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THE IMPACT OF ACCESS ROADS ON SPONTANEOUS COLONIZATION

CHANE-PIRAY AREA - DEPARTMENT OF SANTA CRUZ

BOLIVIA

by

Thomas C. Royden

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Soil Science and Biometerology

Approved:

UTAH STATE UNIVERSITY
Logan, Utah

1973

ABSTRACT

The Impact of Access Roads on Spontaneous Colonization

Chane-Piray Area

Department of Santa Cruz

Bolivia

by

Thomas C. Royden, Master of Science

Utah State University, 1973

Major Professor: Dr. R. J. Hanks
Department: Soils and Meteorology

Thesis Director: Dr. E. Boyd Wennergren
Department: Agricultural Economics

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(88 pages)

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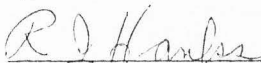
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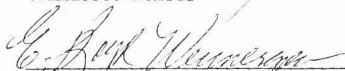
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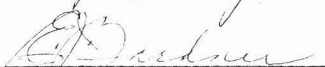
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Tom C. Royden

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ABSTRACT

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INTRODUCTION

Bolivia is the fifth largest country in South America. Its population was estimated to be 4.7 million in 1970. Those classified as non-urban constituted 65% of the total.¹ The overall population density was eleven persons per square mile, but this statistic is misleading because 70% of the population lives on the Altiplano and in the high valleys. Large areas of the lowlands in the Upper Amazon Basin are virtually uninhabited. Highland Bolivia is very poor. In 1969 the per capita income of the rural population was calculated at only \$44 per annum.² The highlands are characterized by a harsh climate, extensively eroded areas and generally depleted soils. In the more favored areas of the valleys there is considerable population pressure on the land. Farming units tend to be small, and crop yields are generally very low.

Lowland Bolivia, isolated from the highlands by extremely difficult mountainous terrain, presents a complete contrast. It is very sparsely populated with population density averaging less than two persons per square mile. The climate is tropical, and much of the land is virgin jungle. The lowlands account for 70% of the total land area (Figure 1), and is the least developed and most isolated region in the country. The agricultural potential of the area has not yet been assessed, but it is considered by Bolivian government officials to possess enormous unused natural resources and to be the last low-cost major unexploited land resource for food production on an international scale in South America.

¹USAID Bolivia, Estadísticas Economicas, No. 13 (1971), page 3.

²Franklin Antezana Paz, "Ingreso anual per capita," Presencia (La Paz, July 12, 1972), page 3.



Figure 1. Physiographic Regions and Political Departments³

³Tennessee Valley Authority, A Fertilizer Program for Bolivia (Alabama, January, 1970), page 6.

Role of Colonization in Bolivian Development Strategy

Until 1952 the government policy on economic development emphasized the mining industry and industrial development in the highlands. After the 1952 revolution, the development of the eastern lowlands received top priority in the development strategy of the country. Since the lowlands were so sparsely populated, agricultural colonization from the highlands was selected to play a key role in development of the region. Colonization was to have three main objectives:

(1) Correct the unequal distribution of rural population with regard to land resources. 85%⁴ of Bolivia's rural population was crowded into the resource poor highlands, while the tropical lowlands comprising 70% of the national territory only had 15% of the rural population.

(2) Diversify and increase agricultural production by promoting the cultivation of tropical and subtropical crops, such as rice and sugar; in order to reduce food imports, diversify exports and increase the national income.

(3) Populate frontier zones and remote areas in order to promote their integration into the national life.

The role of colonization as stated in the government's ten year plan 1961-70⁵ called for the resettlement of 100,000 families and the cultivation of 250,000 hectares of new land in the tropical lowlands.

Between 1954 and 1966 the government selected three regions (Figure 2) to begin the process of colonization: (1) Alto Beni with a connecting

⁴Instituto Nacional de Colonization, Banco InterAmericano de Desarrollo, Programa de Colonizacion Informe Final (La Paz, Bolivia, 1970), page 1.

⁵Republica de Bolivia, Junta Nacional de Planeamiento, Planeamiento (La Paz, Bolivia, 1961), page 164a.

highway to La Paz, (2) Chapare with a new road under construction to Cochabamba and (3) the region to the north of Santa Cruz. Santa Cruz, which had previously been isolated from the rest of the country, obtained a route for marketing its agricultural produce on completion of the paved road from Cochabamba to Santa Cruz in 1956.

Colonization Programs in Bolivia

Directed colonization

The cold arid highlands presented a very different environment to the hot and humid jungles to which the highland Indians were supposed to move. Adaptation of the highland Indians to the tropics was considered an extremely difficult task.⁶ Even the Inca empire, of which Bolivia was a part, never extended into the lowland tropical areas because of the difficulties of health, communications, etc.

In recognition of this very different environment, the first programs of colonization were highly organized. The Cotoca project begun in 1954 in the Department of Santa Cruz under the auspices of the Corporacion Boliviano de Fomento (C.B.F.) and the United Nations provided very comprehensive assistance. Land was cleared in advance for the settlers, and a monthly subsidy, housing, medical attention, credit, technical assistance and community services were provided. This colonization proved extremely expensive (US\$3,350 per family)⁷ and had very poor results. The poor results were due to the dependence of the

⁶Home J. Henney, et al., Report of Santa Cruz Area Development Mission, U.S. Foreign Operations Administration (1954), page 21.

⁷Instituto Nacional de Colonizacion Banco InterAmericano de Desarrollo, Programa de Colonizacion Informe Final (La Paz, Bolivia, 1970), page 2.

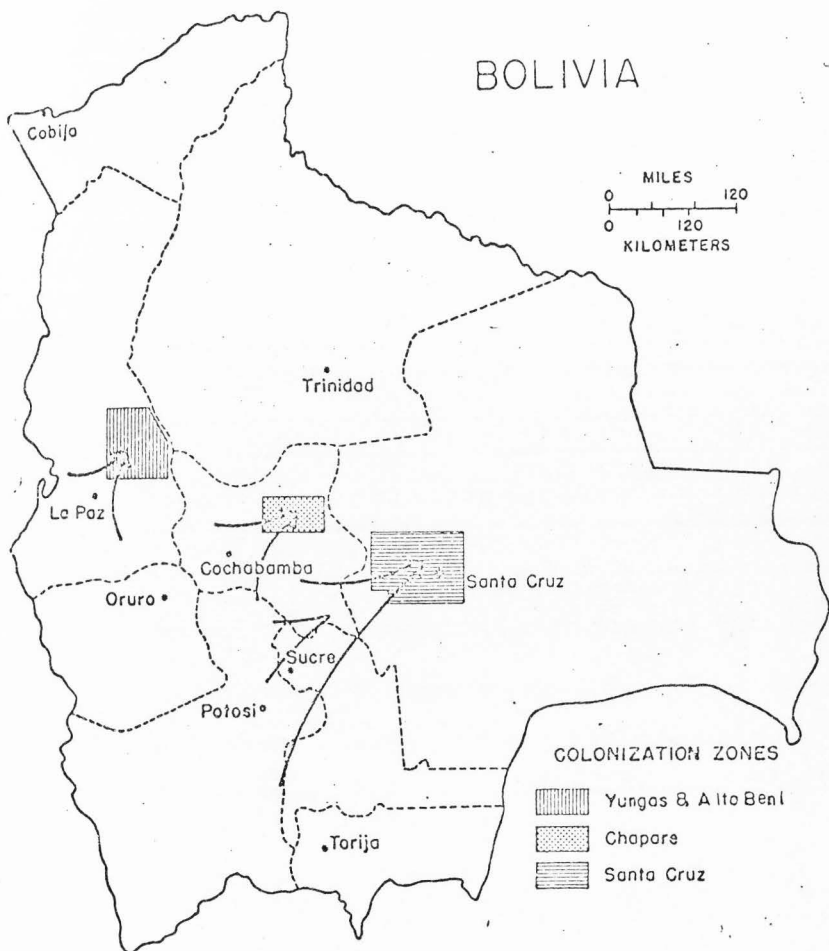


Figure 2. Internal Migration Patterns During Recent Decades, 1972⁸

⁸K. L. Wessel, An Economic Assessment of Pioneer Settlement in the Bolivian Lowlands, Cornell University (1968), page 33.

colonizers on the sponsoring body and excessive paternalism on the part of the project administration.

Colonization with less comprehensive support was tried next. The colonist had to clear his land, build his house and plant his fields, but received land, foodstuffs for an initial period, technical help, seeds, medical care, credit and an infrastructure of roads. The sponsoring agencies were the C.B.F. and the military.

In 1965 the Bolivian government launched its most ambitious colonization program with funds provided by the InterAmerican Development Bank. The plan called for 8,000 families to be settled on 300,000 hectares of state lands in the areas of Alto Beni and Chapare, and the Yapacani Area of Santa Cruz. A loan (51-TF-B0) for US\$6.5 million was to be used for infrastructure projects in the colonization areas as well as to cover the cost of moving the colonists. A complimentary loan (29-5F-B0) for US\$2.6 million was to be used as "start up" production credit to be channeled through the agricultural cooperatives to be formed in the colonization areas. The objectives of the program as stated by the newly created Instituto Nacional de Colonizacion (National Colonization Institute) were similar to those given by earlier planners. However, recognition was given to spontaneous colonization. The objectives were:

- (1) To serve as a pilot project for the transplanting of rural population from the densely populated highlands.
- (2) Increase and diversify the agricultural production of the country.
- (3) Serve as an incentive for the settlement of a large number of spontaneous colonists on land influenced by the government project.

The project is now completed and the final report to the InterAmerican Development Bank shows that directed colonization by the Bolivian government has been an excessively costly method of sponsoring the settlement of the "tropical frontier." Of the 8,717 colonists sponsored by the project, 43% abandoned their land.⁹ The main reasons given for the abandonment were illness, transportation difficulties, bad selection of land, and the desire to escape debts due to the project. The project appears to have suffered from the same evils as earlier directed projects: excessive paternalism, political maneuvering, discontinuity of effort, poor administration, and inadequate technical capability.¹⁰ The average cost of resettling a family under the project was US\$1,605.¹¹ If account is taken of the urgency of moving 100,000 families to the tropical lowlands, it is seen that an investment approximating US\$160 million is totally beyond the economic capacity of the country.

Spontaneous Colonization

One of the results of the various government projects to actively sponsor the movement of population to the tropical lowlands has been a parallel increase in population moving on their own initiative. Spontaneous colonization, which is movement of population without direct government help or stimulus, has developed in those areas where there existed free land of reasonable productivity and some sort of highway or the anticipation of its construction.

⁹Ibid., page 40.

¹⁰Frederick Ziertén, Colonization in Bolivia (Montero, 1971), page 6.

¹¹Ibid., page 32.

In contrast to directed settlement where services such as roads, health, credit and extension were provided to attract settlers, spontaneous colonization only required the building of penetration roads to connect the frontier areas with the highway system. Once access roads connected the new land resources with major urban markets and centers of population pressure, a flow of people and capital to exploit the economic opportunities resulted.

As mentioned previously, the government directed projects have a dismal record with large scale abandonment by settlers and very slow growth in relation to the massive doses of public capital applied. In general, high levels of state involvement in the settlement process seem to have introduced rigidities leading to misallocation of resources. In contrast, spontaneous colonization, which is a direct response by individuals to the economic opportunities offered by quality of natural resources, availability of markets and the viability of agriculture, has shown great flexibility and growth.

In the Department of Santa Cruz since the completion of the Chochabamba-Santa Cruz highway in 1956 (Figure 3) and its extension north to Montero and the potentially rich provinces of Ichilo, Santiesteban and Sara in 1967, between 11,000 and 12,000 families¹² from the highlands have arrived as colonizers. This colonization process has been to a large extent spontaneous (70-80% of all immigrants).

These settlers now make up about 10% of the population of the whole Department and have made a very significant contribution to the economic

¹²Seminario de Ideas y Proyectos Especificos, Comité de Obras Publicas de Santa Cruz, Estrategia para Consolidar las Colonias Campesinas del Interior en el Departamento Santa Cruz (1972), page 1.



Figure 3. The Bolivian Surface Transport Network, 1972¹³

¹³K. L. Wessel, *An Economic Assessment of Pioneer Settlement in the Bolivian Lowlands*, Cornell University (1968), page 23.

development of the region.¹⁴ It is difficult to imagine that the development of Santa Cruz could have been as dynamic as it has been without the contribution of these colonizers opening up new land and creating new settlements and roads; and providing agricultural labor for the expansion of major industries such as sugar cane and cotton. Although the Department has only 6% of the rural population of the country, it already contributes 30% by value of the gross agricultural production and produces 80% of the agricultural exports.¹⁵ Even with this performance the potential of the Department has hardly been scratched. Of the 25 million hectares of potentially arable land available in Bolivia, 40% is found in the Department, and as of 1972 only 180,000 hectares out of a total of 10 million hectares were under cultivation.

Although the government had intended that its directed colonization project should serve as an incentive to spontaneous colonizers, it was caught unprepared and without funds, studies, technicians and "know-how" to face this massive movement of people to the new frontier.

Disadvantages of spontaneous colonization

Social and political problems

The sustained and massive flow of rural population from the highlands to Santa Cruz may have been of considerable benefit to the country and in particular to the Department of Santa Cruz, but it has also created some significant social and political problems.

¹⁴Dr. Ing. P. Dante Invernizzi, Proyecto Capacitacion de Colonos, Seminario de Ideas y Proyectos Especificos, Comite de Obras Publicas de Santa Cruz (May, 1972), page 2.

¹⁵Jose Romero Loza, Politica Agricola, Seminario de Ideas y Proyectos Especificos, Comite de Obras Publicas de Santa Cruz (1972), page 14.

Since no government assistance for roads, medicine, water supply, etc., was initially available and the new colonists had very meager financial resources, their living conditions were deplorable. Their health was often badly affected by tuberculosis, internal parasites, tropical diseases and protein calorie deficiency. Not surprisingly, infant mortality rates were over 300 per 1,000.¹⁶ Due to isolation, lack of credit, ill-health, lack of experience with tropical agriculture and chaotic crop marketing conditions, the settler's economic progress has often been very slow. In resentment against the social sacrifice endured and the lack of government concern, extreme left-wing organizations such as UCAPO (Union de Campesinos Pobres) were formed and took such radical action as putting up road blocks, holding government officials captive and taking over the haciendas of large landowners (Chane Bedoya). The colonization areas are regarded at present by government officials¹⁷ as potential focuses for guerrilla activity because of the social deprivation experienced by the colonists.

Destruction of resources

The colonist, being limited to hand labor, uses slash and burn techniques to bring the jungle land into production. Rice is the principle crop grown because it has a guaranteed government support price and gives a quick cash return for the new colonist with its short growing season. Unfortunately, dryland rice is very sensitive to weed competition. This results in a costly cycle where yields decline and labor demands for

¹⁶Montero Community Health Project, Rural Health Services for Colonies, Northern Provinces of Santa Cruz (Montero, Bolivia, 1971), page 3.

¹⁷Widen Razuk Abrene, "Mensaje del Prefecto de Santa Cruz," Presencia (La Paz, Bolivia, August 18, 1972), page 10.

weed control rise after the second year. To keep farming the same land, the farmer must change to permanent crops such as sugar cane, bananas and pasture, or resort to chemicals and mechanized farming. None of these alternatives are open to the spontaneous colonizer because of lack of capital and credit; so he moves on to clear another small area. By using hand methods, the individual farmer is never able to cultivate more than 2 to 4 hectares at one time. The results of this situation are the following:

- (1) Low productivity.
- (2) Low income.
- (3) Low rate of savings and reinvestment.
- (4) Abandonment of homesteads when all the high forest is cleared.
- (5) Instability in community formation and development.

According to studies by the Food and Agricultural Organization of the United Nations (F.A.O.) experts, 100-120,000 hectares¹⁸ of valuable virgin forest are being destroyed each year in Bolivia. The dynamic energy of the settlers has already resulted in unrestricted encroachment into forest areas. There exists the great threat that these pioneer families trapped in a position of subsistence farming on a nomadic basis will cause degradation of wide areas of potentially very fertile land. This degradation of the land by clearing through cutting and burning and later abandonment causing the so-called "hollow frontier" has already reached frightening proportions in some areas of Santa Cruz.

Present situation

Spontaneous colonization has become so popular that many would-be settlers are pressing forward on their own initiative. The acceptance

¹⁸"Destruccion de la Cobertura Forestal," Panorama, Edicion 33 (Santa Cruz, Bolivia, 1972), page 2.

of this stream of immigrants requires the provision and opening up of additional reception areas. A clear decision by the government on the role that these spontaneous colonizers are to be expected to play in the national economy must be made. Already considerable dislike and resentment against the highland colonizers has been generated in Santa Cruz among the local population.¹⁹ However, for all the current problems if managed and directed with imagination the process of moving people to the resource rich lowlands, that started as an expensive and not very successful government initiative, can become a self-sustaining spontaneous movement and potent force in Bolivia's development.

¹⁹Widen Razuk Abrene, "Mensaje del Prefecto de Santa Cruz," Presencia (August 18, 1973), page 10.

OBJECTIVES OF THE STUDY

Since spontaneous colonization implies only nominal participation of government in the settlement process, little is known by government about the conditions of the settlers. Political demonstrations by the colonists from time to time drew attention to their plight, but little has been done to help them.

In order that government may be able to manage and direct spontaneous colonization for the greatest benefit of all concerned, an understanding of the economics of this type of development should be obtained. The specific objectives of this study were to assess:

- (1) The viability of the agriculture practiced by spontaneous colonists in the region of Santa Cruz.
- (2) The impact of spontaneous colonization on agricultural production and employment generation in the area.
- (3) The economic return to public investment in infrastructure in support of spontaneous colonization.
- (4) The social and economic conditions of the colonists.
- (5) The long-run implications of present trends in the area.
- (6) The policy implications for the government concerned with encouraging economic development on the one hand and wise use of resources on the other.

SETTING OF THE STUDY

Brief History of the Road

The area selected for study was the Chane-Piray region north of Santa Cruz (Figure 4). Aerial photographs taken in 1964 show the area from Chane to Piray to be entirely covered by high forest except for one isolated ranch. In the same year the Gulf Oil Company pushed through an oil exploration track. A very small trickle of colonists then began to occupy land along the track and cut down the forest.

In 1966 with the prospect of imminent completion of the paved road north from Montero to Cuatro Ojitos, and thus a link to Santa Cruz and the national market, more colonists started to push north along the oil exploration track that had been partially kept open by loggers extracting the rich mahogany reserves of the area. In 1967 and 1968 the various colonies organized into sindicatos or farmer's unions for the purpose of getting title to their land. By 1969 the colonists were sufficiently organized and had enough agricultural production for sale that it became an urgent necessity to improve their access road, which was impassable to motor traffic most of the year and which caused them great hardship, isolation, and loss of sales.

Each colony took responsibility for their particular stretch of the road. The sindicatos in the area between San Pedro and Hardeman (Figure 4) collected \$b100 from each colonist (if the colonist did not pay, he was threatened with loss of his land) and with a total of \$b47,000 on their own initiative hired two D-8 bulldozers from a road contractor

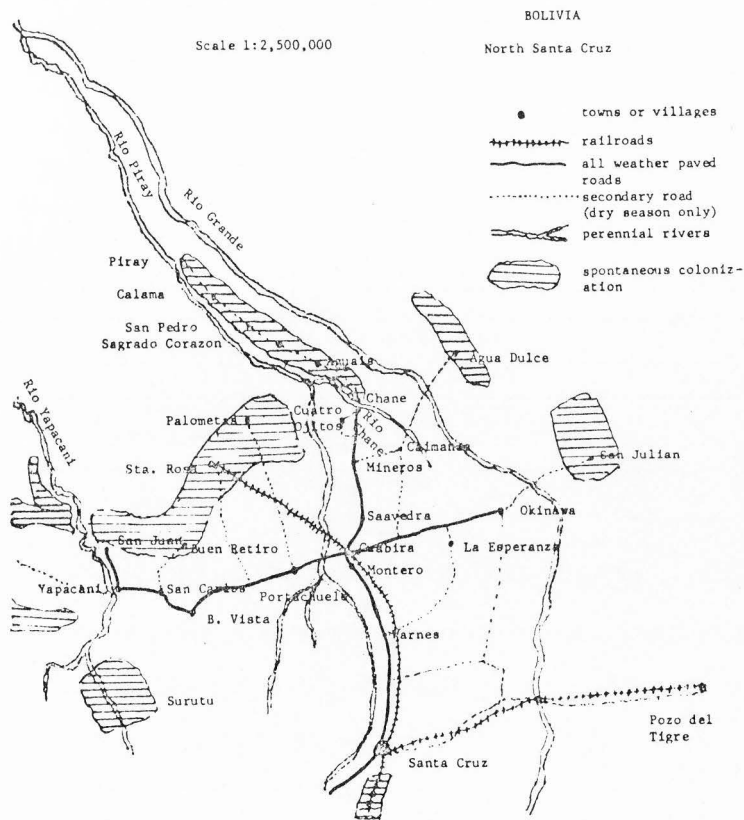


Figure 4. Relationship of Spontaneous Colonization Areas to Transport Facilities, Northern Santa Cruz, Bolivia, 1972

(Bartos Cia) to build up the road platform. All colonists in the area (540 turned up) had to give two weeks of free work. Their work was to chop down the forest in front of the bulldozers. Due to astute public relations and political pressure by the colonists on a sympathetic government, the Servicio Nacional de Caminos (National Road Service) provided a survey team to select the best alignment for the road, and finally a motor grader to smooth off the work of the bulldozers. The road work was finished in January, 1971. Maintenance of the road since then has been done on a community basis. However, the road has deteriorated badly through use by loaded trucks when wet and in many places can be described as little more than a canal in the wet season and a trench in the dry season.

Reasons for Selection of the Road

The road from Chane to Piray was chosen for the following reasons:

(1) The soils of the area being opened up are some of the richest in Bolivia.²⁰ The fertility of the soils gives every chance for the establishment of a permanent agricultural system rather than a nomadic slash and burn system, if the inputs of technology and capital become available at the right time.

(2) The area is representative of almost 1,000,000 hectares of top quality land on the east bank of the Rio Grande (Figure 4) which is still almost totally unoccupied and has been completely inaccessible by road. The area, however, is now being opened up by the government for settlement.

²⁰T. T. Cochran, A Land System Map of Central Tropical Bolivia, Ministry of Agriculture, Bolivia-British Agricultural Mission (Santa Cruz, Bolivia, 1967), page 80.

Little more than access roads, wells for water supply and medicines are being promised by the government in this recently initiated low-cost, semi-directed project.²¹

(3) The area has been opened up entirely by spontaneous settlement. The only assistance given by government, under mounting pressure from the established settlers, has been the drilling of artesian wells for water supply, assistance in improvement of the access road, and the supply of teachers and health workers for the schools and dispensaries built by self help.

(4) The access road runs down the middle of a long tongue of good quality land that is surrounded by the swamps of the Rio Grande to the east and the swamps of the Rio Piray on the west (Figure 5). This isolation provides a hinterland area with no interference from other access roads.

Also, since the tongue of land is never more than 15 kilometers and in most places only 10 kilometers across, most farms are very close to the access road. This means that a one dimensional rather than two dimensional model demonstrates the effect of deteriorating transportation facilities along the road.

²¹Instituto Nacional de Colonizacion, Proyecto de Colonizacion San Julian (La Paz, Bolivia, 1971).

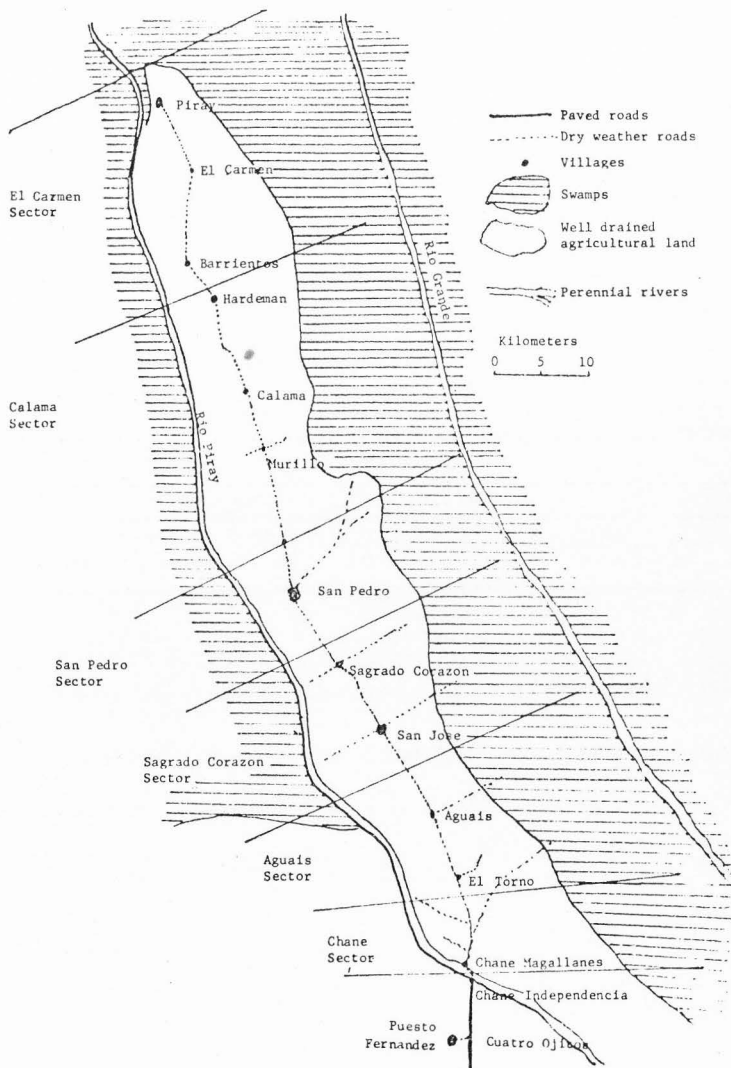


Figure 5. Access Road Chane-Piray Area, Department of Santa Cruz, Bolivia, 1972

DATA COLLECTION AND PROCEDURE

Use of Aerial Photography

Because no records were in existence except the aerial photographs taken in 1964, and a scattered settlement pattern made sampling on the ground difficult, it was decided to take aerial photographs of the area. The use of aerial photographs for providing some of the initial data needed has many attractive features. A large area can be photographed quickly and photographs will show details exactly as they appear on the ground. In locations such as the flat Santa Cruz lowlands where photographic scales are not appreciably altered by topographic changes, areas can be measured directly on contact prints with considerable accuracy.²²

Accordingly, the area was flown and photographed by the Bolivian Air Force on Monday, June 19, 1972, at a scale of 1:30,000. This scale was later checked on the ground. This scale gives enough definition on the photographs for the hectareages of the more important crops and different vegetation types to be recognized and totaled. A mosaic of the photographs was prepared for the total length of the road.

Calculation of Areas of Crops and Vegetation Types

The device used for determining areas on the aerial photographs was a dot grid. A dot grid is a transparent overlay with dots systematically

²²U. S. Department of Agriculture, Forest Service, "Forester's Guide to Aerial Photo Interpretation," Agriculture Handbook, No. 308 (Washington, 1969).

arranged on a grid pattern. In use, the grid was aligned with a straight-line feature (the road) to avoid position bias and then dots were tallied for each crop and vegetation type. Type areas were calculated by proportions, i.e., the number of dots of a given type divided by the total number of dots counted yielded a percentage value that was multiplied by the total area to obtain the hectareage of each type. Initially nineteen separate areas were measured. For convenience in the final analysis, the various areas that showed common features were amalgamated into six sectors along the length of the road. The proportions of the various crops and vegetation types were then calculated for each sector.

Use of Data from Aerial Photographs

The data from the aerial photographs were then combined with results from the field study made between April and July, 1972, in the project area and used to calculate the following:

- (1) Total land area under cultivation.
- (2) Gross regional agricultural production.
- (3) Total number of beneficiaries.
- (4) Increase in employment.
- (5) Total public investment.

In order to clarify the economic factors operating along the Chane-Piray road, complimentary socio-economic data were collected. In addition, four communities on which economic data were available were selected to illustrate the change in economic conditions with deteriorating transportation facilities along the road.

RESULTS OF THE STUDY

Crops Grown in the Area

The climate of Santa Cruz is suitable for a wide range of tropical and sub-tropical crops. Unfortunately, markets do not exist for most of the crops that could be grown by the colonists. The domestic market is small and can easily be saturated by minor increases in production. Due to the high cost of transport, exports of agricultural products (cotton excepted) are not competitive with alternative sources of supply in neighboring countries. The spontaneous colonizers, being at the "frontier" or extreme end of the road network and being served by a chaotic, inefficient and exploitive marketing system, find themselves at a distinct disadvantage when competing in the domestic market.

Rice

As part of the program for national self-sufficiency in food production guaranteed prices have been given by the government for rice. Attracted by the stable price, spontaneous colonizers have become major producers of rice. The particular advantages of rice for the colonist are that it can be produced with hand labor (his major resource), requires simple technology, gives a quick return, and has a guaranteed market.

Sugar Cane

Sugar cane, the second crop with a guaranteed price, also has the advantages of using large quantities of hand labor and simple technology. However, the crop cycle is much longer (five years) and requires a much greater capital investment. Until 1970, the quotas for delivery of cane

to the sugar mills were controlled by the large cane growers (Federacion de Canieros) and considerable pressure was used to keep the small producers out of the industry. Since 1970 and the drastic reduction in sugar production which necessitated imports from Brazil, the quota system has been abolished.

The reduction in sugar production was in large part due to the large growers taking their land out of cane and putting it into more profitable cotton production. This abolishment of the cane quota system has allowed the longer established colonists with a better location near access roads to rapidly expand their cane plantings. Sugar cane profitability, however, is extremely sensitive to transport costs as will be shown later and becomes an alternative to rice production only in the best locations.

Bananas

Of the crops that do not have a government support price, bananas are well adapted to peasant production if the physical growing conditions are suitable. In the area studied, rainfall and soil conditions provide high yields of good quality. The problem is marketing the crop. Bananas are extremely perishable, unlike the alternative crop, rice, that can be stored for months as rough or unhusked rice. When bananas are mature they must be marketed immediately. Banana production is, therefore, sensitive to the reliability and regularity of transport services.

Maize and other crops

Maize is another crop that yields well and in the area studied can give two harvests per year. Unfortunately, the marketing situation is very chaotic with prices moving through wild swings. In two weeks in Santa Cruz in 1971, the price dropped from \$b30 to \$b17 per quintal. In

April, 1972, maize was selling for as low as \$b8 per quintal in Montero, the main service town for the colonists. Along the access road colonists claimed that their harvest costs were \$b6 per quintal and that transport to Montero cost \$b4 per quintal. Many of the farmers did not intend to plant maize again except for their home needs. The same story of glut or famine can be repeated for such crops as potatoes, yuca and citrus which are mainly grown for home consumption because of the difficulties of marketing.

Analysis of the Aerial Photographs and Changes in Land Use

As can be expected from the above discussion, analysis of the aerial photographs showed that only rice, cane and bananas were grown in commercial quantities during the 1971-72 rainy season. Little evidence was found of the sizeable maize plantings reported for 1970-71²³ in the area. For the purposes of analysis, the small areas of maize, potatoes, yuca, and citrus planted for home consumption were ignored.

The percentages of scrub regrowth and high forest were included in the analysis because they showed firstly the intensity of land use, and secondly the dangers inherent in nomadic "slash and burn" cycles of rice growing where high forest had to be continually cut down to replace weed infested rice land. The ratio of the two percentages, in areas of rice monoculture, was an indication of how soon the colonists would run out of high forest and be forced to move on to look for new land to repeat their destructive cycle.

²³Kenneth Graber, La Vida Agricola en las Colonias, Comite de Obra Rural, Distrito Oriental Iglesia Evangelica Metodista en Bolivia (1972), page 15.

Changes in land use patterns

From analysis of the aerial photographs, the road was divided into six representative sectors. As a control or basis for comparison, a seventh analysis was made at Cuatro Ojitos three kilometers before the end of the paved road. This seventh analysis was included because the colony was founded at a much earlier date (1956). It was considered that land use patterns would be a function of both length of time of settlement and quality of transportation facilities. The particular area chosen at Cuatro Ojitos for analysis had the same level of fertility as land along the access road studied.

Land use patterns were found to change quite rapidly as transport distances increased and roads deteriorated, Table 1, page 26.

Sugar cane

As can be noted, commercial sugar cane production extends for 14 kilometers down the access road. The area is known to produce extremely high yields of sugar cane both because of its well distributed rainfall and its rich alluvial soils. Yields in excess of 70 tons of cane per hectare are spoken of as common place. In comparison, the average national yield for 1970-71 was only 24 tons per hectare. Many colonists further down the road show great interest in growing cane now that the quota system has been abolished. However, when the transport costs involved are examined, Table 2, page 27, it is seen why the greater distance discourages sugar cane production. Transportation costs at the most distant grower sites could reach as much as 65% of the total value of the cane delivered to the mill.

Table 1. Percentage of Each Sector in Different Uses, Chane-Piray Area, Bolivia, 1971-72

		(1)	(2)	<u>Sector</u> (3)	(4)	(5)	(6)
	Cuatro Ojitos	Chane	Aguais	Sagrado Corazon	San Pedro	Calama	El Carmen
Year Settled	1956	1965	1965	1966	1966	1967	1970
Distance from paved road in kilometers	-----	0-6	6-14	14-26	26-34	34-65	65-85
<u>Land Use (%)</u>							
Sugar Cane	35.2	20.1	9.2	-----	-----	-----	-----
Bananas	2.3	8.7	12.5	2.6	0.7	0.3	-----
Rice	1.0	4.9	14.0	16.3	12.2	7.5	1.3
Scrub Regrowth	49.9	40.5	26.2	60.3	50.9	22.5	2.2
High Forest	<u>12.6</u>	<u>25.8</u>	<u>38.1</u>	<u>20.8</u>	<u>36.2</u>	<u>69.7</u>	<u>96.5</u>
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 2. Cost of Transport in Sugar Cane Production, Chane-Piray Area, Bolivia, 1972

Sector	Distance from Guabira Sugar Mill Kms ^a	Distance from Paved Road Kms	Percent of Sector in Sugar Cane	Value of Cane at Mill \$b/Ton	Average Transport Costs to Sugar Mill \$b/Ton	Cost of Transport as a % of Price Received by Grower at Mill
Chane	42-48	0-6	20.1	90	35	38%
Aguais	48-56	6-14	9.2	90	45	50%
Sagrado Corazon	56-68	14-26	----	90	59 ^b	65%

^aKms or kilometers.

^bExtrapolated from cost for other sectors.

Bananas

Bananas are bought on the farm by independent truck owners either on their own account or for fruit merchants in Montero, Santa Cruz or Camiri. When the trucks can pass along the access road during a dry spell, the price paid for bananas is \$b2 per stem. Distance from the paved road seems to make no difference in the price paid. Once the weather deteriorates and the road becomes a quagmire, truckers are extremely cautious about venturing down the road in case they get stuck in deep "mud holes" and waste three or four days in digging themselves out. With fruit maturing and few truckers daring to venture down the road, the price of bananas drops rapidly. Colonists are happy to accept \$b.50 per stem. Those farthest down the road have the least chance of concluding a sale.

Banana production is not as commercially attractive as sugar cane production, but is still a lot more attractive than growing rice (see

Table 4, page 30). It has the great advantage that the crop can be used to follow two years of rice instead of abandoning the rice land to weeds and scrub regrowth. This means that the expenditure of clearing high forest for producing rice for only two or three years is not wasted as in the "rice only" cycle where the land reverts to scrub. Since bananas can be considered a tree crop with more flexibility in timing of cultural operations, its cultivation allows good use to be made of family labor during slack times in the agricultural year.

Banana production also provides a more permanent agricultural base which the colonist can use to step out of the cycle of nomadic rice cultivation discussed previously. It gives the colonist a chance to establish a more permanent agriculture and start to accumulate capital. Table 1, page 26 illustrated that as cane production becomes progressively more uneconomical because of high transportation costs, it is replaced by banana production.

Banana production reaches a peak in the Aguais sector which is only 6-14 kilometers from the end of the paved road. Production then drops rapidly because of the increased unreliability of transport to collect the mature fruit.

Rice

As has been discussed previously, rice production plays a very important part as the principle cash crop during the initial years of the spontaneous colonist while he is trying to establish himself. Apart from its advantages of a guaranteed market, short growing cycle, etc., it can also be stored for considerable lengths of time after harvest as rough or unhusked rice without serious deterioration. This allows considerable time flexibility for the access road to dry out so that trucks can enter

and transport the rice for marketing. Also, rice profitability is relatively less sensitive to increases in transport costs due to distance from the market at the rice mill (Table 3, below). Transportation costs were found to vary from 6% to 12% of the total value of the rice at the mill.

Table 3. Farm Gate Value of Rice and Transportation Costs, Chane-Piray Area, Bolivia, 1972

Sector	Value of Rough Rice at Mill per Fanega ^a \$b	Incidental Delivery Costs Fanega ^b \$b	Transport Costs to Santa Cruz per Fanega \$b	Farm Gate Value per Fanega \$b	Cost of Transportation as % of Price Received by Farmer at Mill
Chane	161	9	11	141	6%
Aguais	161	9	11	141	6%
Sagrado Corazon	161	9	12	140	7%
San Pedro	161	9	14	138	8%
Calama	161	9	16	136	9%
El Carmen	161	9	20	132	12%

^aOne fanega is equivalent to 384 pounds rice in hull.

^bIncidental delivery costs per fanega:

Four sacks at \$b5 usable for three years	\$b7
Unloading truck at \$b1 per fanega	1
Drying rice in hull on drying floor	<u>1</u>
Total	\$b9

Certainly, compared to sugar cane and banana production, rice is the obvious choice where transport facilities are minimal. It is no coincidence that it is "the" pioneer crop. As will be noted in Table 1, page 26, rice grows in importance as one goes down the access road and transport facilities deteriorate.

Net return to land and management

To get an understanding of the importance of location on the relative profitability of various crops and the reasons for the rapid changes in land use patterns described previously, the return to land and management has been calculated for each crop (Tables 30 to 32, pages 78 to 80). These tables are summarized below in Table 4. The extremely large differences in return per hectare to land between the beginning and the end of the road can be viewed as an economic return or rent due to location. This return to location would be expressed in rents or capitalized into sale value of land given a functioning land market in the area.

Table 4. Net Return to Land and Management for Various Crops, Chane-Piray Area, Bolivia, 1971-72

Sector	Distance From Paved Road Kilometers	Sugar Cane \$/Hectares	Bananas \$/Hectares	Rice \$/Hectares
Chane	0-6	1332	363	333
Aguais	6-14	832	363	333
Sagrado Corazon	14-26	132	230	323
San Pedro	26-34	----	142	311
Calama	34-65	----	142	283
El Carmen	65-85	----	---	243

Scrub regrowth and high forest

The significance of the percentages of scrub regrowth and high forest in the various sectors in Table 1, page 26, is that they give an indication

of how much of the original asset, the fertility of the high forest, is still available to the colonist. Where rice cultivation is practiced almost exclusively, such as in the sectors of Sagrado Corazon and San Pedro, the percentages give an indication of how far advanced is the cycle of "slash and burn" cultivation. The sector of Sagrado Corazon is particularly noticeable in that 80% of the high forest has been destroyed and that 60% of the land area has already been abandoned to scrub regrowth, while closer to the paved road the sectors of Chane and Aguais only show percentages for land abandoned to scrub regrowth of 40% and 26% respectively. The stabilizing effect of perennial crop production of sugar cane and bananas is very obvious.

If consideration is given to the fact that rice production only reached sizeable proportions in 1968-69, it will be seen that it is not unreasonable to suggest that by 1974-75 all high forest will have been eliminated in the sectors of Sagrado Corazon and San Pedro. Once the high forest is eliminated, rice production in the weed infested scrub regrowth will become uneconomical and most colonists will be forced to abandon their land, homes and communities and move on to look for new land with unrestricted high forest to devastate. A cycle that the Bolivian government cannot allow to expand and proliferate with all its attendant social instability, misery, and destruction of valuable forest resources. The alternatives available to the Bolivian Government to break the nomadic rice cycle are discussed in a later section.

Economic Balance Attributed to Development
of the Chane-Piray Area

Farm gate value of regional agricultural production marketed

The farm gate value per hectare for each crop was calculated from production figures quoted as being average for the area both by colonists interviewed and by agricultural extension officials responsible for the area. Transport costs were subtracted in the case of sugar cane (Table 2, page 27) and rice (Table 3, page 29). The total area of each crop for each sector was found by multiplying the percentages for the sector (Table 1, page 26) by the total area of the sector measured by planimeter (Table 5, page 33). The farm gate value per hectare for each crop was then multiplied by the different hectareages to give a value for the total number of hectares (Table 6, page 34). A global value for the farm gate value of the regional agricultural production marketed in 1971-72 is \$b14,230,918. The assumption was made that the conservative yield figures used in Table 6, page 34, allowed for a small part of the crop to be used for home consumption. Most of the colonists are from the highlands where maize and potatoes are the favored staple foods. Even though they grow bananas and rice commercially, these foods only make up a small part of their diet.

Employment generation

In 1960 the United Nations estimated that about 40 percent of the labor force of South America was either unemployed or underemployed.²⁴

²⁴William C. Thiesenhusen, "Latin America's Employment Problem," Science, Volume 171 (March 5, 1971), page 868.

Table 5. Percentage and Area of Each Sector in Different Uses, Chane-Piray Area, Bolivia 1971-72

	(1)		(2)		(3)		Sector (4)		(5)		(6)		Total
	Chane		Aguais		Sagrado Corazon		San Pedro		Calama		El Carmen		
Distance from Paved Road	0-6 Kms ^a		6-14 Kms		14-26 Kms		26-34 Kms		34-65 Kms		65-85 Kms		
<u>Land Use</u>	<u>%</u>	<u>Ha^b</u>	<u>%</u>	<u>Ha</u>	<u>%</u>	<u>Ha</u>	<u>%</u>	<u>Ha</u>	<u>%</u>	<u>Ha</u>	<u>%</u>	<u>Ha</u>	<u>Ha</u>
Cane	20.1	1,090	9.2	833	-----	-----	-----	-----	-----	-----	-----	-----	1,923
Bananas	8.7	472	12.5	1,131	2.6	237	0.7	54	0.3	55	-----	-----	1,949
Rice	4.9	266	14.0	1,267	16.3	1,485	12.2	947	7.5	1,367	1.3	177	5,509
Regrowth	40.5	2,198	26.2	2,371	60.3	5,494	50.9	3,954	22.4	4,083	2.2	297	18,397
High Forest	25.8	1,400	38.1	3,448	20.8	1,895	36.2	2,812	69.7	12,704	96.5	12,868	35,127
Total	100.0	5,426	100.0	9,050	100.0	9,111	100.0	7,767	100.0	18,209	100.0	13,342	62,905

^aKms or kilometers.

^bHa or hectares.

Table 6. Farm Gate Value of Crops Marketed, Chane-Piray Area, Bolivia, 1971-72

	(1) Chane	Sector						(4) San Pedro	(5) Calama	(6) El Carmen	Total			
		(2) Aguais	(3) Sagrado Corazon											
Distance from Paved Road	0-6 Kms ^a	6-14 Kms	14-26 Kms		26-34 Kms		34-65 Kms	65-85 Kms						
Land Use	<u>Ha</u> ^b	<u>Value</u>	<u>Ha</u>	<u>Value</u>	<u>Ha</u>	<u>Value</u>	<u>Ha</u>	<u>Value</u>	<u>Ha</u>	<u>Value</u>	<u>Ha</u>	<u>Value</u>	<u>Ha</u>	<u>Value</u>
Cane ^c	1,090	2,997,500	833	1,874,250	-----	-----	-----	-----	-----	-----	-----	-----	1,923	4,871,750
Bananas ^d	472	416,304	1,131	997,542	237	209,034	54	47,628	55	48,510	---	-----	1,949	1,719,018
Rice ^e	<u>266</u>	<u>375,060</u>	<u>1,267</u>	<u>1,786,470</u>	<u>1,485</u>	<u>2,079,000</u>	<u>947</u>	<u>1,306,860</u>	<u>1,367</u>	<u>1,859,120</u>	<u>177</u>	<u>233,640</u>	<u>5,509</u>	<u>7,640,150</u>
Total	1,828	3,788,864	3,231	4,658,262	1,722	2,288,034	1,001	1,354,488	1,422	1,907,630	177	233,640	9,318	14,230,918

^aKms or kilometers.

^bHa or hectares.

^cYield estimated at 50 tons/Ha valued at \$b90/ton delivered at Guabira sugar mill.

^dYield estimated at 24,000Kgrs/Ha valued at \$b1 per 60 lbs bunch giving a farm gate value of \$b882 per hectare.

^eYield estimated at 10 Fanegas of rough rice/Ha valued at \$b161/Fanega of rough rice delivered at Sant Cruz rice mills.

The unofficial figure for Bolivia's unemployment and underemployment rate was stated as being as high as 50% of the work force in 1972.²⁵ Because of the restricted opportunities in the overpopulated and resource poor highlands, the rural population has been moving into the cities. The shanty towns that are found on the outskirts of La Paz, Cochabamba and Santa Cruz are a symptom of this migration. When these rural migrants arrive in the towns they have no training or skills to help them find employment. Even if these rural migrants could be trained, the local manufacturing industries would not be able to expand sufficiently to absorb them. The rural poor arriving in the towns constitute a highly volatile and unstable element in the urban and national political scene. It could be argued that a considerable part of Bolivia's political instability can be blamed on the festering problem of the urban unemployed. Anything that the Bolivian government can do to keep these people on the land rather than flooding into the cities would reduce the social costs and maladjustments related to premature migration.

A positive value could be put on keeping the rural poor underemployed in the countryside rather than totally unemployed in an urban setting with the attendant high social costs. An alternative solution could be to encourage the rural poor to immigrate to the lowlands to put idle land and labor into productive use. Spontaneous colonization provides an extremely useful and low cost safety valve to the government for the problem of rural population growth and increased lack of opportunities that would otherwise force a flood of rural unemployed to the towns to look for economic opportunity. The Bolivian government's problem is to ensure

²⁵"Foreign Investors Show More Interest in Bolivia," Times of the Americas (November 15, 1972), page 6.

that spontaneous colonization offers sufficient economic opportunity through development of markets for agricultural production so that the colonization option is selected.

The contribution of development of the Chane-Piray Area to employment generation of 4.530 man/years of full-time employment in 1971-72 is given in Table 7, page 37.

The increase in average size of holding for areas further down the road and settled later in time, noted in line 2, Table 7, page 37, is due to the fact that the maximum land entitlement authorized by the agrarian reform law was increased from the original 30 hectares to 50 hectares.²⁶ This change was made because the "rice only" cycle requires much larger quantities of land.

As will be noted in Table 7, page 37, no data was available for the El Carmen sector, because the land has only recently been allocated and colonists were just starting to move in. From the beginning of the access road to the sector of Calama, all land that is suitable for cultivation (not subject to flooding) has been allocated.

As will be noted from Table 7, page 37, the use of hired labor is surprisingly high. The ratio of hired labor to total labor used in production ranging from 1:2 for Chane and Aguais to 1:3.5 for Calama is a useful index of colonist involvement and integration into the wider economy. The high use of hired labor shows how strong the orientation of the colonist is to the money economy. Most of the labor is hired for either the two months of the rice harvest or the three months of the sugar cane harvest. Each colonist will have up to five laborers working for

²⁶Abraham Maldonado, Derecho Agrario (La Paz, Bolivia, 1956), page 331.

Table 7. Employment Generation, Chane-Piray Area, Bolivia, 1971-72

	Chane	Aguais	Sagrado Corazon	San Pedro	Calama	El Carmen	Totals
Total Areas of Sector Ha	5,426	9,050	9,111	7,767	18,209	13,342	62,905
Average Size of Holding Ha ^a	22 ^b	22 ^b	22	33	33	no data	-----
Number of Holdings	246	411	414	235	551	no data	1,857
Average Labor Use per Holding Family Labor ^c Man/Years	1.41 ^d	1.41 ^d	1.31	1.31	1.24	no data	-----
Average Labor Use per Holding Hired Labor ^e Man/Years	1.46 ^f	1.46 ^f	1.44	0.84	0.48	no data	-----
Average Total Labor Use Man/Years	2.87	2.87	2.88	2.14	1.72	no data	-----
Net Increase in Employment Man/Years	706	1,179	1,192	505	948	no data	4,530

^aKenneth L. Braber, *La Vida Agricola en las Colonias*, Comite de Obra Rural-Distrito Oriental Iglesia Evangelica Metodista en Bolivia (Montero, 1972), pages 44 and 45.

^bExtrapolated from data for Sagrado Corazon. The Chane and Aguais sectors have many holdings of larger commercial farmers. These holdings are, however, balanced by the large number of small holdings noted in the aerial photographs.

^cIbid., page 76.

^dExtrapolated from data for Cuatro Ojitos.

^eIbid., page 76.

^fExtrapolated from data for Cuatro Ojitos.

him during this period. The laborers are often recruited from the colonist's home village in the highlands. This period of work as a contract harvester provides a very useful exposure for the future colonist to the problems and advantages of settling in the tropical lowlands. The strong demand for government to open up new areas for settlement is a demonstration of the success of this exposure.

Economic Return to Public Investment in Infrastructure

Public investment

Although access roads may be the principle stimulus to settlement and development of new lands, services such as medical assistance, schooling, water supply, credit and extension are needed for the original settlement gains to be consolidated. These services should be provided in response to the demands of settlers as channels develop for their needs to be articulated.

In this study only government expenditure on road work, medical assistance, schooling and water supply has been collected (Table 8, page 39). No account has been taken of agricultural extension work or credit extended since no credit was granted for rice production in 1971-72 as a matter of government policy because of rice surpluses. Extension workers are only rarely able to reach the Chane-Piray area due to lack of money to pay for their travel and because of the pressure to serve commercial farming interests located closer to Santa Cruz.

Road construction

Due to greater priority in other areas of the economy, the standards for farm to market roads in Bolivia are very low. In the tropical lowlands roads, with the road platform built up from soil excavated from the

Table 8. Public Investment: Annual Equivalent Costs, Chane-Piray Area, Bolivia, 1972

		Annual Equivalent Costs
<u>Road Construction</u>		
Survey for road alignment September 1970	\$b 10,146	
Road construction personnel November - December 1970	20,977	
Total construction costs amortized for 20 years at 15%	<u>39,658</u>	
Total road construction	\$b 70,781	\$b 11,304
<u>Water Supply</u>		
Well drilling for drinking water 11 wells of 4 inch diameter September 1968	\$b269,108	
4 wells of 6 inch diameter August 1970	<u>134,250</u>	
Total drilling costs amortized for 25 years at 15%	\$b403,358	62,399
<u>Ministry of Health</u>		
Maintenance of 2 dispensaries 2 doctors @ \$b32,500 per year	\$b 65,000	
4 nurses @ \$b10,200 per year	40,800	
Equipment and drugs	<u>60,000</u>	
Total annual costs	\$b165,800	165,800
<u>Ministry of Education</u>		
Maintenance of nine schools 17 teachers @ \$b7,800 per year	\$b132,600	
Books and equipment	<u>20,000</u>	
Total annual costs	\$b152,600	<u>152,600</u>
TOTAL ANNUAL EQUIVALENT COSTS		\$b392,103

site and with no additional materials such as gravel being used for surfacing, are considered adequate as long as they are closed to traffic after rain and preventive maintenance is done regularly in the dry season.

Total expenditure by the Servicio Nacional de Caminos on the Chane-Piray road is detailed in Table 8, above. The Bolivian Transport Survey suggests dirt roads of the Chane-Piray type should be amortized over a twenty year period. The total annual equivalent cost is \$b11,304.

Potable water supply

Although the area has a well distributed rainfall in excess of 1,300 millimeters and a dry season that is not severe, the shortage of drinking water at times causes great hardship. The nature of the alluvial flood plain means that no sources of good drinking water, such as springs, are available naturally.

As soon as the dry season begins the shallow swamps and water courses dry up. Easily contaminated shallow wells must be used or a long trek made to the rivers Piray or Grande. Luckily for the area, an artesian source of good quality water is found at a depth of about 120-160 meters. Obras Publicas, the public works organization of the Department of Santa Cruz has drilled 15 wells of 4 inches and 6 inches in diameter in the area to supply most of the incipient population centers. Great satisfaction has been expressed by the colonists with this supply. The effective life of the wells is taken as 25 years. The total annual equivalent cost is \$b62,339.

Health services

As discussed in the section on spontaneous colonization, there is a considerable health hazard in moving from the highlands to the tropical lowlands. Without the support of health services, settler resilience and enthusiasm would decline rapidly. In recognition of this, the central government provides staff for two dispensaries (postas sanitarias) at Sagrado Corazon and San Pedro. The government philosophy is that, if colonists will build the dispensary and provide housing for the staff, then the government will pay the salaries of the staff and will also furnish some drugs. The facility at San Pedro is a primitive low-cost structure with palm leaf roof and walls. At Sagrado Corazon a brick

structure built with funds raised by Italian students working in conjunction with the Silesian fathers from Muyurina (Montero) serves as a dispensary. The total annual cost of the health services is \$b165,800.

Education

The government philosophy as regards the supply of educational services is the same as for the health services, with the colonists being responsible for construction of schools and housing for teachers. There are a total of nine schools with seventeen teachers in the project area. The largest school at San Pedro has six teachers and five years of schooling are provided. The colonists show great interest in obtaining the best schooling possible for their children. The total annual cost of the educational services provided by the government is \$b152,600.

Comparison of Costs and Benefits

Normally, the cost benefit ratio or the internal rate of return is used as a measure of comparison between alternative projects and to determine which project will give the greatest return to the capital resources used. In this study only the annual equivalent costs incurred by the government are compared with the gross and net benefits obtained in 1971-72. This was done because it proved difficult to predict the shape of future cost and benefit streams. Of particular difficulty in predicting the shape of future cost and benefit streams are unknowns such as:

- (1) The future rate of land abandonment by rice growers.
- (2) The possibility that ranchers will buy at a cheap price the semi-cleared, but abandoned rice land.

(3) The possibility of the introduction of profitable new crops, such as sunflower and soya which may make a difference in the areas of rice monoculture as to whether the colonists abandon their land or practice crop rotation.

Costs

A value has only been put on government resources committed to the area. Fiscal land was considered as free or having no value until it was made accessible by construction of the access road. The original investment by the Gulf Oil Company in making an exploration track that subsequently became the access road was considered to have no salvage value. Also, no value was placed on labor by colonists for work such as road maintenance, building of schools and dispensaries, etc. It was considered that the labor had near zero cost because the work was done during the slack time in the agricultural year.

Gross benefits

For calculation of gross benefits, no value was placed on labor used in production, since it was considered that in the highlands, where the colonists came from, the marginal value product or opportunity cost of their labor was zero. This position can be taken if the figure mentioned previously of a 50% unemployment and underemployment rate for the Bolivian work force in 1972 is accepted. No production was foregone in the highlands after the colonists moved except that used for their subsistence. The only direct benefit calculated was the value of the agricultural output based on farm gate value (Table 9, page 43). No calculation was made for the benefits obtained from reduced transportation costs from increased volume of agricultural products marketed. Indirect

Table 9. Gross Return to Government Investment, Chane-Piray Area, Bolivia, 1971-72

	Amount
Annual Equivalent Costs	\$b 392,103
Farm Gate Gross Value of Regional Agricultural Production	\$b14,230,918
Annual Return Government Investment	3495

benefits such as the multiplier effect on the regional economy from development of the area and the creation of employment opportunities with the subsequent wealth generation were not included. An annual gross return to government investment in 1971-72 of 3,495 was obtained.

Net benefits

For calculation of net benefits agricultural labor has been valued at the wage it commands in commercial agriculture in the Department of Santa Cruz. Tables 27 to 29 give the production costs and Tables 30 to 32 give the total return to land and management for the various crops in each sector. These returns to land and management totaled \$b4,511,013 as shown in Table 10, page 44. Since this value is for 1972 only, it may underestimate return for the project life, since only part of the area is developed.

Net benefits with government paying all road construction costs

The government's expenses for road construction have been very low, since advantage was taken of the original investment of the Gulf Oil Company and work and money raised by the colonists.

Table 10. Net Return to Government Investment, Chane-Piray Area, Bolivia, 1971-72

	Amount
Annual Equivalent Costs	\$b 392,103
Net Benefits	\$b4,511,013 ^a \$b9,771,276 ^b
Annual Return to Government Investment	1,045 ^a 2,380 ^b

^aWith family labor paid at commercial wage rates.

^bIncludes net benefits of \$b5,260,263 considered paid to family labor. Family labor would have been unemployed if it had not moved to Chane-Piray area.

If the government is to contemplate opening up another area equivalent to the Chane-Piray Area, then the costs of road construction will be much higher. Costs of \$b60,000-\$b72,000 per kilometer for local access roads in the lowland regions of moderate to heavy rainfall are suggested.²⁷

Net benefits from the Chane-Piray Area with government paying the full construction costs of \$b60,000 per kilometer for the 65 kilometers of the access road that are fully settled, plus all the other water supply, educational and health costs have been worked out in Table 11, page 45.

Economic Factors Operating Along Access Road

The advantages of location

The principle stimulus for the initiation of spontaneous colonization is the construction of access roads. The quality of the transport

²⁷Stanford Research Institute, et al., Final Report Bolivia Transport Survey, Highways, Volume 4 (La Paz, Bolivia, 1968), page 288.

Table 11. Net Return to Government Investment Including Road Construction Costs of \$60,000 per Kilometer for 65 Kilometers, Chane-Piray Area, Bolivia, 1971-72

	Amount
Annual Equivalent Costs	\$b1,003,629
Net Benefits	\$b4,511,013
Annual Return of Government Investment	348

facilities available to move the initial production of the colonists plays a large part in determining the success or failure of the colonization venture. Proximity to a reliable highway provides great advantages. In the case of the Chane-Piray area, colonists located close to the paved road do not face the problems of colonists at the end of the access road, who must transport their products for long distances along a very poor road. The changes in crops grown (Table 1, page 26), the changes in net return to land and management (Table 4, page 30) and the changes in the index of net return to land and management per unit of cultivated land (Table 12, page 46) show how the location advantages operate. The index of net return in different sectors clearly shows the great advantages enjoyed by those with better transport facilities.

Intensity of land use

Location advantages will directly influence the intensity of land use. Increasing transport costs and increasing isolation of the colonists as one goes down the access road will be reflected in the decreasing relative value of production per unit of total land area served by the road. These changes are shown in Table 13, page 47. The very low value

Table 12. The Index of Net Return to Land and Management per Unit of Cultivated Land, Chane-Piray Area, Bolivia, 1971-72 (Chane taken as 100%)

Sector	Cultivated Land Area of Sector Ha	% of Total Cultivated Land Area	Net Return to Land and Management \$b	% of Total Net Return to Land and Management	Net Return to Land and Management per Ha ^a of Cultivated Land \$b	Index of Net Return to Land and Management per Unit of Cultivated Land Area
Chane	1,828	19.5	1,711,461	37.9	936	100.0
Aguais	3,231	34.5	1,525,520	33.8	412	50.4
Sagrado Corazon	1,722	18.4	534,165	11.9	310	33.3
San Pedro	1,001	10.6	302,185	6.7	301	32.5
Calama	1,422	15.1	394,671	8.7	277	29.6
El Carmen	<u>177</u>	<u>1.9</u>	<u>43,011</u>	<u>1.0</u>	243	27.0
Total	9,381	100.0	4,511,013	100.0		

^aHa or hectares.

Table 13. The Index of Aggregate Production per Unit of Total Land Area, Chane-Piray Area, Bolivia, 1971-72
(Chane taken as 100%)

Sector	Land Area of Sector Hectares	% of Total Land Area	Gross Value of Agricultural Production \$b	% of Gross Value of Agricultural Production	Gross Value of Agricultural Production per Hectare of Total Land Area of Sector	Index of Agricultural Production per Unit of Total Land Area
Chane	5,426	8.6	3,788,864	26.6	698	100.0
Aguais	9,050	14.4	4,658,262	32.7	514	73.4
Sagrado Corazon	7,111	14.5	2,288,034	16.1	321	35.9
San Pedro	7,767	12.4	1,354,488	9.5	174	24.8
Calama	18,209	28.9	1,907,630	13.4	104	15.0
El Carmen	<u>13,342</u>	<u>21.2</u>	<u>233,640</u>	<u>1.7</u>	17	2.6
Total	62,905	100.0	14,230,918	100.0		

for the index as one approaches the end of the road raises the question as to whether the level of production justifies expenditure on road improvement. A lot of the land in sectors such as San Pedro and Calama has already been cropped to rice and then abandoned.

When these changes are computed per kilometer of road (Table 14, page 49), then a basis can be established as to when increased production warrants upgrading of the road. Where new agricultural areas are being divided into holdings of 25 to 50 hectares for intensive farming by colonists, the recommendation²⁸ is that local access roads should be provided at a rate of one kilometer to each 100 to 200 hectares of cultivated land. As can be seen, the first 14 kilometers of the access road have a much higher intensity of land use with the sectors of Chane and Aguais already having 305 hectares and 404 hectares, respectively, of cultivated land per kilometer of road and production valued at \$b631,477 and \$b582,282 per kilometer.

The Social and Economic Conditions of the Colonists

It would appear outwardly that most underemployed and land-hungry peasants from the highlands would benefit by leaving their villages to take a land grant in the resource rich tropical lowlands. This study, however, has stressed that those colonists settling the "frontier" suffer considerable isolation and hardship. Who these pioneer families are that have chosen to abandon their traditional way of life, and how they have fared in their colonization venture is of considerable importance to the evaluation of spontaneous colonization. Four communities on which

²⁸Stanford Research Institute, et al., Final Report Bolivia Transport Survey, Highways, Volume 4 (La Paz, Bolivia, 1968), page 288.

Table 14. Hectares Cultivated and Value of Production per Kilometer of Road, Chane-Piray Area, Bolivia, 1971-72

Sector	Distance from Paved Road Kilometers	Hectares Cultivated per Kilometer	Value of Production per Kilometer \$b
Chane	0-6	305	631,477
Aguais	6-14	404	582,282
Sagrado Corazon	14-26	143	190,699
San Pedro	26-34	125	169,311
Calama	34-65	46	61,536
El Carmen	65-85	9	11,682
Average	-----	110	115,775

data is available for 1970-71 from the study by Kenneth Graber, La Vida Agricola en las Colonias²⁹, are discussed. The data has been divided into social and economic factors.

The four communities are:

(1) Cuatro Ojitos which is sited on the paved road and was founded in 1956.

(2) Sagrado Corazon which is 35 kilometers from the paved road and was founded in 1966.

(3) San Pedro which is 45 kilometers from the paved road and was founded in 1966.

(4) Calama which is 60 kilometers from the paved road and was founded in 1967.

²⁹ Kenneth Graber, La Vida Agricola en las Colonias, Comité de Obra Rural, Distrito Oriental Iglesia Evangelica Metodista (Montero, Bolivia, 1972).

The data is based on a 10% sample of the colonists in each colony.³⁰

Social factors

Educational level

The rate of illiteracy for Bolivia was estimated in 1961 at 70% for the country and at about 80% in the rural areas.³¹ The colonists, if they were the disadvantaged or landless sector of the rural population of the highlands before moving, would be expected to have the highest rate of illiteracy. This idea turns out to be very far from the truth. The colonists are, in fact, a well-educated group (Table 15, page 51). The most isolated colony, that of Calama, which draws its members from the Potosi Area is particularly interesting, having 41% of the heads of households with 4 to 6 years of formal education. Rural Potosi is one of the most isolated and backward departments, so there has been a very selective response to the expected rewards and difficulties of moving to the lowlands.

It is easy to conjecture that this mobile and well-educated group would have migrated to the towns to add to the urban unemployed if colonization opportunities had not been available.

Percentage that colonized on their own initiative

Mention was made earlier that in the directed colonization program funded by the InterAmerican Development Bank, that 43% of the colonists

³⁰Kenneth Graber, La Vida Agricola en las Colonias, Comité de Obra Rural, Distrito Oriental Iglesia Evangelica Metodista (Montero, Bolivia, 1972), page 5.

³¹Stanford Research Institute, et al., Final Report Bolivia Transport Survey, Economics, Part B, Volume 2 (La Paz, Bolivia, 1968), pages 4-29

Table 15. Years of Formal Education for Heads of Households, Chane-Piray Area, Bolivia, 1971^a

Years of Formal Education	Cuatro Ojitos	Sagrado Corazon	San Pedro	Calama
0	26%	47%	44%	22%
1-3	44%	36%	28%	37%
4-6	27%	17%	20%	41%
7-9	2%	---	8%	---

^aKenneth Graber, *La Vida Agricola en las Colonias*, Comite de Obra Rural, Distrito Oriental Iglesia Evangelica Metodista (Montero, Bolivia, 1972), pages 39-40.

sponsored by the project abandoned their land. Many returned to their original villages, but others looked for better land in areas such as that served by the Chane-Piray road. Table 16, page 52 shows the percentages of colonists that came entirely of their own initiative and at their own expense. The colonies founded at an earlier date show more colonists moved at government expense. This is an indication that the colonists originally moved at government expense to a government project and then responded to the greater economic opportunities seen in settling the Chane-Piray Area.

Family data

The average household of a colonist can be described as that typical of a young married family (Table 17, page 52). The father is 33 years of age, has 2 to 3 children and has 1 relative, usually either a parent or unmarried brother, living in his house. This corresponds well with

Table 16. Percentage Who Colonized on their own Initiative, Chane-Piray Area, Bolivia, 1971^a

	Cuatro Ojitos	Sagrado Corazon	San Pedro	Calama
Percentage that Colonized on their own Initiative	85.7	86.6	100	90.6

^aGraber, page 51.

Table 17. Family Data, Chane-Piray Area, Bolivia, 1971^a

Family Data	Cuatro Ojitos	Sagrado Corazon	San Pedro	Calama
Average Age of Head of Household in Years	35.7	32.5	31.9	34.1
Average Number of Children in Household	3.3	2.0	2.1	2.9
Average Number of Persons in Household	5.9	5.2	5.4	5.6

^aGraber, page 33.

assumptions on which age group would be most attracted to the economic opportunities available in the tropical lowlands.

The close relatives who help with the agricultural work will often use the family home as a springboard for their own colonization efforts.

Health

Moving from the healthy arid highlands to the humid tropics can be traumatic in itself. When this move to a new environment with completely new health hazards is made with no government health services to support the colonists, it can be easily understood if failures are many. One of

the greatest fear of the colonist is to fall ill during a crucial period in the crop cycle and thus lose his crop. The number of days lost due to sickness in Table 18, below, gives a good idea of how great this risk is. An average of a month of work lost in every year is a heavy toll to pay. Many of the illnesses will leave the colonists severely debilitated.

Table 18. Average Number of Days of Work Lost Due to Sickness per Year, Chane-Piray Area, Bolivia, 1971^a

	Cuatro Ojitos	Sagrado Corazon	San Pedro	Calama
Average Number of Days Lost per Year	36	28	21	31

^aGraber, page 34-35.

Permanence of settlement

For those at the end of the access road feeling the worst of the transportation difficulties and caught up in the unending toil of the slash and burn cycle of rice monoculture, the temptation to abandon the struggle to make a living on the "frontier" must be very real. Those with better transportation facilities will be less likely to be thinking of moving as is shown in Table 19, page 54. The fact that 15% of the population of Calama interviewed are thinking of moving within a year shows how marginal they consider their existence at the end of the road and what little hope they have for an improvement in their circumstances. The 6.7% of the population of Sagrado Corazon who are thinking of moving are probably those who are running out of high forest.

Table 19. Permanence of Settlement, Chane-Piray Area, Bolivia, 1971^a

	Cuatro Ojitos	Sagrado Corazon	San Pedro	Calama
Date when Colony was Founded	1956	1966	1966	1967
Average Number of Years Lived in Colony	7.8	3.9	3.9	3.2
Percentage Who are Thinking of Moving within 1 Year	1.3	6.7	0	15.6

^aGraber, page 30.

Economic factors

For the colonist to survive during the period of initial settlement, he will have to grow at least one crop which can provide him with a quick cash return. This crop is usually rice. For the colonist to expand his farming operation and increase his standard of living he will have to diversify his production with more capital intensive enterprises such as sugar cane or livestock production. This expansion will require greater use of yield increasing technology, greater access to organized markets and increased availability of capital and credit. In examining the various economic factors affecting the colonists' success in converting from a subsistence level of living to the status of a commercial farmer, the effects of deteriorating transport facilities will be particularly prominent.

Availability of production credit

One of the greatest bottlenecks to expanded production experienced by the colonists has been the lack of financial resources to hire extra

labor during busy times in the agricultural year, such as planting and harvest. In recognition of this the government made available limited amounts of production credit to rice growers. This credit was last made available in 1970-71. In 1971-72 because of embarrassing national surpluses of rice, no more credit was made available. However, non-government sources of credit provided by produce middlemen or rescatadores continued. Loans are made by these produce middlemen on the guarantee of the standing crop to colonists who do not have adequate funds to complete the crop cycle. Interest rates of 8 to 10% per month are charged with adequate security. The interest rate charged by the official Agricultural Bank has a legal maximum of 12% per annum. A loan from the Agricultural Bank is, therefore, preferable if it is obtainable. In 1970-71 the most isolated colonies received the least credit and a considerable portion of that was made up of expensive credit supplied by the rescatadores (Table 20, page 56). It could be argued that institutional credit would be too "risky" in an unstable frontier area, such as Calama, where many colonists are contemplating moving out of the area. Rescatadores with their closer personal connections with the colonists and high interest rates can better tolerate this risk.

Use of labor in agricultural production

The colonists, when they arrive to claim their plot of jungle land, bring with them little else except their enthusiasm and physical strength.

From this labor of cutting down the forest and planting crops, must be created all the resources to keep their families alive. Their lives for the first few years are little more than a struggle to keep alive and slowly expand their foothold in the jungle. Only slowly does their

Table 20. Availability and Source of Credit, Chane-Piray Area, Bolivia, 1970-71^a

	Cuatro Ojitos	Sagrado Corazon	San Pedro	Calama
Percent that Received Credit	42	27	12	10
Percent that Received Funds Direct from Agricultural Bank	58	25	67	34
Percent that Received Agricultural Bank Funds Directed through Cooperatives	27	50	33	33
Percent that Received Funds from <u>Rescatadores</u>	--	--	--	33
Percent that Used other Sources Friends, Neighbors, etc.	15	25	--	--

^aGraber, pages 61-63.

way of life pass from that of subsistence living to full participation in commercial agriculture. In the early years while establishing themselves, colonists will often hire themselves out as laborers to work for their richer neighbors or for the large commercial farms nearer Santa Cruz.

As their economic circumstances improve, they will in turn hire labor to expand their production. As Table 21, page 57, shows, the widespread use of hired labor is an indication of the involvement and integration of the colonists into the wider economy. As expected, the more isolated colonies use less hired labor. One interesting point is the number of colonists who hired themselves out for wage labor. Little of the traditional highland custom of mutual help without payment of wages within a community seems to have survived the colonists' entry into commercial agriculture.

Table 21. Use of Labor in Agricultural Production, Chane-Piray Area, Bolivia, 1970-71^a

	Cuatro Ojitos	Sagrado Corazon	San Pedro	Calama
Percent Who Worked for other Persons for a Wage	11.70	85.00	48.00	50.00
Percent Who Hired Labor	67.50	73.30	64.00	53.00
Family Labor used on the Farm Man/Years	1.41	1.44	1.31	1.24
Hired Labor used on the Farm Man/Years	1.46	1.44	0.84	0.48
Total Labor used on the Farm Man/Years	2.87	2.88	2.15	1.72

^aGraber, pages 51, 54, and 76.

Technical assistance

Access to yield increasing technology is vital if the colonists are to expand their agricultural production by increased productivity of their labor and so improve their standard of living. The colonists in the area are not well served by the extension division of the Ministry of Agriculture because large commercial farmers closer to Santa Cruz obtain priority in assistance. The cooperatives in the area, as well as the produce middlemen, however, have a vested interest in giving technical assistance to protect the colonists' crops from insects and diseases, in order to protect their loans. The various sources of technical assistance used by the colonists are given in Table 22, page 58. The experimental station in Saavedra, which services the Department of Santa Cruz, is on the main highway to Santa Cruz. The surprisingly high use of the extension

Table 22. Sources of Technical Assistance, Chane-Piray Area, Bolivia, 1970-71^a

Percent Who Used	Cuatro Ojitos	Sagrado Corazon	San Pedro	Calama
Extension Division Ministry of Agriculture	5	7	8	25
Experimental Station	18	7	12	9
Cooperative	3	13	20	19
Commercial Agency/Produce Middleman	13	7	12	6
Neighbor	53	63	24	22

^aGraber, pages 49, 50.

division of the Ministry of Agriculture by the colony of Calama could be due to the high educational level of the colonists.

Marketing of crops

In most situations where there is an underdeveloped marketing and processing system, a group of middlemen traders will usually take advantage of the primary producers. The Chane-Piray Area is no exception. The increased distance from the main road, greater difficulties in arranging for trucks to carry produce to market and increased time away from the farm to market crops all encourage the more isolated colonists to sell their produce through middlemen. Table 23, page 59, shows how the more isolated colonists, because of greater marketing difficulties, are often forced to sell their produce on the farm and thereby receive lower prices. The very high percentage of colonists (63%) at Calama who sell their crops within the colony shows how great their marketing

Table 23. Crop Marketing Patterns Along Access Road, Chane-Piray Area, Bolivia, 1970-71^a

	Cuatro Ojitos	Sagrado Corazon	San Pedro	Calama
Percent Who Sell Crops within their colony	17	17	38	63
Percent Who Received Rice Support Price of \$b150/Fanega	72.7	50	10	19
Average Price Received for Rice \$b/Fanega	139	136	127	114

^aGraber, pages 55-58.

difficulties are and how they must be resigned to accept a price well below the government support price of \$b150 per fanega. Because of the bad condition of the access road, the colonists at Calama will be the last group that the truck owners will want to contact for sale or transport of their rice.

Production and income data

Crop production. All the various trends in access to markets, availability of credit, etc., discussed previously should be reflected in very considerable advantages to those enjoying a better location and better transport facilities. These advantages are reflected in the production and gross income data shown in Table 24, page 60. With regards to average gross income from annual crops, the expected trend is demonstrated by all colonies except Cuatro Ojitos. It is suggested that the unexpected low average gross income for annual crops in Cuatro Ojitos (a much older colony) is due to scrub regrowth being cleared for crop production. Yields will be depressed by weed infestation and declining

Table 24. Crop Production and Gross Income Data, Chane-Piray Area, Bolivia, 1970-71^a

	Cuatro Ojitos	Sagrado Corazon	San Pedro	Calama
Average Number of Hectares in Annual Crops, Hectares	5.3	6.6	6.7	4.8
Average Gross Income from Annual Crops \$b/Year	3,253	7,658	6,804	5,173
Average Number of Hectares in Permanent Crops, Hectares	10.2	1.8	2.0	1.7
Average Gross Income from Permanent Crops \$b/Year	26,217	295	180	157
Percent with Income from Permanent Crops	70.1	16.7	8.0	12.5

^aGraber, pages 66, 67.

fertility. With regard to average gross income from permanent crops, the expected trends are demonstrated very strongly. Only Cuatro Ojitos has a suitable location to exploit commercially permanent crop production of sugar cane and bananas. The hectares of permanent crops reported for the other areas are plantations of bananas, citrus and yuca, mainly used for home consumption with very limited sales being effected because of high transport costs.

Livestock production. In an area of surplus maize and rice production, it is surprising that excess production is not converted into marketable livestock products, such as pork, lard, milk, beef, etc., for which there is a strong internal and external demand. Unfortunately, this type of production requires considerable investment by the government in supporting veterinary services to safeguard the health of the animals in

the area. This support has been almost totally lacking with livestock being regularly devastated by ferocious epidemics which are common to this humid tropical environment.

Because of the initial high investment required to start livestock production with cattle (to establish a hectare of pasture with fencing requires a minimum investment of \$1,500 per hectare) and the risks of losing ones' animals from uncontrolled epidemics in pig production, colonists are not prepared to risk their hard won capital in livestock production (Table 25, below). The very low gross income reported shows that most livestock products are used for home consumption. As expected, more people have horses or mules for transportation as the road deteriorates.

Table 25. Livestock Production and Gross Income, Chane-Piray Area, Bolivia, 1970-71^a

	Cuatro Ojitos	Sagrado Corazon	San Pedro	Calama
Percent Who Have Cattle	11.7	3.3	0.0	3.2
Percent Who Have Pigs	9.1	6.7	4.0	9.4
Percent Who Have Sheep or Goats	12.4	6.7	4.0	0.0
Percent Who Have Horses or Mules	0.0	6.7	4.0	9.4
Average Gross from Livestock \$b/Year	203.0	0.0	110.0	137.0

^aGraber, pages 68, 69.

Net income

All the economic trends mentioned previously work to the disadvantage of most recently arrived settlers who must occupy the most isolated land.

The trends are reflected in net income data (Table 26, below). Cuatro Ojitos, the colony with the best location, shows an average per capita net income of \$b2,140. If this figure is compared with the average per capita net income of \$US44.00 or \$b528 quoted previously for the rural population of Bolivia in 1969, it can be seen that the colonists have improved their standard of living very considerably by moving. For those near the end of the access road at Calama with a net income per capita of only \$b841, the advantages of moving are less obvious if one takes into consideration all the hardships and health hazards involved in the move to the tropical lowlands. The low average net income per capita for Calama easily explains the instability of settlement mentioned previously for this colony.

Table 26. Net Income Data, Chane-Piray Area, Bolivia, 1970-71^a

	Cuatro Ojitos	Sagrado Corazon	San Pedro	Calama
Average Income per Farm \$b	12,625	9,433	5,476	4,709
Average Income per Adult Worker \$b	4,399	3,275	2,547	2,738
Average Income per Capita \$b	2,140	1,747	1,053	841

^aGraber, page 75.

LONG RUN IMPLICATIONS OF PRESENT TRENDS

The basic thesis of this study is that knowledge of the economic opportunities available, very limited operating capital and a firm market for a few products have been combined by spontaneous colonizers to put virgin land and idle labor to use in expanding Bolivia's agricultural production. How far continued expansion is self-sustaining without further government inputs for such activities as technological innovation, introduction of new crops and rationalization of marketing will now be examined.

The first thing to mention is that the highland colonists are not low performers because of lack of aspirations, but rather from lack of opportunity. The destructive cycle of rice monoculture has been adopted by the more isolated colonists because of lack of opportunity to adopt any other type of agricultural production. The lack of economically viable alternative crops has left the colonists trapped in their nomadic "slash and burn" cycle. The long-run implications of the growth of this cycle and its expansion from the addition of new colonists, in forest destruction, soil deterioration, instability in community formation, and waste of human energy are serious. As the government prepares to cope with the expected increased flow of colonists from the highlands, plans should be made so that future colonists will be able to establish prosperous and stable farming communities.

Up to the present, the dimensions of the problem of the "hollow frontier" of abandoned land and unstable communities as the colonists move on to look for new land with high forest, has been masked by the

rapid expansion of commercial agriculture into the abandoned land. The Santa Cruz Area has been enjoying a cotton boom for the last few years. Cotton growing is a full mechanized and highly technological activity that is almost entirely confined to highly capitalized large commercial farmers or corporations. The clearing of high forest to begin the growing of cotton is extremely expensive at an average cost in 1972 of \$b2,300 per hectare for 10 hours of work with a D8 bulldozer. If a commercial farmer can buy up the semi-abandoned land of a colonist which is mainly scrub regrowth, he can save himself considerable land clearing costs. The cost of clearing scrub regrowth averages out at \$b500-1,000 per hectare and only requires 2 to 4 hours of work with a D8 Bulldozer. The current sale price for scrub regrowth land ranges anywhere from \$b200-700 per hectare depending on location. The margin in clearing costs acquired by the commercial farmer plays an important part in local capital accumulation.

It can be observed that the settling and clearing of state land and sale of the partially improved property is starting to emerge as a way of life for some colonists who will have migrated successfully to new frontier areas twice in the last 10 years. Sadly, the colonist's role has frequently been that of contributing towards the development of someone else's production unit, while making no progress towards his own economic and social improvement. The colonist finds that while the commercial farmer expands his production, his own pioneering efforts earn little more than survival in poverty and ignorance. How much longer the cotton boom continues and commercial farmers continue to reoccupy the abandoned land of the "hollow frontier" is a matter for debate. Also, for debate is the question whether the capital intensive and labor

extensive cattle ranching enterprises will expand into areas with abandoned land where the climate is too wet for cotton such as the Chane-Piray Area.

The Consequences from no Increase in Commitment of Government
Resources to Spontaneous Colonization

The obvious choice for the government when deciding where to best employ scarce resources will be to stimulate growth at the point where immediate response will be greatest. The greatest returns will be seen to be obtained by expanding the opportunities of commercial farmers. Already a dualistic pattern is emerging around Santa Cruz where food production with primitive technology is being left to the colonists, while commercial agriculture concentrates with government support on export and industrial crops. This, unfortunately, has the result of encouraging the consolidation and excessive concentration of large land holdings in the more accessible and better lands with the exclusion of the small farmers to the isolated "frontiers." Some of the colonists with better location are managing to reach for a better level of living, but the rest of them are being squeezed into tighter and tighter corners by the more productive and advantaged commercial farmers. If the colonists remain trapped in their nomadic agriculture, and the level of living of the mass of colonists as compared to the large farmers draws too wide apart, then disruptive social upheavals as experienced by Bolivia during the Agrarian Reform of 1952 will again threaten. The invasion of large properties, such as Chane-Bedoya, by colonists in 1970-71, has already signaled the threat of social conflict.

The Expected Results from Increased Commitment
of Government Resources

If both welfare of the colonists and economic growth are emphasized, there are many attractive alternatives. The Andean group (Pacto Andino), of which Bolivia is a member, represents an immense potential market for agricultural products from the Santa Cruz Area. The countries of the group were deficient in wheat, milk products, vegetable oils, maize, meat, rice, and timber to the value of \$US400 million in 1972.³² All of these products could be supplied by the Santa Cruz Area.

With the provision by government and private enterprise of a system of silos, price stabilization and exporting organizations to overcome market limitations, the colonists could rapidly expand their production without undue subsidy. Provided with profitable and stable markets for their products, the colonists could give up their nomadic rice monoculture, practice crop rotation and introduce work animals, such as mules or oxen. The introduction of work animals would expand the cultivated land area of a colonist to 10-20 hectares from the 2-4 hectares cultivated at present by hand methods. The use of work animals would increase the productivity of labor by increasing the land area cultivated per colonist and lowering costs. In the colonization areas, it is the very low productivity of labor that partially accounts for the low standard of living.

To the colonists, the crops that are particularly attractive are maize and oil seeds, such as soya and sunflower. The crops are attractive because of the simple technology needed and the high yields obtained.

³²"Espectativas en Mercados Internacionales," Panorama, Edicion 33 (Santa Cruz, Bolivia, 1972), page 5.

The oil seed crop and industry which has been neglected up to the present by the government would not only supply vegetable oil as an import substitute, but also soya bean meal for poultry and swine production. With a local volume oriented pork processing and marketing industry developed with soya bean meal, a market for maize would evolve. A firm market for maize and soya beans would remove the development ceiling that has hovered over the colonists. Processing the feed grains in situ through livestock would provide a product less vulnerable to Bolivia's high transport costs which has usually stopped domestic production being competitive in international markets.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

Bolivian agriculture is composed of two sectors, the over-populated highlands and the resource rich, but under-populated lowlands. During the last 20 years the Bolivian government has devoted considerable resources to the development of the tropical lowlands. Since the lowlands are sparsely populated, agricultural colonization from the highlands was selected to play a key role in development of the region.

The various government colonization programs to sponsor the movement of population to the lowlands have not been particularly successful. They have proved to be extremely expensive and suffered from lack of adequate planning and coordination between government agencies.

While government resources were being devoted to development of the tropical lowlands and planned colonization of selected areas, various voluntary and uncontrolled migration patterns were developing. These movements of population developed in response to new economic opportunities offered by availability of free land and government investment in roads and other infrastructure in the lowlands. This study is concerned with settlement of virgin forest land in the Department of Santa Cruz by people from the highlands without direct government help or stimulus. This type of settlement is called spontaneous colonization.

The general objective of this study was to clarify the factors involved in the initiation, subsequent rate of expansion and role that spontaneous colonization could be expected to play in the development of Bolivia's tropical lowlands. Special attention was paid to the impact

of access roads on spontaneous colonization. To make the study, an access road serving an area opened up during the period 1966-72 by spontaneous colonization was selected. Aerial photography of the immediate area of the road, together with relevant data collected in the field between April and July of 1972, was used to evaluate the impact of the access road on spontaneous colonization. All government expenditures on road construction, potable water supply, education and medical services was compared with the value of agricultural production from the area for the agricultural year 1971-72.

Conclusions

(1) The limited government investment in infrastructure for the spontaneous colonization area studied was economically justified, if analysis permits using gross regional product as a measure of benefits.

(2) The investment had a major employment impact and met minimum acceptable income standards.

(3) The spontaneous colonization area examined showed that a permanent and viable agriculture had been established in areas of better location at low public investment cost.

(4) The public investment cost for infrastructure in support of spontaneous colonization was \$US21 per family as compared to a cost of \$US1,605 per family reported for the last major government colonization project.

(5) As a process for settlement of the tropical frontier, spontaneous colonization showed great flexibility for responding to economic opportunities. High levels of state involvement in the settlement process introduced rigidities leading to misallocation of resources.

(6) The widely held belief of spontaneous colonization in virgin areas as the most precarious and miserable form of subsistence agriculture, wasteful of soil and forest resources only proved to be partially valid for the more isolated colonies.

(7) The cost and reliability of transportation proved to be the key variable in the degree of successful and permanent settlement.

(8) The limitations imposed by inability to find markets for certain agricultural crops were severe.

(9) The production gains obtained from putting idle land and labor to work in the more isolated areas were only considered temporary, unless the colonists could be assisted to move forward technologically from the primitive "slash and burn" cycle of land utilization.

(10) If assistance for modernization of production was not made available, then the government would be faced with accelerated forest destruction and proliferation of marginal units.

Recommendations

(1) The process of moving people to the resource rich lowlands, that started as an expensive and not very successful government initiative and has become a selfsustaining spontaneous movement, should be treated as a valuable and dynamic force in Bolivia's development.

(2) Explicit government support should be given to spontaneous colonization as a dynamic force that can open up frontier areas at low cost by tapping the energy and initiative of the colonists and the enormous community interest in roads, schools, etc.

(3) Once permanent settlements have been established and land put into production, government should concentrate on supporting the

colonists with adaptive research, credit, marketing development and promotion of agro-industries. This support will allow the modernization of production techniques, the transformation of the present exploitive agricultural methods and achieve the necessary increase in the productivity of labor.

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APPENDIX

Table 27. Sugar Cane--Per Hectare Costs. Sale at Farm Gate, Chane-Piray Area, Bolivia, 1971-72

Practice	Plantation Each 5 Years \$b/Hectare	Annual \$b/Hectare
<u>Fixed Costs</u>		
Land preparation	\$b 450	\$b 134
Seed: 6 tons at \$b.94	564	168
Planting: by hand 20 men	300	90
Replanting: 7 men	<u>100</u>	<u>30</u>
Total fixed cost (Amortized for 5 years at 15%)	\$b1,414	\$b 422
<u>Variable Costs</u>		
Cleaning: 7 men (3 times) at \$b.70		\$b 210
Harvesting: \$b15/ton for 50 tons/hectare yield		<u>750</u>
Total variable costs		\$b 960
Interest on operating capital (1/2 total costs for 6 months at 15%)		<u>\$b 36</u>
Total annual cost		<u><u>\$b1,418</u></u>

Table 28. Bananas--Per Hectare Costs. Sale at Farm Gate, Chane-Piray Area, Bolivia, 1971-72

Practice	Plantation Each 5 Years \$/Hectare	Annual \$/Hectare
<u>Fixed Costs</u>		
Land preparation: burning of rice stubble	\$b100	\$b 30
Banana transplants and transport	500	150
Planting: 20 men	<u>300</u>	<u>90</u>
Total fixed cost (Amortized for 5 years at 15%)	\$b900	\$b270
<u>Variable Costs</u>		
Cleaning: 5 men (2 times) at \$b60		\$b120
Harvesting: 10 men		<u>120</u>
Total variable costs		\$b240
Interest on operating capital (1/2 total variable costs for 6 months at 15%)		<u>\$b 7</u>
Total annual cost		<u><u>\$b517</u></u>

Table 29. Dryland Rice--Per Hectare Costs. Sale at Farm Gate, Chané-Piray Area, Bolivia, 1971-72

Variable Costs	\$/Hectare
Land preparation: cutting down forest and burning	\$b 450
Seed: 15 kilos at \$b2	30
Seeding: 2 men	24
Weeding: 6 men (2 times) at \$b.72	144
Harvesting: contract 10 fanegas at \$b2.40 per fanega ^a	240
Food for harvesters	100
Transportation: field to farm	10
Hull rice: at \$b4 per fanega	<u>40</u>
Total variable costs	\$b1,038
Interest costs on operating capital (1/2 total variable cost for 6 months at 15%)	<u>\$b 39</u>
Total annual costs	<u><u>\$b1,077</u></u>

^a1 Fanega equals 384 pounds of rough rice.

Table 30. Sugar Cane Revenues, Production Costs and Returns to Land and Management, Chane-Piray Area, Bolivia, 1971-72

Sector	Net on Farm Value Per Ton ^a	Net on Farm Value per Hectare ^b	Total Annual Costs per Hectare ^b	Profit to Land and Management ^c	Area in Sugar Cane Hectares	Total Return to Land and Management
Chane	55	2,750	1,418	1,332	1,090	1,451,880
Aguais	45	2,250	1,418	832	833	693,056
Sagrado Corazon	31	1,550	1,418	132	-----	-----
Total						2,144,936

^aTable 2.^bYield of 50 tons per hectare.^cTable 27.

Table 31. Rice Revenues, Production Costs and Returns to Land and Management, Chane-Piray Area, Bolivia, 1971-72

Sector	Net on Farm Value Per Fa ^a \$ ^b	On Farm Value Per Ha ^c \$ ^d	Total Annual Per Ha ^d	Profit to Land and Management ^e	Area in Rice Ha	Total Return to Land and Management
Chane	141	1,410	1,077	333	265	88,245
Aguais	141	1,410	1,077	333	1,267	421,911
Sagrado Corazon	140	1,400	1,077	323	1,485	479,655
San Pedro	138	1,388	1,077	311	947	294,517
Calama	136	1,360	1,077	283	1,367	386,861
El Carmen	132	1,320	1,077	243	177	<u>43,011</u>
Total						1,714,200

^aFa means fanega.

^bTable 3.

^cHa means hectare.

^dYield of 10 fanegas per hectare.

^eTable 29.

Table 32. Banana Revenues, Production Costs and Return to Land and Management, Chane-Piray Area, Bolivia, 1971-72

Sector	Net on Farm Value per Hectare	Total Annual Cost per Hectare ^c	Profit to Land and Management	Area in Bananas Hectare	Total Return to Land and Management
Chane	882	519	363	472	171,336
Aguais	882	519	363	1,131	410,553
Sagrado Corazon	749 ^a	519	230	237	54,510
San Pedro	661 ^b	519	142	54	7,668
Calama	661 ^b	519	142	55	<u>7,810</u>
Total					651,877

^aValued at \$b.85 per 60 pound bunch due to increased spoilage from lack of transport to collect mature fruit.

^bValued at \$b.75 per 60 pound bunch due to increased spoilage from lack of transport to collect mature fruit.

^cTable 28.