pointed out: "...environmental poverty should not be disassociated from underlying structural conditions."

One of the main strategies to achieve sustainable development is the participation and involvement of local people in the decisions that affect their lives (Redclift, 1993, Brundtland Commission(WCED) 1989, Redclift 1987, UN 1992). This strategy encourages grass roots organizations (UN, 1992:22) which are a very effective tool for achieving significant participation of the "common" people. Development planning should promote participation at all levels of the decision making process in order that the "common" people have influence in decision making. In order to make that possible and not just empty rhetoric, sustainable development should enable people to have a share of access and control over resources.

Another characteristic that makes sustainable development a different approach to development is that sustainable development does not only mean economic growth (Brundtland Commission (WCED), 1989; Redclift, 1987; World Resources Institute, 1992:4; Yadav, 1992:405). Here stress is on the idea that the important thing is the quality of growth and the way this growth is distributed, not the quantity of growth. It emphasizes that the benefits should be distributed in an equitable manner (Brundtland Commission (WCED) 1989:44,55; World Resources Institute, 1992:2; Yadav, 1992:405). Sustainable development does not reject economic growth but it stresses that "Economic and social development can and should be mutually reinforcing." (Brundtland Commission (WCED), 1989:54)

We can see then, that in order to achieve sustainable development we should change not only the techniques that we use to work on the environment, but also the politics of any activity we do. As the Brundtland Commission highlights:

"Yet in the end, sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investment, the orientation of technological development and institutional change are made consistent with future as well as present needs." (WCED, 1989:9)

The achievement of sustainable development is not an easy task. This is not only due to the limited knowledge on how to better manage the environment but also, and may be most important, because:

"...a whole culture has evolved around the principle of fighting against limits, rather than learning to live with them." (Meadows as quoted in Redclift, 1987:101)

It is in this fight that development has evolved. Currently, most development goes against sustainability because it is responsible for the depletion of resources and causes environmental

degradation (Adams, 1990; MacNeil, 1991; Redclift, 1987). Also current "development" has brought a social and economic system that not only affects negatively the natural environment (Redclift, 1987) but also frustrates the possibility of equity and peace. As Redclift points out:

"For sustainable development to become a reality it is necessary for the livelihoods of the poor to be given priority, but how can this priority be pursued at the local level while the effects of international development systematically 'marginalizes' them?" (Redclift, 1987:36)

Consequently, it was argued that the term "sustainable development" contains a contradiction in itself because "development" follows the opposite path to sustainability (Redclift 1987). However, I find that the problem here is not the use of the term "development" but the meaning that has been commonly attached to it. If we understand development as purely economic growth then we cannot talk of sustainable development for the reasons mentioned before. If we understand development as the path to reach men's and women's goals in an equalitarian manner respecting each other's cultures and societies, then we can talk of how to reach sustainable development.

2.3 Sustainable Agriculture

The CIRDP works in peasant communities whose lifestyles and income depend on agriculture. These families' survival depends on each harvest. That is why this work considers sustainable agriculture and its practices as key issues to discuss in order to establish a basis for the analysis of potential growth of crops.

2.3.1 Definitions

According to Agenda 21, the most important environmental problem for both Northern and Southern countries is the worrisome land degradation caused by inappropriate and uncontrolled land uses (UN, 1992:44,34). This is far reaching because one third of the land surface in our planet is occupied by agriculture (UN, 1992:442), which represents the central activity of much of the world's labor force, 47% in 1990 (World Resources Institute, 1994:300). The path that agriculture has followed in its "development" (e.g. mechanization, heavy use of chemical inputs, predominance of cash crops) has produced the depletion of many natural resources (Foster-Carter, quoted in Redclift, 1984:18). The specialized production and farming systems of "modern" agriculture tend to increase the use of external inputs which causes stress and vulnerability to the environment as well as market fluctuations (UN, 1992:25). According to Levins and Vandermeer:

"Adopting this factory view of the cultivated field has led to many errors of shortsightedness whereby the single-minded pursuit of one goal (usually profit or total production) is thwarted by 'unexpected' indirect consequences of technology. Thus, declining fertility, increased pest problems, loss of genetic diversity, and increased vulnerability to natural or economic disasters, to name a few, are all consequences, in our view, of the industrial model of agriculture." (Levins and Vandermeer, 1990:34)

In order to reduce these negative effects new approaches to agriculture are being developed. What has been termed "ecological agriculture" or "agroecology" is currently the

most advocated approach. Agroecology is based on treating agriculture as an ecosystem⁶ (Sen, 1988:158; Gliessman, 1990:367-69; Torres Guevara et al, 1990:182; Torrance, 1993:9). Thus it proposes that:

"...[Agroecology] rather than managing agriculture as an industry in which each problem is isolated and treated with an individually tailored solution, the management task is primarily one of understanding the rich complexity of the ecosystem (...), anticipating problems before they arise, and rationally planning production for clearly stated multidimensional goals."(Levins and Vandermeer, 1990:342)

The goal of these approaches is to achieve "sustainable agriculture". The similarity in the terms sustainable development and sustainable agriculture is not arbitrary. The former includes sustainable agriculture in its strategies; the latter is a necessary contribution to sustainable development and it adopts many of the strategies and characteristics of sustainable development. This is implicit in the definition of sustainable agriculture proposed in 1990 by the American Society of Agronomy:

"A sustainable agriculture is one that, over the long term, enhances environmental quality and the resource base on which agriculture depends; provides for basic human food and fibre needs, is economically viable, and enhances the quality of life for farmers and society as a whole."(Quoted in Torrance, 1993:5)

Sustainable agriculture aims to maintain the natural resource base upon which it depends while increasing the productivity and use intensity of the land (Gliessman, 1990:367; Yurjevic, 1990:23; Yadav, 1992:405).

⁶ "System formed by the interaction of all living organisms (...) with each other and with the chemical and physical factors of the environment in which they live, all being linked by the transfer of energy and materials"(Clark, 1990:101)

In order to achieve sustainable agriculture we should look not only at the natural aspects of the environment related to agriculture, but also to the human ones (Gliessman, 1990:369; Kollmans et al, 1990:126; Sánchez Enríquez, 1993). In this case, the market plays an important role because:

"...[the market] is one of the main risk factors for the small farmer,..., which substantially reduces the peasant's effort and unfairly nullifies their economic and social improvement, raising the price of the consumer products to the benefit of whoever commercializes them."(Cardona, 1985:298)

The market forces can push some sustainable agricultural practices to change into unsustainable ones (Torrance, 1993:8). Thus, the present market system does not meet the requirement to improve the agricultural conditions in both natural and human environments. The actual market system must change indeed, not only to allow sustainable agriculture, but also sustainable development. Closely related to this is the issue of access to credit. The economic system must allow a more democratic access to it. Furthermore, it is also necessary to make available access to the education that will permit farmers and peasants to act upon the market and economic forces.

2.3.2 Some Practices for Achieving Sustainable Agriculture

If people's access to land and resources is equally distributed; the next requirement for the achievement of sustainable agriculture is the use of environmentally sound practices in order to conserve the agricultural resource base (Woodmansee, 1984:145; Gliessman, 1990:367; Yurjevic, 1990:16). To enable widespread utilization, the technologies adopted should demand low energy inputs (UN, 1992:443).

Several indigenous practices may be part of these environmentally-sound practices.

According to Redclift (1987:13):

"...indigenous agricultural systems, far from being dismissed as irrelevant or injurious to development, might in fact provide workable models of how to achieve a greater measure of equality without doing irreparable damage to the environment."

The overuse or unwise use of external inputs in agriculture is one of the major causes of resource degradation. Among these inputs, chemicals present risk to both human and natural environments. A clear example of this is the use of chemical for pest control which, according to Bull (1982, in Redclift 1984:36) has led to:

- Chemical resistance in some pest species
- The killing of the natural enemies of the target pest
- The persistence of harmful residues on food, even if the food is processed
- Human health risk

Use of chemical herbicides also has led to the increased development of herbicide tolerance in weed populations and the eradication of weeds that are close relatives of crops (Barrett, 1988:70). The latter effect is negative because close relatives of crops, that are weedy in nature, build crop/weed complexes which are "...an important reservoir of genetic diversity for crop improvement." (Barrett, 1988:70). In addition, regular use of chemical herbicides can stimulate plant species that were not previously harmful for the crops to become weeds which can damage it (Barrett, 1988:71).

Agricultural management practices depend not only on the natural resources of any land but also depend on "...the cultural traditions, social organization, and economic forces that nurture agricultural systems"(Altieri, 1988:5). Hence, both the physical environment and the

human environment determine the use of chemical inputs. In fact, the human environment probably has more influence in the decision-making process of whether or not to use these inputs. If this is the case, changes in the human environment factors are essential towards reducing chemical inputs to optimal levels and thereby reducing their negative effects on agricultural sustainability.

Crop rotation and intercropping are among the practices advocated for the achievement of sustainable agriculture (Jackson, 1984:218; Vukasin, 1988:53; Kolmans et al, 1990:128) and both assist in weed management (Thomas, 1990:49). The main reason for the latter is that monocultures seldom monopolize all the nutrients, light and moisture available for plant growth, and as a consequence monocultures must be protected from the many weeds they allow to grow (Altieri and Liebman, 1988:333).

The main value of intercropping as a strategy to achieve sustainable agriculture is that it can produce more food in a smaller area than monoculture of the same crops (Liebman, 1988:198; Amador and Gliessman, 1990:147). This can be attributed to a more efficient use of resources such as light, water or nutrients, in comparison with monoculture (Berkowitz, 1988:102). Other advantages of using intercropping are:

- It is one of the most inexpensive ways to increase crop production⁷.
- It increases capture of nutrients that otherwise are lost in deep percolation: e.g. decrease in nitrate loss on the intercropping of corn and beans.
- It increases the total water use through the prevention of water loss by surface evaporation.
- Reduction of soil loss.

⁷ This could not be the case in high mechanized or heavy mechanized systems

- If the intercropping presents a complementarity in the crops' canopy, it allows a more efficient use of light, because it enables the crops to capture light that otherwise will be lost in the ground.
 - Herbivorous insects which are crop-specific are at a disadvantage, while the presence of beneficial insects is promoted. (Berkowitz, 1988:102-103; Jackson, 1984:219; Liebman, 1988:198; Amador and Gliessman, 1990:156)
- Regardless of the potential benefits of intercropping, it is necessary also to point out that these benefits are not always met because:
 "...when intercrops fail to extract more nutrients than sole crops they are unlikely to be more productive or weed-suppressive than sole crops." (Liebman, 1988:204)

The important thing is to find out for each specific case which intercropping systems have positive impact on yields, weed control and the environment in general.

Achievement and maintenance of soil fertility is essential for the achievement of sustainable agriculture, because if the soil fertility of an area is lost the possibility of sustainable crop production disappears. The challenge is how to increase or maintain the fertility of the soil. In "modern" agriculture the answer has been the use of chemical fertilizers, but recently the search for other answers has led to other methods such as non-tillage practices and live mulching systems (Sen, 1988:164-65). On the cautionary side, it is important to realize that the higher the fertility the higher the potential weed competition (Zindahl, 1988:152). Therefore practices and strategies that allow the maintenance and/or improvement of soil fertility along with weed control are needed.

It is important to note that organic agriculture, defined as the elimination of synthetic chemical inputs, is much easier to put into practice on high quality soils (Torrance, 1993:9) and that:

"While many people assume that an organic agriculture is a sustainable agriculture, this is unproven. Input of organic materials from off-site entails the risk of decreasing the sustainability of the areas from which this material is obtained. There is also legitimate debate as to whether a totally-organic agriculture could meet current or future world demand."(Torrance, 1993:9)

Consequently, I suggest the balanced utilization of organic and chemicals inputs and methods. This balance cannot be prescribed as a single recipe; it should be adopted according to the specific characteristics and needs of each land and farmer. However it should be based on the principle of sustainability, oriented towards the achievement of sustainable agriculture.

In order to reach sustainable agriculture, not only is the conservation of the required resources for crop growth important but also the conservation of plant genetic resources (UN, 1992:531). In "modern" agriculture the tendency to use few varieties of one crop, the ones that produce the highest yields, is leading to the loss of important varieties that not only have a value per se, but also are important sources of nutritious human food, potential sources of "positive" intercropping, potential source of pest resistance, etc. It is vital to restrict these genetic losses and to encourage research in plant genetic diversity.

Finally, a respect for the various cultural and traditional agricultural practices must exist and must be practiced. It is important to remember that the world is made of different cultures and societies with their own agricultural systems and practices, which in turn respond to their particular goals. This diversity of systems, practices and goals only can enrich the possibility of a sustainable agriculture. In order for this to happen the strategies for the achievement of sustainable agriculture must be flexible to the belief of each culture and respectful of their own particular goals.

I have argued that sustainable agriculture is a goal and the path to reach it is a dynamic one which must be site and culturally specific. An important characteristic of these paths is that they must treat the environment as it is: a system with a complex web of interrelations. This means that any practice that is applied to achieve sustainable agriculture, interacts with all elements of the system and has implications for the whole system. It is crucial to take into account how the system and its elements will change in response to an action in order to develop the appropriate strategy for the achievement of sustainable agriculture.

Nevertheless, the question remains: is it possible to achieve sustainable agriculture?. It is important to realize that the human and physical environments are dynamic and in constant change. Thus, if we have developed what we believe to be a sustainable agricultural model in a specific location (in space and time), we should understand that this location will not be the same environment which we started to work on. The location will have changed in, for example, its soil fertility, soil moisture, social and cultural values. Agricultural sustainability may subsequently be lost if we are not constantly adjusting our strategies to those changes. Therefore, the important thing is not only sustainable agriculture in itself (an abstract concept) but the principles and methods used in order to achieve and maintain it.

2.4 Basic Principles for Rural Sustainable Development Strategies in Southern Countries

The western model of development has not been successful in most Southern countries and in many cases has contributed to a deterioration in the living conditions of most people. This development model which "...put economic growth and the production of goods, before

improved welfare and the eradication of poverty." (Redclift, 1984:101), is responsible for much of the depletion of resources and degradation of environments suffered in the Southern countries. The people living in rural areas have been greatly affected by this so-called development:

"Land resources have been mortgaged to short-term commercial interests rather than developed in a sustainable way. Once again environmental poverty serves as a stimulus to increased economic dependence rather than a signal that alternative development models need urgent consideration"(Redclift, 1984:38)

Rural areas in Southern countries also have been affected by the agribusiness approach to food-crop production from which the local people have received little or no benefit at all. In many cases they have been harmed by reduction or cessation of government support for peasant production. While the cash crop benefits go to large foreign companies, the people have a lack of food (Redclift, 1984:37). In addition, development assistance in rural areas, has not always contributed to sustainable development and in some cases has even detracted from it by such actions as the promotion of chemically dependent agriculture (Brundtland Commission (WCED), 1989:77). It is imperative to find and apply new development strategies in rural areas of the Southern countries.

New development strategies must support the achievement of sustainable agriculture because for most of the rural southern areas agriculture is their principal human activity and way of life. But: "There is no magic formula for sustainable development" (Adams, 1990:199), or for sustainable agriculture. It will not be possible to proceed with a single detailed strategy; rather, it will be necessary to establish the basic principles on which any strategy and activity should be based and to test possible approaches against these principles.

2.4.1 Adjustment

I strongly believe that development is not a synonym of "westernization" and that each society should follow its own development path. Southern peoples have their own history, culture and world views which are as valid and important as any other. Development strategies should respect and take into account the different ways of live and cultural perspectives of rural southern communities. It is crucial to avoid what Boulding called the global-style of ethnocentrism, where we think that our values and our answers to any problem are THE value and THE answer. As Adams (1990:168) stressed:

"The consistent failure of government ministry and development agency bureaucracies and their 'expert' employees to take adequate account of the environmental impacts of their action is matched by their frequent blindness to the needs and capacities of those they develop."

A basic step in such an approach is that the people involved in development practices must know the human and physical environment where they are working as well as their web of interrelations. Thus, it is necessary to have a diagnosis that elucidates the current conditions of the specific rural location. This diagnosis should not be based just on quantitative and statistical data, as Sayer (1985:165) pointed out:

"...we must understand what people understand, mean or intend by their actions and not merely rely on measurements of their physical behaviour."

The development of networks for exchange of experience is another important tool (ONU, 1992:444). However, each project, strategy and technique should be adapted to the conditions of the area and the needs of the users because any place has somehow unique conditions such that any activity undertaken must be culturally and site specific.

2.4.2 Participation and Project Ownership

"The failure of many rural development efforts is reflected in the indifference with which rural people have responded to outside 'development'. Often nobody had asked the local people what they wanted"(Redclift, 1984:93)

In recent years the importance of the participation of local people in any development project has been recognized through different experiences. Indeed, the involvement of the people benefiting from any rural development activity is the best way to guarantee its success (Redclift, 1993; Haverkort et al, 1991; Guizt, 1991).

In order to achieve a truly local participation, any project must start with the local people's will of working on it either because they asked for the project or because they accept the project's offer without any mean of persuasion. Steady communication with the local people, organizations and project staff becomes a requirement in order to involve the local people in the decision making process. Finally, involvement of local cost, use of local technology, knowledge and expertise will add the last ingredient for the local people to feel and have ownership of the project and work for its success (Adams, 1990:201; Brundtland Commission (WCED), 1989:78).

The degree of local control over local resources has a strong influence in the decision-making process. In Southern rural areas the access to resources, especially land, is of vital importance. Strategies should be directed towards ensuring equitable access to resources, technologies, financing, marketing, processing and distribution of the farmer's production (Redclif, 1993; ONU, 1992:17B). Project strategies must permit and enhance that access and control by local people.

Finally, we must understand that it is fundamental and essential to work not on the people but with the people. Local rural people should not only feel the project as theirs but it must be their project.

2.4.3 Conservation of the Natural Environment

"Poverty and environment are linked in a close and complex way. Poor people live in and suffer from degraded environments, and very often create environmental degradation because their poverty forces them to do so. It is obvious, but worth repeating, that farmers in the highlands of Ethiopia or Nepal do not farm steep and eroded hillsides through perversity but through necessity (Blaikie 1988). On the other hand, degraded environments themselves create poverty." (Adams, 1990:87)

It is imperative that any activity should fight, rather than enhance, the structural causes, such as inequitable land tenure, that force rural people to degrade their physical environment. At the same time, the strategies should be directed towards improving the long term productivity of the available resources (Brundtland Commission (WCED), 1989:77).

One of the main reasons for failure of many development projects in rural areas of the South has been the lack of environmental impact forecasts (Adams 149-53). These forecasts are needed for cost calculation of any project (Adams, 1990:142), but, more importantly, their absence may lead to damage to the environment and jeopardize the success of the project. Some projects have worked on that aspect but with no success because they began the impact assessment too late or they used external consultants with little knowledge of the region (Adams, 1990:152-53). For that matter the use of knowledgeable local expertise working cooperatively with the project's staff is crucial. However, environmental impact assessment is not an easy task in Southern rural areas due to lack of physical environmental data and the fact

that the impacts can be delayed, have secondary or tertiary effects or be geographically remote from the project (Adams, 1990:149-53).

It should be reiterated that conservation of the natural environment in rural areas of Southern countries should follow a conservationist rather than a preservationist approach. Preservationist attitudes do not recognize peasant practices (Adams, 1990:184) such as hunting or cultivation on land that may not be their legal property but which they feel theirs due to tradition, history and ancestors. Reality reveals the crucial need of rural people for the use of the natural resources in order to survive. Conservation of the natural environment should be seen as the sustainable use of natural resources that responds to both physical and human environment.

2.4.4 Baselines for Technology Transfer

It is obvious that environmentally sound technology should be used in any strategy for development. On the specific case of Southern rural regions, these technologies need to be both cost effective and based on renewable energy sources in order to be sustainable (ONU, 1992:93).

As was pointed out in Agenda 21:

"The availability of scientific and technological information and access to and transfer of environmentally sound technology are essential requirements for sustainable development."(ONU, 1992:455)

Consequently, rural development practices should be oriented towards this dynamic (i.e. availability, access and transfer) of technologies without discarding the possibility that the local techniques may be the most appropriate. However, before introducing new technologies, they

must be tested through pilot projects to make sure that they will work in the specific environment in which they will be applied. In this context it must be recognized that environmentally sound technologies are a total system of know-how, procedures, goods and services, equipment, organization and managerial procedures (ONU, 1992:454). Technology transfer must take into account the human resources, including gender aspects, and the building capacity of the rural community (ONU, 1992:454). According to Delbert (1985:302), there are three main basic factors that frustrate the adoption of a new technology by rural peasants:

- Technology that is not suitable for specific conditions.
- A support system that is inappropriate in providing information, raw material, credit and the selling of the production.
- The farmer's adverse perception of the innovations and the lack of the farmer's willingness to adopt them.

The first factor can be avoided when the technology is fully adapted to the local environment. The second factor is something any project should take into consideration before undertaking to implement technology transfer. The third one may be alleviated if the farmer is an active participant in the whole process of technology transfer. Being an active participant means being aware of the problem and willing to find a solution through the use of a new technology. According to Berhourt (1985:209), farmer participation in the technology transfer is crucial. He considers that the theoretical results of new technology are not enough to appeal the peasant's will to use it. To adopt a new practice the peasants must get involved in the demonstration activities using their own resources.

The experience of technology transfer to the rural communities in the valley of Río Colorado in Argentina has been a success. The key conditions that support the success of that

experience were (Parral, 1985:51):

- The technologies represent little additional cost and are related to traditional methods.
- Expensive technologies will be adopted anyway if they respond to the farmer's needs.
- The existence of a stable market which permitted the producer to assume a certain degree of indebtedness.
- The presence of technical and economic support. Technology transfer is

neither an easy task, nor the single solution to a problem. An efficient approach to it is the assessment of the necessity and impact of the new technology versus the improvement of local technologies.

2.4.5 The Use of Indigenous Knowledge and Technologies

The knowledge of indigenous people has been acquired and transmitted from one generation to another. They have learned how to survive and how to live with their own environment. The proof of this is that in spite of the multiple forces committed to their extermination, they are still here. In many ways their knowledge of their particular environment is many times wiser than ours. As Redclift (1987:132) stressed:

"...the livelihood strategies which people pursue, in ecologically fragile areas like the Amazon, provide important pointers to the kind of technologies that are most appropriate on social as well as ecological grounds"

Unfortunately there is an underestimation of common people's knowledge and skills (Redclift 1987, Korten 1986), and Western patterns of life are the ones to blame. They discourage indigenous practices and introduce new needs, new goods that require to be bought, new goals and aspirations. The market economy pushes them towards the race of benefits and production, making indigenous technologies somehow obsolete and useless.

The use of the indigenous knowledge and the adaptation of indigenous technologies to achieve the goals of the local people might be an approach worth consideration. As Chambers (1988:3) pointed out: "The poor are not the problem, they are the solution." (Quoted in Adams, 1990:201).

2.4.6 Conclusions

The principles for the strategies and activities related to sustainable development in rural regions of Southern countries pose a big challenge. A holistic approach is required because sustainable development works on both human and physical environment. Consequently, interdisciplinary methodologies and a team work effort, oriented towards the same goal, are indispensable.

Another challenge is the impact forecasting of the activities and practices of any rural development project. It is crucial to insure that the actions we choose will neither create other problems nor worsen the present ones.

The enterprise of development is not an objective and neutral activity. Each project and each of us have cultural baggage and personal values and our work will always be impregnated and influenced by them. The local people should be aware of that situation but we must be wary about imposing our point of views and values.

In Southern rural regions the big challenge is to achieve sustainable land use (e.g. sustainable agriculture) despite adverse structural conditions (e.g. cash crops, inequitable distribution of resources, little land access.). The method of achievement will be specific to

each particular location because each has its own particular environment.

"...societies are 'developing' whether or not they are the target of some specific government [or project] 'development' scheme"(Adams, 1990:199)

As a rule, the more participation and involvement of the local people and their ownership of the project, the bigger the chances of success. Then, why do foreigners have to go there and work for them? There is not an easy answer for that; maybe the key is in a little word: for, which must be changed to with:

"WE NEED OUTSIDE HELP FOR ANALYSIS AND UNDERSTANDING OF OUR SITUATION BUT NOT FOR TELLING US WHAT WE SHOULD DO"(Quoting a Nepal peasant, Gronow and Shrestha, 1990:5)

CHAPTER 3

THE CURRENT CONDITION OF THE VILLAGES

3.1 Contextual Framework

The current living and agricultural conditions of the peasant communities of the CIRDP are the result of historical process. In order to understand the social settings of these communities we must understand the broader social context of the country, Perú. The following discussion provides the background to the present situations of these communities, the agricultural production constraints and other challenges.

3.1.1 The Peruvian Case

The Andean and some coastal areas of Perú were part of the Inca Empire before the Spanish Conquest. Agriculture was the main activity before and during Inca domination and the land was communally owned by extended family units (De Wit, 1990: 143-44). Land use patterns were based on the vertical (altitudinal) arrangement of the Andean physical environment. Within their communities, peasants usually owned land in a vertical arrangement and the crops adapted to different altitudes complemented each other in the daily diet. If that was not the case, trade was established among peasants and communities that worked on land at different altitudes. Animal husbandry was also an important activity and breeding of llamas, alpacas and vicuñas was developed. Guinea pigs were also raised for human consumption.

The Spaniards arrived in South America in 1534 and they invaded, conquered and colonized the territory of the Inca Empire. They captured the Inca in what is now the city of

Cajamarca, and killed him there, but not before receiving huge amounts of gold and silver which was supposed to be the price of the Inca's liberation.

The Spanish conquerors destroyed the existing social and economic systems and imposed their new order (Deere, 1990:xiii and Reyes, 1989:10). They introduced new livestock such as cattle, horses, goats and pigs which took the place of the American camelids (Montoya and Figueroa, 1990:61). The land became owned by the Spaniards or the Catholic Church (Spanish anyway), in a completely private system which marked the birth of the Hacienda system characterized by large private holdings. Meanwhile the aboriginal were left with less and less land.

During the XVI and beginning of the XVII century a huge demographic catastrophe occurred in the old Inca Empire. The main reasons for this catastrophe were sickness, oppression and exploitation, all of them brought by the Spanish conquerors. The exact numbers are unknown, but according to Espinoza Soriano (1986, in Montoya and Figueroa, 1990:45) the aboriginal population depletion in Jaén, San Ignacio and part of Cutervo (Provinces of Perú) was 95% in 57 years!

In 1821, Perú became officially independent and emerged as a new country. However, the Spanish social and cultural system, including the Hacienda system, was maintained. One of the first mandates of the government installed by a military coup in the late 1960s was agrarian reform. Hacienda land was expropriated and distributed to peasants when this reform was applied in 1970. The motivations for land reform were the idea that the major problem causing ongoing agricultural stagnation was the land tenure system and the belief that land distribution

would lead to development of its productive capacities (De Wit, 1990:141). Priority as beneficiaries of the agrarian reform went to peasants who had been working on the hacienda lands (Deere, 1990:231). They received land, cattle and other goods from the haciendas (Montoya and Figueroa, 1990:64), but individual male peasants were only able to obtain small parcels because of the limited amount of land (Deere, 1990: 231). The military dictatorial government tried to establish a system of cooperatives, but was not successful.

Currently Perú is a constitutional republic with a democratic political system, ruled by a centralized government based in the capital city of Lima.⁸ It is divided in Regions, which in turn are divided in Departments, Provinces and Districts (Figure I.1 and I.2). Figure 3.1 depicts the administrative structure of the country.

In 1993, Perú's population was 22 639 443 (Censo Nacional 1993, Peruvian Embassy, Ottawa) and was growing at 1.95% per year (Webb and Fernández Baca, 1993:109). Life expectancy was 67 years and infant mortality was 66.4 per thousand (Webb and Fernández Baca, 1993:1909). The life expectancy and infant mortality indicate that the standard of living of average Peruvian people corresponds to those of Southern countries (World Resources Institute, 1992:248-51).

Average population density is 17.6 persons per Km² (INEI, Censo Nacional 1993); however this number varies according to location. Migration from rural areas of the country to urban areas led to 71.3% of the people living in urban areas (Table 3.1).

⁸ For general information on the physical characteristics of Perú see appendix I

Figure 3.1
Administrative Structure of Perú

Table 3.1
Rural Vs. Urban Population Growth

Census Year	Rural Population	Urban Population
1940	64.61%	35.39%
1961	52.58%	47.42%
1972	40.48%	59.52%
1981	35.14%	64.86%
1993	28.70%	71.30%

Source: Webb and Fernández Baca 1991:116 and 1993:104

Lima, the capital, which has 6,434,323 inhabitants (INEI, Censo Nacional 1993), is the main destination city for this migration. This rural to urban migration is caused in part by irrational use of the natural resources in the country which in turn has generated its depletion (Sánchez Cabrera y Silva Quirós, 1993:12). Rural to urban migrants also hope to receive the services, such as education and health care, that they lacked in their home localities.

However, that wish usually is not fulfilled in the crowded city of Lima because the rural people become very poor urban people and live in the slums and shanty towns scattered around the cities.

Life in rural areas may not present better conditions than in urban areas. Most of the rural population lives in extreme poverty and rural incomes are decreasing (Figueroa, 1988:8). This situation has generated violence in the form of terrorist-guerrilla movements which, according to the Government, are almost eliminated since the recent capturing (1992) of the most important leaders of the terrorist movements.

Perú generates its main income from primary activities, such as agriculture, fisheries and mining. Andean peasant agriculture is specially important because it is the main activity for a large percentage of the population (34% in 1981) (Notes from CEPREPUC teaching material) and is a major source of food for the country.

3.1.2 Andean Agriculture

Perú has a great variety of biophysical environments in spite of its relatively small territory of 1,285,215.6 Km². This complexity, shared by the Andean Region, imposes the requirement for special approaches, in order to make agriculture a sustainable land use system

(Becker, 1988:47, 147). The approach most advocated is the use of a large number of different crop species and crop rotations which should be selected according to the characteristics of the particular area (Tapia, 1992:389). This approach is not new for the Andean people; it is an approach they have used even before Incan times. Throughout history, the Andean people had successfully managed their physical environment to nourish themselves and their knowledge made the Andean Region one of the world centers of domestication of crop species (Tapia, 1992:389).

High land use pressure is a characteristic in Perú, where only 5.9% of the area is suitable for agriculture (Montoya and Figueroa, 1990:39). Traditional land use patterns are being abandoned due to the infiltration of "modern agriculture" which pushes the Andean peasants to intensify land use and to monocrop with cash crops. This "modern agriculture" also has brought foreign technologies, the high cost of which generates dependence (Torres Guevara et al, 1990:179). Often, these technologies are inappropriate for the Andean environment. In particular, mechanized practices are not always suitable for the Andean region because much of the terrain has steep slopes and flat areas are infrequent (Ives, 1979:19).

Currently in Perú, there are some large agricultural enterprises but the majority of the agricultural producers are small parcel owners (Guerrero Figueroa, 1989:3). According to the last Peruvian agrarian census (1972), the owners of minifundios (farms between 1 and 5 hectares) constituted 79% of the Peruvian farms land and 81.59% of these minifundios were located in the Andean region (Abanto, Azareño and Rodríguez, 1991:36). The number of

minifundios is increasing while their average size is decreasing: in 1972 the average size of the minifundio was 2.4 hectares and in 1990 it was 2.1 hectares, with the tendency to continue to diminish (Yurjevic, 1990:23).

These minifundio conditions augment the land pressure and threaten both the physical environment and agriculture (Sánchez Cabrera and Silva Quirós, 1993:9, Guerrero Figueroa 1989:3). For example the erosion rate in the Andean region has been estimated at 3 cm of soil per year (Rojas Díaz, 1988:28), a circumstance which threatens the life conditions of the peasants whose livelihood is based in agricultural activities. The intense land use of the Andean region jeopardizes the agriculture by causing problems such as:

- Overexploitation of natural resources
- Land erosion
- Low quality soils
- Scarcity of agricultural land
- Floods and droughts
- Crop pests
- Yield fluctuations
- Low productivity

(Treacy, 1889:211; Kolmans et al, 1990:132; Torres Guevara et al, 1990:179; Sánchez Cabrera and Silva Quirós, 1993:9)

The challenge is to increase the production and productivity of the small agricultural parcels and to recover the soil fertility (Guerrero Figueroa, 1989:3). Soil quality and soil conservation are extremely important factors because they are a key base of the peasant agricultural production (Rojas Díaz, 1988:28).

Peruvian agricultural experts advocate the practice of ecological agriculture. According to Kolmans et al (1990:125) the goal of this ecological agriculture is:

"...to apply a technology adequate to our particular agroecosystems, in such a way that it harmonizes the legitimate right to improve our quality of life with the processes which govern the forces of nature."

These experts recognize that ecological agriculture alone cannot do much if the social, political and economic structures of the country do not change (Torres Guevara et al, 1990:182). These structures discourage not only sustainable agriculture but also agricultural activity per se. Peruvian agriculture does not supply enough food for the Peruvian population.

We can see then why Peruvian agriculture is considered to be in a crisis with one of the causes being that "... agriculture is not a lucrative activity anymore"(Figueroa, 1988:8). The low prices imposed by the import of foreign products (Seifert, 1990: 271) are inadequate for the Peruvian peasants (mainly Andean peasants) because usually they are not even enough to cover the production costs. These low prices also are imposed by governmental policies of "cheap food for urban areas" (i.e. the city of Lima), where the majority of votes are concentrated. There is also a huge gap between the selling prices of products in the urban markets and the prices received by the peasants. The farmers are very poorly paid. For example, the urban/farmer price comparison for potato, a very important crop in Perú not only for their high nutrient value but also because they are the basic food for the Peruvian people (Vásquez Arce, 1977:53) are presented in Table 3.2.

Table 3.2
Price Comparison of Potato Between Farm and
Wholesale Market(I/Kg)⁹

	1985	1986	1987	1988	1989
Farm	0.72	2.47	3.21	12.92	573.67
Wholesale	1.34	3.94	4.27	20.24	1078.18

Source: INEI, 1990: 576, 578-80

The different Peruvian governments, instead of encouraging an increase of internal agricultural production, have followed a politic of food importation. This importation damages Peruvian agriculture and has further detrimental effects in that the imported products have a lower nutritional value than the national ones (Aliaga, Cabanillas and Ramírez, 1988:97). With all these structural conditions, we should not wonder why the 78% of the Andean Region agricultural production is used for selfconsumption (Abanto, Azareño and Rodríguez, 1991:42).

The past and current agrarian policies of Perú do not encourage the peasants to increase their production and productivity. At the same time, these policies perpetuate practices which damage the physical environment on which the peasants depend for survival. Some professionals advocate a more intensive agricultural use of the Andean region in order to reduce the need for food importation (Rojas, Telmo 1989:3). Others ask for major government investment in the rural areas which not only will increase crop production but also will stop the huge rural to urban migration (Aliaga, Cabanillas and Ramírez, 1988:58).

⁹ Intis (the name of the Peruvian currency at that time) per Kilogram

3.1.3 The Peruvian Andean Peasant

For the Peruvian Andean case an appropriate definition of peasant is:

"Any rural dweller who owns (in legal, communal and/or factual manner) and works directly the land without mediation of pure paid work"(Rojas Alcalde, 1982:25)

Minifundista peasants, the occupants on minifundios (1-5 ha.), are the main dwellers of the Peruvian Andean region. Their distinctive characteristic is the use of family labor and traditional agricultural practices(Rojas Alcalde 1982:27, Abanto Azareño and Rodríguez 1991:37-38). Their agricultural production is consumed mainly by the minifundista family, with a small surplus to be sold (Benito and Janvry 1985:355, Abanto Azareño and Rodríguez 1991:37). On the minifundios, the family labor available exceeds the labour demand of the parcel and, because the parcel of land does not guarantee the family subsistence (Rojas Alcalde, 1982:27), the minifundista family sells its excess labour either to bigger land owners or in temporary migrations to the Coast or Amazonian Regions. Handicraft production, mainly by women, is another strategy to increase family income (Abanto Azareño and Rodríguez 1991:37).

Another important group of peasants living in the Andean region is the small landowners (5 - 10 ha.). They differ from the minifundistas in their use of both family labor and occasional or permanent extra-family labor (Rojas Alcalde 1982:27). This extra labor requirement is because they have larger parcels of land and better land than the minifundistas (Rojas Alcalde, 1982:27). Another difference is that the small landowners' children migrate to the cities in order to study and/or work so their labor input is temporary (Abanto, Azareño and

Rodríguez, 1991:39). Due to this migration there is a lower rate of hereditary land division in comparison with the minifundistas. Unlike the minifundistas, the small landowners have some possibilities of capital accumulation but this accumulation is slow and depends on their productivity and production conditions (Abanto, Asareño and Rodríguez, 1991:39).

Regardless of their differences, minifundistas and small landowners both belong to a regime of economic subsistence. Their work is oriented towards the satisfaction of the basic family needs, family labor is the baseline of their production, they use traditional agricultural practices and they control small parcels of land (Benito and Janvri, 1985:353). It is important to note that these traditional agricultural practices may make efficient use of the land and are commonly environmentally sound.

The Andean peasant women are probably the hardest workers of the peasant family. They care for the home and children, and also participate in agricultural activities such as the selection of seeds, the breeding and grazing of animals, etc. Furthermore, these women sell the family products in the local markets and make handicrafts which they also sell (Rojas, Juana, 1993). Unfortunately, all this hard work is not socially recognized and there is the popular belief that the Andean peasant women only accomplish a reproductive role (Rojas, Juana, 1993).

The Peruvian Andean peasants do not possess large numbers of animals, although they always have a few which are seen as "bank accounts". In very bad times they can count on their animals to increase the family income. However, animal husbandry is troublesome for the Peruvian Andean peasants: on one side, they have a deficit of pastures due to the small size of

their land parcels (Abanto, Asareño and Rodríguez, 1991:59); on the other, they do not have enough money to buy commercial animal feed.

The relation of reciprocity is an important characteristic of the Peruvian Andean peasants. This relationship involves an exchange of goods, labor and services, without the use of money, which is ruled by traditional values such as mutual help. Such relationships supply inputs (e.g. temporary labor) at critical times and are indispensable for this peasant system which lacks cash.

Another distinctive feature of these peasant communities are the Community Tambos. These Tambos are small stores, owned by the peasant community or by the Government, which offer retail products (Aliaga, Cabanillas and Ramírez, 1988:144) and locations where the peasant also can sell theirs (i.e. products).

The Peruvian Andean peasants because of the low land productivity and low production, are unable to accumulate capital to invest in improving their productivity and production (Abanto, Azareño and Rodríguez, 1991:39 and 57). They become trapped in a circle of impoverishment (Fig. 3.2) whereby they are forced to intensify their land use, which in turn depletes their natural resources and causes decrease in their productivity.

In summary the Peruvian Andean peasants depend on small-scale subsistence-oriented agriculture using family labor and have limited access to modern technology, resources, means of production and alternative livelihoods.

Figure 3.2
Circle of poor peasantry production

3.2 The Target Communities of the Project

3.2.1 The General Physical Environment of the Communities

The target communities of the CIRDP belong to the districts of Cajamarca (SESA), Jesús (PDRI-Jesús), Baños del Inca, La Encañada, Llacarona and Namora (Chim-Shaullo) and are located in the Province of Cajamarca near the city of Cajamarca (Figure 3.3). The bounding coordinates, area and altitudinal limits of the study area are shown in Table 3.3.

Figure 3.3

Table 3.3
Location of the Beneficiaries Communities

ORGANIZATION	COORDINATES	AREA	ALTITUDE
SESA	7 08'55" - 7 15'00" S. 78 25' 7" - 78 33'55" W.	7296 Ha.	2600-3856 m.
PDRI-Jesús	7 12'17" - 7 19'24" S. 78 20'21" - 78 26'28" W.	7050 Ha.	2500-3550 m.
Chim-Shaullo	7 6' 5" - 7 11'30" S. 78 20'19" - 78 27'10" W.	6380 Ha.	2675-3450 m.

Sources: Godoy and García Chu 1992 and 1993, Poma R. and Díaz N. 1991 and 1993

pampas (Landa et al 1978:28-29 Montoya and Figueroa 1990:145,172,186,192,200 Quiñones and Tirado:1991:47-47). This territory is part of a huge sedimentary basin which was uplifted, faulted and folded during the formation of the Andes in the Tertiary (Landa et al.:1978:12 ONERN, 1975:5). Glaciation and deglaciation during the Quaternary produced glacial, fluvio-glacial and fluvial landforms (Landa et al., 1978:12).

3.2.1.1 Geology

The general lithology of the studied territory is dominated by sedimentary rocks, mainly sandstones and limestones of diverse color and grain size (Poma and Díaz 1993). In Chim-Shaullo region the metamorphic rocks, quartzites and slate are found as well as lutites in small quantities. In PDRI-Jesus lutites are found also in small quantities. SESA region presents quartzites and slate and igneous rocks such as andesites.

The geologic formations that are present in the communities of the CIRDP area are summarized in Table 3.4.

Table 3.4
Geologic Formations in the Study Area

ERA	PERIOD	FORMATION	LITHOLOGY
Cenozoic	Quaternary	Alluvial Deposits	Conglomerates
		Fluvial Glacial and Lake Deposits	Sand, silt and clay
	Terciary	Huambos Volcanic	Extrusive volcanic material(e.g. tuff)
Mesozoic	Cretaceous	Cajamarcan Formation	Limestones and margas with fossils
		Quilquiñán Mujarrún Formations	Margas with fossils, lutites and limestones
		Yumagual Formation	Clay limestones and margas with fossils
		Inca Chulec Pariatambo Formations	Lutites, sandy and clay limestones and margas
		Goyllarisquisga Group	Sandtones and lutites

Source: Poma and Díaz 1993, Landa et al 1978:12-21

3.2.1.2 Physiography

The landscape of the study area presents low hills and mountains, alluvial deposits and bedrock outcrops with a few depressions and pampas (Picture 3.1, 3.2, 3.3). Low hills and hills were created from the combination of glacial erosion and fluvial erosion during the Quaternary. They have different lithic composition and present a relief from moderate to strongly rugged.

Picture 3.1: Aerial picture over 2 communities of the CIRDP.

Picture 3.2: Picture taken during field trip, July 1993, CIRDP region.

Picture 3.3: Picture taken during field trip, July 1993, CIRDP region

The landscape units are (Landa et al, 1978:21-29; Poma and Díaz 1993):

- a) Low Elevations and Low Hills which are moderately abrupt and they are located in the low part of hills.
- b) High Hills which present a rugged relief of deep ravines, steep rocks and slopes.
- c) Colluvial Deposits Hillsides which are located at the base of rocky slopes. They are made of big fragments such as stones, gravel and cobble.

Chim-Shaullo Region (Figure 3.4).- This territory is mainly characterized by a very rugged landscape due to its strong slopes and the lack of vegetation cover that encourages erosion. It presents not only depressions and hills but also pampas which is its distinctive feature. The region is dominated by a fluvio-glacial and glacial landscape which was built during the glacial and postglacial times of the Pleistocene with the progression and regression of ice masses (Landa et al, 1978:21-29; Poma and Díaz 1993). Sedimentation plains are the major unit for this landscape in Chim-Shaullo area. They are made of material that came from the surrounding hills which is composed of fine sediments such as sand, silt and clay mixed with other bigger fragments (Landa et al, 1978:21-29; Poma and Díaz 1993).

PDRI-Jesús Region (Figure 3.5).- Besides hills and depressions, this region is characterized by an old alluvial landscape made of material transported by the rivers and from areas of old fluvial deposits. Its major landscape units are high terraces and old alluvial fans. The high terraces are made of the accumulation of sediments which came from the Andes due to erosion during the Pleistocene. These sediments are mainly

Figure 3.4

composed of sand, silt and clay mixed with bigger fragments and sometimes they are cemented by carbonates. The high terraces generally are flat with little slope but also are cut by deep ravines which turn them into low hills. The old Alluvial Cones are in contact with the high terraces and Andean buttress in the mouths of ravines and gullies. These fans are made as the same material as the high terraces and their topography has little slope as well (Landa et al, 1978:21-29; Poma and Díaz 1993).

SESA Region (Figure 3.6).- This region has a recent alluvial landscape which is smoother than Chim-shaullo and PDRI-Jesús. Alluvial Cones are localized in the mouth of ravines on the Cajamarca Valley. Generally they have little slope and are made of big fragments such as stones, gravel and cobble in a matrix of sand, silt and clay. The SESA communities also present a fluvio-glacial and glacial landscape like Chim-Shaullo's, but the units that dominate here are foothill deposits and moraines. The former were made of the weathering and erosion of lithic substrates of low hills and hills. They are located in the low part of hillsides and are mainly generated by the erosion products of limestones which fill small interhills basins and are mixed with bigger fragments. They usually are flat with little slope and cut by a system of erosion channels. Moraines constitute individual or successive low hills that present a great heterogeneity of lithology and grain size. Their relief is usually smooth but it can be abrupt if they are in contact with old glacial valleys. They are strongly eroded to the point that some of them are huge erratic blocks.

Appendix III summarizes the physiographic units that are present in the territory occupied by the target communities of the CIRDP as well as their specific locations.

3.2.1.3 Hydrography

The region of the CIRDП communities is part of the Cajamarca river watershed (Godoy and García Chu, 1992 and 1993). The Cajamarca river, born in the confluence of the Chonta and Mashcon rivers, is approximately 65 Km. of length with a North-west South-east orientation (Landa et al 1978:29-30; Montoya and Figueroa 1990:147). In this basin rivers and ravines usually are torrential but with an irregular regime. Many of them are dry during the dry season (Godoy and García Chu 1992 and 1993, Land et al 1978:29-30, Montoya and Figueroa 1990:148).

Springs are another characteristic feature of this region; however, many of them are dry during part of the year and some more than a whole year or years (Godoy and García Chu 1992 and 1993, ONERN 1975:7-8). Lakes are usually of glacial origin and many of them also dry during dry years (Montoya y Figueroa 1990:148, 181).

3.2.1.4 Climate

The climate of the study area varies from dry temperate at lower altitudes to colder and more humid at the higher altitudes (Montoya and Figueroa 1990:146). At high altitudes daily thermal amplitude and incidence of hail are higher than at the lower altitudes (Montoya and Figueroa 1990:18). The minimum temperature generally occurs in June, July and August and night-time frost may occur from June to September (i.e. winter) (Montoya and Figueroa 1990:18, Poma R. and Díaz N. 1991). In the area there are two different seasons, the dry season from June to August and the rainy season from December

to March, the rest of the months have sporadic rains (Montoya and Figueroa 1990:18, Poma R. and Díaz N. 1991).

3.2.1.5 Vegetation

The study communities are localized in the Quechua ecoregion; however, the Cajamarca Integrated Rural Development Program has recognized environmental differences in the Quechua region itself (Poma and Díaz 1991, TIINTA 1992, Godoy and García Chu 1992 and 1993). Using the altitudinal variable, the Program has divided the area in three zones: the Low zone, the Middle zone and the High zone. The characteristics of these Zones are summarized in Table 3.5 The characterization of the vegetation was done based on the Holdrige classification of forests. The meaning of the symbology is as follow:

b : bosque (forest)	B : Bajo (Low)
h : húmedo (humid)	M : Montano (Mountain)
m : muy (very)	T : Tropical (Tropical)
s : seco (dry)	

The Low zone has a natural vegetation of bosque seco Montano Bajo Tropical (dry Tropical Low Mountain forest) and the Middle zone presents the bosque húmedo Montano Tropical (humid Tropical Mountain forest). Both forests have had their primary vegetation replaced by crops or secondary vegetation such as gramineous, bushes or introduced trees such as eucalyptus (Landa et al 1978:32-33, Poma and Díaz 1991). The High zone, presents an herbaceous vegetation and a humid tropical mountain forest below

Table 3.5
General Characteristics of the Altitudinal Zones

Zones	Altitude	Climate	Vegetation
Low Zone	2500 - 2800 m.	Temperate pp. 500 - 600 mm. m.a.T. 14 C	bs - MBT
Middle Zone	2800 - 3000 m.	Temperate - cold pp. 600 - 800 mm. m.a.T. 11 C	bh - MT Herbaceous
High Zone	Above 3000 m.	Cold pp. 1000 mm. m.a.T. 9 C	Above 3400 bmh - MT

the 3 400 m.a.s.l. Above the latter altitude the forest is a bosque muy húmedo Montano Tropical (very humid Tropical Mountain Forest) which presents gramineous forage and shares plant species with the humid tropical mountain forest (Landa et all 1978:33, ONERN 1975:54-55). The very humid Tropical Mountain Forest can only be found in the communities of the SESA area (Poma and Díaz 1991).

What is not shown in the table is the lack of forest areas and that the native vegetation has been replaced by a foreign one¹⁰ (Montoya and Figueroa 1990:148-149 171, Poma and Díaz, 1991). About 50-100 years before the arrival of the Spaniards, the Incas had already introduced a high demand for fields as well as converting forest into grazing land for their camelids herds(Becker, 1988: 156). After the arrival of the Spanish conquerors (1532), there was a very high timber demand for construction and the

¹⁰ The vegetation is secondary composed by gramineous, bushes, trees.

introduction of livestock accelerated the deforestation process (Becker, 1988:156). The replacement of native vegetation was accelerated in the late 1960s when the reforestation projects were mostly done with eucalyptus. This fact caused a quite negative environmental impact because the eucalyptus impoverished the soils. However the peasants like this tree due to its fast growing capacity and its straight trunk, a characteristic that is useful for construction purposes (Poma and Díaz 1991). Despite these reforestation efforts, the area presents a landscape dominated by naked hills.

In summary, the communities are located in a physical environment with a rugged topography dominated by the Andes and narrow valleys. The geology of the area as well as its soils are of diverse nature in spite of the relative small size of the region. The climate is quite temperate but presents two different seasons: the dry and the rainy seasons. These communities are in the Quechua ecoregion but the altitudinal levels create dissimilarities within this ecoregion which results in different kinds of climate and vegetation.

3.2.2 Peasant's Living Condition

The peasants of Cajamarca Province live in what can be considered as Andean peasant communities, in a dispersed arrangement in a series of relatively small areas, even though most do not have the legal status of "Peasant Communities". If such an Andean peasant community has a centre, it usually would be the school. The inhabitants work the land in a traditional fashion and are usually interrelated through family networks. The Cajamarcan peasant communities are distinct from other Andean Highland communities in Perú in that they are more open to new ideas and new people and they lack community organizations (Reyes 1989

and 1990, TIINTA Report 1993). Common characteristics of these peasant holdings and households are summarized in Table 3.6. Each member of the peasant families in the Project area plays a specific role. However individual interests are subordinated to the common one because cooperation is their only way to survive (Rojas Alcalde 1980:11). The members of the peasant families in the PDRI-Jesús region have the following functions and responsibilities (Fernández, Silba and Díaz 1990:124-29):

- **Father:** is responsible for the financial productivity and the agricultural productivity and production. Manages and controls the agricultural process and other basic resources. Directs the activities of the family and members.
- **Mother:** Takes care of the children and their education, family nourishment, family wardrobe, the house and animals. She is responsible of the social and organized activities such as the exchange of products between the different altitudinal zones and participation in community events. She also participates in much of the agricultural labor.
- **Children:** they collaborate in the agricultural and husbandry activities, in raising their younger brothers and sisters, and in the housekeeping. They should be ready to replace any member of the family who is absent. Their activities are differentiated according to their sex and age.

Table 3.6
Characteristics of Households in the CIRDP

ASPECTS	CHARACTERISTICS
Land Holdings	<ul style="list-style-type: none"> • Consist of small parcels located in different places, not always near their home; • Usually located in marginal areas on easily eroded hillsides.
Agriculture	<ul style="list-style-type: none"> • Crops and livestock raising are mixed, Minifundistas mainly with small animals (e.g. guinea pigs, chickens, pigs), and smallholders with larger animals (e.g. cows); • They use traditional tools and techniques; • They do not have access to technical assistance.
Labor	<ul style="list-style-type: none"> • They use family labor; • They may work individually or communally. Smallholders usually trade labor for work of oxen; • Family members migrate to sell their labor in order to supplement family income.
Economy	<ul style="list-style-type: none"> • They are family enterprises; • Products are mainly for self-consumption with little for commerce; • They may rent pastures for livestock mainly cattle; • They are unable to accumulate capital or invest due to low production and market conditions; • Usually they do not have access to credit or technical assistance.

Source: Aliaga, Cabanillas and Ramírez 1988:46,47,49; Fernández, Silba and Díaz 1990:94; Rojas Alcalde 1980:6,14, Rojas Alcalde 1988:3,43-44

3.2.2.1 Land Tenure¹¹

When analyzing the peasant's living conditions in the CIRDP region, it must be recognized that the peasantry is not a homogeneous social sector (Deere 1990, Quiñones and Tirado 1991, Sánchez Enríquez 1990). Social, economic and productivity differences derive mainly from the amount of land that belongs to each peasant nuclear family. The peasants of Cajamarca have been classified into the categories of: nearlandless (<1 hectare), minifundista (1 -3 hectares), small holder (3-5 hectares), medium owner (5-20 hectares) and large owners (>20 hectares) (Seminario Vásquez 1989, Deere 1990, Rojas Alcalde 1988). The nearlandless, minifundistas and smallholders categories dominate in the CIRDP. For example, in PDRI-Jesús in 1990, 73% of the peasants were nearlandless or minifundistas and 26.7% were smallholders (Fernández, Silba and Díaz 1990:109). Individual family land holdings usually consist of parcels which are located in different ecozones (Table 3.7 for PDRI-Jesús). The nearlandless peasants usually work some land that is owned by others, in what is called the "al partido" system. The production is divided between the nearlandless peasant and the land owner (Fernández, Silba and Díaz 1990:102, Montoya and Figueroa 1990:60, Seminario Vásquez 1989:57-58).

In 1973 in the Province of Cajamarca only 1/4 of the rural households had access to enough land to be potentially viable farmers and the average of land per family was in the order of 0.35 ha. (Deere 1990:272, 212). The nearlandless in the Province increased from 32% in 1961 to 42% in 1972 (Deere 1990:212). In the other categories the average land holding in 1980 was closer to the lower level of the class: minifundistas 1.12 ha., smallholders 3.88 ha. and medium owners 6.63 ha. (Rojas Alcalde 1980:4).

¹¹ The history of peasant land tenure has been discussed in section 3.1.1

Table 3.7
Parcel Distribution in the PDRI-Jesús Area

Number of Parcels per Family	% of Total Families
1	38.3
2	46.7
3	12.8
4	1.7
5	0.5

Source: Fernández, Silba and Díaz 1990:97

It is important to point out that the peasants in the Project area have direct control and legal ownership of their land and the status of independent farmers (Fernández, Silba and Díaz 1990:101, Sánchez Enríquez 1993). They are able to sell or do any legal transaction with their land. However what usually happens is the use of an inheritance system from parents to children, with the usual beneficiaries being the elder sons and the sons that have their own families (Fernández, Silba and Díaz 1990:102). The process starts with the father assigning part of his parcel to the sons for them to work, but they do not gain total control or legal ownership until the father dies (Fernández, Silba and Díaz 1990:102) The pace of this land-division process has slowed recently due to migration (Rojas Alcalde, 1980:14-15).

3.2.2.2 Services

The peasants of the CIRDP have poor access to the services of health care, education, water system and electricity. The dispersion of the rural population, which makes the cost of providing such services very high, is the major reason (Rojas Alcalde 1980:31). Communication within and among communities is poor because the roads are mainly narrow trails and telephone service is non-existent.

With regard to formal education, the usual situation is that children go to school only until they learn to read and write (Rojas Alcalde 1980:12). This situation is due to the children's labor being required in the agricultural tasks and to the lack of school services. In Cajamarca Department only 58% of the school age population receive any formal education, either because there are no qualified teachers or because teachers lack adequate infrastructure and didactic material (Montoya and Figueroa 1990:75-76). While primary education services are found in most rural areas, secondary and technical education are only available in the District capitals, and University services in the Department capital (i.e. Cajamarca city).

The education status is illustrated by the situation of La Succha (Table 3.8) in the PDRI-Jesús area where a primary school, but only to the third grade, exists.

Malnourishment is a common problem among the peasant families. Their average protein and caloric intake is below the theoretical requirement and below the national average (Table 3.9). In the study area, consumption of meat, eggs or vegetables is very rare and carbohydrates constitute the major food source (Abanto, Asareño and Rodríguez 1991:130). This is because the peasants either do not produce meat, eggs and vegetables or because they

Table 3.8
Educational Level in La Succha 1986

Educational Level Attained	% of Children
Partial primary school (mainly only to the second grade)	68.11
Complete primary school	16.76
Partial secondary school	9.73
Complete secondary school	2.16
Superior studies	.54

Source: Seminario Vásquez 1989:44

Table 3.9
Average Protein and Caloric Intake

	Proteins	Calories
Theoretical Requirement	65.1 gr.	2410
National Average	59.0 gr.	1907
Andean Highland Peasants	52.2 gr.	1712

Source: Abanto, Asareño and Rodríguez 1991:44

sell them to buy manufactured goods (Abanto, Asareño and Rodríguez 1991:130). Food-related purchases in the market are heavily weighted towards carbohydrates (Table 3.10). The extent of malnourishment and undernourishment in the study area (Table 3.11) should come as no surprise.

Table 3.10
Percentage of Various Products Bought in the Market

	Rice	Pasta	Sugar	Salt	Potato	Oil	Kerosene
Huayrapongo	13%	9%	8%	37%	22%	4%	6%
Yanamarca	15%	9%	19%	10%	33%	9%	6%
Llimbe	9%	6%	6%	10%	47%	6%	15%
Llacarona	23%	16%	10%	5%	25%	4%	15%
El Tambo	25%	12%	17%	29%	3%	4%	10%

Source: Bazán et Al 1981:13

Table 3.11
Undernourished Children Under 5 Year Old (%)

	1990	1991	1992
SESA	30.25	28.10	28.05
Chim-Shaullo	28.00	25.00	25.00
PDRI-Jesús	16.00	15.90	14.20

Source: Technical Report from the three UNC Organizations 1993

3.2.2.3 Migration

The peasant families of the CIRDP have established relationships with the city of Cajamarca which have a big influence on them. These relations are commercial, political-administrative, work, education and social services (Sánchez Enríquez 1993).

The peasant families in the CIRDP are seasonally underemployed (Seminario Vásquez 1989:9,58, Castillo Sánchez y Salirrosas 1990:95, Fernández, Silba and Díaz 1990:53). Usually they sell their labor during those periods, either in the province or outside it, producing a temporal migration movement (Seminario Vásquez 1989:9,58, Castillo Sánchez y Salirrosas 1990:95, Fernández, Silba and Díaz 1990:53).

Permanent migration is also a widespread characteristic which occurs mainly among young males (Urrutia Ceruti 1992:36), probably because the women are still seen as male dependants. The decision to migrate to the city in search of a better standard of living is encouraged by parents who think that the city is the solution for their children (Seminario Vásquez 1989:133), mainly because they realize that there is less land and production per capita (Sánchez Cabrera and Silva Quirós 1993:15). This latter is a natural consequence of the population density in the Department of Cajamarca; population density has increased by six times in the past 134 years (Montoya and Figueroa 1990:46).

Another factor encouraging migration is the concentration of education, health care and housing services in Cajamarca city. The two hospitals in the Cajamarca Department are situated in Cajamarca city. Medical centers are present in the capital of districts, but in only a few rural villages (Montoya and Figueroa 1990:165). In the housing context, Cajamarca city offers electricity, potable water, sewage services, and fancy city-style houses. However, these housing services as well as electricity are in limited supply and not easy to obtain, even for the people who already live in Cajamarca city, let alone for the rural immigrants.

3.2.2.4 Peasant Economy

The rural peasant households in Cajamarca Province are in a subsistence economy. Their principal activity (agriculture) usually does not provide enough income to satisfy their basic needs (Deere 1990, Fernández, Silba and Díaz 1990). The few families that have income above subsistence usually have large land holdings or do not engage in agricultural activities (Sánchez Enríquez 1993). Table 3.12 presents the economic status situation within some communities of the CIRDP, and illustrates the predominance of a subsistence economy in the area.

The production of the peasant households is mainly used for their own consumption (Table 3.13) (Landa et al 1978:33, 36). Even so the peasant families have to generate cash income in order to buy food (Table 3.13).

Most of the production work in the community is done on the individual family basis (Table 3.14). Labor relationships between families involve the exchange of labor, of labor for oxen, or labor for part of the harvest (Rojas Alcalde 1980:13-14). This cooperation works for the building of community infrastructure through what is called "minga". The income of typical peasant families is generated by a multiplicity of activities. Table 3.15, which presents data from 1973, shows that almost all the peasants are engaged in agricultural production, animal raising and wage labor. The situation has not changed much since 1973. Artisanal

Table 3.12
Household Economic Status

	Above Subsistence	Subsistence	Below Subsistence
Laguna de Santa Ursula	71.9%	23.2%	4.9%
Muyoc	44.6%	44.6%	10.7%
Paccha Chico	39.0%	50.8%	10.2%
Shahuarpampa	33.3%	54.5%	12.1%
Agomarca Alto	30.3%	57.6%	12.1%
La Huaylla	26.8%	31.7%	41.5%
Choropunta	26.2%	50.0%	23.8%
Shita	20.4%	68.2%	11.4%
Chuco	19.3%	59.1%	21.6%
Cumbico	18.7%	79.5%	1.7%
Porconcillo Bajo	9.5%	75.7%	14.8%
Chaquil Alto	6.0%	45.7%	48.2%
Chaquil Pampa	3.9%	68.6%	27.5%
Shaullo Grande	1.5%	34.8%	63.6%
Total Average	25.1%	53.1%	21.7%

Source: TIINTA Report, 1993

Table 3.13
Average of Autoconsumed Production and Peasant Families Expenses

	Autoconsumed Production	EXPENSES		
		Food	Wardrobe	Education
Llacarona	70%	68%	20%	12%
El Tambo	65%	63%	28%	9%
Llimbe	93%	85%	14%	1%
Huayrapongo	75%	66%	29%	5%
Yanamarca	67%	57%	31%	12%
Yanamango	82%	No info	No info	No info

Source: Bazán et al 1981:64,67 and Castillo Sánchez and Salirrosas 990:156

Table 3.14
Composition of the Production System
in the Community of Yanamango (SESA)

Production System	% of Total Families
Individual	66.70%
Sharecropping	20.80%
Communal	12.50%

Source: Castillo, Sánchez and Salirrosas 1990:102)

Table 3.15
Cajamarca: Rates of participation in Income-Generating Activities (1973)

	Nearlandless	Minifundista	Smallholders	Medium Owner
Agricultural Production	95.7%	99.0%	99.4%	97.5%
Agricultural Processing	1.4%	1.0%	1.7%	1.2%
Animal Raising	70.0%	79.5%	85.9%	95.1%
Rental of Resources	4.3%	8.4%	13.0%	21.0%
Artisan Production	31.4%	28.6%	32.8%	33.3%
Wage Labor	71.4%	55.7%	41.8%	34.6%
Commerce	8.6%	8.6%	9.6%	6.1%
Remittances	13.6%	13.9%	6.2%	6.2%

Source: Deere 1990:273

production is also an important source of income. The leasing of resources increases in importance as the land-holding size increases. Peasant participation in agricultural processing is minimal probably due to lack of credit and capital.

The participation rate in an activity and the percentage of total income from that activity are not directly related (Table 3.16). The main source of income for nearlandless and minifundistas is not farming activities but wage labor. This fact is probably due to the small

Table 3.16
Cajamarca: Composition of Net Income by Relative Importance of Source

	Nearlandless	Minifundista	Smallholders	Medium owner
Agricultural Production	1 %	10.4%	19.6%	42%
Agricultural Processing	0.1%	0.2%	0.1%	0.2%
All Animal Production	18.8%	10.4%	27%	24.4%
Rental	0.4%	3.4%	8.7%	15.4%
Total For Farm Activities	20.3%	24.4%	55.4%	82%
Artisan Production	9.2%	7%	4.1%	2.1%
Wage Labor	55.5%	48.6%	23.5%	11.4%
Commerce	10.3%	12.5%	10.4%	3.6%
Remittance	4.7%	7.5%	6.6%	0.9%
Total For Non-Farming Activities	79.7%	75.6%	44.6%	18%

Source: Deere 1990:274

amount of land that they own with its subsequent small production. This is not the case for the smallholders and medium owners who rely more on their farming activities as their source of income.

The cash produced by the peasant families in absolute terms is very little. In 1989 for the Cajamarca Department the legal minimum monthly wage, which usually is just enough for one person to survive, was 484 000 I/. (INEI 1992: Table # 13.5). In the community of La Succha (PDRI-Jesús region) the monthly income in 1989 for the average nearlandless family was 13 526.51 I/.¹², for the minifundista family 24 135.13 I/., and for the smallholder family 32 798.50 I/. (Seminario Vásquez 1989:85). The income generated by the average household in La Succha was 33% to 81% of the minimum legal wage.

Figure 3.7 illustrates the economic situation of the Cajamarcan peasants in relation to productivity and land tenure. According to it if the productivity and the land area per worker increase the peasants can exceed the peasant cumulating threshold and will accumulate capital. But the peasants of the CIRDP do not have the possibility of increasing their land size because no more arable land is available and there is no possibility of reducing the number of workers per unit area because the farms are already too small even for a small family. The only possibility of passing the peasant accumulation threshold is increasing land productivity which is very hard without a minimum cash investment. One approach to accumulate some cash is to grow more food for selfconsumption (the majority of their income is spent to buy food) and obtain a surplus production that can be sold at fair prices.

Summarizing, the peasant households in the study area own small pieces of land which are not enough to satisfy their basic needs and they lack basic services. They present a subsistence economy with selfconsumption of their harvest and with

¹² I/. are Intis which was the Peruvian currency at that time

the need to be involved in other activities in order to try to supplement their income and survive.

Figure 3.7
Cajamarca: Threshold of Peasant's Accumulation

Source: Seifert 1990:166

3.3 Characteristics of Agriculture and Land Use

The potential for crop growth and crop production is directly related to how the land is used and to farming practices. The following describes the agricultural practices of the area in preparation for their assessment in Chapter Four.

Quiñones and Tirado (1991:39) describe Cajamarcan agriculture as being:

"...seasonal, of subsistence character and insufficient to satisfy nourishment requirements and associated to a market economy"

The use of "traditional" techniques, traditional tools and animal energy (Landa et al 1978, Seminario Vásquez 1989:139, Quiñones and Tirado 1991:75) is another important characteristic.

The agriculture in the CIRDP area is typical of Cajamarca Province. It is a dry extensive agriculture with a few small irrigated areas that are mainly used for growing potato and alfalfa (Seminario Vásquez 1989:61-62, Montoya and Figueroa 1990:62, Sánchez Enríquez 1993). The common crops on unirrigated areas are corn, wheat, barley, oats, potatoes which are for their own subsistence. If the harvest is unusually good, some of the production is sold on the Cajamarca markets (Reyes 1989 and 1990, Poma and Díaz 1991, TIINTA 1992).

Animal husbandry is integrated into the whole agricultural process and is important for producing natural fertilizers and energy (oxen and ploughing) (Seminario Vásquez 1989:71, Fernández, Silba and Díaz 1990:88, Montoya and Figueroa 1990:62). In the Cajamarca Department animal husbandry usually is extensive; in the area of the CIRDP it is mainly domestic, at a low scale of 2 to 3 animals per farm which are fed by "the leftovers of the plants that have been harvested, grains or waste products of human food production." (Montoya and Figueroa 1990:62). Pastures are currently inadequate because of the small land parcels and the poor quality of the pasture (Rojas Alcalde 1982:45). However, on the larger parcels of land there is a disposition to replace crops by cattle, because livestock represent a more secure income (Fernández Silba and Díaz 1990:90).

The CIRDP has done a study (Poma and Díaz, 1991) of land use for the three Centers areas. Land use was classified as Food Crops, Pastures and Forests, and Lands Without Actual Use (Translation). Tables 3.17 and 3.18 summarize the result of the study.

The study indicates that the land is mainly divided between barren lands and land used for cultivated agriculture (Table 3.17). Significant barren land percentage indicates that land suitability for agriculture and erosion probably are a big problem. Forest and pastures data corroborate the process of deforestation and the deficit of pastures in the area. Natural Pastures are highly dominant in the area of Pastures and Forests with 65.77% of the area.

The proportion of fallow land is very high representing more than one quarter of the Food Crops land. Wheat, corn and barley are the most important crops of the communities' region (Reyes 1990, Poma and Díaz 1991, TIINTA 1992) which is usual for rural communities in the Andean Highlands.

All crops occupy similar proportions of land in the three regions. The only noticeable differences are that Chim Shaullo presents a higher amount of fallow lands, wheat is lower in SESA, barley is higher in Chim Shaullo, and lentil is higher in PDRI-Jesús. The following pages will discuss the result of that study for each Center's region.

3.3.1 Chim Shaullo

This region has the lowest percentage of the three Centers regarding lands unsuitable for cultivated agriculture, but the highest percentage of fallow land which represent 18% of the total area of lands suitable for cultivated agriculture. Therefore its percentage of crop land in use is similar to the other three regions. The main crops cultivated are barley, wheat and corn.

Table 3.17
Percentage of Land Use In the CIRDP (% of area)

Land Used for Cultivated Agriculture				Land unsuitable for Cultivated Agriculture			
	Total Crop Land	Fallow Crop Land	Crop Land in Use	Pasture and Forests	Vegetated Land	Barren Land	Total unsuitable
Chim-Shaullo	58	18	40	6	13	22	41
PDRI-Jesús	45	9	36	13	35	8	56
SESA	40	9	31	21	24	15	60
Overall	48	12	36	13	24	15	52

Table 3.18
Crop Distribution in the CIRDP
(% by total land used for agriculture)

	Corn	Wheat	Barley	Lentil	Tubers
Chim-Shaullo	14.31	15.68	31.71	1.93	1.63
PDRI-Jesús	18.53	26.19	22.82	6.50	2.08
SESA	24.89	12.78	32.75	1.32	3.20
Overall	19.24	18.21	29.09	3.25	2.3

Pastures and forest areas in Chim Shaullo region are very small which reflect the need for using land for agriculture in this region higher in PDRI Jesús (Table 3.19). The barren lands exceed 20% of the area.

3.3.2 PDRI-Jesús

This region has a higher percentage of land unsuitable for cultivated agriculture than Chim Shaullo's and is almost the same percentage of land use for cultivated crops. However the fallow lands just occupy a smaller percentage given a higher percentage for crop lands in use.

The main crops for PDRI-Jesús region are the same as Chim Shaullo (wheat, barley, corn) adding lentils as another important crop for the household.

Forest and pastures occupy a small area, although it is bigger than the one of Chim Shaullo. Pastures are much more evident in PDRI-Jesús where animal husbandry is more intensively practiced in the Low zone (Sandra Fogliani, Field trip 1993).

Barren lands in PDRI-Jesús are mainly covered with vegetation which is possible evidence that maybe here the soil is less degraded than Chim Shaullo or the intensity of land use was lower here.

3.3.3 SESA

The SESA area of influence presents a similar picture of land use: high percentage of barren lands, high percentage of fallow lands; small areas of forest and pastures. Barley, corn and wheat (in that order) are also the main crops. Barren lands with vegetation dominates over the ones without vegetation, as in the PDRI-Jesús area of influence. However, it is important to point out that each ecozone according to its own physical characteristics have representative crops (Fernández, Silba and Díaz 1990:93) (Table 3.19).

Table 3.19
Representative Crops

	LOW ZONE	MIDDLE ZONE	HIGH ZONE
Chim-Shaullo	Corn	Barley,lentil, potato, rye,tubers,wheat	Barley,lentil,tubers, wheat
PDRI-Jesús	Corn, vegetable	Barley, wheat	Barley,lentil,oat, rye, tubers, wheat
SESA	Barley, corn,wheat	Barley, wheat	Barley,potato, tubers

Source:Poma and Díaz, 1991

This chapter has described the main characteristics of the communities of the CIRDP: lack of basic services; limited access to health care and education; and living conditions on or below the subsistence level. The peasants are mainly minifundista farmers whose physical environment, especially the rugged topography with narrow valleys, represents a major limiting factor for agricultural production.

CHAPTER 4

THE BIO-PHYSICAL CHALLENGE

The following chapter analyses the potential for production of barley and wheat, corn and potato, as related to constraints arising from the physical environment. It also discusses the peasants' farming practices and the market as factors that influence crop production in the CIRDP region.

4.1 Analysis of Physical Indicators for Crop Growth

Detailed soil studies of the three centers were carried out by Poma Rojas and Navarro (1993). They studied the soil conditions of material, slope, erosion, depth, stoniness, soil horizons, texture, drainage and pH. They divided the area into polygons of variable coverage (from 2 to more than 100 ha.), described the soil characteristics of each polygon and made a map for each center. These maps, at a scale of 1:10 000, show altitude contours, communities¹ and soil polygons. The soil polygons are numbered, each number corresponding to its description in the report, and they presented a legend of soil characteristics.

For the current analysis, I used the slope, erosion, texture, depth, drainage and pH information of Rojas and Navarro (1993). My objective was to be able to map individual characteristics and combinations of characteristics of the soils of the area. Instead of having the individual soil polygons, I wished to have a series of maps where polygons are merged according to their common characteristics for the parameters and parameter combinations.

¹ The communities are not indicated in the case of SESA

Table 4.1
Soil Parameters and Ranges

Erosion	None	None to Moderate	Moderate	Moderate to Severe	Severe
Slope	None to Almost none (0 - 12%)	Gentle (8 - 25%)	Steep (20 - 50%)	Very Steep (30 - 70%)	
pH	Very Acid (0-5.5)	Acid (5.6-6.5)	Neutral (6.6-7.5)	Basic (>7.5)	
Texture	Light	Light to Medium	Medium to Heavy	Heavy	Layered Medium over Heavy
Drainage	Well drained	Well to Imperfectly drained	Imperfectly drained	Well to excessively drained	Excessive ly drained
Depth	Shallow (0-40cm)	Moderately Deep (20-60cm)	Deep (30-120cm)	Very Deep (>120cm)	

Each parameter was divided into mapable ranges according its condition (Table 4.1) and the results plotted on 6 different maps, one for each parameter. This task was accomplished in a digital format using EPPL7 as the GIS software. The steps of the GIS process were:

1. to digitize each map, including its topography, and give the attribute number to each polygon;
2. to code each polygon with a number related to the value of each parameter in that polygon (Table 4.1) (e.g. 1 for well drained on the drainage map, 2 for gentle slope on the slope map, 4 for basic soil on the pH map, etc.).
3. to make tables, using Excel software, calculating the percentage of each class of each parameter in each center. The mapped and tabulated results (Table 4.2a, 4.2b, 4.2c) give an overview of the physical soil conditions of each centre.

Table 4.2a
Estimates of the Area of the Classes of each Soil Parameter. Chim-Shaullo

SLOPE	ha	%
None to Almost None	806.5	12.7
Gentle	1792.8	28.1
Steep	2419.2	37.9
Very Steep	1270.5	19.9
Variable	91	1.4

DEPTH	ha	%
Shallow	2835	44.4
Moderately Deep	685.7	10.8
Deep	2413.3	37.8
Very Deep	355	5.6
Variable	91	1.4

pH	ha	%
Very Acid	00.0	00.0
Acid	3098.7	48.6
Neutral	1183.3	18.5
Basic	2007	31.5
Variable	91	1.4

EROSION	ha	%
None	584.5	9.2
None to Severe	118	1.9
Moderate	1493.3	23.4
Moderate to Severe	1335.7	20.9
Severe	2848.5	44.7
Variable	68	0.9

TEXTURE	ha	%
Light	1131	17.7
Light to Medium	231	3.6
Medium	2985.2	46.8
Medium to Heavy	1636	25.7
Heavy	238.8	3.7
Layered	107	1.7
Variable	51	0.8

Drainage	ha	%
Well Drained	4617.5	72.4
Imperfectly Drained	8.5	0.1
Excessively Drained	1038	16.3
Well to imperfectly Drained	21	0.3
Well to Excessively Drained	604	9.5
Variable	91	1.4

Table 4.2b
Estimates of the Area of the Classes of each Soil Parameter. PDRI-Jesús

SLOPE	ha	%
None to Almost None	547	7.7
Gentle	2022.75	28.4
Steep	2124	29.8
Very Steep	2425.5	34.1
Variable	0.0	0.0

DEPTH	ha	%
Shallow	3209	45.1
Moderately Deep	2834.5	39.8
Deep	1066.75	15
Very Deep	0.0	0.0
Variable	9	0.1

pH	ha	%
Very Acid	325.5	4.6
Acid	971	13.6
Neutral	954	13.4
Basic	4852.75	68.2
Variable	16	0.2

EROSION	ha	%
None	399.5	5.6
None to Severe	124.5	1.75
Moderate	1255.25	17.6
Moderate to Severe	2042.5	28.7
Severe	3297.5	46.3
Variable	0.0	0.0

TEXTURE	ha	%
Light	714	10
Light to Medium	500.5	7
Medium	5279.2	74.2
Medium to Heavy	565.5	7.9
Heavy	8	0.1
Layered	27	0.4
Variable	25	0.3

Drainage	ha	%
Well Drained	4409.25	61.9
Imperfectly Drained	24	0.3
Excessively Drained	2103	29.6
Well to imperfectly Drained	147	2.1
Well to Excessively Drained	0.0	0.0
Variable	436	6.1

Table 4.2c
Estimates of the Area of the Classes of each Soil Parameter. SESA

SLOPE	ha	%
None to Almost None	1332	18.2
Gentle	1469	20.1
Steep	1893.5	25.8
Very Steep	2542.5	34.7
Variable	90	1.2

DEPTH	ha	%
Shallow	3725	50.8
Moderately Deep	2394.5	32.7
Deep	1037	14.2
Very Deep	00.0	00.0
Variable	170.5	2.3

pH	ha	%
Very Acid	2173	29.7
Acid	2069	28.2
Neutral	1008.5	13.8
Basic	1923.5	26.2
Variable	153	2.1

EROSION	ha	%
None	129	1.8
None to Severe	536.5	7.3
Moderate	1480	20.2
Moderate to Severe	19.25	26.3
Severe	318.5	43.5
Variable	68	0.9

TEXTURE	ha	%
Light	1359.5	18.5
Light to Medium	1296	17.7
Medium	4027.5	55
Medium to Heavy	219	3
Heavy	37.5	0.5
Layered	229.5	3.1
Variable	158	2.2

Drainage	ha	%
Well Drained	4081.5	55.7
Imperfectly Drained	00.0	00.0
Excessively Drained	2299	31.4
Well to imperfectly Drained	129.5	1.8
Well to Excessively Drained	659	9
Variable	158	2.1

4.1.1 Chim-Shaullo Physical Soil Conditions

The physical soil conditions of Chim-Shaullo are dominated by slope and erosion. The 37.9% of the area consists of steep slopes (20%-50%) and by adding the percentage of very steep slopes and gentle slopes, it gives us a total figure of 85.9% of land located on slopes. The consequences of the high proportion of steep slopes combined with deforestation and intensive agricultural land use are evident in the erosion conditions of the region: 44.7% of the land has experienced severe erosion, and only 9.1% is non-eroded land.

Soil depth conditions are variable with deep soils and shallow soils which cover 37.8% and 44.4% of the total area, respectively, dominating. The shallow soils appear to be, in part, a consequence of soil erosion, as indicated by a comparison of the location of the areas of eroded and shallow soils on the maps.

The Chim-Shaullo area tends to be dominated by medium textured soils. This is a positive characteristic for farming purposes as medium-textured soils are preferred for the kind of crops grown in the region (i.e. barley, wheat, potato, etc.).

The soils all have pH above 5.6 but acid soils (48.6%) are more abundant than basic soils (31.5%). Because well-drained soils are dominant in Chim-Shaullo (72.4%), we can assume that the soil pH conditions are related to the parent material of the soils.

In summary, the Chim-Shaullo Center region of influence is dominated by slopes greater than 8% which predisposes it to severe erosion conditions. The soils are mainly shallow with medium texture and range from acid to basic. Almost all the soils are either well or excessively well drained.

4.1.2 PDRI-Jesús Soil Conditions (Table 4.2b)

The PDRI-Jesús region has slopes >8% covering 92.3% of its territory. Steep and very steep slopes predominate. Erosion problems are evident on 94.6% of PDRI-Jesús.

Shallow (45.1%) and moderately deep soils (39.8%) dominate in PDRI-Jesús territory. The proportion of shallow soils is probably related to the severe erosion conditions. Very deep soils are non-existent.

The soil pH is mainly basic (68.2%). This condition affects negatively the growth of potato. The soils of PDRI-Jesús are largely of medium texture (74.2%). This fact, along with slope conditions, probably contributes to well drained soils occurring in 61.9% of the region. Excessively drained soils occupy 29.6% of this territory, and are probably more related to the steep slope conditions than to the presence of light-textured soil.

In general, PDRI-Jesús has important erosion problems related to the abundance of steep slopes. More soils are shallow than Chim-Shaullo and their pH is mainly basic. Medium textured soils predominate and most soils are either well or excessively drained.

4.1.3 SESA Soil Conditions (Table 4.2c)

Almost 20% of the SESA area of influence is characterized with little or no slope, although moderate to severe soil erosion problems have occurred over 90.9% of the territory. Topographic factors alone are not the single cause of erosion in this region.

Most soils are either shallow (50.8%) or moderately deep (32.7%). Erosion problems and steep slopes are probably the reason for the absence of very deep soils and presence of few deep ones.

Soil pH in SESA ranges more broadly than for the other communities with roughly similar percentages of the land in each of the four categories. The percentage of very acid soils is much higher in SESA than elsewhere.

Medium soil textures (75.7%) prevail over light or heavy textures, although substantial areas of light-textured soils occur. The combination of slope and light textures probably are the main causes of the 31.4% of excessively drained soils in this region. Regardless, well drained soils dominate in SESA (55.7%).

4.1.4 Comparisons

As a whole, all the study areas are dominated by steep to very steep slopes and have experienced significant erosion over the majority (>90%) of their area. Soil depth conditions cover a similar range in all communities. pH generally ranges from acidic to basic, with SESA having significant areas of very acid soils. Well to excessively drained soils dominate in all areas.

4.2 Landscape suitability for Production of Barley and Wheat, Corn, and Potato

The growth suitability of the study region for barley, wheat, corn and potato are analyzed here. The reasons for choosing these crops are that, corn and potato are traditional crops in the area and major parts of the peasant family diet, while barley and wheat are introduced crops that are very important cash crops and provide income for the peasant family.

The range of each natural parameter which is amenable to the growth of each crop is presented in Table 4.3. The CIRDP region fulfills the precipitation requirement for any of the chosen crops, and will not be further discussed as it not a primary parameter in restricting the potential to grow these crops in the study area. Tables 4.4a,b,c establish the extent of the limitation to each crop related to the range of the natural parameters encountered in the region.

Following the above, the digital soil maps for each parameter were reclassified according to unfeasible, not recommended, marginal, and good conditions for each crop. The result was a set of 6 maps, one for each parameter, for each crop for each Center. Next, a decision making process was established in order to assess the combinations of conditions for each crop (Figure 4.1). In this decision-making process; unfeasible means that it is not possible to grow the specific crop in that area; the not recommended category stands for areas where the crop can grow with high limitations (low productivity) and that the land will deteriorate more because of that farming activity; if the crop can produce with some limitations and the overcoming of one limitation results in a reasonable production, then the polygon is under the marginal conditions category; finally, the good conditions category refers to areas with few limitations and where the crop growth conditions are more suitable.

Table 4.3
Acceptable Range of Growth Conditions for Barley and Wheat, Corn, and Potato

	Barley	Corn	Wheat	Potato
Altitude (m)	1000-3900	0-3500	1000-3700	1000-4000
Precipitation	200-2700 mm	300-400 mm	300-2500	300-4600
Erosion Status	Low-moderate	None	None-moderate	None-moderate
Slope	0-12	0	0-12	0
pH	4.3-8.6	4.3-8.3	4.5-8.6	4.2-8.3
Texture	Light-Medium	Medium-Heavy	Medium	Light-Medium
Drainage	Good	Good	Good	Good
Soil Depth	Deep-moderately deep	Deep	Deep-moderately deep	Deep

Table 4.4a
Landscape Conditions and Suitability for Crop Production. Barley and Wheat

BARLEY & WHEAT	Good Conditions	Marginal Conditions	Not Recommended
Altitude	1000 - 3900m		
Erosion Status	None and none to moderate	Moderate	Moderate to severe and severe
Slope	None to almost none	Gentle	Steep and very steep
pH	Acid	Very Acid	Neutral and basic
Texture	Medium	Medium to light and Light	Medium to heavy and heavy
Drainage	Well drained	Imperfectly to well drained, imperfectly drained, well to excessively drained	Excessively drained
Soil Depth	Deep and very deep	Moderately deep	Shallow

Table 4.4b
Landscape Conditions and Suitability for Crop Production. Corn

CORN	Good Conditions	Marginal Conditions	Not Recommended
Altitude	0 - 3500m		
Erosion Status	None and none to moderate	Moderate	Moderate to severe and severe
Slope	None (0 - 1%)	None to almost none (1 - 12%)	Above 12%
pH	Acid	Very Acid	Neutral and basic
Texture	Medium	Medium to light and light	Medium to heavy and heavy
Drainage	Well drained	Imperfectly to well drained, imperfectly drained, well to excessively drained	Excessively drained
Soil Depth	Very deep	Deep	Moderately deep and shallow

Table 4.4c
Landscape Conditions and Suitability for Crop Production. Potato

POTATO	Good Conditions	Marginal Conditions	Not Recommended
Altitude	1000 - 4000m		
Erosion Status	None and none to moderate	Moderate	Moderate to severe and severe
Slope	None (0-1%)	None to almost none (1-12%)	Above 12%
pH	Acid	Very Acid	Neutral and basic
Texture			
Drainage	Well drained	Imperfectly to well drained, imperfectly drained, well to excessively drained	Excessively drained
Soil Depth	Very deep	Deep	Moderately deep and shallow

Figure 4.1
Decision Making Process for Assessing the Factors of Crop Productivity

The steps for the analysis of each polygon resulting from the physical conditions study are:

1. **Altitudinal Range Requirement.**- This single parameter is the starting point of the analysis because it is a condition that cannot be overcome. If an area is beyond the range of altitude requirements, it is categorized as unfeasible for growing that crop; if the Altitudinal range is acceptable continue to step 2.
2. **Slope Condition.**- It is taken as a single parameter because slope condition problems are difficult to overcome unless a change in the landscape is done (e.g. terracing). If the slope is excessive it is classified under the not recommended category; if the slope is acceptable, continue to step 3.
3. **Three Parameters in the Not Recommended Category.**- if the polygon has 3 parameters in the not recommended class, it is improbable that the farmer will be able to overcome successfully these 3 obstacles, and the area is classified under the not recommended category. If fewer than 3 continue to step 4.
4. **Two Parameters in the Not Recommended Category.**- if the polygon has 2 parameters in the not recommended class, it is classified as marginal conditions (the farmer may be able to overcome 2 obstacles); if only one or no parameters are in the not recommended class, the site is considered to have good conditions.

Another Excel table was built classifying the polygons according to their potential growth for each crop (Appendix IV). The summary conditions of productivity for crop according to each soil parameter is summarized in Table 4.5.abc

Table 4.5a
Percentage of each Study Area in which each Factor is Suitable for Specific Crops.
Chim-Shaullo

BARLEY and WHEAT	Good Conditions	Marginal Conditions	Not Recommended
Altitude	100	0.0	0.0
Slope	17.3	1.4	81.3
Depth	43.4	10.7	45.9
Erosion	11	23.4	65.6
Texture	46.8	21.3	31.9
pH	48.6	0.0	51.4
Drainage	81.8	0.5	17.7

CORN	Good Conditions	Marginal Conditions	Not Recommended %
Altitude	100	0.0	0.0
Slope	3.2	15.6	81.2
Depth	5.6	37.8	56.6
Erosion	11	23.4	65.6
Texture	46.8	21.3	31.9
pH	48.6	0.0	51.4
Drainage	81.8	0.5	17.7

POTATO	Good Conditions	Marginal Conditions	Not Recommend ed
Altitude	100	0.0	0.0
Slope	3.2	15.6	81.2
Depth	5.6	37.8	56.6
Erosion	11	23.4	65.6
Texture	68.2	25.6	6.2
pH	48.6	0.0	51.4
Drainage	81.8	0.5	17.7

Table 4.5b
Percentage of each Study Area in which each Factor is Suitable for Specific Crops.
PDRI-Jesús

BARLEY and WHEAT	Good Conditions	Marginal Conditions	Not Recommended
Altitude	100	0.0	0.0
Slope	8.6	1.1	90.3
Depth	15	39.8	45.2
Erosion	7.4	17.6	75
Texture	74.2	17	8.8
pH	13.6	4.6	81.8
Drainage	61.9	2.4	35.7

CORN	Good Conditions	Marginal Conditions	Not Recommended	Unfeasible
Altitude	95.8			4.2
Slope	0.8	7.8	91.4	0.0
Depth	0.0	15	85	0.0
Erosion	7.4	17.6	75	0.0
Texture	74.2	17	8.8	0.0
pH	13.6	4.6	81.8	0.0
Drainage	61.9	2.4	35.7	0.0

POTATO	Good Conditions	Marginal Conditions	Not Recommended
Altitude	100	0.0	0.0
Slope	0.8	7.8	91.4
Depth	0.0	15	85
Erosion	7.4	17.6	75
Texture	91.2	7.9	0.9
pH	13.6	4.6	81.8
Drainage	61.9	2.4	35.7

Table 4.5c
Percentage of each Study Area in which each Factor is Suitable for Specific Crops.
SESA

BARLEY and WHEAT	Good Conditions	Marginal Conditions	Not Recommended
Altitude	100	0.0	0.0
Slope	15.2	2.9	81.9
Depth	14.1	32.7	53.2
Erosion	9.1	20.2	70.7
Texture	55	36.2	8.8
pH	28.2	29.7	42.1
Drainage	64.7	1.8	33.5

CORN	Good Conditions	Marginal Conditions	Not Recommended	Unfeasible
Altitude	87			13
Slope	0.6	17.5	81.9	0.0
Depth	0.0	14.2	85.8	0.0
Erosion	9.1	20.2	70.7	0.0
Texture	55	36.2	8.8	0.0
pH	28.2	29.7	42.1	0.0
Drainage	64.7	1.8	33.5	0.0

POTATO	Good Conditions	Marginal Conditions	Not Recommended %
Altitude	100	0.0	0.0
Slope	0.6	17.5	81.9
Depth	0.0	14.2	85.8
Erosion	9.1	20.2	70.7
Texture	91.2	3	5.8
pH	28.2	29.7	42.1
Drainage	64.7	1.8	33.5

The assessment of the general crop productivity for each polygon was done using the table in which the results of crop potential growth were classified according to the parameters and the criteria established for altitude, slope, and 2 and 3 not recommended parameters (Figure 4.1) The percentage of the 4 categories related to the total area of each region (Chim-Shaullo, PDRI-Jesús and SESA) is calculated (Table 4.6), followed with a map for each crop and region (Figure 4.2, 4.3, 4.4).

4.2.1 Chim-Shaullo

The three maps (Figure 4.2a,b,c) on crop suitability for barley and wheat, corn and potato for Chim-Shaullo display a territorial domination of the not recommended class. However there are no areas where altitude makes it unfeasible to grow these crops. The main reason for the not recommended situation are the slope conditions which fall in the not recommended category for all crops on above 81% of the area.

The areas with good conditions for the crops are situated in the communities of Shaullo Chico, El Tambo de Santa Ursula and part of Chinchin Chuquipuquio, all in flat areas. The marginal conditions also are located in non-sloping and low slope areas but the soil texture and pH are in the not recommended category. A substantially larger area is good for potato than for the other crops, because Chaquil Pampa de La Culebra, has soil texture conditions in a large flat area that are good for growing potato but marginal for barley, wheat and corn, while the pH is marginal for all the crops. A similar situation occurs with the northern part of the community of La Laguna de Santa Ursula.

Table 4.6
Land Percentage of Crop Productivity

Chim-Shaullo

	Good Conditions	Marginal Conditions	Not Recommended
Barley and Wheat	5.4	13	81.6
Corn	5.3	13.4	81.3
Potato	15.4	3.4	81.2

PDRI-Jesús

	Good Conditions	Marginal Conditions	Not Recommended	Unfeasible
Barley and Wheat	8.8	0.9	90.3	0.0
Corn	4.8	2.7	86.3	6.2
Potato	6.3	2.0	91.7	00

SESA

	Good Conditions	Marginal Conditions	Not Recommended	Unfeasible
Barley and Wheat	11.4	4.5	84.1	0.0
Corn	5.3	8.3	73.4	13
Potato	9.6	6.8	83.6	00

Figure 4.2a

Figure 4.2b

Figure 4.2c

Figure 4.3a

Figure 4.3b

Figure 4.3c

Figure 4.4a

Figure 4.4b

Figure 4.4c

In summary, Chim-Shaullo has above 81% of its land as not recommended for crop production. Of the suitable area, a much greater proportion is suitable for potato (15.4%) than for barley, wheat and corn, due to the different soil texture tolerance of potato.

4.2.2 PDRI-Jesús

Conditions of non-suitability for production of barley, wheat, corn and potato dominate in PDRI-Jesús (Figure 4.3a,b,c). Slope plays a crucial role in this picture having 90.3%, 91.4% and 91.4% of the region for barley and wheat, corn and potato respectively under the not recommended category. The high altitude area (4.2%) which is unsuitable for corn also has slope problems.

The greater ability of barley and wheat to limit erosion leads to a greater proportion of the area (8.8%) exhibiting good conditions for their production, as opposed to only 4.8 and 6.3% of the area being good for corn and potato respectively.

4.2.3 SESA

Barley and wheat show the highest percentage of land with good cropping conditions (Figure 4.4a,b,c.). The cause for that is a substantial area that was marginal for corn and potato because of shallow soil, was assessed as good farming conditions for barley and wheat. The total area of good and marginal conditions for the four crops is very similar: 15.9% for barley and wheat, 13.6% for corn and 16.4 for Potato.

The good conditions for the growing of the studied crops are located around the communities of Agomarca, Pariamarca, Guitarrero and Paccha.

Altitude above 3500m eliminates 13% of the territory from consideration for corn. This area affects all or part of the communities in the west part of the region: Los Manatiales, Cumbemayo alto, Huayllapampa, Choropunta and Milpo.

Again, in SESA, a higher percentage of land has good conditions, for barley and wheat than for corn and potato.

In summary, slope conditions which are not suitable for any of the crops are the major and common problem shared by the three regions. Slight difference among the regions show potato as the more suitable crops for Chim-Shaullo while barley and wheat are the most suitable crops for PDRI-Jesús and SESA. A few high altitude areas in PDRI-Jesús and SESA are completely unfeasible for corn. The limited areas that are truly good for barley and wheat have important socio-economic implications because these are the main cash crops grown in the study area.

The general results describe a very problematic situation which, if no actions are taken in order to improve the physical conditions of crop productivity, can only worsen to the detriment of the peasants' living conditions.

4.3 Human Indicators

4.3.1 Farming Practices

The practice of rain-fed agriculture in the area of research requires that seeding seasons and other activities should be closely tied to the behavior of weather (Sánchez Enríquez 1993). The normal agricultural calendar is presented in Table 4.7. The peasants use traditional knowledge and beliefs to guide them with the timing of specific activities. For example, in the community of La Succha if the moon "pass" (i.e. new moon) during a crop seeding season, it is believed that it is going to rain the whole week, and the seeding activity will start (Seminario Vásquez 1989:98). In the community of Tual Alto, they believe that a "soil blowing smoke" (i.e. mist close to the soil) and frogs croaking in the afternoon are signs that it is going to rain, so the seeding labors begin (Savendra Medina 1987:80).

In the CIRDP area a range of traditional varieties of seeds which are adapted to this particular physical environment exists. The peasants select the seeds during the harvest using their traditional knowledge. In La Succha (1986) 84% of the peasants obtained their seed by selection from the latest harvest, while 16% bought seed in Cajamarca city (Seminario Vásquez 1989:90). In Jesus, Encañada and part of Cajamarca, 86% selected their seed potatoes from their own harvest and 14% bought them, although the purchased ones were not necessarily of a good quality (Quiñones and Tirado 1991:70-71). Unfortunately the current tendency is toward seed quality degeneration partly because the same seed source is used more than 2 seasons in a row (In Cajamarca the weather conditions tend to produce diseases to seeds which is why it is

Table 4.7
Agricultural Calendar

Crop	Seed	Harvest
Alfalfa	Dec. - Feb	May - Jul.
Barley, Wheat, Lentils	Dec. - Jan.	Jun. - Jul.
Corn	Oct. - Nov.	
Potato	Oct. - Nov.	Feb. - Mar.
Minor Tubers	Sept. - Oct.	Jul. - Aug.

recommended to use the same seed source more than two seasons in a row) (Vilca Auroi 1987:23, Sánchez Cabrera and Silva Quirós, 1993: 16, Sánchez Enríquez 1993). The peasants are not especially careful in their seed selections practices, either for economic reasons and/or because they attribute a bad harvest to bad soil rather than to bad seed (Rojas Alcalde 1980:28, Quiñones and Tirado 1991:70).

Agricultural labors are conducted mainly using manual tools, such as shovels, picks and planting sticks (wood or metal), and oxen or horses. The ploughing is done using oxen which pull a plough that makes a furrow but does not overturn the soil (Castillo, Sánchez and Salirrosas 1990:117, field trip 1993). Not every peasant has his own oxen or horse and a deficit of animal power during the seeding season forces some peasants to plough their land simply with their labor (Rojas Alcalde 1980:27).

Fertilizer practices and availability of fertilizer may limit production. The main fertilizer available is animal dung, with ashes and stubble sometimes being used. In the community of

Yanamango, 89.4% of the peasants use dung as fertilizer and 37% use chemical fertilizers (Castillo, Sánchez and Salirrosas 1990:97). However, both fertilizers are insufficient to meet the needs due to lack of resources (animal and economic). Even the occasional use of chemical fertilizers often lacks success because either it is not applied in sufficient quantities due to its high cost, or the peasants do not handle it properly (Vukasin 1988:25, Aliaga, Cabanillas and Ramírez 1988:51, Quiñones and Tirado 1991:71-72). Potato receives the greatest quantity of fertilizer, with dung being used by 88.4% of the peasants (Quiñones and Tirado 1991:72). Corn may be fertilized with a combination of dung, ashes and stubble (Castillo Sánchez and Salirrosas 190:117). Chemical fertilizers are mainly used on potato (Castillo, Sánchez and Salirrosas 1990:118, Sánchez Enríquez 1993).

Disease, insect and weed control are not practiced in an efficient manner or not practiced at all, due to peasant's lack of knowledge and/or to the high cost of chemical pesticides (Rojas Alcalde 1982:45, Aliaga, Cabanillas and Ramírez 1988:52). The main disease control, if used, is chemical (Table 4.8). The community of Yanamango offers the same picture where 58.8% of the peasants use chemicals for disease control while the rest (41.2%) either do not use any type of control or use "traditional remedies" (Castillo Sánchez and Salirrosas 1990:98-99, 118). Insects are even less controlled: in Yanamango, 73.3% of peasants do not practice any insect control because they do not consider them as a real threat (which might be true) and the cost of pesticides is too high (Castillo Sánchez and Salirrosas 1990:98-99). Potato is the crop that usually receives pesticides; in the Districts of Jesús, Encañada and part

Table 4.8
Principal Ways of Plant disease control 1986 (%)

Ways	La Succha	Yanamango
Chemical Products	69.2	58.8
Organic Products	15.3	41.2
No control	34.6	

Source: Seminario Vásquez 1989:95

of Cajamarca, 61.9% of peasants use them for potato (Castillo, Sánchez and Salirrosas 1990:118, Quiñones and Tirado 1991:73, Sánchez Enríquez 1993). Manual weeding is a common practice among the peasants, and its timing is also determined by traditional belief, as in the case of La Succha where weeding is done during the "mature" moon (full moon) (Seminario Vásquez 1989:98, Fernández, Silva and Díaz 1990:71-72).

Harvest is done manually and involves the members of the extended family. The grain stalks are cut and gathered into small piles where they stay for about 20 - 40 days to dry. The grain is threshed by animals walking over it (e.g. horses) and then winnowed by throwing it into the wind. No system of grain quality control is used (ONERN 1975:465, Seminario Vásquez 1989:92, field work 1993). Corn is harvested at two different times, first between May and August (50%) as dry grain for seed or food, later between February and June as fresh corn to be sold in Cajamarca city (i.e. La Succha) (ONERN 1975:459, Seminario Vásquez 1989:91-92). Potato is harvested when it is "mature" which is when the tuber does not peel if

the peasant strongly kneads the potato with his thumb (Seminario Vásquez 1989:92).

Potato is stored for use as seed and for self-consumption (Quiñones and Tirado 1991:67). The storage of this tuber in high zones is done by gathering them into piles and covering them with straw or dry herbs (ONERN 1975:457). Another common storage practice is to put potato in "el terrao"² or in a dry place in the house, sometimes covering them with ashes, straw or leaves of "champca" a repellent against lepidopterous insects (Seminario Vásquez 1987:93, Castillo, Sánchez and Salirrosas 1990:118, Quiñones and Tirado 1991:66-67). Seed potatoes are stored in "trojes" (small constructions above the surface and beside the house) where they are protected against rodents (Castillo, Sánchez and Salirrosas 1990:118). Small potatoes or the bad ones are boiled, peeled, mashed, and dried outdoors for 8 - 15 days, as a way to store them. The result is 1 kg of "papa seca" (dry potato) for each 5 - 6 kg of tuber (ONERN 1975:457, Castillo, Sánchez and Salirrosas 1990:118). The process of corn storage consists of gathering it, letting it dry with its husk, hanging it on ropes under the outside roof, shelling it by hand and finally putting it into fabric bags. (ONERN 1975:460-461, Seminario Vásquez 1989:92, Castillo, Sánchez and Salirrosas 1990:118, Field work 1993).

The storage of the harvest can lead to losses. In the Districts of Jesús, Encañada and part of Cajamarca, it has been calculated that 10-15% of the stored potatoes are lost (Quiñones and Tirado 1991:67).

Crop rotation and intercropping is practiced in the studied region (ONERN 1975:374, Sánchez Enríquez 1993). In the PDRI-Jesus area the peasants intercrop potato with haba, oca

²Place between the ceiling and the roof of the house

and olluco; quinoa with olluco and oca; corn with haba, bean, chiclayos, squash, arverja, oca, olluco and quinoa; and oat with forage oat. The common crop rotations are wheat, lentils, wheat or barley; potato, barley or wheat or chocho(type of bean); and potato, forage oat (ONERN 1975:374, CEPIA 1988:28, Fernández, Silba and Díaz 1990:78-79, Field work 1993).

In general, farming practices in the CIRDP area contain few elements oriented toward improvement of the physical condition of the agricultural parcels (Sánchez Enríquez 1993). One of the main problems in the area is erosion, and unfortunately farming measures to control it are not practiced. Terracing is very little used in the area. Even if there seems to be a will from the peasants to make them, either they do not recognize them as a necessity or they do not have time available for their construction (Field work 1993). Fallow is common but not all the farmers practice fallow areas if their farms are very small. Those peasants who do not fallow practice crop rotation and try to fertilize the soil as much as possible (Fernández, Silba and Díaz 1990:79). For these peasants the problem is not ignorance of what to do, of which soil is suitable for what crop, of which rotation or intercropping is the best, or of the usefulness of fallow periods, rather the size and conditions of their property and their need to have it in production are the real problems (Floríndez Díaz and Vega Risco 1986:24, field work 1993).

4.3.2 Market

Cajamarca city is the main market for the study area. The commerce of Cajamarca Province is also concentrated here, due to the concentration of population and its condition as the main dealer with other provinces (Aliaga, Cabanillas and Ramírez 1988:109, Seminario Vásquez 1989:70, Montoya and Figueroa 1990:189-201).

The market system for agricultural products is a long chain which links the two extremes of the peasants (producers) and the urban people (consumers)(Figure 4.5). In between them are the main regulators of the system: wholesalers, retailers and intermediaries. The intermediaries are the persons who buy from individual peasants and then transport and sell the product, usually to the urban wholesalers. The peasants have no control over the prices they receive for their agricultural products or for the prices the wholesalers, retailers and intermediaries charge in the market when they sell to the public (Rojas Alcalde 1982:44, Abanto, Azareño and Rodríguez 1991:58, Quiñones and Tirado 1991:87). The latter people are the ones who get the benefits (Aliaga, Cabanillas and Ramírez 1988:53). The imposed purchase prices are usually unfair for the peasants who generally sell their products at low prices that do not even cover the production cost (Table 4.9). Why then do the peasants sell at these low prices? One reason is that when they sell they do not take into account all costs of production, such as the value of their labor (Quiñones and Tirado 1991:83). The main reason, however is that they do not have many choices; they either sell at that price or they do not sell anything at all.

Figure 4.5
Market System Chain for Agricultural Products

¹ Usually more than one.

Table 4.9
Difference Between Cost of Production and Market Prices

Product	Cost of Production	Market Prices	Difference
Corn	289	110	- 179
Barley	286	100	- 186
Wheat	190	140	- 50
Potato	140	100	- 40

Source: Bazán et al 1981:87 (interviews with people from Llacarona District)

The most important factors that prevent the peasants from selling directly to the Cajamarca market and thereby avoiding the intermediaries are the difficult access to the market place, the deficient transportation system and the lack of transportation means. (Rojas Alcalde 1982:45, Bromley 1988:3, Abanto, Azareño and Rodríguez 1991:58-59). A concrete case that

illustrates this is the community of La Succha which receives its largest income benefit from alfalfa but the peasants themselves cannot commercialize it due to transport difficulties (Seminario Vásquez 1989:70). In addition, the dispersion of the peasant communities inhibits intercommunication among them, and the intermediaries take advantage of this lack of communication (Bromley 1988:4)

Seasonal production and lack of storage systems and infrastructure also contribute to defining the present market conditions. During the harvest season, the abundance of a particular product (e.g. potato) produces a temporary surplus supply and low selling prices for the peasants (Quiñones and Tirado 1991:43). Rojas Alcalde (1982:47) concludes that an increase of production does not necessarily mean increased benefits for the producers. The exception is for peasants who increase their production with a high percentage of superior quality potatoes, because these they can sell at higher prices (Quiñones and Tirado 1991:108-109).

The peasants are conscious of the adverse market conditions. The potato producers from Jesús recognize that the major problems are the intermediary, lack of storehouses, expensive transport and the long distance to reach the market (Quiñones and Tirado 1991:83-84).

According to my research, the peasants from the study area receive low and unfair prices for their products due to their dependency of the intermediary and the surplus of supply at harvest time (Figure 4.6). The dependence on intermediaries originates due to lack of capital,

lack of transportation means and a low production in quantity and quality which impedes a direct deal with the wholesaler. The need to rapidly sell all the crop at harvest time is produced by the lack of any storage system.

Figure 4.6
Relation Between Peasant Conditions and Low Market Prices

CHAPTER 5

THE CHALLENGES FOR THE PEASANT FAMILIES AND THE CIRDP

The discussion on the living conditions of the Cajamarca peasant families shows big challenges for both the CIRDP and the peasants. Since the goal of the CIRDP is the achievement of sustainable development, the challenges it faces have both physical and human components. This means that socio-economic, cultural and political needs should be met while meeting the requirements for conservation and sustainable use of the natural resources. All these needs are equally important and also interrelated in such a way that sustainability can only be reached if all and each of them are met. To achieve sustainability it is essential to know and to understand the physical and human environment of the communities involved in the Project; and to understand Perú, Cajamarca, Cajamarca City and their interrelations with the peasant families.

5.1 Farming Aspects

Any action undertaken by the CIRDP must be environmentally sound and ensure the sustainable use of resources. Table 5.1 summarizes the main physical problems for crop growth and their possible solutions.

Slopes are by far the main factor that affect productivity and production in the CIRDP area. The number of steep slopes is increasing due to soil erosion which is causing the loss of agricultural land.

Table 5.1
Main Crop Restrictions and Possible Solutions

Restrictions	Solutions?
Steep Slopes	Terracing
Erosion	Terracing, contour ploughing, mulching, conservation tillage, reforestation
Soil fertility	Nitrogen fixing crops
Pest and Diseases	Traditional and "new" organic remedies

In this study of suitability for growing barley and wheat, corn, and potato, it was found that most of the area was not recommended for their cultivation because of steep slopes. Nevertheless, these crops are cultivated and producing in many of these steep areas because the peasants cannot afford to restrict themselves to the very small areas where the conditions for farming these crops are, if not the best, at least suitable. The key is to find alternative land uses or alternative ways of farming that reduce erosion and avoid the use of the steepest slopes.

Steep slope conditions can be alleviated by terracing. This old Inca method is being used in the CIRDP area and elsewhere in Perú. However among the peasants in the area, terracing does not seem to be an important activity, probably because it involves hard work and they are time consuming to build. Through community consultation the Project should assess the peasants' will to engage themselves in terracing. If the peasants recognize that steep slopes are a problem and they want to put time and effort into constructing terraces, the Project can provide guidance in the techniques of terracing, conduct research on the feasibility of terracing, and identify the more suitable areas for terracing.

Soil erosion can be reduced using alternatives practices such as contour ploughing, mulching and conservation tillage. Reforestation with deep rooted indigenous trees on steep slope areas is highly recommended. In the farming parcels, trees not only will minimize erosion but they can be used for food, fodder, woodpoles, firewood, etc.

Soil fertility and pest control are concerns for the farmers, but chemical products are not usually accessible to them (they are too expensive) and even if they are, they usually are not properly applied. Organic fertilizers can be an alternative but their use incurs an increased labor cost and animal manure is not available in adequate quantity. Consideration should be given to whether nitrogen-fixing crops could play a useful role.

Finally, grain crops should not be the singular alternative as cash crops. Vegetables and fruits should be an important ingredient in the peasant diet. Their production will save money for the peasants who currently buy them instead of producing them and they might become an income source. School gardens are usually a good strategy to promote gardening among the peasants. The feasibility of alternative crops, whether for subsistence or cash deserves investigation.

The above recommendations are not new for this type of Andean project, the question is how to introduce these practices to the peasants and how to induce them to try them. The key is not to impose but to allow the peasants the opportunity to determine if the practices might be beneficial.

One approach is to follow the saying "I see, I believe". If the peasants have no experience of how a new farming practice will work out, why should they take the risk of

adopting it? Through community meetings and consultation, the CIRDP can assess if the community or any farmer is interested in trying new farming practices. If so, the next step is to discuss with them what they want to improve in their production and how they might do it. Then the practice of the "new technique" should be tested and the Project should continuously follow the experience. Assuming successful testing, the Project should facilitate workshops where the promoters will explain and show to other peasants the benefits and techniques of these new practices.

It is much better if the peasants themselves run the workshops because they should be more credible than an outside person, partially because they are known and partially because they have experienced the peasant's problems (Berhoult, 1985:209). They will need help in organizing and presenting the workshop and the CIRDP should provide this support.

Change is a long process of testing and adapting, several harvests will be needed in order to convince more peasants to adopt the new farming practices. As change occurs, other practices will be "discovered" by the peasants themselves and improvement and adaptation of the original practices may occur as experience and knowledge is gained. In the long run, the new practices will be accepted only if the peasants want them and need them.

5.2 Economic Aspects

The main obstacles for the peasants to obtain economic benefits are:

- low production;
- the need for an intermediary to market their crops;
- lack of transportation means and lack of capital;
- and the surplus supply at harvest time because of a lack of storage.

Some of the causes for low production, in quantity and quality, have been analyzed on the basis of physical constraints; the role of the intermediary and his other links require a different approach.

The power of the intermediary is mainly based on the peasant's need for a person who will buy his product at the farm (because he does not have the means of transportation to the market) and for a link person to the wholesaler or retailer. Unfortunately, the peasant can not afford to buy or rent a truck due to the low or nonexistent benefit obtained from his products. In addition, the small quantities of the peasant's products do not justify the cost for renting a truck.

The situation can be changed if, instead of one peasant, we have a large group of peasants. By grouping their products together they can obtain such a volume that the cost of renting a truck will be covered. If that is the case, they will not need to sell their product to the intermediary but can directly sell to the Cajamarca market where they will obtain a higher benefit. The CIRDP should encourage this type of cooperation among the peasants in the area of marketing and maybe test to lease a truck providing payment facilities to the peasant.

The peasants will still need a person capable of selling their products either on the Cajamarca market or to the wholesalers and retailers. On this aspect the CIRDP could sponsor workshops to train these peasants who are interested in dealing directly with the market. The Project can also contribute by researching the best way to approach self-marketing of their products (i.e. through the market, wholesalers, retailers). Workshops on basic economic concepts and organization would be desirable and women must be involved in the process.

Women already deal with the market selling their hand-made and farming products there; so their experience must be valued and used.

Building an adequate storage system (i.e. building and storage techniques) will help to avoid the surplus supply at harvest time. The CIRDP can initiate research on how adequate storage facilities and storage techniques can be developed utilizing low cost materials available in the area.

Low prices on the market for the peasants' products are difficult to avoid and even with the elimination of the intermediaries by selling directly to the market, the prices of the products are low. If the peasants agree to establish a common price, not too high that the market will not buy it but sufficient that the peasant will obtain a reasonable benefit, their profit will increase. The CIRDP could assist the peasants by assessing what a "reasonable price" would be and encourage the peasants to organize themselves in order to establish a single price for their products.

If the peasants' incomes increase and they are "liberated" from the intermediary, they will be achieving independence and they will be their own entrepreneurs. If profits coming to the peasant exceed the costs for food, education and clothing, they will have the option to invest in their farming production. Productivity could increase, breaking down the circle (Figure 3.2 and 3.7) that traps the peasant of the area and freeing them to use the benefits as they please.

5.3 Social Aspects

The peasant families in the study area lack essential services, such as a reliable health care system and the opportunity to receive good formal education. The CIRDP cannot fill this gap; however these problems must be addressed by the Project because they are vital for the improvement of the peasants' living conditions. The CIRDP must foster community organization in order to facilitate ways to improve those services.

The lack of other services, such as electricity and running water, might be an easier task for the Project (indeed, it is already working on these aspects). However it must make sure that the peasant families identify such needs as real priorities instead of them being priorities taken from a urban perspective.

Peasant women carry a heavy burden, if it is relieved they can be a great resource for development. Gender issues have been introduced as an important aspect of the CIRDP.

Alcoholism is an unspoken problem that severely reduces the chances of success of any attempt to obtain sustainable development. The CIRDP should be more than only aware of that problem; it should vigorously address it.

Community organization is the essential pillar for the success of the Project. Unfortunately, community organization is not an easy challenge to address. Regardless the CIRDP must put this forward as one of its main tasks. Approaches such as workshops and promotion of exchange of working experiences may assist with this need.

5.4 Cultural and Political Aspects

The introduction and imposition of culture and values from Western countries (Spanish-European first, North American later) has had detrimental effects on Andean culture and values. Actions promoted by the CIRDP should be consistent with the traditions and culture of the peasants of the region. The Project must take that cultural tradition as its starting point. The peasant's traditional knowledge must be accepted not only as a tool but as a part of a way of life. The involvement of women must be cognisant of and respect the cultural differences between man and woman established by the Andean peasant society.

Politically speaking, the peasant families do not have power, nor do the politicians consider them important. The usual pattern is that politicians will “suddenly” realize the impoverishment of the peasants during election campaigns, but once in power the electoral promises are forgotten, mainly because to priorities the improvement of the peasants’ living conditions is not popular among urban residents who are the ones that support the politicians. Demagogy is queen. Some improvement in that aspect probably can be obtained through better access to formal education for the peasants.

5.5 GIS and Implementation of the CIRDP

Geographical Information Systems (GIS) are a powerful tool for planning and planners because, among other things, they enable the user to perceive the general conditions of an area and manipulate the variables according to the user's needs. One of the main assets of GIS is its flexibility. GIS is an interactive tool where the user can choose what to ask and what to see.

The exercise done in this work has used GIS and demonstrates its multiple practical applications. Other possibilities might be studies of productivity of other crops, modeling environmental impacts of an activity, determining land distribution, etc. In short, GIS allows the overlaying of all types of information which can be expressed on a geographic basis.

A GIS working station¹ would be extremely useful for the CIRDP. It would allow the analysis of the general conditions and potential of the study area, probably following similar steps as the ones followed here (Figure 5.1). First, it will be necessary to generate base maps by digitizing topographic maps of the area; second, the available information that can be expressed in appropriate manner should be input; third an analysis or modeling of the information can be undertaken and; finally a hard copy product can be used for a final analysis. In many cases the hard copy is not necessary, the planner can take a decision directly after seeing what is showing on the screen monitor. However, because the CIRDP is a Project whose decisions directly affect the lives of the peasant communities, any decision taken by the planners must be taken in consultation and agreement with the peasant families. In order to do so, a hard copy of the results of any analysis which lead to a decision must be shown and explained to the peasants through community meetings.

It must be remembered that GIS is only a tool and not a decision maker. The users are the ones to decide which information to use, which decision to take and which goals they want to achieve.

¹ A digitizing table, 1 or 2 PC, 1 or more GIS software, a printer (color if possible or even better a plotter).

Figure 5.1
Practical Steps to Take for a GIS Analysis

Finally, what is shown on the monitor screen or on the hard copy usually is a GENERAL description of a situation. With limitations determined by the in situ condition, the scale of data collection and representation, etc. might not necessarily be adequately represented for all purposes, especially in the CIRDP region where diversity is the rule. In the end, the peasants, who are the ones who best know their region, should be the ones to take the final decision on how to manage their own land.

This work has presented a summary description of the living conditions of the peasant families of the CIRDP and the causes of those conditions. It has analysed the potential for crop production, particularly for barley and wheat, corn and potato, and has mapped them. The human aspects related to the crop production of the area, in particular, farming practices and market, deserve further research. Many questions remain to be resolved through other research

work, including feasibility and potential of terracing in the area, and alternative crops more suitable for the area and with more potential for income generation. However this research illustrates the use of GIS as a powerful tool for planning practice and provides a framework for analyzing the potential for other crops.

The CIRDP will fail if the peasant families, who are the focus of this Project, remain as simple passive spectators. If the ultimate goal of the Project is to achieve sustainable development, the peasants must be actively involved in the Project and have a feeling of ownership. During this work some questions have haunted me: Do we take into account the people of the area? Are we underestimating them? What if what they really want is to not be involved and to go on with their lives? Why should we force them to change?

The response to these questions is that the Project must HEAR and LISTEN to the peasants. They must be aware of what the peasants want, which help they want and from where, and how can the peasants and the Project work together. Only when the Project can withdraw because the peasant families do not need any more external assistance will we be able to say that the Project has succeeded. To gain control of their own lives in a sustainable manner, that is the main challenge.

APPENDIX I

The Peruvian Physical Environment

Perú is located on the western side of the South American Continent in the tropical zone of the Austral hemisphere (Figure I.1 and I.2). Its bounding coordinates are:

0°1'48" to 18°21'03" S.Latitude and
68°39'27" to 81°19'34.5" W.Longitude

Within its territory of 1 285 216 km² (Notes from CEPREPUC teaching material) Perú contains 7.8% of the species of superior plants on Earth (i.e. 35,000 of 450,000) and 9% of the animal species (i.e. 3,780 of 42,100) (Sánchez Cabrera and Silva Quirós, 1993:11).

The physiographic regions of Perú are the Peruvian Sea, the Coast region, the Andean region or Sierra, the Amazonian region or Selva and the Titicaca Watershed or Altiplano.

The water of the Peruvian Sea is cold due to the presence of the Humboldt Current, known also as the Peruvian Current, which is a cold Current that moves from south to north along the west coast of South America bringing cold water from the extreme South Pacific. The North of the Peruvian Sea has warmer water because it extends to the Equator and is influenced by the El Niño current, which distributes warm water from the equatorial zone of the Pacific Ocean. The Peruvian Sea is rich in life because of its abundant plankton which thrives in the cold nutrient-rich water.

The other Peruvian Regions (i.e. Coast, Andean, Amazon and Altiplano) are described with reference to the 8 Peruvian eco-regions delineated by Dr. Pulgar Vidal (Table I.1). The eco-regions are differentiated largely on the basis of altitude and location running from West (Pacific Ocean) to East (Eastern Andean slopes).

Regional Division of Perú

Departamental Division of Perú

Table I.1
The 8 Peruvian Ecoregions According to Pulgar Vidal

REGION:	Cost or Chala (Region of fogs) 0 - 500 m.a.s.l.
CLIMATE:	North: tropical with 400mm pp Center and South: Arid but with high humidity
RELIEF:	Huge variety: deserts, valleys, plains hills, mountains
FLORA:	Algarrobo, date palm, mangle, bamboos
FAUNA:	Fishes, dolphin, whale, pinguins, fox, birds
ACTIVITIES:	Irrigated agriculture, cattle, industry and commerce
REGION:	Yunga (Warm Valley) beginning of the Andean Region 500 - 2300 m.a.s.l.
CLIMATE:	Sea Y.: few pp and high T Fluvial Y.: Seasonal pp, m.a.T. 15 - 22°C
RELIEF:	Rugged, deep channels of huaycos, deep narrow ravines
FLORA:	White and blue cabuya, boliche, lucumo, palto, huarango
FAUNA:	Birds (pigeons, hummingbirds, parrots)
ACTIVITIES:	Fruit crop trees
REGION:	Quechua (Lands of Temperate Climate) 2300 - 3500 m.a.s.l.
CLIMATE:	Dry temperate, abundant seasonal pp and long dry season m.a. T 11 - 16°C
RELIEF:	Abrupt + interandine valleys
FLORA:	Bamboo, retama, cantuta, corn, fruit trees
FAUNA:	Pigeons, falcons, pumas, eye-glass bears, skunks
ACTIVITIES:	Agriculture, commerce
REGION:	Suni or Jalca (Highlands) 3500 - 4000 m.a.s.l.
CLIMATE:	Cold, abundant seasonal pp 800 mm, m.a.T 11 - 12°C
RELIEF:	Very rugged, narrow valleys
FLORA:	Quinual
FAUNA:	Birds (pigeons, woodpeckers, partridges)
ACTIVITIES:	Upper limit of agriculture, mining, forestry
REGION:	Puna or Alto-Andino (Altiplane) 4000 - 4800 m.a.s.l.
CLIMATE:	Cold, frequent pp 400 - 1000 mm m.a.T 7 - 0°C
RELIEF:	Wavy, moraine deposits, lakes
FLORA:	Ichu, quinoal, puya Raimondi
FAUNA:	Alpacas, llamas, vicuñas, condors
ACTIVITIES:	Shepherd, mining

Table I.1 (Continuation)

REGION:	Janca (white) or Cordillera End of the Andea region up to 4800 m.a.s.l.
CLIMATE:	Very cold, year round pp, m.a.T 0°C
RELIEF:	Abrupt with profound abyss, glaciers
FLORA:	Ichu
FAUNA:	alpacas, vicuñas, condor
ACTIVITIES:	Mining, tourism Table 1
REGION:	Rupa Rupa (Hot) or High Jungle beginning of the Amazon region 400 - 1000 m.a.s.l.
CLIMATE:	Warm and humid, pp 3000 mm m.a.T 22 - 25°C
RELIEF:	Rugged, canyons, longitudinal valleys
FLORA:	Tropical rain forest
FAUNA:	Tropical rain forest
ACTIVITIES:	Agriculture, cattle, fruit, crops, forestry
REGION:	Omagua or Low Jungle 80 - 400 m.a.s.l.
CLIMATE:	Warm and humid, pp 1000-5000 mm, m.a.T 25°C
RELIEF:	Low round hills
FLORA:	Tropical rain forest
FAUNA:	Tropical rain forest
ACTIVITIES:	Agriculture, cattle, forestry, mining, oil

Perú has three main watersheds: Pacific, Amazon and Titicaca. The Pacific zone rivers originate on the western slopes of the Andes and flow to the Pacific Ocean. They are short and on their upper courses are torrential and erosive. These rivers have an irregular regime and form wide valleys near their mouths. The Titicaca zone rivers are also short and irregular but less torrential. The Amazonian watershed originates on the Eastern slopes of the Andes. These rivers are longest and carry the large volumes. They have a regular regime and form part of the largest navigable fluvial net of the planet (Notes from CEPREPUC teaching material).

For Perú, the Andes are like its heart and soul because they not only run across the whole country, but also they are a determining factor of the different physical environments that can be found in Perú. The Andes are the longest mountain chain of the Earth extending from 10 North to 40 South (Becker, 1988:148) with a length of 7 250 Km (Thomas and Winterhaldor, 1976:22).

Their formation began during the Pliocene and Pleistocene (Thomas and Winterhaldor, 1976:23) and they were built up by long processes of uplifting and erosion mainly in the Cretaceous Era (Becker, 1988:148). Normal thrust faulting and extensive folding during this uplift produced interior basins, in particular the Titicaca Lake Basin (Thomas and Winterhaldor, 1976:23). Their latest uplifting was during the Tertiary (Becker, 198:148), thus they are very young mountains with immature soils (Becker, 1988:148, Thomas and Winterhaldor, 1976:21).

Within Perú, the Andes diverge into different chains (Thomas and Winterhaldor, 1976:22) and have a mean elevation of 4 880 m.a.s.l. (Thomas and Winterhaldor, 1976:23). The highest peak in Perú is the Huascarán at 6 768 m.a.s.l.

The Peruvian Andes are characterized by deep valleys both U-shaped and V-shaped, probably because glacial erosion in some areas and strong fluvial erosion which has been intense because of the rapid uplift and the faulting (Thomas and Winterhaldor, 1976:23). They present a very rugged topography which creates various ecological zones in close proximity (Thomas and Winterhaldor, 1976:21).

The Peruvian Andes, as the Andes in general, contain a huge variety of ecological zones (Table A1.1) due to the heterogeneity of geology, soils and climate (Becker, 1988:147-48, Ives, 1979: 14). Eighteen different agroecological zones have been described in the Peruvian Andes (Tapia, 1992:389). One valley is different from the next; its weather is different as well as its soil (Thomas and Winterhaldor, 1976:36). However this environmental richness and complexity is fragile and is in danger due to the heavy use of the land (Becker, 1988:147).

Perú, according to its geographical location, might be expected to have typical tropical weather (i.e. warm, humid and rainy), however, the influence of the Humboldt and Niño Currents and the Andes lead to large variety of climatic conditions. The phenomenon of thermal inversion¹ occurs along the Peruvian coast, except in the extreme North. This phenomenon is caused by the Humboldt Current which generally maintains cool water temperature in the coastal zone of the Peruvian Sea and cools the air above causing condensation of its water vapor (Notes CEPREPUC). This condensed moisture forms fog along the coast and builds thick stratified clouds (Notes CEPREPUC). These clouds temperate the coastal weather and prevent strong rains to occur, resulting in a desertic coast.

In the extreme North, thermal inversions do not occur. This is because the Peruvian (i.e. Humboldt) Current heads away from the coast near the and the warm el Niño current is the major influence (Notes CEPREPUC). In this area, the weather is warmer and more humid and rainy.

¹ When temperature increases with height in the atmosphere layers close to the land surface.

The Andes because of their high elevation also influence on the weather. They divide the Pacific and the Amazonian air masses. The Eastern slopes of the Andes and the Amazonian region receive year round rainfall from the moist air of the South Atlantic Anticyclone which reaches the Andes' Eastern slopes, and brings heavy rainfalls (Notes CEPREPUC, Thomas and Winterhaldor, 1976:24). When this air mass crosses the Andes and descends down the western slopes its barometric pressure and temperature increase which increases its capacity to hold water with the result that it dries out, rather than brings rain to the western slopes and the coast (Thomas and Winterhaldor, 1976: 24). The air, having lost most of its moisture on the eastern slopes also bring little rainfall to the mountain basins and the altiplano (Thomas and Winterhaldor, 1976:33).

The complex topography of Perú is dominated by the Andes and the general climatic trends by the ocean currents, both combined result in a diverse series of natural environments which vary substantially over the whole country.

APPENDIX II

The Physical Environment of the Cajamarca Department

The Department of Cajamarca covers 34 022.88Km² (3 402 288 hectares) and represents the 2.65% of the Peruvian territory (Montoya and Figueroa, 1990:6, 39). It is located in the Northern part of Perú (Figure A2.1) and its coordinates are (Montoya and Figueroa, 1990:5):

North: 4 36' Lat.S.

South: 7 45' Lat.S.

East: 77 44' Lon.W

West: 79 27' Lon.W.

It shares borders with Ecuador to the North, the Peruvian Departments of La Libertad to the South, East and West, Amazonas to the East and Piura and Lambayeque to the West

The Cajamarca Department is crossed by 2 branches of the Andean Cordilleras from South to North and from South East to North West. These sections are known as the Peruvian Northern Andes, are lower than the Peruvian Central and Southern Andes, and lack snow-covered peaks (Montoya and Figueroa, 1990:7). The highest elevation is Rumi Rumi Mountain at 4 496 masl. (Montoya and Figueroa, 1990:8).

The Department of Cajamarca has 6 of the 8 Peruvian eco-regions: Chala, Yunga (Sea Y and Fluvial Y.), Quechua, Jalca, Puna and High Jungle (Montoya and Figueroa, 1990:14), but is dominated by the Andean components (i.e. Yunga, Quechua, Jalca and Puna) at 64.4% of the area, while the High Jungle occupies 27.9% and Chala only 7.7% (Montoya and Figueroa, 1990:39).

Most rivers of the Cajamarca Department start within the Department itself. The majority of its lakes are located on the Quechua and Jalca eco-regions, usually above 3 000 masl. (Montoya and Figueroa, 1990:13). These occupy numerous depressions in the Quechua and Jalca eco-regions (Montoya and Figueroa, 1990:13). Many of these lakes are temporary, only appearing in the rainy season.

Natural grass lands occupy around 35% of the Cajamarca Department territory. They are of low quality for the support of grazing animals such as cattle, sheep, horses and goats (Montoya and Figueroa, 1990:49, 61).

Forests occupy only 1.28% (43 712 hectares) of the whole Department (Montoya and Figueroa, 1990:40). This area currently occupied by forests is much smaller than the area that is suitable as a consequence of strong deforestation practices over several centuries (Montoya and Figueroa, 1990:40).

APPENDIX III Physiographic Units of the CIRD Region

APPENDIX IV

Tables of Evaluation for Crop Growth Conditions

Good Conditions: 1
 Marginal Conditions: 2
 Not Recommended: 3
 Unfeseable: 4

Table IV.1a

Chim-Shaullo: Crop Suitability for Barley and Wheat

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
1	21	3	1	3	1	1	1	3
2	15.5	2	1	2	3	3	1	2
3	47.5	3	1	3	3	3	1	3
4	67	3	3	3	3	3	1	3
5	46	3	1	2	3	1	1	3
6	27	3	2	3	1	3	1	3
7	73	3	1	2	1	1	1	3
8	126	3	3	3	1	3	1	3
9	26	3	2	3	1	1	1	3
10	20	1	1	2	3	3	1	2
11	142	3	3	3	1	3	1	3
12	21	1	1	2	3	3	1	3
13	12	3	2	3	1	1	1	3
14	78	3	3	3	1	3	1	3
15	22	1	1	1	3	3	1	2
16	12.5	3	2	2	3	3	1	3
17	21	1	1	1	3	3	2	2
18	93	3	3	3	3	3	1	3
19	15	3	1	3	3	1	1	3
20	4.5	1	1	2	3	3	1	2
21	45	3	1	3	3	1	1	3
22	12	1	1	1	3	3	1	2
23	14	3	1	3	3	3	1	3
24	35	3	1	2	1	1	1	3
25	246.5	3	3	3	3	3	1	3
26	11.5	3	3	3	1	3	3	3
27	55	3	1	3	3	3	1	3
28	33	3	1	3	3	3	1	3
29	94	3	2	3	1	1	1	3
30	397	1	1	1	3	3	1	2
31	35	1	1	2	3	1	1	1
32	81	3	1	2	3	3	1	3
33	165	3	3	3	3	3	1	3
34	48.5	3	1	2	1	1	1	3
35	10	1	1	1	1	1	1	1
36	86	1	1	1	3	3	1	2

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
37	10	1	1	2	3	3	1	2
38	137.5	3	3	3	1	3	1	3
39	69	1	1	2	3	3	1	2
40	14.5	3	0	3	0	0	0	3
41	277.5	3	1	2	1	1	1	3
42	27.7	3	2	3	1	1	1	3
43	12.5	3	2	3	1	1	1	3
44	30	3	3	3	1	1	1	3
45	16	3	1	3	2	1	1	3
46	88	1	1	2	2	1	1	1
47	2.5	3	3	3	2	1	3	3
48	57	1	1	2	2	1	1	1
49	7	1	3	3	2	1	1	2
50	8.5	1	2	1	3	1	2	1
51	139	3	3	3	2	1	3	3
52	70	3	2	3	2	1	1	3
53	7.5	3	3	3	1	1	1	3
54	40.5	3	1	3	2	1	1	3
55	32.5	3	3	3	1	1	1	3
56	55	3	3	3	1	3	1	3
57	154	3	1	2	1	1	1	3
58	24	3	2	3	1	1	1	3
59	67	3	1	3	1	1	1	3
60	110	3	1	3	1	1	1	3
61	74.5	2	1	2	1	1	1	1
62	20	3	0	3	0	0	0	3
63	57	1	2	2	2	1	1	1
64	645	3	3	3	2	1	3	3
65	240	3	3	3	2	1	3	3
66	12	1	1	2	1	1	1	1
67	13.8	3	1	2	3	3	1	3
68	6.5	1	1	2	1	1	1	1
69	43	3	1	2	1	1	1	3
70	78	3	1	3	1	1	1	3
71	10	3	2	3	1	3	1	3
72	5	3	3	3	1	3	1	3
73	9	3	1	3	1	1	1	3
74	165	3	3	3	1	3	1	3
75	78	3	2	3	1	3	1	3
76	47	3	1	3	1	3	1	3
77	118	1	1	1	3	3	1	2
78	20.5	3	2	3	1	3	1	3
79	9.5	3	1	3	1	3	1	3
80	40	3	0	3	3	0	0	3
81	3	1	1	2	3	3	1	2
82	7	3	2	2	1	1	1	3
83	32	3	1	2	1	1	1	3
84	13	1	1	2	3	3	1	2

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
85	11	3	1	3	1	3	1	3
86	107	3	1	2	3	3	1	3
87	28	1	1	1	3	3	1	2
88	18	3	2	3	1	1	1	3
89	116	3	1	3	1	1	1	3
90	69	3	2	3	1	1	1	3
91	60	3	2	2	1	1	1	3
92	430	3	3	3	1	3	1	3
93	10	3	3	3	1	3	1	3
94	17	3	2	2	3	3	1	3
95	16.5	3	0	3	0	0	0	3
96	35	3	2	3	1	3	1	3
Total Ha	6380							
Good	348.5	5.4624						
Marginal	826	12.947						
Not Rec	5205.5	81.591						
	6380	100.00						

Table IV.1b
Chim-Shaullo: Crop Suitability for Corn

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
1	21	3	2	3	1	1	1	3
2	15.5	2	2	2	3	3	1	2
3	47.5	3	2	3	3	3	1	3
4	67	3	3	3	3	3	1	3
5	46	3	2	2	3	1	1	3
6	27	3	3	3	1	3	1	3
7	73	3	2	2	1	1	1	3
8	126	3	3	3	1	3	1	3
9	26	3	3	3	1	1	1	3
10	20	2	2	2	3	3	1	2
11	142	3	3	3	1	3	1	3
12	21	2	2	2	3	3	1	2
13	12	3	3	3	1	1	1	3
14	78	3	3	3	1	3	1	3
15	22	2	1	1	3	3	1	2
16	12.5	3	3	2	3	3	1	3
17	21	2	2	1	3	3	2	2
18	93	3	3	3	3	3	1	3
19	15	3	2	3	3	1	1	3
20	4.5	2	2	2	3	3	1	2
21	45	3	2	3	3	1	1	3
22	12	2	2	1	3	3	1	2
23	14	3	2	3	3	3	1	3
24	35	3	2	2	1	1	1	3
25	246.5	3	3	3	3	3	1	3
26	11.5	3	3	3	1	3	3	3
27	55	3	2	3	3	3	1	3
28	33	3	2	3	3	3	1	3
29	94	3	3	3	1	1	1	3
30	397	2	2	1	3	3	1	2
31	35	2	2	2	3	1	1	1
32	81	3	2	2	3	3	1	3
33	165	3	3	3	3	3	1	3
34	48.5	3	2	2	1	1	1	3
35	10	2	2	1	1	1	1	1
36	86	1	2	1	3	3	1	2
37	10	2	1	2	3	3	1	2
38	137.5	3	3	3	1	3	1	3
39	69	2	2	2	3	3	1	2
40	14.5	0	0	3	0	0	0	3
41	277.5	3	2	2	1	1	1	3
42	27.7	3	3	3	1	1	1	3
43	12.5	3	3	3	1	1	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
44	30	3	3	3	1	1	1	3
45	16	3	2	3	2	1	1	3
46	88	1	1	2	2	1	1	1
47	2.5	3	3	3	2	1	3	3
48	57	2	2	2	2	1	1	1
49	7	2	3	3	2	1	1	2
50	8.5	2	3	1	3	1	2	2
51	139	3	3	3	2	1	3	3
52	70	3	3	3	2	1	1	3
53	7.5	3	3	3	1	1	1	3
54	40.5	3	2	3	2	1	1	3
55	32.5	3	3	3	1	1	1	3
56	55	3	3	3	1	3	1	3
57	154	3	2	2	1	1	1	3
58	24	3	3	3	1	1	1	3
59	67	3	2	3	1	1	1	3
60	110	3	2	3	1	1	1	3
61	74.5	2	2	2	1	1	1	1
62	20	3	0	3	0	0	0	3
63	57	2	3	2	2	1	1	1
64	645	3	3	3	2	1	3	3
65	240	3	3	3	2	1	3	3
66	12	2	2	2	1	1	1	1
67	13.8	3	2	2	3	3	1	3
68	6.5	2	2	2	1	1	1	1
69	43	3	2	2	1	1	1	3
70	78	3	2	3	1	1	1	3
71	10	3	3	3	1	3	1	3
72	5	3	3	3	1	3	1	3
73	9	3	1	3	1	1	1	3
74	165	3	3	3	1	3	1	3
75	78	3	3	3	1	3	1	3
76	47	3	2	3	1	3	1	3
77	118	2	2	1	3	3	1	2
78	20.5	3	3	3	1	3	1	3
79	9.5	3	2	3	1	3	1	3
80	40	3	0	3	3	0	0	3
81	3	2	1	2	3	3	1	2
82	7	3	3	2	1	1	1	3
83	32	3	2	2	1	1	1	3
84	13	2	2	2	3	3	1	2
85	11	3	2	3	1	3	1	3
86	107	3	1	2	3	3	1	3
87	28	1	2	1	3	3	1	2
88	18	3	3	3	1	1	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
90	69	3	3	3	1	1	1	3
91	60	3	3	2	1	1	1	3
92	430	3	3	3	1	3	1	3
93	10	3	3	3	1	3	1	3
94	17	3	3	2	3	3	1	3
95	16.5	3	0	3	0	0	0	3
96	35	3	3	3	1	3	1	3
Total Ha	6264	%						
Good.	340	5.3292						
Marginal	855.5	13.409						
Not Rec	5068.5	79.444						
	6264	98.18						

Table IV.1c
him-Shaullo: Crop Suitability for Potato

Polygon	Hectare	slope	Depth	Erosion	Texture	pH	Drainage	Conditions
1	21	3	2	3	1	1	1	3
2	15.5	2	2	2	2	3	1	1
3	47.5	3	2	3	2	3	1	3
4	67	3	3	3	2	3	1	3
5	46	3	2	2	2	1	1	3
6	27	3	3	3	1	3	1	3
7	73	3	2	2	1	1	1	3
8	126	3	3	3	1	3	1	3
9	26	3	3	3	1	1	1	3
10	20	2	2	2	2	3	1	1
11	142	3	3	3	1	3	1	3
12	21	2	2	2	2	3	1	1
13	12	3	3	3	1	1	1	3
14	78	3	3	3	1	3	1	3
15	22	2	1	1	3	3	1	2
16	12.5	3	3	2	2	3	1	3
17	21	2	2	1	3	3	2	2
18	93	3	3	3	2	3	1	3
19	15	3	2	3	2	1	1	3
20	4.5	2	2	2	3	3	1	2
21	45	3	2	3	2	1	1	3
22	12	2	2	1	3	3	1	2
23	14	3	2	3	2	3	1	3
24	35	3	2	2	1	1	1	3
25	246.5	3	3	3	2	3	1	3
26	11.5	3	3	3	1	3	3	3
27	55	3	2	3	2	3	1	3
28	33	3	2	3	2	3	1	3
29	94	3	3	3	1	1	1	3
30	397	2	2	1	2	3	1	1
31	35	2	2	2	2	1	1	1
32	81	3	2	2	2	3	1	3
33	165	3	3	3	2	3	1	3
34	48.5	3	2	2	1	1	1	3
35	10	2	2	1	1	1	1	1
36	86	1	2	1	3	3	1	2
37	10	2	1	2	3	3	1	2
38	137.5	3	3	3	1	3	1	3
39	69	2	2	2	2	3	1	1
40	14.5	0	0	3	0	0	0	3
41	277.5	3	2	2	1	1	1	3
42	27.7	3	3	3	1	1	1	3
43	12.5	3	3	3	1	1	1	3

Polygon	Hectare	slope	Depth	Erosion	Texture	pH	Drainage	Conditions
44	30	3	3	3	1	1	1	3
45	16	3	2	3	1	1	1	3
46	88	1	1	2	1	1	1	1
47	2.5	3	3	3	1	1	3	3
48	57	2	2	2	1	1	1	1
49	7	2	3	3	1	1	1	2
50	8.5	2	3	1	3	1	2	2
51	139	3	3	3	1	1	3	3
52	70	3	3	3	1	1	1	3
53	7.5	3	3	3	1	1	1	3
54	40.5	3	2	3	1	1	1	3
55	32.5	3	3	3	1	1	1	3
56	55	3	3	3	1	3	1	3
57	154	3	2	2	1	1	1	3
58	24	3	3	3	1	1	1	3
59	67	3	2	3	1	1	1	3
60	110	3	2	3	1	1	1	3
61	74.5	2	2	2	1	1	1	1
62	20	3	0	3	0	0	0	3
63	57	2	3	2	1	1	1	1
64	645	3	3	3	1	1	3	3
65	240	3	3	3	1	1	3	3
66	12	2	2	2	1	1	1	1
67	13.8	3	2	2	3	3	1	3
68	6.5	2	2	2	1	1	1	1
69	43	3	2	2	1	1	1	3
70	78	3	2	3	1	1	1	3
71	10	3	3	3	1	3	1	3
72	5	3	3	3	1	3	1	3
73	9	3	1	3	1	1	1	3
74	165	3	3	3	1	3	1	3
75	78	3	3	3	1	3	1	3
76	47	3	2	3	1	3	1	3
77	118	2	2	1	2	3	1	1
78	20.5	3	3	3	1	3	1	3
79	9.5	3	2	3	1	3	1	3
80	40	3	0	3	2	0	0	3
81	3	2	1	2	3	3	1	2
82	7	3	3	2	1	1	1	3
83	32	3	2	2	1	1	1	3
84	13	2	2	2	3	3	1	2
85	11	3	2	3	1	3	1	3
86	107	3	1	2	3	3	1	3
87	28	1	2	1	3	3	1	2

Polygon	Hectare	slope	Depth	Erosion	Texture	pH	Drainage	Conditions
88	18	3	3	3	1	1	1	3
89	116	3	1	3	1	1	1	3
90	69	3	3	3	1	1	1	3
91	60	3	3	2	1	1	1	3
92	430	3	3	3	1	3	1	3
93	10	3	3	3	1	3	1	3
94	17	3	3	2	3	3	1	3
95	16.5	3	0	3	0	0	0	3
96	35	3	3	3	1	3	1	3
Total Ha	6380	%						
Good	980.5	15.368						
Marginal	215	3.3699						
Not Rec	5184.5	81.262						
	6380	100.00						

Table IV.2a
PDRI-Jesús: Crop Suitability for Barley and Wheat

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
1	25.5	3	2	1	1	1	2	3
2	75	3	2	3	1	2	1	3
3	14	3	1	2	1	2	1	3
4	78.5	3	3	3	1	3	1	3
5	18	3	2	2	1	2	1	3
6	79	3	3	3	1	3	1	3
7	101	3	2	3	1	2	1	3
8	18.5	3	2	3	1	1	1	3
9	63.5	1	1	1	1	2	1	1
10	34	3	2	2	1	2	1	3
11	25	3	2	1	3	3	1	3
12	140	3	2	3	3	3	1	3
13	22	2	2	1	1	1	1	1
14	16	3	2	3	1	3	1	3
15	20	3	2	3	1	2	1	3
16	15	3	2	3	1	1	1	3
17	200	3	3	3	3	3	1	3
18	4	3	1	2	1	3	1	3
19	12.5	3	2	3	1	3	1	3
20	4	3	2	3	1	3	1	3
21	20	1	2	2	1	3	2	1
22	32.5	3	3	3	2	1	3	3
23	16	1	2	1	1	3	2	1
24	34.5	3	2	1	1	3	2	3
25	45.5	1	2	3	2	1	1	1
26	172	3	2	3	2	3	0	3
27	14.5	3	2	3	1	3	1	3
28	57.5	3	2	3	2	1	1	3
29	161	3	3	3	2	1	3	3
30	12	3	2	3	1	3	1	3
31	45	3	1	2	1	3	1	3
32	16.5	3	2	3	1	3	1	3
33	39	3	2	3	1	3	1	3
34	40	3	3	3	1	3	1	3
35	43.5	3	2	3	2	3	1	3
36	34.5	3	2	3	2	3	1	3
37	4	3	3	3	2	3	3	3
38	12.5	3	3	3	2	3	3	3
39	108	3	2	2	2	3	1	3
40	25	1	2	2	1	3	1	1
41	21	3	2	3	1	3	1	3
42	13	3	2	3	1	3	1	3
43	33	3	1	3	1	3	1	3
44	19.5	3	2	3	1	3	1	3
45	110	1	1	2	1	3	1	1

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
46	50	3	1	2	1	3	1	3
47	41	1	1	1	1	3	2	1
48	46.5	3	2	3	1	3	1	3
49	26.5	1	1	1	1	3	1	1
50	78	1	1	1	1	3	1	1
51	29.5	3	3	3	1	3	1	3
52	19	1	1	2	1	3	1	1
53	18	3	2	3	1	3	1	3
54	16	3	2	2	1	1	1	3
55	10	1	2	2	1	3	1	1
56	14.5	3	1	2	1	3	1	3
57	29.5	3	1	2	3	3	1	3
58	63.5	3	1	2	3	3	1	3
59	8	1	1	1	3	3	1	2
60	13.5	3	2	3	1	3	1	3
61	51	3	1	1	1	3	1	3
62	34.5	3	2	3	1	3	1	3
63	55	3	2	3	1	3	1	3
64	45	3	3	3	1	3	1	3
65	8	3	2	2	1	1	1	3
66	64	3	2	3	1	3	1	3
67	34	3	2	2	1	1	1	3
68	22.5	3	1	3	3	3	1	3
69	69	3	3	3	1	3	1	3
70	31	3	2	2	1	3	1	3
71	40	3	1	2	1	3	1	3
72	65	3	3	3	1	3	3	3
73	10	2	1	2	1	3	1	1
74	13	3	1	2	1	3	1	3
75	101	3	3	3	1	3	3	3
76	93	3	1	2	1	3	1	3
77	16	3	3	3	0	0	0	3
78	96	3	3	3	1	3	1	3
79	32.5	3	3	3	1	3	1	3
80	46	3	3	3	1	3	1	3
81	7	3	2	3	1	3	1	3
82	10.5	3	2	3	1	3	1	3
83	5.5	3	2	3	1	3	1	3
84	1353	3	3	3	1	3	3	3
85	14.5	3	2	3	1	3	1	3
86	186	3	2	3	1	3	1	3
87	13.5	3	2	3	2	3	1	3
88	40.5	3	2	3	2	3	1	3
89	37	3	2	3	2	3	1	3
90	34.5	3	2	3	1	3	1	3
91	20	2	2	2	1	3	1	1
92	52	3	2	3	1	3	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
93	57	3	2	3	1	3	1	3
94	25.5	3	3	3	1	3	1	3
95	21	1	1	1	3	3	1	2
96	15	3	2	3	1	3	1	3
97	4	1	1	2	1	3	1	1
98	74.5	3	2	2	1	3	1	3
99	21.5	1	1	1	1	3	1	1
100	112.5	3	2	2	1	3	1	3
101	25.5	3	2	3	1	3	1	3
102	29.5	3	2	3	3	3	1	3
103	19.5	3	2	3	1	3	1	3
104	10	1	2	1	1	3	2	1
105	11.5	1	2	1	2	3	2	1
106	2	1	2	2	2	3	2	1
107	2.5	1	2	1	2	3	2	1
108	2.5	1	2	1	2	3	1	1
109	2	2	2	2	2	3	1	1
110	27	2	1	2	3	1	1	1
111	40	3	2	3	1	1	1	3
112	88.5	3	2	3	1	1	1	3
113	34	3	3	3	1	3	1	3
114	32	3	3	3	1	1	1	3
115	26	3	1	2	1	3	1	3
116	13	3	1	2	1	1	1	3
117	67	3	2	2	2	1	1	3
118	10	3	2	2	1	3	1	3
119	7	3	1	2	3	3	1	3
120	10	3	2	2	1	3	1	3
121	13	3	2	3	1	3	1	3
122	11.5	3	2	2	1	3	1	3
123	30	3	1	3	1	3	1	3
124	39	3	2	3	1	3	1	3
125	13.25	3	1	2	1	3	1	3
126	4	3	2	2	2	1	1	3
127	8.5	3	2	3	1	3	1	3
128	239	3	3	3	2	1	0	3
129	15	3	2	3	1	3	1	3
130	34	3	3	3	1	3	1	3
131	19.5	1	1	1	3	3	1	2
132	10	3	2	2	1	3	1	3
133	53	3	2	3	1	3	1	3
134	28.5	3	2	3	1	3	1	3
135	8	1	2	1	3	3	2	2
136	309	3	3	3	1	3	3	3
137	10	3	3	3	1	1	1	3
138	13	3	2	2	1	3	1	3
139	8.5	1	1	1	1	3	1	1

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
140	65	3	3	3	2	3	3	3
141	10.5	3	2	3	1	3	1	3
142	15	3	2	3	2	1	1	3
143	19	3	1	2	1	3	1	3
144	42	3	2	3	2	3	1	3
145	9	3	0	3	0	3	0	3
146	10	1	1	1	1	3	1	1
147	8	1	1	1	1	3	1	1
148	10	1	1	1	1	3	1	1
149	5	3	2	3	1	3	1	3
150	9	1	2	3	1	3	1	2
Total Ha	7119.25	%						
Good	626	8.7931						
Marginal	65.5	0.92						
Not Rec	6427.75	90.287						
	7119.25	100						

Table IV.2b
PDRI-Jesús: Crop Suitability for Corn

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
1	25.5	3	3	1	1	1	2	3
2	75	3	3	3	1	2	1	3
3	14	3	2	2	1	2	1	3
4	78.5	3	3	3	1	3	1	3
5	18	3	3	2	1	2	1	3
6	79	3	3	3	1	3	1	3
7	101	3	3	3	1	2	1	3
8	18.5	3	3	3	1	1	1	3
9	63.5	2	2	1	1	2	1	3
10	34	3	3	2	1	2	1	3
11	25	3	3	1	3	3	1	3
12	140	3	3	3	3	3	1	3
13	22	3	3	1	1	1	1	3
14	16	3	3	3	1	3	1	3
15	20	3	3	3	1	2	1	3
16	15	3	3	3	1	1	1	3
17	200	3	3	3	3	3	1	3
18	4	3	2	2	1	3	1	3
19	12.5	3	3	3	1	3	1	3
20	4	3	3	3	1	3	1	3
21	20	2	3	2	1	3	2	2
22	32.5	3	3	3	2	1	3	3
23	16	2	3	1	1	3	2	2
24	34.5	3	3	1	1	3	2	3
25	45.5	2	3	3	2	1	1	2
26	172	3	3	3	2	3	0	3
27	14.5	3	3	3	1	3	1	3
28	57.5	3	3	3	2	1	1	3
29	161	3	3	3	2	1	3	3
30	12	3	3	3	1	3	1	3
31	45	3	2	2	1	3	1	3
32	16.5	3	3	3	1	3	1	3
33	39	3	3	3	1	3	1	3
34	40	3	3	3	1	3	1	3
35	43.5	3	3	3	2	3	1	3
36	34.5	3	3	3	2	3	1	3
37	4	3	3	3	2	3	3	3
38	12.5	3	3	3	2	3	3	3
39	108	3	3	2	2	3	1	3
40	25	2	3	2	1	3	1	2
41	21	3	3	3	1	3	1	3
42	13	3	3	3	1	3	1	3
43	33	3	2	3	1	3	1	3
44	19.5	3	3	3	1	3	1	3
45	110	2	2	2	1	3	1	1

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
46	50	3	2	2	1	3	1	3
47	41	2	2	1	1	3	2	1
48	46.5	3	3	3	1	3	1	3
49	26.5	2	2	1	1	3	1	1
50	78	2	2	1	1	3	1	1
51	29.5	3	3	3	1	3	1	3
52	19	2	2	2	1	3	1	1
53	18	3	3	3	1	3	1	3
54	16	3	3	2	1	1	1	3
55	10	2	3	2	1	3	1	2
56	14.5	3	2	2	1	3	1	3
57	29.5	3	2	2	3	3	1	3
58	63.5	3	2	2	3	3	1	3
59	8	2	2	1	3	3	1	2
60	13.5	3	3	3	1	3	1	3
61	51	3	2	1	1	3	1	3
62	34.5	3	3	3	1	3	1	3
63	55	3	3	3	1	3	1	3
64	45	3	3	3	1	3	1	3
65	8	3	3	2	1	1	1	3
66	64	3	3	3	1	3	1	3
67	34	3	3	2	1	1	1	3
68	22.5	3	2	3	3	3	1	3
69	69	3	3	3	1	3	1	3
70	31	3	3	2	1	3	1	3
71	40	3	2	2	1	3	1	3
72	65	3	3	3	1	3	3	3
73	10	3	2	2	1	3	1	3
74	13	3	2	2	1	3	1	3
75	101	3	3	3	1	3	3	3
76	93	3	2	2	1	3	1	3
77	16	3	3	3	0	0	0	3
78	96	3	3	3	1	3	1	3
79	32.5	3	3	3	1	3	1	3
80	46	3	3	3	1	3	1	3
81	7	3	3	3	1	3	1	3
82	10.5	3	3	3	1	3	1	3
83	5.5	3	3	3	1	3	1	3
84	1353	3	3	3	1	3	3	3
85	14.5	3	3	3	1	3	1	3
86	186	3	3	3	1	3	1	3
87	13.5	3	3	3	2	3	1	3
88	40.5	3	3	3	2	3	1	3
89	37	3	3	3	2	3	1	3
90	34.5	3	3	3	1	3	1	3
91	20	3	3	2	1	3	1	3
92	52	3	3	3	1	3	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
93	57	3	3	3	1	3	1	3
94	25.5	3	3	3	1	3	1	3
95	21	2	2	1	3	3	1	2
96	15	3	3	3	1	3	1	3
97	4	2	2	2	1	3	1	1
98	74.5	3	3	2	1	3	1	3
99	21.5	2	2	1	1	3	1	1
100	112.5	3	3	2	1	3	1	3
101	25.5	3	3	3	1	3	1	3
102	29.5	3	3	3	3	3	1	3
103	19.5	3	3	3	1	3	1	3
104	10	2	3	1	1	3	2	2
105	11.5	2	3	1	2	3	2	2
106	2	2	3	2	2	3	2	2
107	2.5	2	3	1	2	3	2	2
108	2.5	2	3	1	2	3	1	2
109	2	3	3	2	2	3	1	3
110	27	3	2	2	3	1	1	3
111	40	3	3	3	1	1	1	3
112	88.5	3	3	3	1	1	1	3
113	34	3	3	3	1	3	1	3
114	32	3	3	3	1	1	1	3
115	26	3	2	2	1	3	1	3
116	13	3	2	2	1	1	1	3
117	67	3	3	2	2	1	1	3
118	10	3	3	2	1	3	1	3
119	7	3	2	2	3	3	1	3
120	10	3	3	2	1	3	1	3
121	13	3	3	3	1	3	1	3
122	11.5	3	3	2	1	3	1	3
123	30	3	2	3	1	3	1	3
124	39	3	3	3	1	3	1	3
125	13.25	3	2	2	1	3	1	3
126	4	3	3	2	2	1	1	3
127	8.5	3	3	3	1	3	1	3
128	239	3	3	3	2	1	0	3
129	15	3	3	3	1	3	1	3
130	34	3	3	3	1	3	1	3
131	19.5	1	2	1	3	3	1	2

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
132	10	3	3	2	1	3	1	3
133	53	3	3	3	1	3	1	3
134	28.5	3	3	3	1	3	1	3
135	8	1	3	1	3	3	2	3
136	309	3	3	3	1	3	3	3
137	10	3	3	3	1	1	1	3
138	13	3	3	2	1	3	1	3
139	8.5	1	2	1	1	3	1	1
140	65	3	3	3	2	3	3	3
141	10.5	3	3	3	1	3	1	3
142	15	3	3	3	2	1	1	3
143	19	3	2	2	1	3	1	3
144	42	3	3	3	2	3	1	3
145	9	3	0	3	0	3	0	3
146	10	2	2	1	1	3	1	1
147	8	1	2	1	1	3	1	1
148	10	1	2	1	1	3	1	1
149	5	3	3	3	1	3	1	3
150	9	2	3	3	1	3	1	3
Total Ha	7119.25	%						
Good	336.5	4.7266						
Marginal	193.5	2.718						
Not Rec.	6145.75	86.326						
Unfeas.	443.5	6.23						
	7119.25	100.00						

Table IV.2c
PDRI-Jesús: Crop Suitability for Potato

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
1	25.5	3	3	1	1	1	2	3
2	75	3	3	3	1	2	1	3
3	14	3	2	2	1	2	1	3
4	78.5	3	3	3	1	3	1	3
5	18	3	3	2	1	2	1	3
6	79	3	3	3	1	3	1	3
7	101	3	3	3	1	2	1	3
8	18.5	3	3	3	1	1	1	3
9	63.5	2	2	1	1	2	1	1
10	34	3	3	2	1	2	1	3
11	25	3	3	1	2	3	1	3
12	140	3	3	3	2	3	1	3
13	22	3	3	1	1	1	1	3
14	16	3	3	3	1	3	1	3
15	20	3	3	3	1	2	1	3
16	15	3	3	3	1	1	1	3
17	200	3	3	3	2	3	1	3
18	4	3	2	2	1	3	1	3
19	12.5	3	3	3	1	3	1	3
20	4	3	3	3	1	3	1	3
21	20	2	3	2	1	3	2	2
22	32.5	3	3	3	1	1	3	3
23	16	2	3	1	1	3	2	2
24	34.5	3	3	1	1	3	2	3
25	45.5	2	3	3	1	1	1	2
26	172	3	3	3	1	3	0	3
27	14.5	3	3	3	1	3	1	3
28	57.5	3	3	3	1	1	1	3
29	161	3	3	3	1	1	3	3
30	12	3	3	3	1	3	1	3
31	45	3	2	2	1	3	1	3
32	16.5	3	3	3	1	3	1	3
33	39	3	3	3	1	3	1	3
34	40	3	3	3	1	3	1	3
35	43.5	3	3	3	1	3	1	3
36	34.5	3	3	3	1	3	1	3
37	4	3	3	3	1	3	3	3
38	12.5	3	3	3	1	3	3	3
39	108	3	3	2	1	3	1	3
40	25	2	3	2	1	3	1	2
41	21	3	3	3	1	3	1	3
42	13	3	3	3	1	3	1	3
43	33	3	2	3	1	3	1	3
44	19.5	3	3	3	1	3	1	3
45	110	2	2	2	1	3	1	1

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
46	50	3	2	2	1	3	1	3
47	41	2	2	1	1	3	2	1
48	46.5	3	3	3	1	3	1	3
49	26.5	2	2	1	1	3	1	1
50	78	2	2	1	1	3	1	1
51	29.5	3	3	3	1	3	1	3
52	19	2	2	2	1	3	1	1
53	18	3	3	3	1	3	1	3
54	16	3	3	2	1	1	1	3
55	10	2	3	2	1	3	1	2
56	14.5	3	2	2	1	3	1	3
57	29.5	3	2	2	2	3	1	3
58	63.5	3	2	2	2	3	1	3
59	8	2	2	1	2	3	1	1
60	13.5	3	3	3	1	3	1	3
61	51	3	2	1	1	3	1	3
62	34.5	3	3	3	1	3	1	3
63	55	3	3	3	1	3	1	3
64	45	3	3	3	1	3	1	3
65	8	3	3	2	1	1	1	3
66	64	3	3	3	1	3	1	3
67	34	3	3	2	1	1	1	3
68	22.5	3	2	3	2	3	1	3
69	69	3	3	3	1	3	1	3
70	31	3	3	2	1	3	1	3
71	40	3	2	2	1	3	1	3
72	65	3	3	3	1	3	3	3
73	10	3	2	2	1	3	1	3
74	13	3	2	2	1	3	1	3
75	101	3	3	3	1	3	3	3
76	93	3	2	2	1	3	1	3
77	16	3	3	3	0	0	0	3
78	96	3	3	3	1	3	1	3
79	32.5	3	3	3	1	3	1	3
80	46	3	3	3	1	3	1	3
81	7	3	3	3	1	3	1	3
82	10.5	3	3	3	1	3	1	3
83	5.5	3	3	3	1	3	1	3
84	1353	3	3	3	1	3	3	3
85	14.5	3	3	3	1	3	1	3
86	186	3	3	3	1	3	1	3
87	13.5	3	3	3	1	3	1	3
88	40.5	3	3	3	1	3	1	3
89	37	3	3	3	1	3	1	3
90	34.5	3	3	3	1	3	1	3
91	20	3	3	2	1	3	1	3
92	52	3	3	3	1	3	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
93	57	3	3	3	1	3	1	3
94	25.5	3	3	3	1	3	1	3
95	21	2	2	1	2	3	1	1
96	15	3	3	3	1	3	1	3
97	4	2	2	2	1	3	1	1
98	74.5	3	3	2	1	3	1	3
99	21.5	2	2	1	1	3	1	1
100	112.5	3	3	2	1	3	1	3
101	25.5	3	3	3	1	3	1	3
102	29.5	3	3	3	2	3	1	3
103	19.5	3	3	3	1	3	1	3
104	10	2	3	1	1	3	2	2
105	11.5	2	3	1	1	3	2	2
106	2	2	3	2	1	3	2	2
107	2.5	2	3	1	1	3	2	2
108	2.5	2	3	1	1	3	1	2
109	2	3	3	2	1	3	1	3
110	27	3	2	2	3	1	1	3
111	40	3	3	3	1	1	1	3
112	88.5	3	3	3	1	1	1	3
113	34	3	3	3	1	3	1	3
114	32	3	3	3	1	1	1	3
115	26	3	2	2	1	3	1	3
116	13	3	2	2	1	1	1	3
117	67	3	3	2	1	1	1	3
118	10	3	3	2	1	3	1	3
119	7	3	2	2	2	3	1	3
120	10	3	3	2	1	3	1	3
121	13	3	3	3	1	3	1	3
122	11.5	3	3	2	1	3	1	3
123	30	3	2	3	1	3	1	3
124	39	3	3	3	1	3	1	3
125	13.25	3	2	2	1	3	1	3
126	4	3	3	2	1	1	1	3
127	8.5	3	3	3	1	3	1	3
128	239	3	3	3	1	1	0	3
129	15	3	3	3	1	3	1	3
130	34	3	3	3	1	3	1	3
131	19.5	1	2	1	2	3	1	1
132	10	3	3	2	1	3	1	3
133	53	3	3	3	1	3	1	3
134	28.5	3	3	3	1	3	1	3
135	8	1	3	1	3	3	2	3
136	309	3	3	3	1	3	3	3
137	10	3	3	3	1	1	1	3
138	13	3	3	2	1	3	1	3
139	8.5	1	2	1	1	3	1	1

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
140	65	3	3	3	1	3	3	3
141	10.5	3	3	3	1	3	1	3
142	15	3	3	3	1	1	1	3
143	19	3	2	2	1	3	1	3
144	42	3	3	3	1	3	1	3
145	9	3	0	3	0	3	0	3
146	10	2	2	1	1	3	1	1
147	8	1	2	1	1	3	1	1
148	10	1	2	1	1	3	1	1
149	5	3	3	3	1	3	1	3
150	9	2	3	3	1	3	1	3
Total Ha	7119.25	%						
Good	448.5	6.2998						
Marginal	145	2.0367						
Not Rec	6525.75	91.663						
	7119.25	100.00						

Table IV.3a
SESA: Crop Suitability for Barley and Wheat

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
1	135	3	3	3	1	3	1	3
2	5.5	3	2	2	2	3	1	3
3	22	3	3	3	1	3	1	3
4	38.5	3	2	3	3	3	1	3
5	10	3	2	3	1	3	1	3
6	240	3	3	3	2	2	3	3
7	47.5	3	3	3	2	2	3	3
8	20	1	2	2	1	3	2	1
9	16	1	2	2	1	3	1	1
10	9	3	2	3	1	3	1	3
11	180	3	3	3	1	3	3	3
12	3	1	1	1	1	3	1	1
13	8.5	3	1	2	3	3	1	3
14	9	3	2	2	3	3	1	3
15	7.5	3	3	3	1	3	1	3
16	38.5	3	2	3	3	1	1	3
17	24	3	2	2	3	1	1	3
18	20	1	2	2	3	1	1	1
19	10	1	1	1	1	1	2	1
20	18.5	3	2	3	1	1	1	3
21	18	3	2	3	3	1	1	3
22	11.5	3	2	2	3	1	1	3
23	25	3	2	3	1	1	1	3
24	47.5	3	2	2	1	1	1	3
25	36.5	3	1	2	1	2	1	3
26	220	3	3	3	2	1	1	3
27	21	3	3	3	1	1	1	3
28	53	3	3	3	2	1	1	3
29	12.5	3	1	2	1	3	1	3
30	25	1	2	2	1	3	1	1
31	126.5	3	3	3	1	1	1	3
32	18	3	2	2	1	3	1	3
33	14.5	3	3	3	1	3	3	3
34	54	3	2	2	1	2	1	3
35	49	3	3	3	2	2	1	3
36	45	1	2	1	1	2	3	1
37	24	3	3	3	2	2	1	3
38	28	3	2	2	1	2	1	3
39	31.5	3	3	3	2	1	1	3
40	23	3	2	3	1	2	1	3
41	28	3	2	2	1	2	1	3
42	79	3	3	3	2	1	1	3
43	20	3	2	3	1	1	1	3
44	24	3	1	2	3	3	1	3
45	10	3	2	2	1	3	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
46	44	3	2	2	1	3	1	3
47	43	3	1	2	3	3	1	3
48	26	1	2	2	3	1	1	1
49	27	3	2	3	1	1	1	3
50	7.5	3	3	3	1	3	1	3
51	23.5	3	2	3	1	3	1	3
52	9	0	0	0	1	3	1	3
53	18.5	3	1	2	1	3	1	3
54	33.5	3	3	3	1	3	1	3
55	7	3	3	3	1	3	1	3
56	10	3	2	2	3	3	1	3
57	9	3	2	3	1	1	1	3
58	19	2	1	2	3	3	1	2
59	13	3	3	3	1	3	1	3
60	16	3	2	2	1	3	1	3
61	26.5	3	2	3	1	3	1	3
62	24	3	2	2	2	3	1	3
63	117	3	3	3	2	1	3	3
64	30	3	3	3	0	0	0	3
65	12.5	3	2	3	2	1	1	3
66	102	3	3	3	2	1	3	3
67	14	3	2	2	2	1	3	3
68	91	3	2	3	1	2	1	3
69	135	3	3	2	1	2	1	3
70	21	3	2	1	1	2	2	3
71	5	3	3	3	1	2	1	3
72	23.5	3	3	2	1	2	1	3
73	20	3	3	3	1	1	1	3
74	31	1	2	2	1	2	1	1
75	19	3	3	3	1	2	1	3
76	78.5	1	2	1	1	2	2	1
77	88	3	3	3	1	2	1	3
78	26.5	3	2	2	1	2	1	3
79	15	3	2	3	1	3	1	3
80	3	3	2	3	1	2	1	3
81	410	3	3	3	1	3	3	3
82	42	1	2	2	1	1	1	1
83	48.5	3	3	2	1	1	1	3
84	13	3	2	3	1	1	1	3
85	36	3	3	3	1	3	1	3
86	17.5	3	1	2	3	3	1	3
87	33.5	3	1	2	1	3	1	3
88	127.5	3	2	3	1	3	1	3
89	42.5	3	2	3	1	3	1	3
90	18	3	2	3	3	3	1	3
91	41.5	3	1	2	1	3	1	3
92	50	3	2	3	1	1	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
93	185	2	1	1	1	3	1	1
94	23	3	2	3	2	1	1	3
95	11	3	2	3	1	3	1	3
96	10	3	2	3	1	3	1	3
97	8	3	3	3	2	3	3	3
98	65.5	1	1	2	2	1	1	1
99	18.5	3	3	3	2	3	1	3
100	155	3	1	2	1	3	1	3
101	25.5	1	1	1	2	3	1	1
102	17	3	3	3	1	3	1	3
103	5	3	2	3	1	1	1	3
104	6	3	2	3	1	1	1	3
105	3.5	3	3	3	2	1	1	3
106	59	1	1	3	1	3	1	2
107	96	3	3	3	2	2	3	3
108	11	1	1	1	2	3	1	1
109	51	1	1	1	3	3	1	2
110	10	3	2	3	2	3	1	3
111	46.5	3	2	3	2	3	1	3
112	62	3	2	2	1	3	1	3
113	20	3	3	3	2	1	3	3
114	37.5	1	1	1	3	3	1	2
115	55	1	1	1	3	3	1	2
116	143	1	2	1	2	3	1	1
117	59	0	0	0	0	0	0	3
118	79	3	2	3	1	3	1	3
119	17	1	2	2	1	3	1	1
120	62.5	3	2	3	1	3	1	3
121	75	3	2	3	2	1	1	3
122	20	1	2	2	2	2	1	1
123	47	1	3	3	2	2	3	3
124	12.5	2	2	3	1	2	3	2
125	117.5	1	3	3	2	3	3	3
126	330	3	3	3	2	2	1	3
127	25	3	2	2	2	2	1	3
128	13	3	3	3	2	2	1	3
129	17	1	2	2	3	2	1	1
130	13	3	3	3	1	3	1	3
131	28.5	3	3	3	1	2	1	3
132	18	3	1	3	1	2	1	3
133	16.5	3	0	3	0	2	0	3
134	12	1	1	2	2	1	1	1
135	126	3	3	3	2	1	3	3
136	52.5	3	0	3	0	0	0	3
137	130	3	2	3	1	1	1	3
138	132	3	3	3	1	1	3	3
139	33.5	3	2	2	1	2	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
140	15.5	1	2	2	1	2	1	1
141	280	3	3	3	1	2	3	3
142	22	0	0	3	2	2	3	3
143	11.5	3	2	3	2	2	1	3
144	45.5	3	2	3	2	2	3	3
145	17	3	3	3	2	1	3	3
146	22.5	3	3	3	2	1	3	3
147	31	3	2	3	2	1	3	3
148	42.5	3	2	3	2	1	3	3
149	45	3	2	3	2	2	3	3
150	44	3	3	3	2	1	1	3
151	16	3	2	3	2	1	1	3
152	95	1	1	0	1	3	1	2
153	7	1	2	2	2	1	3	1
154	11.5	3	0	3	2	0	3	3
155	46	3	3	3	2	1	3	3
156	39	3	2	2	2	3	1	3
Total Ha	7327	%						
Good	835	11.396						
Matginal	329	4.4902						
Not Rec	6163	84.114						
	7327	100.00						

Table IV.3b
SESA: Crop Suitability for Corn

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
1	135	3	3	3	1	3	1	3
2	5.5	3	3	2	2	3	1	3
3	22	3	3	3	1	3	1	3
4	38.5	3	3	3	3	3	1	3
5	10	3	3	3	1	3	1	3
6	240	3	3	3	2	2	3	3
7	47.5	3	3	3	2	2	3	3
8	20	2	3	2	1	3	2	2
9	16	2	3	2	1	3	1	2
10	9	3	3	3	1	3	1	3
11	180	3	3	3	1	3	3	3
12	3	2	2	1	1	3	1	1
13	8.5	3	2	2	3	3	1	3
14	9	3	3	2	3	3	1	3
15	7.5	3	3	3	1	3	1	3
16	38.5	3	3	3	3	1	1	3
17	24	3	3	2	3	1	1	3
18	20	2	3	2	3	1	1	2
19	10	2	2	1	1	1	2	1
20	18.5	3	3	3	1	1	1	3
21	18	3	3	3	3	1	1	3
22	11.5	3	3	2	3	1	1	3
23	25	3	3	3	1	1	1	3
24	47.5	3	3	2	1	1	1	3
25	36.5	3	2	2	1	2	1	3
26	220	3	3	3	2	1	1	3
27	21	3	3	3	1	1	1	3
28	53	3	3	3	2	1	1	3
29	12.5	3	2	2	1	3	1	3
30	25	2	3	2	1	3	1	2
31	126.5	3	3	3	1	1	1	3
32	18	3	3	2	1	3	1	3
33	14.5	3	3	3	1	3	3	3
34	54	3	3	2	1	2	1	4
35	49	3	3	3	2	2	1	3
36	45	2	3	1	1	2	3	4
37	24	3	3	3	2	2	1	3
38	28	3	3	2	1	2	1	3
39	31.5	3	3	3	2	1	1	3
40	23	3	3	3	1	2	1	3
41	28	3	3	2	1	2	1	3
42	79	3	3	3	2	1	1	3
43	20	3	3	3	1	1	1	3
44	24	3	2	2	3	3	1	3
45	10	3	3	2	1	3	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
46	44	3	3	2	1	3	1	3
47	43	3	2	2	3	3	1	3
48	26	2	3	2	3	1	1	2
49	27	3	3	3	1	1	1	3
50	7.5	3	3	3	1	3	1	3
51	23.5	3	3	3	1	3	1	3
52	9	0	0	0	1	3	1	3
53	18.5	3	2	2	1	3	1	3
54	33.5	3	3	3	1	3	1	3
55	7	3	3	3	1	3	1	3
56	10	3	3	2	3	3	1	3
57	9	3	3	3	1	1	1	3
58	19	2	2	2	3	3	1	2
59	13	3	3	3	1	3	1	3
60	16	3	3	2	1	3	1	3
61	26.5	3	3	3	1	3	1	3
62	24	3	3	2	2	3	1	3
63	117	3	3	3	2	1	3	3
64	30	3	3	3	0	0	0	3
65	12.5	3	3	3	2	1	1	3
66	102	3	3	3	2	1	3	3
67	14	3	3	2	2	1	3	3
68	91	3	3	3	1	2	1	3
69	135	3	3	2	1	2	1	4
70	21	3	3	1	1	2	2	4
71	5	3	3	3	1	2	1	4
72	23.5	3	3	2	1	2	1	4
73	20	3	3	3	1	1	1	4
74	31	2	3	2	1	2	1	4
75	19	3	3	3	1	2	1	4
76	78.5	2	3	1	1	2	2	1
77	88	3	3	3	1	2	1	3
78	26.5	3	3	2	1	2	1	3
79	15	3	3	3	1	3	1	3
80	3	3	3	3	1	2	1	3
81	410	3	3	3	1	3	3	3
82	42	2	3	2	1	1	1	1
83	48.5	3	3	2	1	1	1	3
84	13	3	3	3	1	1	1	3
85	36	3	3	3	1	3	1	3
86	17.5	3	2	2	3	3	1	3
87	33.5	3	2	2	1	3	1	3
88	127.5	3	3	3	1	3	1	3
89	42.5	3	3	3	1	3	1	3
90	18	3	3	3	3	3	1	3
91	41.5	3	2	2	1	3	1	3
92	50	3	3	3	1	1	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
93	185	2	2	1	1	3	1	1
94	23	3	3	3	2	1	1	3
95	11	3	3	3	1	3	1	3
96	10	3	3	3	1	3	1	3
97	8	3	3	3	2	3	3	3
98	65.5	2	2	2	2	1	1	1
99	18.5	3	3	3	2	3	1	3
100	155	3	2	2	1	3	1	3
101	25.5	2	2	1	2	3	1	1
102	17	3	3	3	1	3	1	3
103	5	3	3	3	1	1	1	3
104	6	3	3	3	1	1	1	3
105	3.5	3	3	3	2	1	1	3
106	59	2	2	3	1	3	1	2
107	96	3	3	3	2	2	3	3
108	11	1	2	1	2	3	1	1
109	51	2	2	1	3	3	1	2
110	10	3	3	3	2	3	1	3
111	46.5	3	3	3	2	3	1	3
112	62	3	3	2	1	3	1	3
113	20	3	3	3	2	1	3	3
114	37.5	1	2	1	3	3	1	2
115	55	2	2	1	3	3	1	2
116	143	2	3	1	2	3	1	2
117	59	0	0	0	0	0	0	3
118	79	3	3	3	1	3	1	3
119	17	2	3	2	1	3	1	2
120	62.5	3	3	3	1	3	1	3
121	75	3	3	3	2	1	1	3
122	20	2	3	2	2	2	1	1
123	47	2	3	3	2	2	3	3
124	12.5	2	3	3	1	2	3	3
125	117.5	2	3	3	2	3	3	3
126	330	3	3	3	2	2	1	3
127	25	3	3	2	2	2	1	3
128	13	3	3	3	2	2	1	3
129	17	2	3	2	3	2	1	2
130	13	3	3	3	1	3	1	3
131	28.5	3	3	3	1	2	1	3
132	18	3	2	3	1	2	1	3
133	16.5	3	0	3	0	2	0	3
134	12	2	2	2	2	1	1	1
135	126	3	3	3	2	1	3	3
136	52.5	3	0	3	0	0	0	3
137	130	3	3	3	1	1	1	3
138	132	3	3	3	1	1	3	3
139	33.5	3	3	2	1	2	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
140	15.5	2	3	2	1	2	1	1
141	280	3	3	3	1	2	3	3
142	22	0	0	3	2	2	3	3
143	11.5	3	3	3	2	2	1	3
144	45.5	3	3	3	2	2	3	3
145	17	3	3	3	2	1	3	3
146	22.5	3	3	3	2	1	3	3
147	31	3	3	3	2	1	3	3
148	42.5	3	3	3	2	1	3	3
149	45	3	3	3	2	2	3	3
150	44	3	3	3	2	1	1	3
151	16	3	3	3	2	1	1	3
152	95	2	2	0	1	3	1	2
153	7	2	3	2	2	1	3	2
154	11.5	3	0	3	2	0	3	3
155	46	3	3	3	2	1	3	3
156	39	3	3	2	2	3	1	3
Total Ha	7327	%						
Good	388	5.2955						
Marginal	607.5	8.2913						
Not Rec	5377	73.386						
Unfeas.	954.5	13.027						
	7327	100.00						

Table IV.3c
SESA: Crop Suitability for Potato

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
1	135	3	3	3	1	3	1	3
2	5.5	3	3	2	1	3	1	3
3	22	3	3	3	1	3	1	3
4	38.5	3	3	3	2	3	1	3
5	10	3	3	3	1	3	1	3
6	240	3	3	3	1	2	3	3
7	47.5	3	3	3	1	2	3	3
8	20	2	3	2	1	3	2	2
9	16	2	3	2	1	3	1	2
10	9	3	3	3	1	3	1	3
11	180	3	3	3	1	3	3	3
12	3	2	2	1	1	3	1	1
13	8.5	3	2	2	2	3	1	3
14	9	3	3	2	2	3	1	3
15	7.5	3	3	3	1	3	1	3
16	38.5	3	3	3	3	1	1	3
17	24	3	3	2	3	1	1	3
18	20	2	3	2	3	1	1	2
19	10	2	2	1	1	1	2	1
20	18.5	3	3	3	1	1	1	3
21	18	3	3	3	2	1	1	3
22	11.5	3	3	2	2	1	1	3
23	25	3	3	3	1	1	1	3
24	47.5	3	3	2	1	1	1	3
25	36.5	3	2	2	1	2	1	3
26	220	3	3	3	1	1	1	3
27	21	3	3	3	1	1	1	3
28	53	3	3	3	1	1	1	3
29	12.5	3	2	2	1	3	1	3
30	25	2	3	2	1	3	1	2
31	126.5	3	3	3	1	1	1	3
32	18	3	3	2	1	3	1	3
33	14.5	3	3	3	1	3	3	3
34	54	3	3	2	1	2	1	3
35	49	3	3	3	1	2	1	3
36	45	2	3	1	1	2	3	2
37	24	3	3	3	1	2	1	3
38	28	3	3	2	1	2	1	3
39	31.5	3	3	3	1	1	1	3
40	23	3	3	3	1	2	1	3
41	28	3	3	2	1	2	1	3
42	79	3	3	3	1	1	1	3
43	20	3	3	3	1	1	1	3
44	24	3	2	2	3	3	1	3
45	10	3	3	2	1	3	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
46	44	3	3	2	1	3	1	3
47	43	3	2	2	3	3	1	3
48	26	2	3	2	3	1	1	2
49	27	3	3	3	1	1	1	3
50	7.5	3	3	3	1	3	1	3
51	23.5	3	3	3	1	3	1	3
52	9	0	0	0	1	3	1	3
53	18.5	3	2	2	1	3	1	3
54	33.5	3	3	3	1	3	1	3
55	7	3	3	3	1	3	1	3
56	10	3	3	2	2	3	1	3
57	9	3	3	3	1	1	1	3
58	19	2	2	2	3	3	1	2
59	13	3	3	3	1	3	1	3
60	16	3	3	2	1	3	1	3
61	26.5	3	3	3	1	3	1	3
62	24	3	3	2	1	3	1	3
63	117	3	3	3	1	1	3	3
64	30	3	3	3	0	0	0	3
65	12.5	3	3	3	1	1	1	3
66	102	3	3	3	1	1	3	3
67	14	3	3	2	1	1	3	3
68	91	3	3	3	1	2	1	3
69	135	3	3	2	1	2	1	3
70	21	3	3	1	1	2	2	3
71	5	3	3	3	1	2	1	3
72	23.5	3	3	2	1	2	1	3
73	20	3	3	3	1	1	1	3
74	31	2	3	2	1	2	1	1
75	19	3	3	3	1	2	1	3
76	78.5	2	3	1	1	2	2	1
77	88	3	3	3	1	2	1	3
78	26.5	3	3	2	1	2	1	3
79	15	3	3	3	1	3	1	3
80	3	3	3	3	1	2	1	3
81	410	3	3	3	1	3	3	3
82	42	2	3	2	1	1	1	1
83	48.5	3	3	2	1	1	1	3
84	13	3	3	3	1	1	1	3
85	36	3	3	3	1	3	1	3
86	17.5	3	2	2	2	3	1	3
87	33.5	3	2	2	1	3	1	3
88	127.5	3	3	3	1	3	1	3
89	42.5	3	3	3	1	3	1	3
90	18	3	3	3	3	3	1	3
91	41.5	3	2	2	1	3	1	3
92	50	3	3	3	1	1	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
93	185	2	2	1	1	3	1	1
94	23	3	3	3	1	1	1	3
95	11	3	3	3	1	3	1	3
96	10	3	3	3	1	3	1	3
97	8	3	3	3	1	3	3	3
98	65.5	2	2	2	1	1	1	1
99	18.5	3	3	3	1	3	1	3
100	155	3	2	2	1	3	1	3
101	25.5	2	2	1	1	3	1	1
102	17	3	3	3	1	3	1	3
103	5	3	3	3	1	1	1	3
104	6	3	3	3	1	1	1	3
105	3.5	3	3	3	1	1	1	3
106	59	2	2	3	1	3	1	2
107	96	3	3	3	1	2	3	3
108	11	1	2	1	1	3	1	1
109	51	2	2	1	2	3	1	1
110	10	3	3	3	1	3	1	3
111	46.5	3	3	3	1	3	1	3
112	62	3	3	2	1	3	1	3
113	20	3	3	3	1	1	3	3
114	37.5	1	2	1	3	3	1	2
115	55	2	2	1	2	3	1	1
116	143	2	3	1	1	3	1	2
117	59	0	0	0	0	0	0	3
118	79	3	3	3	1	3	1	3
119	17	2	3	2	1	3	1	2
120	62.5	3	3	3	1	3	1	3
121	75	3	3	3	1	1	1	3
122	20	2	3	2	1	2	1	1
123	47	2	3	3	1	2	3	2
124	12.5	2	3	3	1	2	3	3
125	117.5	2	3	3	1	3	3	3
126	330	3	3	3	1	2	1	3
127	25	3	3	2	1	2	1	3
128	13	3	3	3	1	2	1	3
129	17	2	3	2	3	2	1	2
130	13	3	3	3	1	3	1	3
131	28.5	3	3	3	1	2	1	3
132	18	3	2	3	1	2	1	3
133	16.5	3	0	3	0	2	0	3
134	12	2	2	2	1	1	1	1
135	126	3	3	3	1	1	3	3
136	52.5	3	0	3	0	0	0	3
137	130	3	3	3	1	1	1	3
138	132	3	3	3	1	1	3	3
139	33.5	3	3	2	1	2	1	3

Polygon	Hectare	Slope	Depth	Erosion	Texture	pH	Drainage	Conditions
140	15.5	2	3	2	1	2	1	1
141	280	3	3	3	1	2	3	3
142	22	0	0	3	1	2	3	3
143	11.5	3	3	3	1	2	1	3
144	45.5	3	3	3	1	2	3	3
145	17	3	3	3	1	1	3	3
146	22.5	3	3	3	1	1	3	3
147	31	3	3	3	1	1	3	3
148	42.5	3	3	3	1	1	3	3
149	45	3	3	3	1	2	3	3
150	44	3	3	3	1	1	1	3
151	16	3	3	3	1	1	1	3
152	95	2	2	0	1	3	1	1
153	7	2	3	2	1	1	3	2
154	11.5	3	0	3	1	0	3	3
155	46	3	3	3	1	1	3	3
156	39	3	3	2	1	3	1	3
Total Ha	7327	%						
Good	700	9.5537						
Marginal	498.5	6.8036						
Not Rec	6128.5	83.643						
	7327	100.00						

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