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CONTROL OF CHAGAS DISEASE VIA HOUSING IMPROVEMENT

FINAL REPORT HEALTH AND SOCIAL AREAS

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1. INTRODUCTION

1.1 Chagas' disease

1.1.1 General aspects

Chagas disease or American trypanosomiasis is a parasitosis caused by the protozoan *Trypanosoma cruzi*, which is transmitted by the feces of a hematophagous insect belonging to the Reduviidae family. The disease was first described by Carlos Chagas in 1909 when he isolated the parasite from a child and later from a cat. Chagas also identified the disease vector as well as the pathology associated with the chronic phase. Originally, the disease was a zoonosis that after the vector domiciliation started to affect man. The human infection is strongly related to the socio-cultural conditions of the populations which interact with the vector, and hence with the parasite.

Chagas disease is widely distributed in Latin America, from the South of the USA all the way through to the South of Argentina. Depending on the zones studied, the percentages of serological prevalence varies from 5% to 60% (1).

According to the World Health Organization, at least 90 million people are exposed to the disease, and between 16 and 18 million are infected from the 360 million people living in the endemic countries (1). Forty percent of the infected people develop a chronic lesion and 0.2% show such severe cardiac complications that require the use of pacemakers. Chronic Chagas is incurable and the convenience of the use of drugs (Nifurtimox and Benznidazole) in the acute phase of the disease are still controversial. Besides, *T. cruzi* antigens seem to stimulate autoimmune reactions which makes the possibility of developing a vaccine difficult (3).

Chagas disease has three phases: a short lasting acute phase, an intermediate phase characterized by a clinical asymptomatic period, and a longer chronic phase where cardiac or gastrointestinal lesions appear (1).

1.1.2 Transmission vias

The most important via of transmission of Chagas disease is through the parasite vector, which occurs in rural areas where the house precariousness, the crowding and the deficient sanitary conditions facilitate the insect proliferation and the maintenance of the domestic cycle. In urban areas, the most important transmission via is by blood transfusion. This is becoming more and more important due to the persistence of rural-urban migration and the lack of serological control in blood banks. Congenital transmission is mediated by chagasic rural and urban women who, during their reproductive life, can infect their children by transplacentary via. The lack of control during pregnancy as well as that of potentially infected children contribute to the rate of occurrence of the disease as a result of the way of transmission.

1.1.3 Epidemiological and control data

In Paraguay, *T. cruzi* infection and its main vector, *Triatoma infestans* are widely distributed. A. Canese, in studies performed during 25 years, established **infestation** percentages that range between **11%** and **60%.** Serological data for native groups from the Eastern region showed the highest value in the country **(72%)** (4).

Studies performed by the Malaria Eradication Service (SENEPA) from the Ministry of Public Health and Social Welfare between 1984 and 1986 revealed a **domiciliary triatomine infestation rate** of **14%** and a *T. cruzi* **human infection rate** of **20%** (5). In 1986, a serological survey performed by the Instituto de Investigaciones en Ciencias de la Salud (IICS) in the areas of highest endemy showed a prevalence of 22% in a sample of 1,601 subjects, which represents a population of 150,000 people settled in those areas (6).

Fifty seven percent of the Paraguayan population live in rural areas and according to the last census, rural dwellings are mainly built of mud (42.1%), have straw roof (75.5%) and dirt floor (80.1%) (7). The hematophagous insect proliferates in the cracks of mud or wattle (branch and mud mixture) walls, between wooden

boards and in straw roofs, preferring very humid and poorly ventilated places. It is common to find triatomines in some places of the peridomiciliary area such as barns, henhouses and wood or brick piles. The predominant house types found in these areas are usually associated with triatomine infestation, and this causes the widespread dispersion of the insect (8,9).

Estimations about the **incidence** of Chagas disease in Paraguay reveal that about **14,680** people are infected every year and that a 30 million dollars loss equivalent to one year of work is produced due to sudden deaths in the acute and chronic phases (3). Thus, it is considered that Chagas disease is the result of the interaction between *T. cruzi*, triatomines and people living in poor socioeconomic conditions. Interruption of this interaction has been performed in endemic areas by vector control measures and social development promotion, by insecticide spraying, housing improvement, health education programs and community participation. However, only isolated evaluations of these programs have been made, which makes the results not absolutely conclusive (3).

The chemical vector control has been successfully implemented in Argentina, Brazil and Venezuela. Apart from their transitory effectiveness, the results of these programs have been hampered by the interruption of spraying which caused a high infestation rate, and allowed, in Brazil, the displacement of *T. infestans* by secondary species. However, certain chemicals such as pyrethroids, maintain the houses free from triatomines for a period longer than a year (3). The Brazilian experience, the richest one on information about control campaigns, shows the necessity of community participation in the control, specially in the surveillance phase, which is the longest, most expensive and difficult period of the control program. Studies performed in Goias State, Central Brazil, revealed the success of pilot programs that incorporate the community to the surveillance phase by triatomine monitoring procedures such as the use of plastic bags for notification in reference posts and the use of white paper sheets for triatomine feces detection (10).

Another procedure used for triatomine control is housing improvement in order to make a hostile environment for the insect; in other words, better lit and ventilated houses, without cracks that could be hiding places. This intervention type is more expensive, but has a long-lasting effect (3). Recently, housing improvement programs were performed in Venezuela with the cooperation of the Ministry of Health and the community support in order to guarantee the persistence of the actions. This program aimed at producing a house construction system that was acceptable for farmers, using techniques and materials familiar to them. The program successfully associated the Government with the farmer, both working together in the improvement and stimulating the social sense of responsibility. The modified house cost was between 150 and 300 dollars (11, 12).

In Paraguay, no Chagas disease control program has been performed at a national level. However, it is known that after four campaigns against malaria, performed between 1957 and 1964, which consisted in intradomiciliary DDT spraying, the triatomine infestation rate drastically decreased during that period. Small-scale spraying have been performed in isolated areas, but nor systematic control work neither post-spraying evaluations have been made, except for assays of new control tools that are currently being performed (1).

1.2 The farmer and his environment.

Although abundant literature about the Paraguayan farmer exists, it has not contributed to concept clarification. Rather, the polysemous sense of the word has been consolidated. Anyway, it would be reasonable to make a contextual characterization of the reality of the Paraguayan farmer.

Some of the elements that constitute the socioeconomic context are:

A. The primary sector is the most important one in the Paraguayan economy because it generates about 30% of the GNP (Gross National Product); makes

up almost 50% of the working population and it is responsible for 90% of the exportations and the corresponding foreign exchange. Nevertheless, adverse climatic effects, diminution of international prices, the absence of a defined farming policy and a deficient credit policy induce a progressive deterioration of the living conditions in the rural areas.

B. It might be expected a worsening of the standard of living of the rural population due to the persistence of an economic model that stimulates accumulation of riches and which benefits the agroexporter sector. It seems that modernization costs and the consequences of deterioration, in terms of exchange, are again placed on the farmers' shoulders.

C. The participation of small farmers in the national economy has no adequate correlation with the political participation, although a trend of increase of citizen free expression is observed. Eventually, this will still improve the governmental decentralization and the consolidation of municipality role. All this will depend on the real availability of resources and the capacity of action and honesty of the elected authorities (governors and majors). If they fail, a worsening of the economic crisis and a dangerous exasperation of the social coexistence will occur.

D. A major element of the quality of human life is "**participation**", one of its main instruments being "**organization**". Generally speaking, farmer organizations can be divided into three categories:

i) **Popular organizations** spontaneously created in the rural population or promoted by Non-Governmental Organizations (NGO's), generally related to the Roman Catholic Church. This is often due to the christian option of human promotion or to tactical reasons related to the summoning power of this ecclesiastic institution. The internal and

external church credibility makes the access to groups already organized easy and supplies the nexus with potential financial resources, without putting aside the security provided by this type of insertion.

ii) Organizations created by official projects to facilitate the delivery of specific services, such as loans, technical assistance, capacitation, neighboring roads, etc., whose persistence depends on the duration of those programs.

iii) Cooperative organizations which have particular success in areas of higher development and with severe limitations in depressed rural areas. Only a minimal proportion of small farmer population is associated to these cooperatives, which determines the expansion of these type of organizations.

E. The strongest element causing social tension is the high pressure of the farmers to obtain access to the land, induced by a dense concentration of land property: 5% of the agricultural surface correspond to 78% of the exploitations, which sometimes has about 20 ha while 1% of the owners occupy 70% of that surface.[1] Regarding land demand, there are two clearly different situations:

i) Farmers who own their lands but have legal problems related to ownership, which hampers their access to official loans;

ii) Farmers who do not own lands and are in an almost permanent helplessness because current policies do not offer alternative solutions such as job generation.

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[1]. PNUD, Document social policies, As. 1989.

The agricultural frontier is closed, which means that no fiscal lands are available for distribution and the access to the land without any supporting system only intensifies the inherent problems of poverty.

F. The following characteristics define the situation of the small farmer:

i) Peasantry constitutes a dependant social group: the restricted access to productive resources places them in a position of subordination and dependency. They hardly do not have decision capacity on the economic or political issues and they are subjected to social control systems which tend to strengthen their uneasiness from the process of making decisions. The asymmetric relationships of power are related to land control because land is the mean of access to financial and non-financial income, which defines the family survival strategy of the small farmer.

ii) Unfavorable agricultural development style: the farmer economy is at disadvantage with the commercial agricultural economy. The former has the "work factor" as critical determinant of the product level **instead of** a highly **productive technology**. Besides, economic categories such as rent, interest, merchandise, work value, economic rationality, risk, sense of management, specialization and competence do not have the same sense than in the "modern sector" of economy. On the other hand, the cost of labor is not necessarily expressed in terms of money and shows difficulties to be apprised in salaries or amount of work because the family constitute a working unity which can be separated only in analytical exercises. Even the highly praised spirit of "competitiveness" spirit is undergoing a cultural reduction that neutralizes it because farmer communities tend to appraise rather the simple fact of warm living together than a relationship of competition maximize production. In conclusion, the situation of dependency

situation and the unfavorable development style shape the structural context where other restrictions are identified:

iii) Inadequate technology is one of the elements that restricts, in the current economic rationality, productivity and production, and it specifically refers to:

a. low endowment of implements and agricultural tools;

b. Inappropriate technological packets for the productive characteristics of the farmer's family unity;

c. research is limited to exportation products and despises the search for specific alternatives for the farmer unities considered as production systems;

d. low covering of technical assistance which only reaches a minimal part of small producers.

iv) Credit absence: most part of the credits, which are accessible to the farmer, are provided by the informal sector of stockbrokers and shopkeepers while bank credits are almost inaccessible for farmers. Insufficiency of assigned funds, lack of real guarantees, incapacity of the working plan for generation of payment capacity that assures the fund recovery or complicated bureaucratic demands are some of the reasons why most credit lines are away from the real possibilities of the small farmers .

v) There are also serious problems with **commercialization** that hinders the farmer access to the market due to an excessive specialized production that reduce negotiation capacity for fixing prices both at the internal and the external level.

vi) Lack of capacitation determined by:

a. Low level of literacy in the farmer population;

b. Inadequacy of methodologies that insist on separating the capacitation process from concrete productive actions;

c. High cost of selected strategies limits the covering of programs;

d. The absence of participative planning of capacitation actions;

e. Lack of compatibility of technical, political, cultural and action objectives in most capacitation programs.

vi) Unemployment: it reflexes the system incapacity to generate jobs in quantities at least enough to equal the economically active rural population growth.

vii) Deficient access to basic services of education and health which have a double limitation:

a. low covering of the systems;

b. low quality of the services.

viii) Absence of communication policy, specifically directed to rural development, consolidates the uneasiness of the farmer sector from problems fundamental to the national society and wastes the real or potential possibilities of their contribution, thus, increasing conflict chances of a basic inequality in social relationships.

ix) Growing exhaustion of natural resources induced by the depredatory style of the current economic rationality which privileges the immediate profit at the cost of the destruction of the environment. In the last three decades, the increase in the agricultural production was basically due to a persistent expansion of the agricultural frontier which has no correlation with the productivity. This has generated a massive

deforestation of approximately 130,000 ha. per year between 1945-1985. During 1989-90, the forest loss rose to 1,500,000 ha. caused by fear of expropriation because of land unproductivity.[2] Cattle raising is extensive and its expansion was mainly carried out through the utilization of lands with agricultural-forest characteristics, which negatively affects the land availability for agricultural purposes. Forest exploitation has been performed irrationally and indiscriminately, which seriously compromises the possibility of maintaining an adequate wood mass and cancels the economic potential of this field. One of the direct consequences of deforestation is erosion which reduces soil fertility and, consequently, the crop yield. To sum up, the current developmental model has exhausted its resources and the design of new strategies is essential to establish an adequate relationship among environment, ecology and development.

1.3 Health situation

At the beginning of this project, the health situation of the country was described by using data provided by the Department of Biostatistics of the Ministry of Public Health and Social Welfare. General mortality rate was 6.0 per 1,000 inhabitants in 1988, which when was compared with the rate registered in 1960 (11.1 per 1,000 inhabitants) implies a reduction of about 46%. The causes of mortality have substantially varied between 1960 and 1988. In the period between 1960 and 1969, diarrhea was the first cause of mortality while it occupied the fourth position in the period 1960-1988. The higher relevance of cardiovascular and cardiac diseases was also observed. The epidemiological profile of the last period studied corresponds to a country which is slowly overcoming mortality due to infectious diseases and shows the stronger role of chronic and degenerative diseases as death causes, just as observed in developed countries. (Table 1).

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[2]. BOZZANO, Bernardo - WEIK, Jörg H. "El avance de la deforestación y el impacto económico". Project of Plannig of Natural Resources Handling (MAG-GTZ). Asunción, Nov. 1992. p.10.

TABLE 1

MAJOR GENERAL DEATH CAUSES, PERIOD 1960-1988

PARAGUAY, 1988

CAUSES	ORDER No. BY PERIODS		
	1980-1988	1970-1979	1960-1969
Cardiac diseases	1	1	3
Cardiovascular diseases	2	3	5
Tumors	3	4	4
Diarrhea	4	2	1
Pneumonia and influenza	5	5	2
Accidents	6	6	6
Homicides	7	8	9
Nutritional deficiencies	8	-	10
Tuberculosis	9	7	7
Atherosclerosis	10	9	-
Tetanus	-	10	8

Source: Sanitary and Vital Statistics. Department of Biostatistics. Ministry of Public Health and Social Welfare, 1988.

Regarding child mortality, official data report a rate of 63.2 per 1,000 live newborns in 1980 and 36.5 per 1,000 live newborns in 1988. There are differences according to the zones because mortality rate increases as urbanization degree diminishes. The same situation is observed when child mortality is analyzed according to social groups because rates decrease in the most favored social groups.

Infectious diseases were the most important cause of child mortality, with small variations, in the period 1960-1988. Diarrhea and respiratory infections seemed to be the main causes of mortality in children under 1 year of age. In fact, the main ten death causes in the group of children under 1 year of age corresponded to infectious diseases, diseases preventible by vaccination, diseases related to childbirth and diseases attributable to alimentary deficiencies. This mortality structure corresponds to the underdevelopmental character of the country (Table 2).

TABLE 2

MAJOR CAUSES OF DEATH IN CHILDREN UNDER 1 YEAR OF AGE REGISTERED IN THE PERIOD 1960-1988 (PARAGUAY, 1988)

CAUSES	ORDER No. BY PERIODS		
	1980-1988	1970-1979	1960-1969
Diarrhea	1	1	2
Pneumonia and influenza	2	2	1
Nutritional deficiencies	3	3	3
Newborn infections	4	4	7
Prematurity	5	6	4
Measles	5	6	5
Tetanus	6	8	6
Whooping cough	6	5	4
Lesions due to delivery	-	8	8
Other diseases of the first childhood	-	7	6

Source: Vital and Sanitary Statistics. Department of Biostatistics. Ministry of Public Health and Social Welfare, 1988.

Neonatal mortality rate, though has clearly diminished, was 15.3 per 1,000 live newborns in 1988. Most of the causes of this rate are related to the inadequate care during pregnancy and delivery, and to infections, especially (Table 3).

TABLE 3

MAJOR CAUSES OF NEONATAL DEATH (<28 DAYS) REGISTERED IN THE PERIOD 1960-1988 (PARAGUAY, 1988)

CAUSES	ORDER No. BY PERIODS		
	1980-1988	1970-1979	1960-1969
Lesions related to delivery	1	1	1
Prematurity	2	3	2
Newborn infections	3	2	6
Tetanus	4	5	3
Pneumonia and influenza	5	4	4
Diarrhea	6	6	5
Other infectious and parasitic diseases	7	7	7

Source: Vital and Sanitary Statistics. Department of Biostatistics. Ministry of Public Health and Social Welfare, 1988.

1.4 Area studied: Department of Paraguarí.

1.4.1 Historical aspects and physical characteristics.

1.4.1.1 History: The Department of Paraguarí is located in the old valley of Yarigua'á, which used to be an old jesuitic stock farm. Together with the central area and the city of Asunción, they were the most thickly populated region of Paraguay in the colonial age. Settlements were consolidated in the 18th century, though the city of Yaguarón, where the community of Ñanduá is located, was established at the end of the 17th century with Guarani natives. In 1854, when the country had a constitutional government, a railway that joined Asunción and Paraguarí was built. After the war (1864 to 1870), that railway was extended up to Villarrica.

This led to the establishment of several communities such as Ybytimí, where Cañada is located, and Escobar, where Ypa ú is located.

1.4.1.2 Geography: Paraguay is located in the south hemisphere of the American continent, between 19° 18' and 27° 36' parallels of south latitude and 54° 15' and 62° 38' meridians at the West of Greenwich, and it has a surface of 406.752 km^2. The Paraguay river splits the country into two natural regions, the Eastern and Western regions. The Department of Paraguarí is located at the South-West of the Eastern region, where the land is constituted by meadows and where some elevations of 200 to 630 meters are found. The land is irrigated by several watercourses that come from the Tebicuary river and Caañabé and Aguaiy streams. The annual average temperature is 21° C, with a maximum of 38.5° C and a minimum of 2°C. The annual rainfall is from 1500 to 1600 mm.

1.4.1.3 Use of the land and productive activity: Most soils derive from sandstones, which turn them into scarcely fertile soils. This situation is worsened by the population antiquity and the land overexploitation. The potential capacity of the land indicates that 25% is adequate for agriculture, 70% for extensive activities such as cattle raising and the remaining 5% correspond to rough surfaces.

Although rent products such as sugarcane and cotton have increased, the agricultural activity is basically oriented to family consumption. It is a smallholding area with the obliged amount of large estates, mainly dedicated to cattle raising. There are also agro-industries that use sugarcane and cotton as raw material and some tanneries that process bovine leather.

1.4.2 Demographic aspects

1.4.2.1 Population growth. In 1950, the department of Paraguarí had 159.161 inhabitants. Its population grew at a rate of 1.30% in the period 1950 - 1962, reaching 203,012 people in 1962. The next intercensus period (1962 - 1972) showed

a decline in the population growth rate, amounting to 0.44, such that the population in 1972 was only 211.977 inhabitants. The downward trend persisted in the following decade (1972 -1982), and a negative growth rate (-0.36) was observed. The population was then reduced to 204,399 people. The annual average growth rate was -0.07 in the period 1982 - 1992 with a total of 203,012 inhabitants. This drop in the growth rate is mainly attributable to emigration shifts, which grew in importance in the last intercensus period but decreased in the last decade. Consequently, the occupation of the total territory (8,705 km^2) in terms of population density has also varied. In 1950, it was 18.3 inhabitants/km^2, 23.3 in 1962, 24.3 in 1972, 23.4 in 1982 and 23.3 in 1992. This last density coincides with the one of thirty years before (1962).

The proportion of the country's population that live in this department has also decreased in 42 years, being 12.0%, 11.2%, 9.0%, 6.7% and 4.9% of the total country population in 1950, 1962, 1972, 1982 and 1992, respectively. The Department numbers 17 districts of differing surface areas: among the smaller ones, Pirayú has 141 km^2; two of the largest ones are Caapucú and Mbuyapey, with 2.294 and 1.092 km^2, respectively. These specified districts amount to 1.6%, 26.4% and 12.5% respectively, of the total surface area of the Department of Paraguarí, which itself represents 2.1% of the country's territory. As a consequence of population movements from the Department of Paraguarí, in 14 of the 17 districts negative population rates were effected consolidating the tendency of the precedent decades. In the period between 1950 and 1962, ten districts presented growth rates higher than 1% per year; the following intercensus period (1962 - 1972) showed a marked fall in these rates: just three districts surmounted 1% growth. During the period 1950 - 1962, the districts of La Colmena, Mbuyapey e Ybycuí registered the highest yearly growth rates: 3.56%, 3.33% and 2.51%, respectively. However,in the next intercensus period (1962 - 1972), Mbuyapey, Carapeguá and Yaguarón had the topmost values of 2.70%, 1.12% and 1.26%. During the period 1972 - 1982, the only districts which displayed positive growth rates, but lower to 1%, were Mbuyapey, Pirayú and Yaguarón (0.98%, 0.85% and 0.98%, respectively). This information is summarized in table 4.

TABLE 4

DEPARTMENT OF PARAGUARI: TOTAL POPULATION DISTRIBUTED BY DISTRICTS ACCORDING TO NATIONAL CENSUS. POPULATION GROWTH RATES

DISTRICTS	POPULATION				AVERAGE ANNUAL GROWTH RATE		
	1950	1962	1972	1982	1950/62	1962/72	1972/82
Paraguarí	11277	13028	13724	13644	1.25	0.54	-0.06
Acahay	15048	15250	16452	15819	0.11	0.79	-0.40
Caapucú	6885	7161	7768	7257	0.33	0.84	0.60
Caballero	9448	10416	9393	8373	0.82	-1.06	-1.14
Carapeguá	23168	24390	27184	27085	0.43	1.12	-0.04
Escobar	6322	7695	7258	6207	1.65	-0.60	-1.55
La Colmena	3113	4739	5053	4462	3.56	0.56	-1.24
Mbuyapey	5754	8520	10982	12112	3.33	2.70	0.98
Pirayú	9067	10871	10934	11905	1.52	0.06	0.85
Quiindy	14280	15609	16419	16401	0.74	0.52	-0.01
Quyquyhó	6643	7584	7848	7575	1.11	0.35	-0.35
R. González	11443	12785	12485	11303	0.93	-0.24	-0.99
Sapucai	7642	9316	8456	6780	1.66	-0.99	-2.18
Tebicuary-mí	-	5151	5306	4168	-	0.31	-2.38
Yaguarón	14697*	17094	19312	21301	1.27	1.26	-0.98
Ybycuí	18877	25404	25567	22863	2.51	0.07	-1.11
Ybytymí	10244	7999	7826	7144	-2.13	-0.11	-0.90
TOTAL	159161	203012	211977	204399	2.05	0.44	-0.36

* Yaguarón district corresponded to Central Department in 1950.

Source: Population and Human Resources Division. Technical Planning Secretary, Asuncion, Paraguay.

1.4.2.2 Population composition according to age and sex

Following the general characteristics of the country in the preponderance of youth in the population, most of the people in Paraguarí are young: somewhat more than 42% are younger than 15 years of age. This and other indicators follow the general pattern of the national mean values, but the data in this department show an even younger mean age for the population. Mean ages found for the population of the Paraguarí department are 16.5, 15.4, 15.9 and 18.3 years, for the censal years of 1950, 1962, 1972 an 1982, respectively. The decrease of this value between 1950 and 1962 is primarily due to emigration trends of adult population groups, rather than to changes in other growth components (mortality or fertility). Similar medians in 1962 and 1972 could reflect the emigration of homogeneously distributed family groups from Paraguarí, and this trend, which persisted through the following decade, could have resulted in the observed increase of this value. In 1982, the proportion of the population under the age of 15 amounted to 42.1% and that in the 15 - 44 age range, which represents the age group having the most important economic participation, reached 39.3%.

No significant changes in the distribution of the population according to age groups were registered in the succeeding censal years; however, a decrease in the proportion of those in the 15 - 44 age range over the whole population during the period 1962 - 1972 is apparent, and it could be associated to emigration shifts to other departments by this economically active lot; while the increase registered by this age group in the following decade could imply a rise in family migration at earlier stages of their life cycle.

The noticeable drop experienced by the growth rate in all age groups, except the groups of the range 0 - 14 and those above 60 years old in the periods 1962-1972 and 1972-1982 would tend to confirm the hypothesis of family migrations.

With respect to the distribution by sex, a slight female preponderance can be observed according to the census of 1950, 1962 and 1972. In this regard, the respective proportions in these census are 95.6, 96.7 and 98.3 men per 100 women. These findings tend to confirm that the migrations have preferentially involved family groups rather than individuals. In 1982, the data show a ratio of 100.8 men per 100 women. This information is summarized in table 5.

TABLE 5

POPULATION DISTRIBUTION BY AGE GROUPS

IN PARAGUAY AND THE DEPARTMENT OF PARAGUARI

YEARS 1950, 1962, 1972 AND 1982

AGE GROUPS	TOTAL COUNTRY POPULATION				PARAGUARI POPULATION			
	1950	1962	1972	1982	1950	1962	1972	1982
0 - 14	43.8	45.9	44.7	40.8	46.6	48.4	47.1	42.1
15 - 29	26.3	24.1	25.6	28.5	24.0	21.9	22.7	25.3
30 - 44	15.1	15.4	14.4	15.3	14.3	14.7	13.5	14.0
45 - 59	8.7	8.7	9.2	9.1	2.5	8.7	9.5	10.1
60 or more	6.1	5.9	6.1	6.3	6.0	6.3	7.2	8.5
TOTAL	100	100	100	100	100	100	100	100
MEDIAN AGE	17.7	16.5	16.9	18.7	16.6	15.4	15.9	18.3

1.4.2.3 Spatial distribution

The distribution of the population of the department of Paraguarí is shown in Table 6.

TABLE 6

PARAGUARI: DISTRIBUTION OF THE POPULATION

PER GEOGRAPHIC AREA

YEARS 1950, 1962, 1972 AND 1982

YEARS	1950		1962		1972		1982		GROWTH RATES		
ZONE	POPUL.	%	POPUL.	%	POPUL.	%	POPUL.	%	50/62	62/72	72/82
TOTAL	159.161	100	203.012	100	211.977	100	204.399	100	2.04	0.43	-0.43
URBAN	28.063	17.6	35.187	17.3	32.498	15.3	41.279	20.2	1.90	-0.8	2.42
RURAL	131.098	82.4	167.825	82.7	179.479	84.7	163.120	79.8	2.08	0.67	0.95

It is interesting to note the similarity of the ratio of urban vs. rural populations in the census of 1950 and that of 1962, while in the following decade, a decrease in the proportion of urban population is observed. This fact is reflected in the negative population growth rate (-0.8 a.a.). The next period, 1972 - 1982, shows a relative decrease in rural population, accompanied again by a negative growth rate (-0.95 a.a.). These changing ratios during the timelag studied can be understood by the variable incidence of emigration events practiced by both population groups.

In addition, the terms urban and rural, seemingly unequivocal when referred to the city and the countryside, turn out difficult to be defined in this setting, since there is no clear-cut objective transition point between urban and rural areas. The definition of urban areas, used in the population census, is based upon purely administrative criteria, not involving sociologic or demographic considerations. In this way, an urban area is defined as a population center which works as a head of a

district, regardless of its population density, or basic infrastructure. In this context, a rural area can be considered as a complement of an urban area.

In the department of Paraguarí, as shown in table 4, the historical predominance of the rural population shows unsteadily decreasing rates of change: in 1950, 82.4% of the total population of 159,161 inhabitants lived in rural areas; in 1962 this proportion increased slightly, with 82.7% of the total population; in 1972 the proportion rises to 84.7%, while in 1982 it drops, both in absolute and relative terms, to 79.8%.

Table 6 shows that, in the time period between 1950 - 1962, the total departmental population rose by 2.0% a.a., with similar shares of the urban (1.9%) and rural (2.1%) zones; the following decade showed a growth rate of only 0.4%, with a negative urban growth (-0.8%) and a slight buildup of the rural population (0.7% a.a).

During the time period between 1972 - 1982, the global downward tendency of population change, as shown by the negative growth rate (-0.36%), is confirmed. However, the urban growth rate is reversed (2,4 %) and the rural population undergoes a downward shift (-0.95%).

During the period 1972 - 1982, the only districts that kept or increased the proportion of rural population were Carapeguá and Mbuyapey, while all the remaining districts went through an unmistakable drop in the magnitude of this variable.

Considering urban population, it can be seen that 8 of the districts experienced positive rates of more than 2%; 2 of the districts reached values near 2%, while the remaining 5 registered growth rates lower than 1%. Just two of the districts presented negative rates.

1.4.2.4 Urbanization and ruralization rates

The urbanization rate is an adequate indicator for the analysis of this process, since the urban growth rates could eventually be misleading, by computing small absolute increases in the population of scarcely populated zones as large relative increments. Inversely, in a densely populated area even large absolute upswings would produce only small relative increases. The former explanation could account for the shifts observed in Caapucú, Quiindy, Yaguarón, Ybycuí, e Ybytimí.

Calculation of the urbanization and ruralization rates for the departments is useful for classifying them according to the weight attributed to these indicators.

Taking as an average rate of ruralization the rate obtained by the nationwide data during 1972-1982, it is possible to classify the department as to whether they are below or above the average. The same procedure is followed at a departmental level, classifying districts based on their relationship with the urbanization and ruralization rates found for the study unit.

Table 7 reveals Paraguarí as a department with a negative ruralization rate, which could reflect a persistent trend of emigration from the rural communities, triggered by a set of expulsion factors.

Similarly, the urbanization rate turns out to be lower than the national level, pointing out a lack of evolution in this sense. The same kind of analysis can be performed for the inside of the department, taking the districts as study units and the departmental average as the basal rates.

As calculated, the departmental ruralization rate is negative (-7.857), well below the national average (0.609). Within the department, the districts of Paraguarí (-13.431), Caapucú (-16.865), Caballero(-12.540), Escobar (-26.450), Tebicuary-mí (-23.580), Ybycuí (-19.483) Ybytimí (-13.814), comprising 70,516 inhabitants (43.3% of the rural population), have rates below the departmental level of ruralization.

inhabitants (43.3% of the rural population), have rates below the departmental level of ruralization.

TABLE 7

URBANIZATION AND RURALIZATION RATES PER DEPARTMENTS

PARAGUAY, 1972-1982 (per thousand of population)

DEPARTMENTS	URBANIZATION RATE (ur)	RURALIZATION RATE (rr)
Concepción	2.745	18.605
San Pedro	4.973	27.233
Cordillera	6.014	6.121
Guairá	2.962	10.985
Caaguazú	9.597	25.118
Caazapá	0.833	6.857
Itapúa	7.382	19.021
Misiones	8.535	2.681
Paraguarí	**4.217**	**7.857**
Alto Paraná	46.452	30.589
Central	39.915	31.749
Ñeembucú	1.006	4.855
Amambay	28.332	23.413
Western Region	17.956	25.363
TOTAL	15.330	9.609

Source: National Population and Housing Census 1972-1982 D.G.B.C. Rates were calculated for this project.

Urbanization rates $ur = \frac{U2 - U1}{\frac{P1 + P2}{2}} \cdot \frac{1}{n} \cdot K$

Ruralization rate $rr = \frac{R2 - R1}{\frac{P1 + P2}{2}} \cdot \frac{1}{n} \cdot K$

The districts of Acahay (-7.750), Quiindy (-5.831) and Quyquyhó (-3.916), with a total population of 32,659 people, representing 20.1% of the departmental rural population, show rates which are proximate to the department 's ruralization rate, while Carapeguá (0.114), Mbuyapey (8.703), Pirayú (3.161) and Yaguarón (4.427) manifest rates higher than the departmental value, close to the national averages (Table 8).

These negative rates, as expressed above, could reflect emigration practices, caused by the interplay of several factors, such as lack of lands, the exacerbation of small-scale exploitation, deficient education and health, which in all make up for unsatisfactory living conditions.

Concerning the degree of urbanization, the districts having rates superior to the departmental level are Paraguarí (12.847), Caapucú (10.063), Pirayú (5.341), Quiindy (5.722), Sapucai (4.449), Yaguarón (5.367), Ybycuí (8.317) and Ybytimí (4.702), which jointly represent 65.9% of the total urban population of 27,399 inhabitants.

The districts of Acahay (3.766), Caballero (1.058), Escobar (0.757), La Colmena (3.951), Mbuyapey (1.082), Quyquyó (0.376) and Roque González (2.446), which together integrate 25.8% of the total urban population with 10,736 people, have values below the departmental urbanization rate.

The districts of Carapeguá (-0.479) and Tebycuary-mí (-0.443), show negative rates, placing them far below the average departmental mean value.

TABLE 8

PARAGUARI: URBANIZATION AND RURALIZATION RATES BY DISTRICT

YEARS 1972 - 1982 (per thousand of population)

DISTRICTS	RATES	
	URBANIZATION	RURALIZATION
Paraguarí	12,847	-13,431
Acahay	3,766	-7,750
Caapucú	10,063	-16,865
Caballero	1,058	-12,540
Carapeguá	-0,479	0,114
Escobar	**0,757**	**16,368**
La Colmena	3,951	-16,347
Mbuyapey	1,082	8,703
Pirayú	5,341	3,161
Quiindy	5,722	-5,831
Quyquyhó	0,376	-3,916
R. González	2,446	-12,384
Sapucai	4,449	-26,450
Tebicuary-mí	-0,443	-23,580
Yaguarón	**5,637**	**4,427**
Ybycuí	8,317	-19,483
Ybytymí	**4,702**	**-13,814**
PARAGUARI DEPARTMENT	4,217	-7,857

Source: National Population and Housing Census 1972-1982 D.G.B.C. Rates were calculated for this project.

2. METHODOLOGY

2.1 The research problems.

The magnitude of the sanitary problem that Chagas disease represents in Paraguay forces research to be orientated to the search for the most efficient control system. Research was based on the fact that triatomines are domiciliary and the periodicity of their biological cycle together with structural factors such as poverty, lack of information and life styles that favor the appearance and persistence of the disease.

All this element conjunction influenced the elaboration of the following strategy:

i. Education and community participation.
ii. Housing improvement.
iii. Fumigation.
iv. Fumigation and housing improvement.
v. Epidemiological surveillance, during the project and after the project's end through an extension.

This project was developed considering the disease importance, after an analysis of the previous experiences and facing the possibility of performing a multidisciplinary project with community participation, short-term results and possibilities of extending its benefits to other countries of the region. Its main purpose was **to determine the effectiveness of three different intervention methods** to control Chagas disease in rural areas. Insecticide spraying, housing improvement and a combined treatment of spraying and improvement plus formation tasks were included as interventive actions. Results of each intervention were evaluated through the measurement of house triatomine infestation, human *T. cruzi* infection and the disease perception by the population. Because of the social feature of this disease, it was also planned a community approach by community participation in order to document the nature of this participation. Besides, it was also attempted to obtain information about the types of traditional materials locally used for housing improvement.

2.2 Research design

The project was designed in order to provide a comparative analysis of pre and post-interventive actions in three localities.

Two dependent variables were considered in the design:

i. level of positive serology;

ii. level of housing triatomine infestation.

Independent variables are:

i. education/participation level

ii. housing improvement;

iii. fumigation action;

iv. combined action of fumigation/housing improvement.

The project comprises the following phases:

I. Baseline Data of Pre-intervention.

1. Serodiagnosis, vector density and infection level.
2. Environmental and community profiles.
3. Materials and characterization of house-building technology.

II. Community participation.

1. Education/Community participation.
2. Demonstration of interventive actions.
3. Triatomine monitoring.

III. Specific interventions.

1. Insecticide application.
2. Program of housing improvement.
3. Program of housing improvement and one insecticide application.

IV. Analysis and Post-Interventive Evaluation.

1. Serodiagnosis, vector density and infection level.
2. Environmental and community profiles.
3. Materials and characterization of house-building technology.
4. Evaluation and analysis.

V. Utilization of results.

The design can be also presented in this way:

Localities	T1	T2	T3
Ñanduá	M1	X1	M2
Cañada	M1	X2	M2
Ypa'ú	M1	X3	M2

M1 = Measurement in T1, M2 = Measurement in T3

X = Interventive action in T2

X1 = Housing improvement, X2 = Fumigation, X3 = Fumigation + improvement

Previous negotiations on the project extended for more than two years (1986/88). Several technical meetings and a workshop with international experts were carried out in order to determine the global viability of the project. The negotiations finished with the contract signature in March, 1988.

The first phase of the project started in October, 1988 and it extended until May, 1989 including the following central activities:

A. Locality selection.

B. Approach and presentation of the project to the communities.

C. Performance of the baseline diagnosis.

D. Participation diagnosis.

E. Preparation of educational modules.

The interventive actions planned for the second phase were developed from August, 1989 to October, 1991:

A. Demonstration of interventive actions.

B. Operative determination of beneficiary participation in improvement activities.

C. Fumigation.

D. Housing improvement.

E. Fumigation and improvement.

F. Return of information to the communities.

G. Application of educational modules.

In the third phase (October, 1991 to January, 1992) tasks of post-intervention measurement and evaluation of interventive actions were performed considering the objectives.

Basically, the same instruments were used to detect variations in domiciliary infestation, infection levels, attitude towards the vector, maintenance of improved houses, and persistence of epidemiological surveillance. However, the housing component developed an instrument for data collection with certain prospective character, based on the investigation of expectative related to the participation in housing programs of regional range, planned in the Housing National Plan.

The fourth phase was developed in February, 1992 during which a diffusion seminar was held to present the final results.

2.3. Description of pre-interventive actions

The pre-interventive phase followed this sequence:

2.3.1 Organization of the working teams.

A general plan of activities was adopted, centered in four phases common to three working fields: Housing, Health and Social Components. This was the procedure followed:

A. Personnel selection, responsibility definition and integration of working teams.

i) Personnel selection. The project staff was divided into three areas: Housing Component, Health Component and Social Component according to the specific objectives and the project methodology. One team was integrated by people from the Centro de Tecnología Apropiada (Universidad Católica "Nuestra Señora de la Asunción"), and the other two by people from the Instituto de Investigaciones en Ciencias de la Salud (Universidad Nacional de Asunción). Every working area had a coordinator who selected the necessary staff.

ii) Responsibility definition. Roles and responsibilities of the different members of the project were defined by an integrated process of the researchers from the three areas.

iii) Integration of the working teams. Working teams were defined in every area and every specific task had a responsible person. Field work was commonly decided among the staff responsible of the Housing, Health and Social components.

B. Equipment acquisition and material preparation

i) Equipment acquisition. Equipments needed for the performance of tasks leading to the baseline studies were considered a priority under the responsibility of the different area's coordinators.

ii) Material preparation. Every area elaborated its instruments for data collection in the field work as follows:

a. Housing Component:

- A questionnaire to collect technical information, predisposition to housing improvement and attitude towards community work.

- A map of architectonic survey.
- A protocol for photographic documentation.
- Protocols for laboratory experiments on material evaluation and building techniques.

b. Health Component:

- A sectorial plan of field work.
- A card for entomologic survey.
- A card for serological survey.
- A card for the evaluation of triatomine *T. cruzi* infection in laboratory.
- Containers for collection of entomologic samples.
- Paper for collection of blood samples.

c. Social Component:

- Sectorial plan of field work.
- Instrument for collection of socioeconomic, sanitary, educational information on knowledge about Chagas disease and attitude towards the vector.
- Informative material to present the project to the communities.
- Global educational material.
- Specific educational modules (2).
- Maps of house location.
- Statistics documents about the assisted population of the Project.
- Metal plates for house identification.

2.3.2 Community selection.

A. Data from the Population and Housing National census (1982), from the National Service of Malaria Eradication of the Ministry of Public Health and Social Welfare (SENEPA) and a list of the country's rural populations from the General Direction of Statistics and Census were employed for the community selection. Communities with high *T. infestans* infestation were identified based on information from the Ministry of Public Health and Social Welfare (SENEPA).

B. Conditions for community selection. These were the selection criteria adopted according to the conditions of communities selection expressed in the project document:

i) Community size: 40 to 70 houses.
ii) Estimated population: 200 inhabitants.
iii) *Trypanosoma cruzi* positive serology, estimated in 20%.
iv) Domiciliary triatomine infestation: 20 to 40%.
v) Access: easy.
vi) Distance from Asunción: no more than 200 km.
vii) Materials for house building: comparable.
viii) Application of insecticides: none for at least 5 years.
ix) Population stability: high, with low level of migration[3].
x) Health public services: non-existent in the community.
xi) Elementary school: present in the community.
xii) Selected localities should not be close to stock farms and in no cases houses should be included.

C. Preselection and selection of communities. The communities with higher triatomine infestation were selected from those that fulfilled the first selection criteria according to the census. This determination was performed based on SENEPA data. Maps from the selected communities were obtained and 23 localities were, then, visited. The following communities, all from the Department of Paraguarí were pre-selected:

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[3]. This point was impossible to satisfy due to the structural conditions of the rural population in endemic areas that induced migratory behaviors.

Ñanduá (District of Yaguarón): 70 houses, 345 inhabitants.

Ñuatí guazú: (District of Yaguarón): 140 houses, 986 inhabitants ([4]).

Ypa'ú (District of Escobar): 80 houses, 50 inhabitants.

Cerro Verde (District of Sapucai): 70 houses, 439 inhabitants.

Cañada (District of Ybyty-mí): 28 houses, 166 inhabitants.

Data about house number and population correspond to the national census of 1982 available in the execution period of the project (1988).

To corroborate SENEPA data, several trips to the pre-selected communities were made. In each visit, four randomly selected houses were visited to evaluate preliminary triatomine infestation rates and to test the instruments for collection of entomologic, social and housing data that would be applied in the baseline study. Fifty percent of the houses showed the presence of triatomines in all the localities visited. Based on the evaluation of the information collected in the field and related to building details, the degree of triatomine infestation plus the initial appreciation of the degree of social organization and the economic-occupational characteristics of the communities, Ypa'ú, Ñanduá y Cañada were selected by using the Delphi Technique. Then, a cartographic survey was performed by members of the Direction of Statistics and Census.

2.3.3 Community approach.

The totalitarian characteristics of the government at that moment and the permanent control of the security organisms of all the activities related to the rural population forced us to design and execute a strategy for official sectors. Explanatory visits were made to political, army, church and health authorities to inform them about the content and the activities planned of the project. They provided us authorization cards to carry out the projects tasks.

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[4]. House location and conditions would determine the house inclusion in the project even though the baseline number was exceeded.

The approach to the communities was made following these criteria:

i)Approach through the Catholic Church under the assumption that this via was compatible with the participative style of the project and;

ii) Contacts through local authorities (company officer, police chief and authorities of the ruling party) which could have initially placed the project in a vertical perspective.

This vertical bias, that collided with the participative methodology, was gradually modified by personal contacts of the social staff, and then by members of the other areas, as well as by explanations about the benefits and objectives of the project offered to both the communities and the police authorities.

2.3.4 Evaluation of the baseline situation.

The quasi-experimental design chosen compares sanitary indicators related to Chagas disease such as *T. cruzi* infection, domiciliary and peridomiciliary triatomine infestation, as well as the ones related to habitability conditions, knowledge about the disease and attitude towards the vector plus the conditions that favor the vector's presence in the houses, its setting and the degree and nature of the community participation before and after the interventive actions. This approach demands a deep knowledge of the initial conditions of the communities in relation to the above mentioned parameters through the application of the suitable instruments that were again used in the post-intervention period to evaluate, by comparison with the baseline data collected in every community, the impact of the interventions applied in each case.

Every component elaborated the methodology to be applied and the collection instruments for the baseline study as follows:

2.3.4.1 Housing Component.

This aspect has been thoroughly developed in chapter 7 (The survey and collection of baseline data) of the specific report of the Housing Component. In order to locate all the baseline activities, we describe essential aspects of the activities developed by the Housing Component.

A. Previous tasks.

Activities such as planning of the Housing Component actions, based on general and specific objectives, adjustment of the schedule of the housing sector to the general adjusted schedule as well as the elaboration of an action plan to establish the intervention strategy and applied research were included.

B. Survey of the technical-building characteristics and spatial use of houses and peridomestic areas.

Two types of activities were performed in each house:

i) Physical measurement of the houses and peridomiciliary areas, including openings. In every phase, information on the type of material used and its maintenance state were registered. The physical survey of every house also included photographic documentation.

ii) Administrative survey performed to every family head about the socio-demographic composition, house characteristics, space use and predisposition to participate in the project activities.

C. Data processing.

Data collected in Ñanduá, Ypa'ú and Cañada were processed in such a way that every house had a technical card that included survey, physical survey (plan), photos, calculation and approximate intervention costs.

2.3.4.2 Health Component.

The baseline survey of the Health Component comprised three tasks:

A. Identification of houses to include them in the project file in order to make possible the comparison of the information collected by the

different components.

B. Entomologic survey to detect the presence of vectors of the causative agent of Chagas disease and their eventual natural infection, and

C. Serological survey to quantify the level of *Trypanosoma cruzi* infection in the populations of the affected communities before the intervention performance.

2.3.4.2.1 House identification.

Before performing the survey about the health conditions related to the project, every house was identified with a numbered metallic plate placed on a visible site of the outside of the house. Every plate had a number of 3 non-repetitive digits, the first one referring to the locality, and the remaining two for the house identification. The 100 series corresponded to Ñanduá, the 200 to Ypa'ú and the 400 to Cañada. This house identifier acted as a code for the handling of the baseline data and the following processing.

2.3.4.2.2 Entomologic survey.

It included two activities:

A census of triatomine infestation in each community and,

A study of the level of *T. cruzi* infection in the triatomines captured during the census.

A. Infestation census: It was carried out through active search by trained staff. The members of the staff used torches, metallic pincers and properly identified plastic containers. The search was performed at a rate of 1 hour/men/house for the domicile and 0.5 hour/men/house for the peridomicile. Triatomines in their different evolutionary stages as well as the presence of embryonic eggs, fresh or dry feces, and vestiges (hatched eggs, exuviae) were searched. Live insects were collected in appropriate containers and transported to the laboratory for further study. All

the findings were registered in the corresponding card.

B. Determination of the natural infection of triatomines: All the captured triatomines were taxonomically classified and their flagellate infection was evaluated by microscopic exam of the insect feces obtained by abdominal compression. The digestive tubes of the positive insects were cultured in liver infusion triptose (LIT) medium (xenoculture) to identify the infecting flagellates. All the findings were recorded in the corresponding card.

2.3.4.2.3 Serological survey.

This includes population census, blood sample collection, and an evaluation of the *T. cruzi* infection level by ELISA whose results were confirmed by indirect immunofluorescence (IFI).

A. Population census.

Information about names, ages, sex and residence time of the permanent inhabitants was obtained from each head of the household.

B. Blood sample collection.

Blood samples from the individuals were collected by fingerprick using disposable sterile lancets after disinfection of the digital soft part with 95° ethanol. Blood was collected on filter paper until two pre-marked circles corresponding to 50 μl were full. The papers, properly identified by the person and house codes, were immediately sent to the laboratory where they were kept at -20°C until the test performance. This was no later than one month after the sample collection.

C. Evaluation of *T. cruzi* infection by ELISA.

One of the two blood samples collected on filter papers was cut and eluted with a buffer solution up to a 1:50 dilution. This was

processed with an ELISA kit produced by the Department of Production of the Instituto de Investigaciones en Ciencias de la Salud and it was used following the procedure recommended by the manufacturer to detect antibodies against *T. cruzi*. The antigen used to coat the microplates was prepared by sonication of *T. cruzi* epimastigote forms. The reading of the quali and quantitative results was made in an ELISA plate reader (Titertek Uniskan I connected to an Epson LX-800 printer). The samples with equal or higher reading than a reference sample with a 1:20 IFI titer were considered positive. The ELISA reagents for *T. cruzi* from the Instituto de Investigaciones en Ciencias de la Salud have been successfully subjected to a external quality assessment in the Instituto Rene Rachou from the Fundación Osvaldo Cruz, Belo Horizonte, Brazil.

D. Serological confirmation by indirect immunofluorescence. The second blood sample of the ELISA positive samples was eluted up to 1:40 dilution and the presence of antibodies against *T. cruzi* were made with an IFI technique using antigens from *T. cruzi* epimastigotes (Multilab, Buenos Aires, Argentina). An ITFC-antihuman IgG conjugate (Sigma, St. Louis, USA) was used in a 1:800 dilution. Ten percent of the ELISA negative samples were randomly selected to discard false negatives. Serological test results were returned to the community inhabitants in written reports and oral explanations through home visits made by the staff of the Social Component.

The field working teams from the Housing and Health components coordinated their visits for data collection. This produced a better work planning, task division per zones, unified criteria for approaching people and complementation of the areas avoiding duplications in the working teams and excessive bothering to the communities.

2.3.4.3 Social Component.

During the baseline study the social component worked on the social viability of the project, facing the communities and the socio-demographic survey with emphasis on knowledge, attitudes and practices of vector and disease control. In order to achieve these objectives, the following activities were developed:

2.3.4.3.1 Community preparation.

The first activity was to inform the governmental authorities and priests about the project objectives and the actions that would be developed in order to preserve the transparency and political viability of the job. Then, communities leaders were identified so that the different components of the project had an easier access to the inhabitants. All heads of the households were invited to informative meetings about Chagas disease and the objectives and actions proposed to control it. Through these contacts, inhabitants were informed about the purposes and operative modalities of the project and their consent for applying the housing, health and socioeconomic surveys was obtained. The process of community approach included a cartographic survey performed by technicians from the Division of Statistics and Census. The identification of leaders and volunteers reasonably identified with the project purposes facilitated the house localization in each community as well as the approach to the inhabitants in a attempt to overcome the natural distrust of the farmers to activities conducted by outsiders. The social component provided information about attitudes, time availability and receptivity towards the surveyors of the different areas during all the process.

Aspirations and interests different from the project objectives, identified trough permanent contacts with the communities, were supported in order to stimulate inhabitant participation in group activities. Improvements of access vias, building of a church and attention of specific health problems were derived to the corresponding official institutions, charitable institutions and good-will people, depending on the nature of each problem.

2.3.4.3.2 Socioeconomic survey.

This instrument was developed by the Social Component and adjusted by the participation of all the affected areas and the adviser of Epidemiology, Dr. Theresa W. Gyorkos in order to make it compatible with the data collection of the Health and Housing Components. Also, this avoided the duplication of the required information. The final version of the instrument allowed to know the demographic, cultural, economic, occupational, educational and sanitary characteristics as well as levels of organizations of each community. Besides, it includes an important chapter referring to knowledge, attitude and practices towards Chagas disease and its vector.

2.3.5 Return of the information obtained in the baseline study.

After finishing the baseline study and the analysis of the collected data, a strategy for returning the information to the communities was developed. The **return** process of the information was based in the equality criteria. General meetings were held, during which the data collected were exposed and discussed. In this way, it was attempted to share the knowledge obtained from the involved populations.

The purposes of the data return were:

A. That the participants acquire a more objective knowledge of their own reality;

B. To jointly identify priority problems;

C. To know the population reactions to the results in order to define action guidelines.

D. To stimulate the population participation in those aspects in which their personal interests coincided with the project aims.

During the general meetings, housing, population and educational subjects as well as knowledge about the disease and the vector, house infestation and serological situation were discussed.

In the Housing Component, the reasons for the architectonic and photographic surveys were explained. It was also clarified that these activities acted as references to detect the most common problems in the community constructions and the alternative solution based on housing improvement. Besides, it was emphasized the importance of collective and solidary participation in all the improving and maintenance of the houses to establish two concepts: house as an access via to a more worthy life and that a well conserved house means health. It was pointed out that the Centro de Tecnología Apropiada would give technical-building assessment by a building worker that would work with every family to show them building procedures and to share the experiences plus periodical visits of a technical staff. In those meetings, inhabitants chose the first house to be improved in each community in such a way that the whole process could be observed by all the inhabitants.

In the health area, the return of information was performed at two levels; one about the general conditions of human infection and house infestation and other for the individual situation, based on a basic equality principle that faced a strong alternative: positive or negative serology. It was attempted to deprive of any showiness the fact of being seropositive and to reach a balance that tended either not to minimize the possibilities of having developed a pathology related to Chagas disease or to excessively dimension it considering the structural situation of deprivation of the rural world and the non-existence of really effective therapeutic measurements, centered on symptomatic treatment and generally unaccessible to small farmers for geographic, economic and cultural reasons.

The information was provided house by house, except in the case of the children, in a dialogue situation that allowed relief manifestations and an explanation adequate to the requirements of the affected people. It was tried to provide objective information about the infection implications, establishing the following criteria to consider that the information was correctly transmitted to the infected people:

A. That the information were provided in a urgent period to all communities, personally and privately to each head of the household in the presence of the person/people with positive serology. This information should be provided in Guarani and supported by a official written result.

B. That the affected person understood the difference between being infected and having the disease as well as the importance of a yearly periodic control. The understanding of these concepts should be probed by questions made at the end of the interview.

C. That the 100% of the infected people had the real possibility of having made a free electrocardiographic test in a fixed date.

The electrocardiographic test was offered to them under the assumption that the most limiting consequences of the disease are the cardiovascular complications to send, then, the pertinent cases to a formal health system. This system of return of the serological data allowed a certain supporting to those that reacted with desperation and helplessness signs when they received the information, although most reacted with the traditional farmer style, laconic fatalism. The ET members lived this situation with a hurtful futility sensation, exacerbated by the pathetic condition of the infected children who have no other choice but waiting. However, the existence of seropositive children acted as a strong motive that induced the parents to attitudes leading to the preservation of hostile conditions for the vector already initiated by the interventive actions and educational modules. In this way, the negative experience was reverted to consolidate attitudes tending to the vector eradication.

2.4 Description of the interventions

The interventions comprised fumigation and housing improvement, that were independent variables differentially applied to the project communities, and a educational-organizational intervention that facilitated the interventions and provided

information about the disease and its control. The interventions were conducted in two complementary stages: an initial one, which consisted on a demonstration based on the assumption of integrated formation to concrete acts, and a second that were the interventions themselves performed in a systematic way.

2.4.1 Demonstration of the intervention.

2.4.1.1 House selection for demonstration of the intervention.

At the beginning of the interventive actions, the selection of the houses to be improved was in charge of the communities. This modality persisted until the coordination and ordering demands required a higher systematization. In this way, some operational conclusions were obtained: the community participation in the improvement was defined as a material aport and manpower. The latter was defined as the work of one man, who did not live in the house, per day plus the work of the members of the involved family. Later, it was established the criteria of giving priority to those who were more interested on cooperating in the improvement of other people's houses as a method of recognizing and appraising that attitude. This criteria, functional and pragmatic, had the undesired effect of interfering in the spontaneous solidarity of the communities by the introduction of elements that cab be generally identified as **economic rationality**, having the consequence of reaching a benefit related to their own participation in the improvement. Thus, old people, deprived of physical strength for working and without means to contract other people, were relegated to the last positions with the consequent risk of being left out of the program due to time and resource consumption because there were more houses than the initially planned in the design in both communities.

At the beginning of the project, the social and housing improvement components (CTA) held previous meetings with the farmers in order to precisely fix who would immediately integrate the improvement program and who would help in the corresponding supporting tasks. In order to do this, lists including the volunteers' names and the days assigned for performing the improvement work with a follow-up

of the participation of the groups' members were elaborated. These lists were weekly controlled to detect who had complied and who did not. In the latter cases, the people were contacted, the causes of the non-fulfillment were found out and a solution to the difficulties was worked out. This modality work, which defined the community participation operatively as "the work of one person - not from the family group - per day during the timelag that the improvement of a determined house required", worked well until the first difficulties appeared. They were partially related to insufficient comprehensiveness of the building workers who felt supported and constricted at the same time, and by the demands of the educational situation that required a more specific relevant attention. Therefore, the educational activities took more time than the specific tasks for supporting the housing improvement. In some ways, the organization work for the improvement limited the role of the social component to some kind of "process helper" in detriment of a wider and more embracing role. The adjustments performed attempted to balance the requirements of the improvement support with the objective educational necessities of the project.

2.4.1.2 Demonstrations in housing improvement and fumigation.

The demonstration of the improvement and fumigation was carried out with the purpose of systematizing experiences in three directions:

A. That the community approaches the project, sees the benefits obtained and dispels the initial distrust and to stimulate the community participation in the improvement and fumigation activities.

B. To test building technical tests, control cards, to evaluate the real time needed for the improvement and to evaluate the cost per unity according to the volume of work and the fumigation conditions.

C. To test the modality participation of the community.

The demonstrations started the 1st of August of 1989 in the communities of Ypa'ú and Ñanduá, previous verification of the working group conformation while fumigation demonstrations started later.

2.4.2 Interventive actions.

2.4.2.1 Housing improvement

The improvement intervention was carried out by the Housing Component with the purpose of creating hostile environmental conditions for the vector and acquiring a visual control of the vector, having a ventilated, light and crack-free house at the end of the intervention. The work operatively concentrated in the following points: improvement of the roofs by plastering, wall covering with plaster or wall rebuilding, painting of walls and roofs (inferior face) and widening of openings (doors and windows). In some specific cases, when house conditions did not allow a proper improvement, new houses were built. Every improvement was preceded by a negotiation with the owner to define the specific supply of material and to reach an agreement about manpower.

The detailed treatment of the improvement process is available in Chapter 9 "The improvement interventions" of the specific report of the Housing Component.

2.4.2.2 Fumigation

The intervention, conducted by the Health Component, comprised the fumigation tasks with insecticide and the corresponding evaluation of the residual effect. This activity was carried out in Cañada and Ypa'ú, where the interventions performed were spraying and spraying plus improvement, respectively. Operatively, community participation was limited to the preparation of the houses to homogenize the conditions of the insecticide application. In this way, it was avoided the possibility bias inherent to different application systems practiced by the inhabitants.

2.4.2.2.1 Community preparation.

A. Cañada: This community, from the Ybytymí district,

Department of Paraguarí, was selected for the insecticide treatment. The intention of fumigating all the houses from the communities was communicated to the householders in a general meeting during which it was required their approval. In this meeting, the expected benefits of this intervention were communicated and cooperation from the inhabitants was asked in order to prepare the houses for the insecticide application. They were fully informed on the hazards of the insecticide and the precautions necessary in dealing with them. Oral consent was required from the heads of the households which was unanimous. One week before application, the date for the campaign start was communicated and a written report of the planned intervention was delivered to each householder.

B. Ypa'ú: This community, from the district of Gral. Escobar, Department of Paraguarí, was selected for the fumigation and housing improvement intervention. A demonstration of the safe use of the insecticides was carried out when the first house to be improved was sprayed. Every head of the household reached an agreement about the extension and conditions of improvement of their houses. They were informed that the intervention required a previous treatment with the insecticide and their consent was asked. The commitment to start the improvement in a period no longer than 30 days after the insecticide application was established as indispensable condition.

2.4.2.2.2 The insecticide.

A synthetic pyrethroid insecticide, lambdacyhalotrine (OMS 3021), which is purchased in the form of a wettable powder containing 10% active substance (Icon WP10, ICI, Brazil), presented in water-soluble packages of 75 grams (0.75 g active/package) was used.

2.4.2.2.3 Dilution and application conditions.

Every package was dissolved in 10 liters of water. Insecticide application was performed with a 20-liter "JACTO" PJH fumigator, 8000 series, (JACTO, Pompeia, Brazil), equipped with hose and nozzles 80.02E at an average rate of 1010 ml/min. The spraying was done holding the nozzle about 45 cm away from the surface of application, and spanning a 70 to 75-cm wide area during spraying. Dose was calculated according to manufacturer's instructions; i.e., 30 - 50 mg/cm^2. Before applying the insecticide, all cooking utensils, food and clothes were taken out of the houses as well as domestic animals. Spraying was performed on the walls, both outside and inside, and the lower surface of the roofs and the eaves. Peridomiciliary installations were also sprayed such as store houses, stables and toilets, as well as the frameworks of the beds and the outside of the closets. Recommendations were to keep the windows closed up to 2 hours after the insecticide application and to ventilate the house before bringing back all the household goods. The spraying was executed by two teams composed of two people each, a fumigator and a supervisor. There was an application register for each house where dose data, volume applied, time of application and surface treated were recorded. Estimations about the treated surface per house was performed by the Housing Component of the project.

2.4.2.2.4 Evaluation of the residual effect.

All the treated houses were regularly visited by the project staff to evaluate the infestation situation by direct search, detection of vestiges on calendars or by controlling the insects captured and conserved by the householders. Besides, a biologic control of the residual effect of the insecticide on *Triatoma infestans* nymphs applied on treated surfaces was carried out. This control was done **one, six and twelve months** after treatment in the houses of Cañada, by exposing ten nymphs of *T. infestans* on the inside walls of three houses that presented different treated material; namely wood, wattle with mud and wattle painted with lime. The insects were kept on the treated surfaces with plastic cones held with nails. Initially, third instar *T. infestans* nymphs exposed during 24 hours were used. Later, fifth instar

nymphs were exposed for 72 hours. First instar nymphs were used in the evaluation at 12 months after fumigation. In all cases, insects recovered after the time exposition to the treated surface, the number of survivors was recorded and these insects were transported in filter paper containers for their observation in the laboratory where the late mortality or recovery was also recorded. The same houses were used in the different evaluations, but the insects were applied on different sectors of the wall.

2.4.2.3 Educational action.

The educational-organizational aspect was a common element to the three communities with emphasis on the information related to the interventive actions but appropriate to the singularity of each community. One of the relevant aspects is related to the ways, conditions and feasibility of the community participation.

2.4.2.3.1 Community participation.

Taking into account the participative scheme, the Social Component developed activities in order to reach a consensus from the community in such a way that the inhabitants favorably considered the project and simultaneously stimulated them to participate in the interventive actions. Tasks related to the community organization were added to the scheme of periodical meetings.

2.4.2.3.2 Implementation of educative modules on health and interventions-related topics.

Three educational modules, which had information about Chagas disease, its vector and causative agent, chain clearance and control systems, were elaborated. The zoonotic and domestic cycles, infection vias, causative agent, vector insect and the danger that house infestation represent were approached. It was emphasized that the physical characteristics of houses and some forms of the life style of the farmer favor the appearance and persistence of the vectors that are parasite carriers. It was also stressed that it was necessary to revert this situation to eliminate the risk of acquiring the disease. This was particularly difficult because the natural living together with the insects, the frequent absence of perceptible and immediate symptoms and the timelag from the contact with the vector to the eventual appearance of serious symptoms and visible consequences exert a **covering** of the **danger** the disease represents. This is specially true when the main problem is the **daily survival**. For most people from rural areas, the daily problems are just **eating,** and it does not matter an insect that might bite or not and if it does, the disease might appear or not; and if it does, it takes 10, 15 or 20 years which is an extremely far and uncertain timelag when the current problem is to satisfy, with a lot of difficulties, some of the basic needs. Although all meetings had educational character, modules were specially designed to provide appropriate and opportune information with a first aid and elemental hygiene components. In the beginning, meetings were mainly attended by men but later women and children also came and a bigger diffusion of the project objectives was obtained at family level and a more constrained application of the contents of the modules was reached. An instrument for data collection about knowledge and attitude was applied in order to measure the retention level of the information given at the meetings. The result was unfavorable because a high proportion of the interviewed people answered inadequately to the questions made. This is no surprising as the persistence of the conscientious focus of assimilated information is of few weeks and tends to dilute, if it does not constitute part of the daily routine. However, this was considered as a situation that should be corrected and

domiciliary visits, house by house, were made and the topics of the educational modules were approached in an informal (colloquial) way. This time, the result was better because most women interviewed demonstrated to have more information than what was collected by the survey, suggesting that the evaluations should be made by combining these two systems. Nonetheless, when the triatomines **disappeared** because of the house improvement, the **only** visual contact with the disease is covered. In this way, the information related to the disease tends to be relegated and finally forgotten induced by the non-existence of the empiric reference for orientation. This shows what is obvious: the best strategy to achieve prevention attitudes in relation to Chagas disease is to educate children with appropriate information and to use a clear pedagogical mediation in relation to the attitudes to be assumed. Probably, this is the most effective way to generate and consolidate prevention life styles against this and any other disease.

2.5 Description of the post-interventive actions.

2.5.1 Evaluation of the final situation.

The same instruments for data collection were used in the post interventive measurements. However, the Housing sector used a different instrument which inquires into the disposition of participating in housing official programs.

After 21 months, the effects of the interventive actions were evaluated by the same instruments (surveys) and measurements used in the initial phase; namely:

A. serological survey

B. survey for house triatomine infestation (domiciliary and peridomiciliary)

C. level of natural *T. cruzi* infection of the triatomines.

D. socioeconomic survey.

E. housing survey, with an instrument different from the initial one.

2.5.1.1 Housing Component.

The methodology employed for the evaluation of the final situation on housing is described in the specific report of Housing Component (Chapter 15).

2.5.1.2 Health Component.

2.5.1.2.1 Serology.

In the post-intervention period, the methodology employed in the baseline was repeated for the evaluation of serological status. This included the census of the population, collection of blood samples on filter paper, serological screening for anti-*T. cruzi* antibodies by ELISA (qualitative and quantitative) and confirmatory test by indirect immunofluorescence. A detailed description of these methods an be found on section 2.3.4.2.3 of the present report.

2.5.1.2.2 Vectors.

A. Triatomine monitoring at Cañada.

One month after fumigation calendar and plastic bags were placed in each house in order to detect traces of triatomines or to confirm their presence, respectively. A complete explanation about the use of both instruments was provided to the inhabitants of each house. Six months after spraying, the field work team of the IICS performed an active search of triatomines in all of the houses of the community. At that time calendars and plastic bags were also removed and substituted by a new set. The calendars were examined looking for insect traces (feces) and captured insects kept on plastic bags were properly identified.

B. Triatomine monitoring at Ypa'ú.

The houses of this community received an insecticide application prior to improvement. After the completion of house improvement, the infestation monitoring was performed by three different means:

i) Active search of triatomines by the field work team of the IICS, every six months.

ii) Calendars placed on the wall of the houses for detecting insect traces were removed and replaced every six months.

iii) Plastic bags placed on the wall of the houses for collecting insects captured by the inhabitants were removed and replaced every six months. Inhabitants were asked to place there any triatomine-like insect captured and killed.

The researchers decided to place calendar in the houses, even before the interventions, in order to cooperate with educational activities of the Social Component and to provide more information on the infestation status of that houses declared as negative in the baseline inspection. Once the houses received the intervention, calendars were removed and replaced

2.5.1.3 Social Component

In the post-intervention period demographic characteristics, knowledge, attitudes and practices concerning Chagas disease and the vector were evaluated using both a procedure and a questionnaire like those utilized during baseline study.

3. RESULTS

3.1 Housing Component.

The results of this component are exposed in detail in the technical report of Housing Component. The topics on "Results" are included in the following chapters:

"Baseline data and survey" (Chapter 7)

"Type of houses in the communities" (Chapter 8)

"Housing improvement interventions" (Chapter 9)

"Intervention costs" (Chapter 10)

"The 'secret' story of the interventions" (Chapter 11)

"Building materials and procedures for housing improvement" (Chapter 14).

"The final evaluation survey" (Chapter 15)

"The results of interventions" (Chapter 16)

3.2 Health Component.

3.2.1 Serology.

One hundred and forty nine (19.6%) individuals from a total of 762 people studied showed positive serology for *T. cruzi* infection through ELISA technique in the three communities. Hundred percent of the positive cases were confirmed as positive by indirect immunofluorescence for *T. cruzi*. Ten percent of the negative samples with ELISA test, randomly chosen, were also negative by indirect immunofluorescence.

Considering the serological positive results in the different communities, values of 14.0%, 19.4% and 28.5% were obtained for Ñanduá, Ypa'ú and Cañada respectively (Table 9).

TABLE 9

PREVALENCE OF *T. cruzi* INFECTION DETERMINED BY ELISA

PRE-INTERVENTION PERIOD

COMMUNITY	NEGATIVE CASES (%)	POSITIVE CASES (%)	TOTAL (%)
ÑANDUA	228 (86.0)	37 (14.0)	265
YPA'U	262 (80.6)	63 (19.4)	325
CAÑADA	123 (71.5)	49 (28.5)	172
TOTAL	613 (80.4)	149 (19.6)	762

The distribution of the positive results in reference to the titre had a different behavior in the three communities. In Cañada, the proportion of results with titre higher than 1:80 was three times higher than in Ñanduá and twice higher than in Ypa'ú. The most frequent positive titre were 1:40, 1:40 and 1:80, and 1:80 in Ñanduá, Ypa'ú and Cañada respectively (Table 10).

TABLE 10

DISTRIBUTION OF ELISA REACTION TITRE FOR *T. cruzi*

IN EACH COMMUNITY. PRE-INTERVENTION PERIOD

RESULTS	ÑANDUA (%)	YPA U (%)	CAÑADA (%)	TOTAL (%)
NEGATIVE	228 (86.0)	262 (80.6)	123 (71.5)	613 (80.4)
1:20	9 (3.4)	8 (2.5)	10 (5.8)	27 (3.5)
1:40	13 (4.9)	20 (6.2)	4 (2.3)	37 (4.9)
1:80	8 (3.0)	20 (6.2)	14 (8.1)	42 (5.5)
1:160	6 (2.3)	6 (1.8)	9 (5.2)	21 (2.8)
1:320	-	5 (1.5)	7 (4.1)	12 (1.6)
1:640	1 (0.4)	1 (0.3)	5 (2.9)	7 (0.9)
1:1280	-	3 (0.9)	-	3 (0.4)

That situation was reflected in the values of the geometrical mean of the inverse of the ELISA titre in the positive populations as well as in the total populations. In both cases, the highest geometrical means were observed in Cañada with values of 97 and 19 for the positive and the total population respectively. The lowest titre were found in Ñanduá with geometrical means of the inverse of the titre of 53 and 13 for the positive cases and the general population respectively (Table 11).

TABLE 11

DISTRIBUTION OF THE GEOMETRICAL MEAN OF THE INVERSE OF ELISA TITRE FOR *T. cruzi* IN EACH COMMUNITY. PRE-INTERVENTION PERIOD

COMMUNITY	POSITIVE CASES	TOTAL POPULATION
ÑANDUA	53	13
YPA U	76	15
CAÑADA	97	19
TOTAL	75	15

Analyzing the distribution of serology in relation to age, positive cases were found in all age groups. The strata of 10 to 14, 40 to 44, and 60 to 64 showed the highest prevalence with 10, 10 and 12 positive cases respectively. Comparison of seropositivity adjusted to age did not show any significant difference among the three populations. However, the positive cases distribution showed different tendencies in the three communities. A higher number of positive cases was observed in the strata of 5 to 9 and 15 to 19 in Ñanduá. In Ypa'ú, positive cases were more homogeneously distributed and most cases were between 5 to 9 and 60 to 64 strata. In Cañada, positive cases followed a bimodal distribution with an important number of cases in the stratum of 25 to 29 years and between 60 to 64 and 75 to 79 strata (Table 12).

TABLE 12

DISTRIBUTION OF RESULTS OF ELISA FOR *T. cruzi* BY AGE GROUPS IN EACH COMMUNITY PRE-INTERVENTION PERIOD

AGE GROUPS	ÑANDUA			YPA U			CAÑADA		
	TOTAL	POSITIVE CASES	%	TOTAL	POSITIVE CASES	%	TOTAL	POSITIVE CASES	%
0-4	45	1	2.2	46	2	4.3	20	2	10.0
5-9	44	7	15.9	62	5	8.1	19	2	10.5
10-14	28	3	10.7	37	4	10.8	22	2	9.1
15-19	21	6	28.6	22	5	22.7	9	0	0.0
20-24	15	2	13.3	21	3	14.3	15	4	26.7
25-29	18	2	11.1	24	6	25.0	15	7	46.7
39-34	14	1	7.1	19	3	15.8	6	2	33.3
35-39	15	1	6.7	14	5	35.7	10	4	40.0
40-44	13	2	15.4	11	4	36.4	2	1	50.0
45-49	9	2	22.2	14	5	35.7	12	3	25.0
50-54	10	2	20.0	11	4	36.4	4	2	50.0
55-59	6	3	50.0	12	3	25.0	11	2	18.2
60-64	8	1	12.5	10	6	60.0	9	5	55.6
65-69	7	0	0.0	5	2	40.0	6	4	66.7
70-74	1	0	0.0	9	2	22.2	3	2	66.7
75-79	8	2	25.0	5	2	40.0	5	5	100.0
80 or more	3	2	66.7	3	2	66.7	4	2	50.0
TOTAL	265	37	14.0	325	63	19.4	172	49	28.5

Seven point eight percent of positive cases were observed among the children up to seven years old, distributed as follows: 7.4% in Ñanduá, 8.9% in Ypa'ú and 10.0% in Cañada. The geometrical mean of the inverse of the ELISA titre were 70 for the positive cases in the three communities, and 30, 88 and 160 for the positive children in Ñanduá, Ypa'ú and Cañada respectively. In the population of seronegative and seropositive children up to 7 years old the geometrical mean was 12, corresponding the values of 11, 12 and 13 to the children of that age group in Ñanduá, Ypa'ú and Cañada respectively (Table 13).

TABLE 13

DISTRIBUTION OF THE GEOMETRICAL MEAN OF THE INVERSE OF THE ELISA TITRE FOR *T. cruzi* IN CHILDREN OF EACH COMMUNITY PRE-INTERVENTION PERIOD

COMMUNITY	POSITIVE CASES	TOTAL POPULATION
ÑANDUA	30	11
YPA'U	88	12
CAÑADA	160	13
TOTAL	65	12

Concerning sex, distribution of positive cases was generally homogeneous in the three communities. However, in Cañada 56% of the women were serologically positive while men showed a 30% of positive cases. Although this distribution had a probability of 0.951, it showed a remarkable tendency of women to present a higher rate of infection in this community (Table 14).

TABLE 14

DISTRIBUTION ELISA RESULTS FOR *T. cruzi* ACCORDING TO SEX IN EACH COMMUNITY. PRE-INTERVENTION PERIOD

RESULTS	TOTAL (%)		ÑANDUA (%)		YPA'U (%)		CAÑADA (%)	
	MALE	FEM.	MALE	FEM.	MALE	FEM.	MALE	FEM.
POSITIVE	72 (9.4)	77 (10.1)	18 (6.8)	19 (7.2)	30 (9.2)	33 (10.2)	24 (14.0)	25 (14.5)
NEGATIVE	323 (42.2)	290 (38.1)	120 (45.3)	108 (40.8)	124 (38.2)	138 (42.5)	79 (45.9)	44 (25.6)
TOTAL	395 (51.8)	367 (48.2)	138 (52.1)	127 (47.9)	154 (47.4)	171 (52.6)	103 (59.9)	69 (40.1)

The evaluation of the serological situation was repeated after performing the different interventions. The methodology applied was identical to the one used in the pre-intervention period. In this occasion, 621 people were studied. Five hundred twenty five (84.4%) people had negative serology and 96 (15.5%) had positive serology for *T. cruzi* infection by the ELISA technique in the three communities. Only two positive cases were not confirmed by the indirect immunofluorescence for *T. cruzi*. The two cases corresponded to patients that had suffered *T. cruzi* acute infection and successfully received antiparasitic treatment. Ten percent of the negative ELISA cases, randomly chosen, were also negative in the indirect immunofluorescence test. The following results of serology were obtained in the three communities (Table 15):

TABLE 15

FINAL PREVALENCE OF *T. cruzi* INFECTION DETERMINED BY ELISA

COMMUNITY	NEGATIVE (%)	POSITIVE (%)	TOTAL	VARIATION %
ÑANDUA	200 (87.3)	29 (12.7)	229	- 1.3
YPA'U	216 (83.1)	44 (16.9)	260	- 2.5
CAÑADA	109 (86.2)	23 (17.4)	132	- 11.1
TOTAL	525 (84.5)	96 (15.5)	621	- 4.1

The variations in the patients serology of the pre and post-intervention were due to several factors such as the loss of cases (dropouts) in the follow-up period. A total of 118 cases were lost, 62 seropositive and 56 seronegative. This distribution was specially unequal in Cañada where 21 positive cases and 9 negative cases were lost (Table 16).

TABLE 16

CASES LOSS IN THE SEROLOGICAL EVALUATION BETWEEN THE PRE AND POST-INTERVENTION PERIOD

COMMUNITY	LOSS OF SEROPOSITIVE CASES	LOSS OF SERONEGATIVE CASES	TOTAL LOSS OF CASES
ÑANDUA	13	25	38
YPA'U	28	22	50
CAÑADA	21	9	30
TOTAL	62	56	118

Distribution of positive results according to titre had again an odd behavior in the three communities. In Ñanduá, the highest titre found was 1:160 and the most frequent were 1:80 and 1:20. In Ypa'ú, the highest titre was 1:320, and the most frequent was 1:160. The distribution in Cañada was more homogeneous with a maximum value of 1:320 and the most frequent value was also 1:320 (Table 17).

TABLE 17

DISTRIBUTION OF ELISA TITRE FOR *T. cruzi* IN EACH COMMUNITY POST-INTERVENTION PERIOD

RESULTS	ÑANDUA (%)	YPA'U (%)	CAÑADA (%)	TOTALS (%)
NEGATIVE	200 (87.3)	216 (83.1)	109 (82.6)	525 (84.5)
1:20	10 (4.4)	11 (4.2)	2 (1.5)	23 (3.7)
1:40	7 (3.1)	2 (0.8)	3 (2.3)	12 (1.9)
1:80	11 (4.8)	4 (1.5)	2 (1.5)	17 (2.7)
1:160	1 (0.4)	22 (8.5)	3 (2.3)	26 (4.2)
1:320	-	5 (1.9)	6 (4.5)	11 (1.8)
1:640	-	-	3 (2.3)	3 (0.5)
1:1280	-	-	4 (3.0)	4 (0.6)

The geometrical means of the inverse of ELISA titre for the positive populations, the whole populations and the different communities were lower than the values observed in the pre-intervention period. The highest values were seen in Cañada in the seropositive and in the general population with values of 216 and 17 respectively. The lowest values were found in Ñanduá, 43 and 12 for the positive cases and the general population respectively. Intermediate values were found in Ypa'ú in both populations (Table 18).

TABLE 18

DISTRIBUTION OF THE GEOMETRICAL MEAN OF THE ELISA TITER FOR *T. cruzi* IN EACH COMMUNITY. POST-INTERVENTION PERIOD

COMMUNITY	POSITIVE CASES	TOTAL POPULATION
ÑANDUA	43	12
YPA'U	91	14
CAÑADA	216	17
TOTAL	89	14

A shifting of the positive cases to higher age groups was observed, specially in the groups of 5 to 9, 25 to 29, 35 to 39 and 45 to 49 years old in the whole population. There were no positive cases in the group of 0 to 4 years old in Ñanduá. A diminution was found in the 5 to 9 and 15 to 19 groups, and a shifting of the positive cases was observed in the age groups up to 14 years old. There were no relevant changes in the remaining groups. In Ypa'ú, positive cases were accumulated in the 40 to 44 group and there was a new case of a child born from an infected mother during the project performance. There were two positive cases in the group of 0 to 4 years old that corresponded, one to a pre-existent post-treatment remaining serology and the other to a child from a family incorporated recently to the community. In this community, positive cases were mainly in the group of 60 to 64 in the post-intervention.

Comparison of the seropositivity rates adjusted to age showed no significant differences among the communities during the post-intervention period (Table 19).

TABLE 19

DISTRIBUTION OF THE RESULTS OF ELISA FOR *T. cruzi* PER AGE GROUP IN EACH COMMUNITY. POST-INTERVENTION PERIOD

AGE GROUPS	ÑANDUA			YPA'U			CAÑADA		
	TOTAL	POSITIVE CASES	%	TOTAL	POSITIVE CASES	%	TOTAL	POSITIVE CASES	%
0-4	40	0	0.0	39	2	5.1	21	2	9.5
5-9	42	4	9.5	51	3	5.9	17	1	5.9
10-14	35	7	20.0	39	3	7.7	10	0	0.0
15-19	8	2	25.0	16	1	6.3	4	0	0.0
20-24	11	3	27.3	10	4	40.0	8	0	0.0
25-29	10	2	20.0	16	2	12.5	12	4	33.3
39-34	10	0	0.0	11	2	18.2	6	1	16.7
35-39	12	0	0.0	8	1	12.5	4	2	50.0
40-44	14	2	14.3	16	7	43.8	7	1	14.3
45-49	6	0	0.0	5	2	40.0	10	1	10.0
50-54	8	2	25.0	16	5	31.3	4	0	0.0
55-59	7	3	42.9	3	0	0.0	8	1	12.5
60-64	7	2	28.6	8	4	50.0	9	6	66.7
65-69	4	0	0.0	7	3	42.9	3	1	33.3
70-74	6	0	0.0	5	0	0.0	3	0	0.0
75-79	6	1	16.6	6	3	50.0	2	2	100.0
80 or more	3	1	33.3	4	2	50.0	4	1	25.0
TOTAL	229	29	12.7	260	44	16.9	132	23	17.4

In this period, 3.7% positive cases were found in children up to 7 years old, distributed as follows: 0% in Ñanduá, 5,9% in Ypa'ú and 6.7% in Cañada. The geometrical means of the inverse of ELISA titre were 50 for the positive cases in the three communities, and 0, 57, and 40 in the positive cases of Ñanduá, Ypa'ú, and Cañada respectively. The geometrical mean for the general population of seropositive and seronegative children was 11 with values of 10, 11 and 11 for the children of that age group in Ñanduá, Ypa'ú and Cañada respectively (Table 20).

TABLE 20

DISTRIBUTION OF THE GEOMETRICAL MEAN OF THE INVERSE OF THE ELISA TITRE FOR *T. cruzi* IN CHILDREN OF EACH COMMUNITY POST-INTERVENTION PERIOD

COMMUNITY	POSITIVE CASES	TOTAL POPULATION
ÑANDUA	0	10
YPA'U	57	11
CAÑADA	40	11
TOTAL	50	11

In relation to sex, the distribution of positive cases was homogeneous in the general situation as well as in each community in particular (Table 21).

TABLE 21

DISTRIBUTION OF ELISA RESULTS FOR *T. cruzi* ACCORDING TO SEX IN EACH COMMUNITY. POST-INTERVENTION PERIOD

RESULTS	TOTAL (%)		ÑANDUA (%)		YPA'U (%)		CAÑADA (%)	
	MALE	FEM.	MALE	FEM.	MALE	FEM.	MALE	FEM.
POSITIVE	50 (8.1)	46 (7.4)	16 (7.0)	13 (5.7)	24 (9.2)	20 (7.7)	10 (7.6)	13 (9.8)
NEGATIVE	259 (41.7)	266 (42.8)	96 (41.9)	104 (45.4)	101 (38.9)	115 (44.2)	62 (47.0)	47 (35.6)
TOTAL	309 (49.8)	312 (50.2)	112 (48.9)	117 (51.1)	125 (48.1)	135 (51.9)	72 (54.5)	60 (45.5)

The results of the indicators of serological changes can be summarized as

follows: A significant difference in the serology was observed in the three communities from 19.5% to 15.5% ($p<0.05$). This diminution was not significant in Ñanduá and Ypa'ú. However, the diminution was significant in Cañada, where it was from 28.5% to 17.4% ($p<0.05$) (Table 22).

TABLE 22

PERCENTAGE OF SEROPOSITIVITY BY ELISA FOR *T. cruzi* PRE AND POST-INTERVENTION

COMMUNITY	PREVALENCE OF SEROPOSITIVE PRE-INTERVENTION (%)	PREVALENCE OF SEROPOSITIVE POST-INTERVENTION (%)
ÑANDUA	14.0	12.7
YPA U	19.4	16.9
CAÑADA	28.5	17.4*
TOTAL	19.5	15.5*

* $p<0.05$

The seroconversion was 0.5% in the three communities (3 new cases) attributable to three cases of seroconversion (1.5%) observed in Ñanduá. Seroconversion rates were 0% for both Ypa'ú and Cañada (Table 23).

TABLE 23

SEROCONVERSION CASES

COMMUNITY	SEROCONVERSION CASES (%)
ÑANDUA	3 (1.5)
YPA'U	0 (0.0)
CAÑADA	0 (0.0)
TOTAL	3 (0.%)

Considering the variation of the geometrical mean of the inverse of the titre (Table 24), it was observed an increase in the total population of positive cases of 14 points. Increases of 15 and 119 points were observed in the seropositive cases in Ypa'ú and Cañada, while there was a diminution of 10 points in Ñanduá. There was a diminution of 1 point in Ñanduá and Ypa'ú and 2 points in Cañada when the whole population (seropositive and seronegative) was considered.

TABLE 24

VARIATION OF THE GEOMETRICAL MEAN OF THE INVERSE OF THE SEROLOGICAL TITRE OF THE ELISA REACTION FOR *T. cruzi*

COMMUNITY	POSITIVE CASES	GENERAL POPULATION
ÑANDUA	-10	-1
YPA'U	+15	-1
CAÑADA	+119	-2
TOTAL	+14	-1

3.2.2 Triatomine infestation.

A total number of 182 houses were evaluated in the three communities during the baseline study. A house was considered infested when there was evidence of domiciliary presence of triatomines in any of their instars as well as embryonic eggs and fresh feces. High rates of domiciliary infestation were detected in the three communities, ranging from 48.5% in Ypa'ú to 32.7% in Ñanduá (Table 25).

TABLE 25

DOMICILIARY INFESTATION OF TRIATOMINES

IN THE PROJECT COMMUNITIES. BASELINE STUDY

N= 182 HOUSES

COMMUNITY	INFESTATION (%)
ÑANDUA	32.7 (20/61)
YPA'U	48.5 (34/70)
CAÑADA	45.1 (23/51)

Peridomiciliary infestation, including triatomine presence or vestiges (hatched eggs, dry feces and exuviae, was lower than the domiciliary ranging from 27.1% in Ypa'ú and to 7.8% Cañada (Table 26).

TABLE 26

PERIDOMICILIARY TRIATOMINE INFESTATION

IN THE PROJECT COMMUNITIES. BASELINE STUDY

N=182 HOUSES

COMMUNITY	INFESTATION (%)
ÑANDUA	14.6 (9/61)
YPA'U	27.1 (19/70)
CAÑADA	7.8 (4/51)

One hundred and forty nine triatomines were captured and they were all identified as *Triatoma infestans*. Parasitologic exam of the digestive tract showed a natural infection rate that oscillates from 4.5% to 17.1 in Ypa'ú (Table 27).

TABLE 27

NATURAL INFECTION OF TRIATOMINES CAPTURED IN THE PROJECT COMMUNITIES. BASELINE STUDY

N= 149 TRIATOMINES

COMMUNITY	NATURAL INFECTION (%)
ÑANDUA	11.4 (4/35)
YPA'U	27.1 (20/92)
CAÑADA	4.6 (1/22)

The entomologic data of the baseline study allowed the calculation of the following indexes:

a. Triatomine density, was defined as follows:

$$\frac{\text{Number of triatomine infested houses}}{\text{Number of houses examined}} \times 100$$

b. Triatomine crowding was defined as follows:

$$\frac{\text{Number of captured triatomines}}{\text{Number of infested houses}} \times 100$$

c. Colonization was defined as follows:

$$\frac{\text{Number of houses with triatomine nymphs}}{\text{Number of infested houses}} \times 100$$

The biggest pressure of the vector in Ypa'ú was systematically shown by these entomologic index. Ypa'ú and Cañada exhibited the highest values for colonization index (Table 28)

TABLE 28

ENTOMOLOGIC INDEX OF TRIATOMINE INFESTATION

IN THE PROJECT COMMUNITIES. BASELINE STUDY

N = 182 HOUSES

INDEXES	COMMUNITIES		
	ÑANDUA	YPA'U	CAÑADA
TRIATOMINE DENSITY	57.4	127.8	43.1
CROWDING INDEX	350.0	541.2	360.7
COLONIZATION	7.0	100.0	83.3

The final entomologic diagnosis in the three communities showed that the different intervention modalities diminished the baseline rates infestation. In the whole, this diminution is statistically significant to $p < 0.001$ (Table 29).

TABLE 29

DOMICILIARY TRIATOMINE INFESTATION

IN THE PROJECT COMMUNITIES

DURING PRE AND POST-INTERVENTIONS

COMMUNITIES	INFESTATION POSITIVE/TOTAL (%)	
	BASELINE	POST-INTERVENTION
ÑANDUA	20/61 (32.7)	2/59 (3.4)
YPA'U	34/70 (48.5)	3/55 (5.5)
CAÑADA	23/51 (45.1)	1/41 (2.4)
TOTAL	77/182* (42.3)	6/155** (3.9)

*,** $P_1 \# P_2$ (α=0.001)

The three positive houses in Ypa'ú (209, 234, and 255) were neither improved nor sprayed. In contrast, the two positive houses of Ñanduá (161, 168) were improved but not sprayed. In Cañada, only one house (466) was positive for triatomines (fresh feces) 20 months after spraying.

From the 182 houses evaluated at the beginning of the study, 100 were improved. Fifty four houses were improved in Ñanduá and 46 in Ypa'ú while 48 houses were sprayed from the 51 initially studied in Cañada.

Forty eight houses out of the 54 improved were controlled in Ñanduá during the post-intervention. Three of these houses had no information about their

initial infestation state. Due to this, only 45 improved houses included in the analysis shown in the table had that information.

Some of these houses were unoccupied during the community diagnosis or rapidly constructed in order to receive some benefits from the improvement program.

In Ypa'ú, 37 out of 46 improved houses were included in the follow-up after the intervention. The difference of nine houses was because some houses, such as 205 and 206, were considered as one house after the improvement or because some peridomiciliary stores were occupied by families in order to receive the improvement and have definitive houses.

The studies performed in 156 houses of the initial study, after 18 months, either improved or sprayed, showed the following results in the search for triatomines (Table 30).

TABLE 30

ABILITY TO DETECT *T. infestans* BY MANUAL CAPTURE, CALENDARS OR PLASTIC BAGS IN IMPROVED AND SPRAYED HOUSES

COMMUNITY AND MONTH OF POST-INTERVENTIVE EVALUATION	NUMBER OF INFESTED HOUSES DETECTED BY EACH METHOD		
	MANUAL CAPTURE	CALENDAR	PLASTIC BAG
ÑANDUA			
6	0/45* (0.0)	1/45 (2.2)	4/43** (9.3)
12	1/30 (3.3)	1/29* (3.4)	5/29 (17.2)
18	0/18 (0.0)	1/16 (6.3)	1/16 (6.2)
YPA'U			
6	0/39 (0.0)	2/37 (5.4)	2/38 (5.2)
12	2/37 (5.4)	0/30 (0.0)	0/29 (0.0)
18	1/15 (6.6)	0/10 (0.0)	0/10 (0.0)
CAÑADA			
6	1/42 (2.4)	0/41 (0.0)	1/35 (2.9)
12	0/41 (0.0)	3/41 (7.3)	1/38 (2.3)
18	1/41 (2.4)	2/41 (4.9)	2/32 (6.3)

(*,**) $P_1 \# P_2$ ($\alpha = 0.05$)

Definition of the criteria used to evaluate the procedures was as follows:

Infestation search: Live triatomine presence, fresh feces or embryonic eggs found by trained personnel of the project.

Infestation determined by calendars: Detection of dry triatomine feces in the calendars exposed for six-month periods.

Infestation determined by bags: Triatomine presence in any stage inside the plastic bag that was used by the house inhabitants.

The difference of houses observed in the previous table is mainly due to temporarily or permanently unoccupied houses, to missing calendars or bags at the moment of the triatomine searching.

The evaluation of the house infestation after 21 months of the project, at the end of the interventions, showed that the infestation of improved or sprayed houses was less than 4% (Table 31).

TABLE 31

TRIATOMINE INFESTATION IN INTERVENED HOUSES OF THE THREE COMMUNITIES

COMMUNITIES	INFESTATION POSITIVE/TOTAL (%)	
	BASELINE	POST-INTERVENTION
ÑANDUA	20/61 (32.7)	2/50 (4.0)
YPA'U	34/70 (48.5)	0/37 (0.0)
CAÑADA	23/51 (45.1)	1/41 (2.4)
TOTAL	77/182* (42.3)	3/128** (2.3)

*,** $P_1 \# P_2$ (α=0.001)

Table 30 shows that the most sensitive method to detect triatomines after the improvement interventions was the inhabitants participation through the search and conservation of the insects in plastic bags.

The quality of the capture performed by the inhabitants was surprisingly excellent. All the insects found in the plastic bugs were *Triatoma infestans* and/or *Triatoma sordida*.

The manual capture was the less sensitive procedure in improved and non-improved houses. The calendar was the most sensitive method in the improved houses, as shown in table 32.

TABLE 32

CAPACITY OF *T. infestans* DETECTION BY MANUAL CAPTURE, CALENDARS AND PLASTIC BAGS IN NON-IMPROVED HOUSES

COMMUNITY AND MONTH OF POST-INTERVENTIVE EVALUATION	NUMBER OF INFESTED HOUSES DETECTED BY EACH METHOD		
	MANUAL CAPTURE	CALENDAR	PLASTIC BAG
ÑANDUA			
6	0/14* (0.0)	6/14** (42.8)	0/14* (0.0)
12	0/14 (0.0)	6/14 (42.8)	3/14 (21.4)
18	1/14 (7.1)	6/14 (42.8)	3/14 (21.4)

Baseline: Manual capture: 9/14 (64.3)

(*,**) P,# P_2 (α=0.01)

Next table (Table 33) shows a comparison between the detection procedures concerning the baseline infestation of 14 non-improved houses. The failure percentage of the methods was 7% and 21.4% for the manual capture corroborating previous observations.

TABLE 33

TRIATOMINE DETECTION BY ALTERNATIVE CONTROL METHODS IN 14 NON-IMPROVED HOUSES IN YPA'U

BASELINE	CONTROL METHODS	NUMBER OF INFESTED HOUSES (%)
POSITIVE	POSITIVE	6/14 (42.9)
POSITIVE	NEGATIVE	3/14 (21.4)* 1/4 (7.2)**
NEGATIVE	NEGATIVE	2/14 (14.3)
NEGATIVE	POSITIVE	3/14 (21.4)

* 2 Houses with vestiges. ** 1 House with nymphs

3.2.3 Residual effect of the insecticide.

3.2.3.1 Cañada

Forty eight houses, 100% of the inhabited houses at that time, were sprayed in four days of summer time (December 1989 to January 1990). The average area to be fumigated was 312 m^2 per house. Thirty five minutes were required to complete each house treatment, during which 42.4 $\pm$ 13.1 ml of treating solution were employed in average. This volume corresponds to a real dose of 31.5 mg of lambdacyhalothrin/m^2.

The first evaluation of the residual effect of lambdacyhalothrin was performed one month after fumigation by exposing 3rd-instar *T. infestans*-nymphs during 24 hours on the three different surfaces treated. Dead insects were only observed on the wood board. In all cases, after 24 hours following initial exposure,

live insects were found detached from the sprayed surfaces, although they recovered their normal stance when placed on untreated surfaces; e.g., filter paper. Surviving insects were observed in the laboratory for the next five days. The initial mortality rate of 30 % recorded on wood board increased to 50% on the fifth day of observation. All the insects placed on mud surfaces remained alive after the 24-hour exposure period (Table 34).

TABLE 34

MORTALITY (%) OF 3RD-INSTAR *T. infestans*-NYMPHS
ONE MONTH POST-FUMIGATION WITH LAMBDACYHALOTHRIN

WALL TYPE	24 HOURS	48 HOURS	5 DAYS
WOOD BOARD	30	40	50
WATTLE & MUD	0	0	0
WATTLE, MUD & LIME	0	10	10

Given the low mortality recorded on the first test, the experiment was immediately repeated with 72-hour exposition, using fifth-instar nymphs of *T. infestans*, and the mortality rates were evaluated for an extended period of time; i.e., up to 7 days. Once again, the knock-down effect was observed in all the insects exposed to the different treated surfaces. However, no dead insects were observed at the end of the exposure period, just the ones exposed to treated wood board showed late mortality when they were moved onto filter paper. Those insects exposed to sprayed mud walls remained alive after seven days in the laboratory (Table 35).

TABLE 35

MORTALITY (%) OF 5TH-INSTAR *T. infestans*-NYMPHS

ONE MONTH POST-FUMIGATION WITH LAMBDACYHALOTHRIN

WALL TYPE	72 HOURS	4 DAYS	5 DAYS	7 DAYS
WOOD BOARD	0	0	40	60
WATTLE & MUD	0	0	0	0
WATTLE, MUD & LIME	0	0	0	0

Evaluation of the residual effects was repeated 6 months after insecticide application at the same houses using fifth-instar *T. infestans* nymphs exposed for 72 hours. At that time, all the insects were alive, but 60% of those placed on wood board were found detached from the sprayed surface, although just one of them showed late mortality. None of the insects placed on mud walls was dead after the exposure time, and just one died in the laboratory. It is interesting to note that two of the insects exposed on wood board and two of those placed on mud painted with lime molted in the laboratory (Table 36).

TABLE 36

MORTALITY (%) OF 5TH-INSTAR *T. infestans*-NYMPHS

SIX MONTHS POST-FUMIGATION WITH LAMBDACYHALOTHRIN

WALL TYPE	72 HOURS	4 DAYS	5 DAYS	7 DAYS
WOOD BOARD	0[1]	0	10	10
WATTLE & MUD	0[2]	10	10	10
WATTLE, MUD & LIME	0[3]	0	0	0

[1] Six bugs were found knocked down, yet they recovered in the laboratory after 5 days. Out of the nine survivors, two molted in the laboratory.

[2] One of the bugs was found knocked down and soon died in the laboratory.

[3] Two of the bugs molted in the laboratory.

One year after fumigation of the houses, the test of the residual effect was repeated using both first- and fifth-instar *T. infestans* nymphs. They were exposed to the three different surfaces of the same three houses during 72 hours. All the fifth-instar nymphs placed on mud and mud plus lime surfaces survived even after the seven-day observation period carried out in the laboratory. From those insects exposed on the wood surface, just one out of ten was found dead (Table 37).

In order to detect low residual effect, parallel experiments were made using first-instar nymphs. In this set of experiments, a 40% mortality rate was observed in those insects placed on sprayed wood. This initial rate increased 10% more during the observation period in the laboratory. All the insects exposed on treated mud surface were found alive, and just one of those placed on mud and lime wall was retrieved dead. No cases of late mortality was observed in those insects exposed on both mud surfaces (Table 38). It should be mentioned that in the consecutive observations at each house, the insects were exposed to different parts of the walls.

TABLE 37

MORTALITY (%) OF 5TH-INSTAR *T. infestans*-NYMPHS

TWELVE MONTHS POST-FUMIGATION WITH LAMBDACYHALOTHRIN

WALL TYPE	72 HOURS	4 DAYS	5 DAYS	7 DAYS
WOOD BOARD	10	10	10	10
WATTLE & MUD	0	0	0	0
WATTLE, MUD & LIME	0	0	0	0

TABLE 38

MORTALITY (%) OF 1ST-INSTAR *T. infestans*-NYMPHS

TWELVE MONTHS POST-FUMIGATION WITH LAMBDACYHALOTHRIN

WALL TYPE	72 HOURS	4 DAYS	5 DAYS	7 DAYS
WOOD BOARD	40	50	50	50
WATTLE & MUD	0	0	0	0
WATTLE, MUD & LIME	10	10	10	10

In order to corroborate the results of the bioassay, two contiguous control houses which had not been fumigated during the intervention period, were sprayed, one of them with lambdacyhalothrin (Icon WP10), and the other one with deltamethrin (K-Othrine 25SC). The walls of the two control houses were of the same material as the experimental ones; i.e., wattle and mud. The house treated with lambdacyhalothrin received 145 ml of spraying solution/cm^2 (109 mg

lambdacyhalothrin/m^2), and that of K-Othrine 188 ml of spraying solution/cm^2 (94 mg deltamethrin/m^2). The residual effects of these applications were evaluated one month later by exposing ten first-instar nymphs and ten fifth-instar nymphs on the inner walls of each house for 72 hours. The experiment carried out using the most sensitive first-instar nymphs showed mortality rates of 70% and 80% for lambdacyhalothrin and deltamethrin respectively, after the 72-hour exposure period. Such rate increased to 100% at the 10th day of observation in the laboratory for the insects exposed to deltamethrin, but it remained invariable for those insects placed in the house treated with lambdacyhalothrin (Table 39).

TABLE 39

RESIDUAL EFFECT OF LAMBDACYHALOTHRIN AND DELTAMETHRIN FIRST-INSTAR *T. infestans* NYMPHS MORTALITY (%) ONE MONTH POST-FUMIGATION

INSECTICIDE TYPE	72 HOURS	4 DAYS	5 DAYS	10 DAYS
LAMBDACYALOTHRIN (109 mg/m^2)	70	70	70	70
DELTAMETHRIN (94 mg/m^2)	80	90	90	100

In the assay with fifth-instar nymphs, all of the fifth-instar nymphs were found alive from both, lambdacyhalothrin and deltamethrin treated surfaces, but a permanent knock-down effect was observed on the insects exposed to both insecticides. By the fifth day of observation in the laboratory, a mortality rate of 70% was recorded for lambdacyhalothrin-exposed insects. Such rate remained invariable by day 10th. Insects exposed to deltamethrin showed 20% of delayed mortality at day fifth, that increased to 100% by day 10th (Table 40).

TABLE 40

RESIDUAL EFFECT OF LAMBDACYHALOTHRIN AND DELTAMETHRIN FIFTH-INSTAR *T. infestans* NYMPHS MORTALITY (%) ONE MONTH POST-FUMIGATION

INSECTICIDE TYPE	72 HOURS	4 DAYS	5 DAYS	10 DAYS
LAMBDACYHALOTHRIN (109 mg/m^2)	0[1]	0	70	70
DELTAMETHRIN (94 mg/m^2)	0[1]	0	20	100

[1] A permanent knock-down effect was observed on the fifth-instar nymphs during the observation time.

Three months after insecticide spraying in these two control houses, evaluation of residual effects was repeated by exposure of fifth-instar *T. infestans* nymphs for 72 hours. A 30% mortality rate was observed in those insects exposed to lambdacyhalothrin after the 72-hour exposure period. At the same time, none of the insects exposed to deltamethrin appeared dead and a delayed mortality of 30% was reached by day 10th (Table 41).

TABLE 41

RESIDUAL EFFECT OF LAMBDACYHALOTHRIN AND DELTAMETHRIN FIFTH-INSTAR *T. infestans* NYMPHS MORTALITY (%) THREE MONTHS POST-FUMIGATION

INSECTICIDE TYPE	72 HOURS	4 DAYS	5 DAYS	10 DAYS
LAMBDACYHALOTHRIN (109 mg/m^2)	30	30	30	30
DELTAMETHRIN (94 mg/m^2)	0[1]	20	30	30[2]

[1] Six bugs were found knocked down.

[2] Three out of the 7 survivors remained knocked down after they were removed from the wall surface.

Baseline evaluation of infestation revealed that 19 (42.2%) out of 45 houses were infested by triatomines at that moment, mainly in the domiciliary area. This was evidenced by the finding of live triatomines, either adults or nymphs, fertile eggs and/or fresh feces.

Six months after insecticide application, the search for triatomines was repeated with community participation. This infestation rate was reduced to 4.5% six months after the intervention. The results were positive in 2 out of the 44 houses evaluated (one of the houses had been thrown down in the mean time). In one of the houses, an adult *T. infestans* bug was caught, and fresh insect feces were found in another house. These results represented a 4.5% infestation rate six months after fumigation. Further examinations, performed every 6 months, showed that the infestation rate did not surpass the 2.3% up to 2 years after insecticide application due to the permanent capture of adult triatomines by the householder of the only house that showed infestation. Infestation rates pre and post-treatment were statistically significant

($p < 0.0001$, Chi-square test, Yates corrected).

In the peridomestic environment, positive infestation was recorded in four out of 45 houses during the pre-intervention survey. Peridomestic environment remained uninfested six, 12 and 21 months after spraying.

3.2.3.2 Ypa'ú.

Forty seven houses were fumigated before the house improvement in order to allow the maximum possibility of success to this intervention in an attempt to control Chagas disease vector. Additionally, other constructions such as churches and school were also fumigated because of the inhabitants request.

Fumigation was performed between August 1989 and February 1991. An average area of 267 m^2 was treated per house which took an average time of 36 minutes.

Lambdacyhalothrin was used in the same dilution and conditions than in Cañada with an average volume of 61.7 $\pm$ 31.7 ml of spraying solution /m^2 (45.8 mg of lambdacyhalothrin/m^2). Insecticide doses were increased based on the results obtained in the residual effects assays performed in Cañada.

A knock-down and lethal effect on T. infestans adult and nymphs was observed in some houses during and immediately after the insecticide application. This effect was observed even when a fast application was performed in order to collect live bugs. These captured insects died rapidly even after being separated from the hostile environment.

Fumigation was followed by improvement which involved the cover of treated surfaces with plastering and/or painting. No systematic control of the residual effect was performed. However, a control was immediately carried out before starting the improvement giving the same results as in Cañada, in spite of the increase in the

amount of insecticide applied to the treated surfaces. One house with mud and wattle walls and other with brick walls without plastering were fumigated, receiving an average volume of 77 ml of spraying solution/m^2 (58 mg of lambdacyhalothrin/m^2). The control of the residual effect was performed by exposing 5th-instar T. infestans nymphs on the treated surfaces during 72 hours. No insects mortality was recorded in both surfaces. A long observation of the insects in the laboratory showed an increase in mortality of the insects that were exposed on the non-plastered bricks walls reaching a 30% mortality by 7 days (Table 42).

TABLE 42

MORTALITY 5TH-INSTAR T. infestans NYMPHS
ONE MONTH AFTER LAMBDACYHALOTHRIN FUMIGATION

WALL TYPE	72 HOURS	4 DAYS	7 DAYS
MUD WATTLE	0	0	0
NON-PLASTERED BRICKS	0	20	30

No complaints about adverse effects of the insecticide application were received from the two communities. Cases of domestic animals mortality were not recorded, in spite of the fact that many fowls ate different insects (specially cockroaches) that fell or ran away from the insecticide action.

3.3 Social Component.

The analysis of the results of the Social Component was performed in extracting the basic information and examining it in order to respond to the objectives of the study.

For that purpose, the analysis of the answers to the questionnaire was made following this sequence:

A. Particular analysis of each reply, with numeric references to tables.

B. Global description of the results in percentage.

C. Significative differences detected in the former analysis.

D. When possible, the assumptions that allow to explain the findings are discussed.

E. Relevant observations are made when they are related to the hierarchical order of the problems detected.

F. The analysis of the results was performed on the whole data set, and the analysis discriminated by communities is presented only when judged relevant.

3.3.1 Demography.

Most of demography analysis is based on the age and sex structure of the population, which depends on the former tendencies of population growth components (fecundity, mortality and migration). In the table 43 is summarized the distribution of the population by age in the three communities of the project, where can be noted that the people under 15 years of age represents more that 40% of total population in both surveys (43% and 41.2%, respectively). The age group between 15 and 64 years represents the 49.4% (433/877) and the 50.1% (407/812) of total population in the two surveys, respectively. The difference between the two evaluations was -7.4% (65). The age group of less than 1 year showed the greatest negative value (-37.5%) and the group 40-44 years of age display the higher positive value (38.5%). It was not considered to be appropriate to show the pyramidal distribution of the population.

TABLE 43

AGE STRUCTURE OF THE TOTAL POPULATION

FIRST AND SECOND MEASUREMENT

AGE GROUPS (YEARS)	FIRST MEASUREMENT		SECOND MEASUREMENT		VARIATION
	N°	%	N°	%	%
<1	24	2.7	15	1.8	-37.5
1 a 4	109	12.4	94	11.6	-13.8
5 a 9	145	16.5	127	15.6	-12.4
10 a 14	99	11.3	99	12.2	0
15 a 19	66	7.5	66	8.1	0
20 a 24	61	7.0	54	6.7	-11.5
25 a 29	69	7.9	51	6.3	-26.1
30 a 34	44	5.0	47	5.8	+6.8
35 a 39	41	4.7	37	4.6	-9.7
40 a 44	26	3.0	36	4.4	+38.5
45 a 49	43	4.9	38	4.7	-11.6
50 a 54	32	3.6	32	3.9	0
55 a 59	25	2.9	18	2.2	-28.0
60 a 64	26	3.0	28	3.4	+7.7
>64	67	7.8	70	8.7	+4.5
TOTAL	877	100.0	812	100.0	-7.4

Source: Socio-economic survey of the project. 1989

Following the age structure analysis, can be observed that Ñanduá and Ypa'ú communities show that almost 45% of their population is under 15 years of

age. However, in Cañada can be noted a lower percentage. It could be explained by the presence of great properties dedicated to cattle raising near Cañada. Besides that, the rural areas of Paraguarí Department are classified as expulsive.

TABLE 44

DISTRIBUTION OF THE POPULATION BY AGE GROUPS IN THE COMMUNITIES OF THE PROJECT. YEAR 1989

AGE GROUPS (YEARS)	COMMUNITIES							
	YPA'Ú		CAÑADA		ÑANDUÁ		TOTAL	
	N	%	N	%	N	%	N	%
0 - 14	157	43.7	70	36.1	149	45.0	376	42.5
15 - 29	78	21.7	43	22.2	78	23.5	199	22.5
30 - 44	50	13.9	17	8.8	45	13.1	112	12.7
45 - 59	40	11.2	33	17.0	30	9.1	103	11.7
60 and more	34	9.5	31	15.9	29	8.8	94	10.6
TOTAL	359	100	194	100	331	100	884	100

Source: Socio-economic survey of the project.

The **dependency ratio**, which represents the number of individual in non-productive age per one hundred individuals in productive age, was 102.5 and 99.5 for baseline and final measurements, respectively (Table 45). The **youth dependence ratio**, which represents the number of young individuals per one-hundred individuals in productive age, was 87 and 82.3, for the baseline and final evaluation respectively. Besides that, there were 15.5 and 17.2 individuals over 65 years of age per one-hundred individuals with age between 14 and 64 years (elderly dependence ratio) for the first and second evaluation, respectively.

The **dependency ratio**, in the baseline, was 106.4, 102.8 and 88.3 for Ñanduá, Ypa'ú and Cañada, respectively. In the final measurement, the values were 103.5, 109.6 and 76.8, for the three different communities, respectively (Table 45).

TABLE 45

DEPENDENCY RATIO

COMMUNITIES	DEPENDENCY RATIO	
	BASELINE (1989)	FINAL (1991)
Ñanduá	106.4	103.5
Ypa'ú	102.8	109.6
Cañada	88.3	76.8
TOTAL	102.5	99.5

Concerning the **masculinity index**, in the whole population there were 114.4 and 119.4 men for every one-hundred women, in the baseline and final evaluation, respectively (Tables 46 and 47).

TABLE 46

DISTRIBUTION OF THE POPULATION BY SEX

FIRST AND SECOND MEASUREMENT

SEX	1st. MEASUREMENT		2nd. MEASUREMENT	
	N°	%	N°	%
Male	468	53.4	442	54.4
Female	409	46.6	370	45.6
TOTAL	877	100.0	812	100.0

In table 47 data on masculinity index in the three communities is shown. The values for this index were 117.6, 101.7 and 137.0 in the baseline for Ñanduá, Ypa'ú and Cañada, respectively. In the final evaluation such values were 112.5, 109.6 and 136.5 for the three communities, respectively. The index was consistently higher in Cañada, which could be more related to a selective migration of women than to other factors. In general, the values found in this project are higher than expected for the national population (102.58 for 1990), except in Ypa'ú, where the masculinity index was very similar to the national value in the baseline measurement, but higher than the reference value by the end of the project.

TABLE 47

MASCULINITY INDEX

COMMUNITIES	MASCULINITY INDEX	
	BASELINE (1989)	FINAL (1991)
Ñanduá	117.6	122.5
Ypa'ú	101.7	109.6
Cañada	137.0	136.5
TOTAL	114.4	119.5

Concerning status, 22-23% of the population declared to be married, 63% single and 10% in concubinage (Table 48).

TABLE 48

DISTRIBUTION OF THE POPULATION ACCORDING TO STATUS

FIRST AND SECOND MEASUREMENT

STATUS	1st. MEASUREMENT		2nd. MEASUREMENT	
	N°	%	N°	%
Married	198	22.6	192	23.6
Concubinage	94	10.7	87	10.7
Widow	20	2.3	11	1.4
Divorced	8	0.9	8	1.0
Single	557	63.5	514	63.3
TOTAL	877	100.0	812	100.0

According to the rural condition of the communities, 32% and 23.6% of the total population develop agricultural activities in the first and second evaluation, respectively. Domestic activities involved 18 and 22 percent of the population in baseline and final evaluation, respectively, and 16 and 23 percent of the population declared as principal activity the work in small industries in both evaluations, respectively (Table 49).

TABLE 49

DISTRIBUTION OF THE POPULATION ACCORDING TO ACTIVITIES AND TIME USE FIRST AND SECOND MEASUREMENT

ACTIVITIES	1st. MEASUREMENT		2nd. MEASUREMENT	
	N°	%	N°	%
Agriculture	281	32.0	211	26.0
Livestock	1	0.1	2	0.2
Domestics works	157	17.9	181	22.3
Trading	19	2.2	16	2.5
Services	34	3.9	47	5.8
Small industries	20	2.3	23	2.8
Students >7 years old	144	16.4	189	23.3
Without activity	14	1.6	18	2.2
Don't know	3	0.3	0	0.0
No reply	8	0.9	1	0.1
It doesn't correspond *	196	22.3	124	15.3
TOTAL	877	100.0	812	100.0

* Children under 7 years of age not attending school yet.

Concerning religious practice, the majority (98%) declares to be catholic, but just between 15% and 19% participates weekly in religious activities, and more than 80% just do it occasionally (Table 50).

TABLE 50

DISTRIBUTION OF THE POPULATION BY RELIGIOUS PRACTICE

FIRST AND SECOND MEASUREMENT

RELIGION AND RELIGIOUS PRACTICE	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
RELIGION				
Catholic	180	98.9	172	98.3
Protestant	2	1.1	3	1.7
RELIGIOUS PRACTICE				
Once a week	28	15.4	34	19.4
Occasionally	147	80.8	140	80.0
Never	7	3.8	1	0.6

3.3.2 Education.

According to table 51, and considering the baseline and final evaluation, the level of illiteracy was 7.5% (66/877) and 5.3 (43/812), respectively, and the population that has not completed elementary school represents 47.9% (420/877) and 49.5% (402/812), respectively. Considering the existence of a "regression effect", the level of functional illiteracy should be higher than detected. The lack of formal education facilities and the difficulties in the reading-writing process are mandatory for educative activities, specially those involving writing.

TABLE 51

DISTRIBUTION OF THE POPULATION BY EDUCATION

FIRST AND SECOND MEASUREMENT

EDUCATION	1st. MEASUREMENT		2nd. MEASUREMENT	
	N°	%	N°	%
Illiteracy	66	7.5	43	5.3
Elementary school, not completed	420	47.9	402	49.5
Elementary school, completed	153	17.4	168	20.7
High school, not completed	47	5.4	45	5.5
High school, completed	5	0.6	8	1.0
No reply	0	0.0	1	0.1
It doesn't correspond*	186	21.2	145	17.9
TOTAL	877	100.0	812	100.0

Note: * under 7 years of age.

The situation concerning the formal education in the three different communities displays some differences. In Ypa'ú the number of individuals with uncompleted elementary school in lower than observed in the other communities, but it is balanced with a higher number of individuals with completed elementary school (Table 52). Generally speaking, the level of formal education accomplished by the individuals in the three communities is comparable. This situation and the extended use of **guarani** (native language), which is spoken by 86% of the population (Table 53), should be considered when specific educative and communication strategies are formulated.

TABLE 52

EDUCATION LEVEL DISCRIMINATED BY COMMUNITIES

BASELINE MEASUREMENT

EDUCATION LEVEL	ÑANDUA		YPA'U		CAÑADA		TOTAL	
	N°	%	N°	%	N°	%	N°	%
Illiteracy	25	7.7	22	6.1	14	7.3	61	6.9
Elementary school, not complete	166	51.6	157	43.2	97	50.5	420	47.9
Elementary school, complete	45	14.0	74	20.4	34	17.7	153	17.4
High school, not complete	12	3.7	20	5.5	156	7.8	47	5.4
High school, complete	2	0.6	2	0.6	1	0.5	5	0.6
It doesn't correspond *	72	22.4	88	24.2	31	16.2	191	21.8
TOTAL	322	100.0	363	100.0	192	100.0	877	100.0

Note: * children under 7 years of age

TABLE 53

DISTRIBUTION OF THE POPULATION BY LANGUAGE

FIRST AND SECOND MEASUREMENT

LANGUAGE	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
Guarani	158	86.8	155	88.6
Guarani and spanish	24	13.2	20	11.4
TOTAL	182	100.0	175	100.0

3.3.3 Sanitary condition

The health situation in rural areas is consistently confronted with the deficient and perverse economic model, the current social asymmetries and certain

cultural patterns involving the natural acceptance of preventable health risks. Within this context should be analyzed the responses concerning the type of health care service used procured by the population when a member of the family gets sick. In both phases of evaluation, baseline and final, the formal health care system was the most used, 64% and 69%, respectively. The informal type of health service was employed by 11% (20/182) and 28.6% (50/175) of the population in the first and second evaluation, respectively. The group which use both formal and informal types of health care service (mixed) have displayed a severe reduction, form 24.7% to 1,1%, when considered both evaluations. This situation could be attributed to a dichotomous behavior in the option for one or other type of service in detriment of the mixed modality (Table 54).

TABLE 54

DISTRIBUTION OF FAMILIES ACCORDING TO THE TYPE OF HEALTH CARE SERVICE USED WHEN A MEMBER OF THE FAMILY GETS SICK FIRST AND SECOND MEASUREMENT

TYPE OF HEALTH SERVICE	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
Formal	117	64.3	121	69.1
Informal	20	11.0	50	28.6
Mixed	45	24.7	2	1.1
No reply	0	0.0	2	1.1
TOTAL	182	100.0	175	100.0

Table 55 shows that 56% of the responders in the baseline, and about 58% at the second measurement, goes to public health centers for medical attention. The second position is for public hospital (23.1% and 14.9%, for the first an second

measurements, respectively), and the third is for private physicians or clinics (9.9% and 16.4%, respectively).

TABLE 55

DISTRIBUTION OF THE POPULATION ACCORDING TO THE INSTITUTION VISITED FOR HEALTH CARE FIRST AND SECOND MEASUREMENT

HEALTH SERVICE	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
Public hospital	4	23.1	26	14.9
Public health center	102	56.0	101	57.7
Private clinic	18	9.9	29	16.4
Health post	1	0.5	1	0.6
Public health center & private clinic	0	0.0	2	1.1
None	0	0.0	14	8.0
No reply	19	10.4	2	1.1
TOTAL	182	100.0	175	100.0

Concerning the type of health care service visited by the population when a member of the family has a swollen eye, Romaña sign which is a sign of acute Chagas infection, most of the people -in both measurements- answered that they didn't have a swollen eye (60.4% and 72.6%, for each measurement, respectively). In those cases where swollen eye was noticed, affected people went to private medical doctors, 11% (20/182) at the baseline and 8% (14/175) at the final evaluation. It is interesting to note that selfmedication was reduced from 12.1% (22/182) in the baseline to zero at the end of the project. The same tendency is observed concerning the visits to local healers, from 4.4% (8/182) in the baseline to 1.1% (2/175) at the final measurement (Table 56).

TABLE 56

DISTRIBUTION OF THE POPULATION ACCORDING TO THE TYPE OF HEALTH SERVICE VISITED WHEN A MEMBER OF THE FAMILY HAS A SWOLLEN EYE

FIRST AND SECOND MEASUREMENT

TYPE OF HEALTH SERVICE	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
Public health center	15	8.2	4	2.3
Private clinic/physician	20	11.0	14	8.0
Traditional healer	8	4.4	2	1.1
Pharmacy	2	1.1	2	1.1
Take to Asuncion	1	0.5	0	0.0
Self medication	22	12.1	0	0.0
It didn't occur	110	60.4	127	72.6
Don't know	4	2.2	0	0.0
None	0	0.0	3	1.7
TOTAL	182	100.0	175	100.0

Concerning to how the population pay for medical care, between 95 and 65 percent (173/182 and 114/175), for first and second measurement, respectively, pay for it with their own means. The reduction of this modality in the second measurement could be related to the combine effect of the economic crisis, an improvement of public health service and a better knowledge about the use of them. This have resulted in an increase of "free attention" a reply to the question in the final evaluation (Table 57).

TABLE 57

DISTRIBUTION OF THE POPULATION ACCORDING TO THE PAYMENT FOR HEALTH CARE SERVICE FIRST AND SECOND MEASUREMENT

PAYMENT FOR HEALTH SERVICES	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
By him/her self	173	95.1	114	65.1
Social security	2	1.1	3	1.7
Free attention	7	3.8	56	32.0
No reply	0	0.0	2	1.1
TOTAL	182	100.0	175	100.0

The type and location of water sources is a relevant aspect of sanitary condition in each house. Around 99% of the families use wells, cisterns or natural fountains as water sources, in both evaluations. In most of the cases, 74.1% and 77.1% for first and second evaluation, respectively, the water source was located out of the house (Table 58).

TABLE 58

DISTRIBUTION OF THE POPULATION ACCORDING TO TYPE AND LOCATION OF WATER SOURCE FIRST AND SECOND MEASUREMENT

TYPE AND LOCATION OF WATER SOURCE	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
TYPE OF WATER SOURCE				
Well-cistern-fountain	181	99.5	173	98.9
River-brook	1	0.5	0	0.0
No reply	0	0.0	2	1.1
LOCATION OF WATER SOURCE				
Inside the house	5	2.7	1	0.6
Out of the house	130	71.4	135	77.1
Out of the property	47	25.8	37	21.1
No reply	0	0.0	2	1.1

Another important indicator is the type of sanitary service available in each house. There was observed an important increase in the number of houses with an improved facility. At the baseline 73.1% (133/182) of the houses had "excusado" (an open hole) as sanitary facility, but at the end of the project 75.4% (132/175) of the houses had latrines. Such improvement can certainly be explained by the activities of the project (Table 59).

TABLE 59

DISTRIBUTION OF THE POPULATION ACCORDING TO THE TYPE OF SANITARY FACILITY FIRST AND SECOND MEASUREMENT

SANITARY FACILITY	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
Water closed with cesspool	9	4.9	10	5.7
"Excusado"	133	73.1	33	18.9
Latrine	36	19.8	132	75.4
None	3	1.6	0	0.0
No reply	1	0.5	0	0.0
TOTAL	182	100.0	175	100.0

In regard to garbage disposal, at the baseline evaluation about 60% (109/182) of the families used to burn or bury the garbage. At the final evaluation this behavior has increased to 86.3% (151/175). It is reasonable to attribute such change to the effects of both educative action and housing improvement (Table 60).

TABLE 60

DISTRIBUTION OF THE POPULATION ACCORDING TO GARBAGE DISPOSAL PROCEDURES FIRST AND SECOND MEASUREMENT

TYPE OF GARBAGE DISPOSAL	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
Burn or buried	109	59.9	151	86.3
Spreading around	61	33.5	23	13.1
Burn/buried and spreading	12	6.6	0	0.0
No reply	0	0.0	1	0.6
TOTAL	182	100.0	175	100.0

3.3.4 Knowledge and attitudes toward Chagas disease and the vector.

The success of either educative, promotion or preventive programs is based on the availability of confident data or sufficient information in order to establish appropriate health care programs. Nevertheless, the knowledge doesn't implies by itself the adoption of an adequate behavior, either due to an objective difficulty or due to lack of a positive tendency to do it. However, the knowledge persists as an assumption to generate actions with meaning and direction.

The evaluation of knowledge was focused on those aspects related to the disease, the modes of transmission, the recognition of the vector and the symptoms of the disease. As an approach to these items, was requested the opinion of the interview about the danger related to insects and pests. Almost everybody have considered them harmful, but it is interesting to note that 23.6% and 26.4% have not associated the transmission of diseases with mice and cockroaches, respectively.

However, mosquitos and vinchucas are associated to diseases by a high number of respondents. Such results could be attributed to the continuous observation of insects and pests in the domestic environment, and the resulting lack of awareness make the people to consider them as innocuous. At the baseline 8.8% of the respondents have failed to consider vinchucas as a health risk (Table 61).

TABLE 61

DISTRIBUTION OF THE POPULATION ACCORDING TO THE KNOWLEDGE ABOUT INSECTS AND PESTS FIRST MEASUREMENT

INSECTS AND PESTS	IS IT HARMFUL?				DOES IT TRANSMIT DISEASES?			
	YES		NO		YES		NO	
	N°	%	N°	%	N°	%	N°	%
Fly	181	99.5	1	0.5	156	85.2	27	14.8
Mosquito	181	99.5	1	0.5	166	91.2	16	8.8
Vinchuca	182	100.0	0	0.0	166	91.2	16	8.8
Cockroach	181	99.5	1	0.5	134	73.6	48	26.4
Mouse	181	99.5	1	0.5	139	76.4	43	23.6

In the post-intervention survey persists the tendency to recognize insect and pests as dangerous, with an increasing number of individuals that associate them with the transmission of diseases. At that moment, just 3.4% of the respondents have not associated vinchucas with diseases (Table 62).

TABLE 62

DISTRIBUTION OF THE POPULATION ACCORDING TO THE KNOWLEDGE ABOUT INSECTS AND PESTS SECOND MEASUREMENT

INSECTS AND PESTS	IS IT HARMFUL?				DOES IT TRANSMIT DISEASES?			
	YES		NO		YES		NO	
	N°	%	N°	%	N°	%	N°	%
Fly	174	99.4	1	0.6	167	95.4	8	4.6
Mosquito	174	99.4	1	0.6	163	93.1	12	6.9
Vinchuca	175	100.0	0	0.0	169	96.5	6	3.4
Cockroach	171	97.7	4	2.3	152	86.8	23	13.1
Mouse	173	98.8	2	1.1	155	88.5	20	11.4

It was also asked about the presence of vinchucas in the houses. At the baseline, 48.4% of the respondents have recognized the presence of the vector in their houses, but only 11.4% have repeated such reply at the end of the project. Negative answers have changed from 48.9% to 85.1% in the same period of time (Table 63).

TABLE 63

DISTRIBUTION OF THE POPULATION ACCORDING TO THE PRESENCE OF VINCHUCAS IN THE HOUSES FIRST AND SECOND MEASUREMENT

PRESENCE OF VINCHUCAS	1st. MEASUREMENT		2nd. MEASUREMENT	
	N°	%	N°	%
Yes	88	48.4	20	11.4
No	89	48.9	149	85.1
Don't know	5	2.5	5	2.9
No reply	0	0.0	1	0.6

Regarding since when there are vinchucas in the houses, at the baseline 24.2% have recognized that there are vinchucas since than five years and about 20% have declared to detect vinchucas one or less years ago. At the second evaluation these figures have changed to 5.1% and 4.0%, respectively, which apparently represents a incongruence in the data. Assuming the absence of bias in data collection process, these results could be explained by the variety of perception in the different respondents, or to the changes in retrospective memory due to vector disappearance (Table 64).

TABLE 64

DISTRIBUTION OF THE POPULATION ACCORDING TO SINCE WHEN THERE ARE VINCHUCAS IN THE HOUSE FIRST AND SECOND MEASUREMENT

SINCE WHEN HAVE THERE BEEN VINCHUCAS IN THE HOUSE?	1st. MEASUREMENT		2nd. MEASUREMENT	
	N°	%	N°	%
Five years or more	44	24.2	9	5.1
One year or more	19	10.4	5	2.9
Less than one year	18	9.9	2	1.1
Don't know	12	6.6	4	2.3
No reply	0	0.0	1	0.6
It doesn't correspond *	89	48.9	154	88.0

Note: * houses without vinchucas or not noticed by the inhabitants

According to table 65, the bedroom is identified as the place where most frequently vinchucas are detected. Such mention has occurred in 24.7% of the cases (45/182) at the baseline and 6.3% of the cases (11/175) at the final survey. When specific location for vinchucas was asked, at the baseline 30.8% of the answers were for the walls, which was reduced to 5.1% (9/175) at the end of the project, but remaining as the most frequent location (Table 65).

TABLE 65

DISTRIBUTION OF THE POPULATION ACCORDING TO WHERE VINCHUCAS ARE DETECTED FIRST AND SECOND MEASUREMENTS

WHERE VINCHUCAS ARE DETECTED?	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
In all the house	21	11.5	3	1.7
Bedroom	45	24.7	11	6.3
Corridor-eaves	3	1.6	2	1.2
Kitchen-henhouse	11	6.0	3	1.7
Store room-yard	5	2.7	1	0.6
No reply	2	1.1	1	0.6
Don't know	6	3.3	0	0.0
It doesn't correspond *	89	48.9	154	88.0
SPECIFIC LOCATION				
Bed	12	6.6	3	1.7
Walls	56	30.8	9	5.1
Floor	15	8.2	1	0.6
Roof	0	0.0	5	2.9
Domestic equipment-clothing	2	1.1	2	1.1
No reply	1	0.5	1	0.6
Don't know	7	3.8	0	0.0
It doesn't correspond *	89	48.9	154	88.0

Note: * houses without vinchucas

When the frequency of vinchucas' bite was asked, 36.3% (66/182) and 45.1% (79/175) reported that they never had one, in the first and second evaluation, respectively. Twenty-two percent (40/182) and 16.0% (28/175) have replied "Several

times", and 27.5% (50/182) and 25.1% (44/175) "Don't know", for the first and second evaluation, respectively (Table 66).

TABLE 66

DISTRIBUTION OF THE POPULATION ACCORDING TO THE FREQUENCY OF VINCHUCAS' BITE

FIRST AND SECOND MEASUREMENT

HAVE YOU EVER BEEN BITTEN BY A VINCHUCA?	1st. MEASUREMENT n= 182*		2nd. MEASUREMENT n= 175*	
	N°	%	N°	%
Never	66	36.3	79	45.1
Just one time	15	8.2	6	3.4
Few times	11	6.0	18	10.3
Several times	40	22.0	28	16.0
Don't know	50	27.5	44	25.1
TOTAL	182	100.0	175	100.0

Note: * one individual interview in each house.

In both evaluations was also inquired about the age of those that had been bitten by vinchucas, resulting the children with 11.5% (21/182) and 8.0 (14/175), the adults with 7.1 (13/182) and 8.6 (15/175), and all (adults and children) with 13.2 (24/182) and 8.0 (14/175), for the first and second survey, respectively. An important number of individuals don't know if they were been bitten, 30.8% (56/182) and 60.0 (105/175) in each evaluation, respectively (Table 67).

TABLE 67

DISTRIBUTION OF THE POPULATION ACCORDING TO THE AGE OF INDIVIDUALS WHO EVER BEEN BITTEN BY VINCHUCAS FIRST AND SECOND MEASUREMENT

WHO HAS EVER BEEN BITTEN BY A VINCHUCA?	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
Children	21	11.5	14	8.0
Adults	13	7.1	15	8.6
Adults and children	24	13.2	14	8.0
Nobody	68	37.4	19	10.9
Don't know	56	30.8	105	60.0
No reply	0	0.0	8	4.6
TOTAL	182	100.0	175	100.0

The answers about the knowledge of Chagas disease are summarized in table 68. The positive reply has changed from 14.3% (26/182) to 50.3% (88/175), and the negative one from 85.7% (156/182) to 49.7% (87/175) for the baseline and final evaluation, respectively. Nevertheless, it was observed an important increase in the knowledge of Chagas disease, the number of individuals declaring ignorance about it is still important. This situation can be explained by the limitations of the survey instrument, since the people reveals more knowledge about Chagas disease during casual conversation (Table 68).

TABLE 68

DISTRIBUTION OF THE POPULATION ACCORDING TO THE KNOWLEDGE OF CHAGAS DISEASE

FIRST AND SECOND MEASUREMENT

KNOWLEDGE OF CHAGAS DISEASE	1st. MEASUREMENT n= 182*		2nd. MEASUREMENT n= 175 *	
	N°	%	N°	%
Yes	26	14.3	88	50.3
No	156	85.7	87	49.7
TOTAL	182	100.0	175	100.0

Note: * one individual interviewed in each house

Concerning the change in knowledge about the symptoms of different stages of Chagas disease in both measurements, it was observed the increase of appreciation on specific manifestations of acute and chronic phases, as well as the reduction of answers concerning non-specific symptoms (Table 69).

TABLE 69

DISTRIBUTION OF THE POPULATION ACCORDING TO THE KNOWLEDGE ON CHAGAS DISEASE SYMPTOMS FIRST AND SECOND MEASUREMENT

KNOWLEDGE OF CHAGAS DISEASE SYMPTOMS	1st. MEASUREMENT n= 182*		2nd. MEASUREMENT n= 175*	
	N°	%	N°	%
Acute phase symptoms	3	1.6	17	9.7
Chronic phase symptoms	3	1.6	61	34.9
Unspecific symptoms	8	4.4	3	1.7
Symptoms of acute and chronic phase	4	2.2	0	0.0
Don't know	0	0.0	7	4.0
It doesn't correspond**	155	85.2	87	49.7
TOTAL	182	100.0	175	100.0

Note: * one individual interviewed in each house

** those who ignore Chagas disease

Most of the individuals interviewed ignore about the occurrence of sudden deaths in their communities, but 14.3% (26/182) and 8.6% (15/175) have recognized the happening of at least one of such events at the first and second survey, respectively (Table 70).

TABLE 70

DISTRIBUTION OF THE POPULATION ACCORDING TO THE KNOWLEDGE OF SUDDEN DEATHS OCCURRENCE FIRST AND SECOND MEASUREMENT

NUMBER OF SUDDEN DEATHS REPORTED	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
One	26	14.3	15	8.6
Two	1	0.5	0	0.0
Three or more	5	2.7	0	0.0
None	149	81.9	160	91.4
Don't know	1	0.5	0	0.0
TOTAL	182	100.0	175	100.0

Table 71 shows the perception of vinchucas in the different seasons of the year. Most of the respondents declare that vinchucas are more abundant in the summer time, in both evaluations.

TABLE 71

DISTRIBUTION OF THE POPULATION ACCORDING TO THE SEASON OF THE YEAR WHEN VINCHUCAS ARE DETECTED FIRST AND SECOND MEASUREMENT

SEASON OF THE YEAR WHEN VINCHUCAS ARE OBSERVED	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
Hot season	132	72.5	131	74.9
Cold season	11	6.0	10	5.7
All the year	16	8.8	23	13.1
Don't know	23	12.6	11	6.3
TOTAL	182	100.0	175	100.0

Regarding to the identification of diseases transmitted by vinchucas, table 72 shows the lowering in the percentage of the replies "Specific non-related to Chagas disease" from 14.3% (26/182) to 3.4 (6/175) in the course of the project. By the contrary, it was noticed an increase of the answers classified as "Specific, non-related to Chagas disease). The number of respondents in the category "Specific, related to Chagas disease" have increased from 4.9% (9/182) to 20.0% (35/175). These observations supports an adequate assimilation process, suggesting the possibility of developing behaviors oriented to avoid objective conditions related to the onset of the disease. Obviously, the situation of poverty involving the communities would establish restrictions to the occurrence of eventual changes in the behavior.

TABLE 72

DISTRIBUTION OF THE POPULATION ACCORDING TO DISEASES TRANSMITTED BY VINCHUCAS FIRST AND SECOND MEASUREMENT

DISEASE	1st. MEASUREMENT		2nd. MEASUREMENT	
	N°	%	N°	%
Non-specific, non-related with Chagas disease	26	14.3	6	3.4
Non-specific, related with Chagas disease	12	6.6	11	6.3
Specific, non-related with Chagas disease	4	2.2	27	15.4
Specific, related with Chagas disease	9	4.9	35	20.0
Don't remember	0	0.0	6	3.4
It doesn't correspond *	16	8.8	6	3.4
No reply	0	0.0	1	0.6
Don't know	115	63.2	83	47.4
TOTAL	182	100.0	175	100.0

Note: * those declaring vinchuca as innocuous.

3.3.5 Control and prophylaxis

Control criteria incorporates the ancient concept of prophylaxis with the current concept of surveillance. Table 73 shows the kinds of insects eliminated by the population, in each survey. The responders used to eliminate vinchucas in a proportion of 87/182 and 73/175 in the first and second evaluation, respectively. However, other insects and pests are most frequently eliminated. This apparent contradiction on these data can be explained by the effect of interventions, either housing improvement or fumigation, presuming that the absence of the vector withdrawed the meaning to vector elimination. However, this is a standpoint that requires additional information in order to clarify it completely.

TABLE 73

CONTROL - INSECTS AND PESTS ELIMINATED

FIRST AND SECOND MEASUREMENT

INSECTS AND PESTS ELIMINATED	1st. MEASUREMENT n= 182 houses				2nd. MEASUREMENT n= 175 houses			
	Yes		No		Yes		No	
	N°	%	N°	%	N°	%	N°	%
Flies	68	37.4	114	62.6	96	54.9	79	45.1
Mosquitos	84	46.2	98	53.8	106	60.6	69	39.4
Vinchucas	87	47.8	95	52.2	73	41.7	102	58.3
Mice	109	59.9	73	40.1	81	46.3	94	53.7
Cockroaches	118	64.8	64	35.2	100	57.1	75	42.9

Table 74 shows a summary of the reasons to eliminate insects and pests. Most of the respondents declare that the main reason to do it is the hazard to health. It is interesting to note that between one-third to one-quarter of interview people have identified the presence of vinchucas as an specific health risk.

TABLE 74

REASONS TO ELIMINATE INSECTS AND PESTS

FIRST AND SECOND MEASUREMENT

REASONS TO ELIMINATE INSECTS AND PESTS	1st. MEASUREMENT		2nd. MEASUREMENT	
	N°	%	N°	%
Risk to the health	44	24.1	53	30.3
Harmful to property	12	6.6	16	9.1
Both reasons	31	17.0	0	0.0
No reply	0	0.0	4	2.3
It doesn't correspond *	95	52.1	102	58.3
TOTAL	182	100.0	175	100.0

Note: * houses where vinchucas are not eliminated.

Concerning to the procedures employed by the population in order to avoid the presence of vinchucas, there was observed an increase in the number of houses where some control procedure is applied from 84.1% (153/182) in the baseline to 89.2% (156/175) at the end of the project. Analyzing the specific procedures employed by the inhabitants in the baseline and final evaluation these figures were respectively obtained: housing improvement from 7.7 (14/182) to 26.3% (46/175), fumigation from 42.9% (78/182) to 32.6% (58/175), direct control procedures (as smashing the insects or using hot water) from 31.9% (58/182) to 26.9% (47/175), and those who don't exercise any control procedure represents 11.5% (21/182) at the baseline and 6.9% (12/175) in the post-intervention period. A limited number of respondents declare to use indirect control methods such as cleaning the house (Table 75).

TABLE 75

PROCEDURES EMPLOYED TO AVOID THE PRESENCE OF VINCHUCAS

FIRST AND SECOND MEASUREMENT

PROCEDURES	1st. MEASUREMENT		2nd. MEASUREMENT	
	N°	%	N°	%
Housing improvement	14	7.7	46	26.3
Fumigation	78	42.9	57	32.6
Direct control methods	58	31.9	47	26.9
Indirect control methods	3	1.6	6	3.4
None	21	11.5	12	6.9
Don't know	7	3.8	7	4.0
No reply	1	0.5	0	0.0
TOTAL	182	100.0	175	100.0

Table 76 summarizes the different types of insecticides, according to the active component, employed to the combat insects or pests in the house. At the baseline, carbamates (17.6%), organophosphates (14.3%) and organochlorines (12.1%) were mostly mentioned. At the end of the project, carbamates (19.4%), organophosphates (14.8%) and pyrethroids (11.4%) were usually employed. A number of individuals have declared to use a combination of active components.

TABLE 76

TYPE OF PESTICIDES EMPLOYED BY THE POPULATION TO COMBAT INSECTS AND PESTS FIRST AND SECOND MEASUREMENT

PESTICIDE	1st. MEASUREMENT		2nd. MEASUREMENT	
	N°	%	N°	%
Organochlorine	22	12.1	10	5.7
Organophosphate	26	14.3	26	14.9
Pyrethroid	7	3.8	20	11.4
Carbamate	32	17.6	34	19.4
Dicumarol	11	6.0	0	0.0
Unknown	10	5.5	5	2.9
Carbamate + Organophosphate	6	3.3	0	0.0
Carbamate + Organochlorine	5	2.7	0	0.0
Pyrethroid + Organophosphate	2	1.1	0	0.0
Organochlorines + Organophosphate	2	1.1	0	0.0
Carbamate + Pyrethroid	1	0.5	0	0.0
Others	0	0.0	5	2.9
It doesn't correspond *	47	25.8	65	37.1
No reply	3	1.6	0	0.0
Don't know	8	4.4	10	5.7
TOTAL	182	100.0	175	100.0

Note: * houses where pesticides are not used.

It was also evaluated the knowledge about building materials for the roof that can prevent vinchucas nesting. This question have revealed a low discrimination power if we consider that the combination of materials as tiles, zinc plates and "Eternit" (fibre+cement) was referred as protecting materials by 68.7% (125/182) of the respondents at the baseline and 44.5% (78/175) of them in the

post-intervention survey. The use of such materials changed from 40.8% (51/125) to 73.1% (57/78) among those individuals who have identified the protective character of such building materials (Table 77). The was observed a disagreement concerning the knowledge of building materials for the roof that could prevent infestation evidenced by a less number of respondents at the end of the project than those at the baseline. Considering the successful performance of housing improvement, such disagreement could be caused by a certain insufficiency in the contents and procedures of specific educative programs on building materials.

TABLE 77

DISTRIBUTION OF THE POPULATION ACCORDING TO THE KNOWLEDGE AND USE OF BUILDING MATERIALS FOR THE ROOF THAT EXERT PROTECTING ACTION AGAINST VINCHUCAS FIRST AND SECOND MEASUREMENT

BUILDING MATERIALS FOR THE ROOF THAT PROTECT AGAINST INFESTATION BY VINCHUCAS	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
TYPE OF PROTECTING BUILDING MATERIAL				
Straw/"Jasapé" straw	7	3.8	2	1.1
Tiles/zinc plates/"Eternit"plates	125	68.7	78	44.5
Cement	0	0.0	1	0.6
Ceiling	0	0.0	5	2.9
Don't know	50	27.5	89	50.9
UTILIZATION OF PROTECTING BUILDING MATERIALS				
Yes	51	28.0	57	32.6
No	81	44.5	29	16.6
It doesn't correspond *	50	27.5	89	50.9

Note: * Respondents declaring ignorance about protecting materials.

A similar question was made about the walls and the materials that could avoid the presence of vinchucas. At the baseline, paint was mentioned by 29.7% (54/182) of the respondents, followed by good plaster, two-layer plaster, with 23.6% (43/182) and plaster plus paint (15.4%, 28/182).

About 63% of the respondents have declared the utilization of such materials (Table 78).

At the end of the project paint was mentioned with a higher frequency as the most convenient treatment for the walls in order to avoid the presence of vinchucas (34.3%, 60/175), followed by poor plaster, one-layer plaster, with 28.0% (49/175), and plaster plus paint (28.0%, 48/175). The use of materials considered as protective have been utilized in 70.3% of the houses.

It is interesting to inform that the option "Don't know" has not been mentioned during the second survey, which is consistent with the performance of housing improvement, fumigation and education activities (Table 78)

TABLE 78

DISTRIBUTION OF THE POPULATION ACCORDING TO THE KNOWLEDGE AND USE OF BUILDING MATERIALS FOR THE WALLS THAT EXERT PROTECTING ACTION AGAINST VINCHUCAS FIRST AND SECOND MEASUREMENT

BUILDING MATERIALS FOR THE WALLS THAT PROTECT AGAINST INFESTATION BY VINCHUCAS	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
TYPE OF PROTECTING BUILDING MATERIAL				
Poor plaster (one layer)	17	9.3	49	28.0
Good plaster (two layers)	43	23.6	16	9.1
Plaster + paint	28	15.4	48	27.5
Paint	54	29.7	60	34.3
Wood board/press brick	14	7.7	0	0.0
Others	0	0.0	2	1.2
Don't know	26	14.3	0	0.0
UTILIZATION OF PROTECTING BUILDING MATERIALS				
Yes	98	53.8	123	70.3
No	58	31.9	241	12.0
No reply	0	0.0	31	17.1
It doesn't correspond *	26	14.2	0	0.0

Note: * Respondents declaring ignorance about protecting materials.

Concerning the materials for the floor, 73.1% (133/182) at the baseline and 66.3% (116/175) at the end of the project have considered floor tiles, bricks or "layota" (ceramic tiles) as floor building materials that can protect against

vinchucas. Those materials were used by 40.1% (59/147) and 49.7% (87/175) of the respondents who have known the materials (Table 79).

TABLE 79

DISTRIBUTION OF THE POPULATION ACCORDING TO THE KNOWLEDGE AND USE OF BUILDING MATERIALS FOR THE FLOOR THAT EXERT PROTECTING ACTION AGAINST VINCHUCAS FIRST AND SECOND MEASUREMENT

BUILDING MATERIALS FOR THE WALLS THAT PROTECT AGAINST INFESTATION BY VINCHUCAS	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
TYPE OF PROTECTING BUILDING MATERIAL				
Earth	2	1.1	4	2.3
Floor tiles/bricks/ceramic tiles ("layota")	133	73.1	116	66.3
Thin grout ("lecherada")	11	6.0	6	3.4
Cement	0	0.0	4	2.3
Bricks + wood	1	0.5	0	0.0
Bricks + thin grout	0	0.0	5	2.9
Bricks + cement	0	0.0	40	22.9
Don't know	35	19.2	0	0.0
UTILIZATION OF PROTECTING BUILDING MATERIALS				
Yes	59	32.4	87	49.7
No	88	48.4	52	29.7
No reply	0	0.0	36	20.6
It doesn't correspond *	35	19.2	0	0.0

Note: * Respondents declaring ignorance about protecting materials.

The presence of animals in the house is considered to be a factor favoring the presence of vinchucas. It is considered that domestic animals are

suitable feeding sources for the vector, increasing thus the risk to human inhabitants. At the baseline 94.5% (172/182) of the houses had poultry, but in the post-intervention survey **there were not** poultry in 99.4% (174/175) of the houses. Concerning dogs and cats, 81.3% (148/182) of the respondents have recognized the presence of such animals in the house at the baseline, but at the second evaluation 73.7% (129/175) of the individuals didn't permit the presence of the animals. A similar change was also noticed with the presence of pigs and other kind of animals (Table 80).

TABLE 80

DISTRIBUTION OF THE POPULATION ACCORDING TO THE EXISTENCE OF ANIMALS AT HOME FIRST AND SECOND MEASUREMENT

ANIMALS PRESENT AT HOME	1st. MEASUREMENT n= 182 houses				2nd. MEASUREMENT n= 175 houses			
	Yes		No		Yes		No	
	N°	%	N°	%	N°	%	N°	%
Poultry	172	94.5	10	5.5	1	0.6	174	99.4
Dogs/cats	148	81.3	34	18.7	46	26.3	129	73.7
Pigs	148	81.3	34	18.7	2	1.1	173	98.9
Horses/cows/sheeps	10	5.5	172	94.5	6	3.4	169	96.6
Others	132	72.5	50	27.5	1	0.6	174	99.4

Concerning the location of the animals, in the first and second surveys, they are locates in this order: outside the house 81.9% and 47.4%, inside and outside the house 4.4% and 43.4%, and inside the house 9.9% and 4.6%, respectively (Table 81).

TABLE 81

DISTRIBUTION OF THE POPULATION ACCORDING TO THE LOCATION OF THE ANIMALS AT HOME FIRST AND SECOND MEASUREMENT

LOCATION OF THE ANIMALS	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
Inside the house	18	9.9	8	4.6
Outside the house	149	81.9	83	47.4
Inside and outside the house	8	4.4	76	43.4
No reply	7	3.8	8	4.6
TOTAL	182	100.0	175	100.0

It is frequently observed the storage of products or materials inside the house. According to the nature of stored material it was classified as those favoring the presence of vinchucas and those that don't favor the proximity of the vector. When it was considered the storage inside the house, in the baseline, in 8.2% of the houses (15/182) were stored products favoring the presence of the vector and 13.2% (24/182) stored those products that don't favor the vector. At the final evaluation, 36.6% (64/175) declared to perform the risky behavior and 22.9% (40/175) stored products that don't favor the proximity of vinchucas (Table 82).

TABLE 82

DISTRIBUTION OF THE POPULATION ACCORDING TO THE STORAGE OF PRODUCTS FAVORING THE PRESENCE OF VINCHUCAS FIRST AND SECOND MEASUREMENT

PLACES WHERE PRODUCTS ARE STORED	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
INSIDE THE HOUSE				
Products that favor	15	8.2	64	36.6
Products that don't favor	24	13.2	40	22.9
Both kinds of products	78	42.9	0	0.0
None	65	35.7	71	40.6
OUTSIDE THE HOUSE				
Products that favor	59	32.4	70	40.0
Products that don't favor	21	11.5	4	2.3
None	102	56.0	101	57.7
IN THE ORCHARD				
Products that favor	8	4.4	8	4.6
Products that don't favor	1	0.5	7	4.0
None	173	95.1	160	91.4

The increase of answers including the storage of products favoring the presence of vinchucas can be probably explained by the lack of a special room for storage and due to temporary trading conditions, when the people retains the harvest at home waiting for better prices.

It was also considered the storage of products outside the house. The storage of products that favor the presence of vinchucas was present in 32.4%

(59/182) of the houses at the beginning of the project and has involved 40.0% (70/175) at the second survey. The storage of products that don't favor the presence of vinchucas has changed from 11.5% (21/182) to 2.3% (4/175). When considered the accumulation in the orchard, the storage of products that favor the presence of vinchucas was present in 4.4% (8/182) of the cases at the baseline and such modality has involved 4.6% (8/175) of them at the completion. The storage of products that don't favor the presence of vinchucas, in the plantation, has increased from 0.5% (1/182) to 4.0% (7/175) (Table 82).

3.3.6 Life habits.

There was also explored the life habits of the inhabitants that could modify the exposure to the vector of Chagas disease. For the first and second measurement, 72.0% (131/182) and 85.1% (149/175) use to sleep inside the house, 6.0% (11/182) and 1.1% (2/175) outside the house, 12.6% (23/182) and 1.1 (2/175) in the corridor (open gallery), and finally 9.3% (17/182) and 12.6% (22/175) use to sleep inside and outside the house, respectively (Table 83).

TABLE 83

DISTRIBUTION OF THE POPULATION ACCORDING TO WHERE THE OCCUPANTS USE TO SLEEP FIRST AND SECOND MEASUREMENT

WHERE DO THE OCCUPANTS SLEEP?	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
Inside the house	131	72.0	149	85.1
Outside the house	11	6.0	2	1.1
In the corridor	23	12.6	2	1.1
Inside and outside the house	17	9.3	22	12.6
TOTAL	182	100.0	175	100.0

It was also asked to the respondents if they have and use mosquito nest. Those individuals having mosquito nest represents 54.4% (83/182) and 44.6% (78/175), in the first and the second evaluations, respectively. Those houses were such facility was absent represented 45.6% (83/182) and 55.4 (97/175), for a similar period of time, respectively. The use of mosquito nest didn't changed significantly among those having it, and represented 83.8% (83/99) and 84.6% (66/78) in each evaluation, respectively (Table 84).

TABLE 84

DISTRIBUTION OF THE POPULATION ACCORDING TO THE TENENCY AND USE OF MOSQUITO NEST FIRST AND SECOND MEASUREMENT

TENENCY AND USE OF MOSQUITO NEST	1st. MEASUREMENT n= 182 houses		2nd. MEASUREMENT n= 175 houses	
	N°	%	N°	%
TENENCY OF MOSQUITO NEST				
Yes	99	54.4	78	44.6
No	83	45.6	97	55.4
USE OF MOSQUITO NEST				
Yes	83	45.6	66	37.7
No	16	8.8	12	6.9
It doesn't correspond *	83	45.6	97	55.4

Note: * those don't having mosquito nest.

Apparently, the information about the benefits related to the use of mosquito nest was deficiently transmitted to the population, because the use wasn't incorporated to the usual behavior.

3.3.7 Economic situation.

The economic situation of the communities was evaluated at two levels, the land ownership and the productive aspects, including type and amount of crops (agriculture), livestock and productive activities related to small industries and handicrafts.

3.3.7.1 Land ownership.

Within the area of the Project, 188 familiar production units are found, 120 of which (nearly 64%) are families that are either partial or absolute owners of their farms. The remaining 36% correspond to families which are not owners. In this category, various cases of land occupation without a definitive possession of the estate can be included. Table 85 illustrates the situation in each community involved in the project.

TABLE 85

LAND OWNERSHIP IN THE PROJECT AREA

BASELINE EVALUATION

CONCEPT	ÑANDUA		YPA'U		CAÑADA		TOTAL	
	N°	%	N°	%	N°	%	N°	%
Owner	35	54.7	38	51.4	38	76.0	111	59.0
Non-owner	22	34.4	34	45.9	12	24.0	68	36.2
Partial owner	7	10.9	2	2.7	0	0.0	9	4.8
TOTAL	64	100.0	74	100.0	50	100.0	188	100.0

It should be noticed that in Cañada there is a higher percentage of land ownership. Nearly 3 out of 4 family units are owners, while in Ypa'ú almost half of all the families are not actual owners of their lands. The latter place is where the most irregular land ownership conditions of the farming lots are found.

Among owners, 55% hold >3 ha of property, 24% hold between 1 and 2 ha, 11% have <1 ha, and the remaining 10% own estates between 2 and 3 ha.

Within the category of non-owners, there are IBR (Institute for Rural Welfare) grantees, petitioners of fiscal lands, renters, plain occupants and

occupants under dependency of the owners. Among the non-owners are those which own land of more than 3 ha (52%), less than 1 ha (22%), 1 to 2 ha (21%), and 2 to 3 ha (5%).

Two types of cases of shared land ownership are found; namely, those where blood relationship exist among the owners, and those where the owners are not relatives at all. These possess land of less than 1 ha, in almost half of all cases, while the remaining half is equally divided between owners of 1 to 2 ha and those possessing 2 to 3 ha, respectively.

3.3.7.1.1. Land ownership in Ñanduá.

The 32 owners in Ñanduá are those in the best legal situation in terms of land possession. About 40% of them own farming lots larger than 3 ha each, 31% own lots from 1 to 2 ha, 16% own land of 2 to 3 ha, and only 12% of the families own properties that are smaller than 1 ha.

Five cases of non-registered proprietorship are found in this community, two of which hold less than 1 ha, and 3 hold between 2 and 3 ha size lands.

Land occupants which are not proprietors include plain occupants, which are found in 27% of all families in the community. These occupy lots smaller than 1 ha in more than half of all cases, 1 to 2 ha in 4 cases, and lots larger than 3 ha in 3 cases. Among these non-owners, one occupant was a kin relative of the proprietor, and 5 of them were under some type of dependency. The latter occupy lands larger than 3 ha.

There were 8 cases of occupants on lease, while 3 instances of shared family ownership were identified. Those occupants on lease have lots of between 1 and 3 ha in 50 of cases; only 1 property was larger than 3 ha. Lands under shared ownership had all less than 3 ha.

Five occupants under a special relationship of dependency (so-called "encargados"; i.e., people in charge) were detected, all of them holding lands larger than 3 ha; a single case of an occupant who was a kin relative of the proprietor was found.

The information concerning land ownership in Ñanduá is summarized in table 86.

TABLE 86

LAND OWNERSHIP IN ÑANDUA

BASELINE EVALUATION

TYPE OF OWNERSHIP AND LAND SIZE (HECTARES)	PARTIAL	TOTAL	PERCENTAGE
PROPRIETORS			
Less than 1 ha.	4		
1 - 1.99 ha.	10	32	45.1
2 - 2.99 ha.	5		
3 ha. or more	13		
NON-REGISTERED PROPRIETORS			
Less than 1 ha.	2	5	7.0
1 - 1.99 ha.	3		
OCCUPANTS ON LEASE			
Less than 1 ha.	1		
1 - 1.99 ha.	3	8	11.3
2 - 2.99 ha.	1		
3 ha. or more	3		
SHARED FAMILY OWNERSHIP			
1 - 1.99 ha.	2	3	4.2
2 - 2.99 ha.	1		
PLAIN OCCUPANTS			
Less than 1 ha.	10		
1 - 1.99 ha.	4	17	23.9
3 ha. or more	3		
KIN RELATIVES OF PROPRIETORS			
2 - 2.99 ha.	1	1	1.4
OCCUPANTS UNDER DEPENDENCY			
3 ha. or more.	5	5	7.0
TOTAL		71	100.0

Source: Data from Socioeconomic Survey, 1989.

3.3.7.1.2. Land ownership in Ypa'ú.

In Ypa'ú, 49% of the land occupants are legal proprietors,

either with or without title. Seventy-four percent of these proprietors hold lands larger than 3 ha, while the remaining 16 own lands of smaller size.

Occupants which are not actual owners of the lands constitute the next most important group in the community (41%). Of these, the most prevalent are the plain occupants, followed by occupants under a certain type of dependency and kin relationship.

The plain occupants hold lands larger than 3 ha in 40% of the cases, and the rest (60%) occupy smaller areas. Occupants who are kin relatives of the proprietors live in lands smaller than 3 ha in all cases, while those under dependency relationship hold estates larger than 3 ha in almost all cases. Two grantees of the Instituto de Bienestar Rural (IBR) or Institue for Rural Welfare were found, 1 case of fiscal land petitioner, and 2 cases of fiscal land occupants.

Table 87 shows land ownership distribution in Ypa'ú.

TABLE 87

LAND OWNERSHIP IN YPA'U

BASELINE EVALUATION

TYPE OF OWNERSHIP AND LAND SIZE (HECTARES)	PARTIAL	TOTAL	PERCENTAGE
PROPRIETORS Less than 1 ha. 1 - 1.99 ha. 2 - 2.99 ha. 3 ha. or more	 1 4 3 27	35	44.9
NON-REGISTERED PROPRIETORS Less than 1 ha. 3 ha. or more	 2 1	3	3.8
IBR GRANTEES 1 - 1.99 ha. 3 ha. or more	 1 1	2	2.6
FISCAL LAND PETITIONERS 1 - 1.99 ha.	 1	1	1.3
FISCAL LAND OCCUPANTS 2 - 2.99 ha. 3 ha. or more	 1 1	2	2.6
OCCUPANTS ON LEASE 3 ha. or more	 3	3	3.8
PLAIN OCCUPANTS Less than 1 ha. 1 - 1.99 ha. 2 - 2.99 ha. 3 ha. or more	 4 4 1 6	15	19.2
KIN RELATIVES OF PROPRIETORS Less than 1 ha. 1 - 1.99 ha.	 3 2	5	6.4
OCCUPANTS UNDER DEPENDENCY Less than 1 ha. 2 - 2.99 ha. 3 ha. or more	 1 1 10	12	15.4
TOTAL		78	100.0

Source: Data from Socioeconomic Survey, 1989.

3.3.7.1.3. Land ownership in Cañada.

In this community, 59% of the farming lots are held by the proprietors, which in 72% of cases have their titles, while the remaining owners do not have a title for their properties. These owners have lots larger than 3 ha, in 66% of cases. Among the rest of the owners, 4 instances were found in which lands were smaller than 1 ha size.

IBR grantees were found in only 3 cases, and 2 of them had lands larger than 3 ha. This community also registered one case of shared ownership of an estate smaller than 3 ha.

Occupants that are not actual owners constitute about 33% of all cases. Fifty percent of these were plain occupants, who had lands larger than 3 ha in 75% of the cases.

Table 88 shows the distribution of land ownership modalities in this locality.

TABLE 88

LAND OWNERSHIP IN CAÑADA

BASELINE EVALUATION

TYPE OF OWNERSHIP AND LAND SIZE (HECTARES)	PARTIAL	TOTAL	PERCENTAGE
PROPRIETORS Less than 1 ha. 1 - 1.99 ha. 2 - 2.99 ha. 3 ha. or more	 3 4 1 13	21	42.9
NON-REGISTERED PROPRIETORS 1 - 1.99 ha. 2 - 2.99 ha. 3 ha. or more	 1 1 6	8	16.3
IBR GRANTEES 1 - 1.99 ha. 3 ha. or more	 1 2	3	6.1
FISCAL LAND PETITIONER 1 - 1.99 ha.	 1	1	2.0
FISCAL LAND OCCUPANT 3 ha. or more	 2	2	4.1
SHARED FAMILY OWNERSHIP 1 - 1.99 ha. 3 ha. or more	 3 1	4	8.2
PLAIN OCCUPANT Less than 1 ha. 1 - 1.99 ha. 3 ha. or more	 1 1 6	8	16.3
KIN RELATIVES OF PROPRIETORS 3 ha. or more	 1	1	2.0
OCCUPANT UNDER DEPENDENCY 2 - 2.99 ha.	 1	1	2.0
TOTAL		49	100.0

Source: Data from Socioeconomic Survey, 1989.

3.3.7.2 Productive aspects.

3.3.7.2.1. Livestock production and other farm products.

Families benefitted by the Project develop a diverse set of productive activities, which include livestock production, especially meat, milk and egg products.

A. Cattle. As shown in Table 89, 71% of the families covered in a survey own between 1 and 9 heads of cattle, and about 2/3 of these produce an average of 750 liters of milk per year; that is, in other words, about 2 liters per family per day (Table 90).

TABLE 89

BOVINE CATTLE PRODUCTION

STRATIFIED GLOBAL DATA

BOVINE CATTLE PRODUCTION	OBSERVED CASES	%
1 - 9 cows	95	70.9
10 - 29 cows	36	26.9
30 cows or more	3	2.2
Total cases studied	134	100

In the three localities, variations were detected among them in terms of the amount of cattle and other livestock owned, as well as other farm products.

Concerning cattle ownership, seventy-six percent of the families in Cañada, and 70% in Ñanduá, own cattle stocks. No data are available for Ypa'ú in this regard.

In Ñanduá, 89% of the families own less than 10 heads of cattle, and 11 own between 10 and 29. In Cañada, on the other hand, cattle ownership is better distributed, since 58% of the families own less than 10, 39% between 10 and 29 and 3% more than 30 heads of cattle.

Somewhat less than 1/4 of the families examined produce an average of 6 liters/day, and they belong to the group of units holding between 10 and 29 heads of cattle.

Besides milk production, which represents the main goal of cattle raising in this type of countryside families, the owners in the first group (who own 1 to 9 heads of cattle) can afford to sell one middle-aged animal, approximately every 2 years. The intermediate group (who owns 10 to 29 heads of cattle) has an increased availability of animals for sale, generally above 2 heads of cattle per year. Considering the population as a whole, 71% of the families supplied information about the amount of cattle owned, while 60% did so on milk production rates.

TABLE 90
ANNUAL MILK PRODUCTION
STRATIFIED GLOBAL DATA

MILK PRODUCTION (LITERS/YEAR)	OBSERVED CASES	%
Less than 1500 l/y	76	67.9
1500 - 3000 l/y	26	23.2
3000 l/y or more	10	8.9
Total cases studied	112	100.0

Regarding milk production in the different communities, there is a strong predominance of small-scale exploitation of this resource, especially in Ñanduá and Cañada, where about 72% and 79%, respectively, of households produces less than 1500 liters of milk each per year. However, in Ypa'ú, this group represents only 6%, while 32% of them produce between 1500 and 3000 liters annually. This level of productivity is only reached by very few families in Ñanduá and Cañada, with 17% and 18%, respectively. The number of families producing more than 3000 liters per year is low: in Ñanduá 11, in Cañada 3, and in Ypa'ú 12 (Table 91).

Considering the two groups with the lowest production rates (which together represent 89%, 97% and 88% of positive cases in Ñanduá, Cañada and Ypa'ú, respectively), the mean production rate per family is shown in table 91.

TABLE 91

AVERAGE MILK PRODUCTION RATE PER FAMILY

DATA DISCRIMINATE BY COMMUNITIES

AVERAGE MILK PRODUCTION	ÑANDUA	YPA'U	CAÑADA
Liters per year	922	998	1140
Liters per day	2.5	2.7	3.1
Number of families producing 3000 l/y or more	11	12	3

Positive cases, concerning milk production, represent about 56% of the families in Ñanduá, 66% in Cañada, and 58% in Ypa'ú.

B. Pigs. According to the results of the survey, the families which provided information own between 1 and 9 pigs. Considering 4.5 pigs per family as mean value, it can be estimated that all of the 133 families studied would each have about 200 kg of meat available per year, which if consumed in the menage, yield approximately 500 g of meat per day. Seventy-one per cent of the families own pigs.

In Ñanduá and Cañada, 64% and 82% of the families, respectively, own between 1 and 9 heads of pigs. No information is available for Ypa'ú. None of the families own more than 9 heads of pigs in the three communities.

C. Poultry Sixty-nine per cent of the families own hens and chickens in an average amount of 25. Only about 15 of the families own less than 10, while 1/5 of them own 40 or more chickens (Table 92).

TABLE 92
POULTRY PRODUCTION
STRATIFIED GLOBAL DATA

POULTRY PRODUCTION	OBSERVED CASES	%
Less than 10 fowl	17	9.8
10 - 39 fowl	119	68.8
40 fowl or more	37	21.4

Concerning poultry production in the three different communities, a high percentage of the surveyed families is engaged in this productive activity (Table 93).

TABLE 93

DISTRIBUTION OF THE FAMILIES PRODUCING POULTRY

DATA DISCRIMINATED BY COMMUNITY

POULTRY PRODUCTION	ÑANDUA n= 64	YPA'U n= 74	CAÑADA n= 50	TOTAL n= 188
Number of producing families	57	69	47	173
Percentage	89	93	94	92

Most of the families own between 10 and 39 chickens. On the other hand, a low number of families own less than 10 chickens. The majority of the families in Cañada own 40 or more chickens (Table 94).

TABLE 94

DISTRIBUTION OF THE FAMILIES ACCORDING TO

THE MAGNITUDE OF POULTRY PRODUCTION

DATA DISCRIMINATED BY COMMUNITIES

POULTRY PRODUCTION	PERCENTAGE OF PRODUCING FAMILIES			
	ÑANDUA (%)	YPA'U (%)	CAÑADA (%)	TOTAL (%)
Less than 10 fowl	12	9	9	100
10 - 39 fowl	79	68	57	100
40 fowl or more	9	23	34	100

Rather little variation in the egg production rate is observed among the three localities. In fact, families in Ñanduá, which reach the highest production average, produce 2% more than those in Cañada, which themselves produce, on the average, 8% more than the households in Ypa'ú. The latter has an average production rate of 322 eggs/year.

From the total stock of fowl results an estimated annual production of 450 eggs per family, which represents 1.2 eggs per family per day. Fifty-two percent of the families revealed a lower rate of production, while 40 of them produce eggs at a higher rate.

Considering the whole population, 173 families provided data on poultry production, and 142 on egg production, which represents 92% and 66% of the total sample, respectively.

D. Other farm products. Very few families appeared to be involved in the production of other farm products. As shown in table 95, 1/4 of the families produce pork fat and cheese. The rest of the products (with the exception of firewood), are produced by less than 10% of the families.

TABLE 95

OTHER FARM PRODUCTS

MEAN ANNUAL PRODUCTION PER FAMILY

OTHER FARM PRODUCTS (MEASURING UNITS)	PERCENTAGE OF PRODUCING FAMILIES	MEAN ANNUAL PRODUCTION	AVERAGE ANNUAL PRODUCTION PER FAMILY
Honey (l)	4.2	175	0.93
Pork fat (kg)	22.9	287	1.53
Cheese (kg)	23.9	285	1.52
Starch (kg)	9.0	426	2.26
Cassava meal (kg)	0.5	ND	ND
Cigars (units)	3.2	ND	ND
Jam/Preserves	2.1	ND	ND
Molasses	1.6	ND	ND
Handicraft	1.6	ND	ND
Charcoal	1.6	ND	ND
Firewood (m^3)	17.0	ND	ND

ND: No data.

When considered the production of these other farm products, pronounced variations among the communities were observed. As shown in table 96, the highest averages of honey and pork fat production are achieved in Cañada. The latter finding is consistent with the relatively greater rates of pork ownership in this community. On the other hand, families in Ypa'ú showed the highest production rates of cheese, starch, and firewood. Mean values for selected products are presented in table 96.

TABLE 96

OTHER FARM PRODUCTS

MEAN ANNUAL PRODUCTION PER FAMILY

PRODUCTS (MEASURING UNIT)	MEAN ANNUAL PRODUCTION			
	ÑANDUA	YPA'U	CAÑADA	TOTAL
Honey (l)	7.8	0.7	17.0	25.5
Pork fat (kg)	33.6	74.3	94.0	201.9
Cheese (kg)	22.6	117.6	54.0	194.2
Starch (kg)	2.3	87.8	12.0	102.1
Firewood (m^3)	ND	33.8	21.0	54.8

ND: No data.

4. CONCLUSIONS

4.1 Housing component.

See the document of the Housing Component, Chapter 17 "Conclusiones del Sector Vivienda".

4.2 Health Component

4.2.1 Serology

1. A diminution of the seropositivity for *T. cruzi*, determined by ELISA, was observed in the three communities, but the variation was significant ($p<0.05$) only in Cañada.

2. The total seroconversion rate was 0.5% concentrated in Ñanduá, with 3 cases (1.5%). No seroconversion was observed in Ypa'ú and Cañada.

3. New positive cases in children under the age of 4, attributable to vectorial infection, were not detected. The two new cases, one in Ypa'ú and another one in Cañada, were a child congenitally infected and a child born outside of the community, respectively.

4. Age-adjusted serological rates were comparable before and after the interventions in each community.

5. The highest serological titre appeared consistently in Cañada both before and after the interventions. The lowest serological titre was found in Ñanduá.

6. No significant differences were observed in the seroprevalence in relation to sex. However, a higher proportion ($p<0.1$) of infected women was observed in Cañada in the pre-intervention period.

7. The results of the ELISA for *T. cruzi* were confirmed by indirect immunofluorescence both before and after the interventions, except for two individuals who showed a positive ELISA and a negative indirect immunofluorescence after treatment.

8. The random control performed through indirect immunofluorescence of 10% of the ELISA negative samples showed a 100% concordance.

4.2.2 Triatomine infestation

The longitudinal characteristics of our work after performing the interventions showed the importance of the domestic infestation surveillance for vectors may repopulate or reinfest the dwellings. This infestation depends on two factors:

a. The intrinsic rate of vector growth, and
b. The success of the control performed, which has to guarantee the absence of both residual focuses or non-intervened houses in the area.

The residual foci of *Triatoma infestans*, a vector of slow reproduction and with a low recuperation rate, can be eliminated with an effective and permanent surveillance system (3).

The recuperation or reinfestation rates, measured at the 21th month in our work, were 4% for the improved locality (Ñanduá), 2.4% for the sprayed locality (Cañada) and null for the sprayed and improved locality (Ypa'ú). This means that a combined intervention composed of domiciliary and peridomiciliary spraying before improvement guaranteed the control during the 21-months follow up period. There was no peridomiciliary intervention in the locality where house-improvement was performed, and this could account for the recuperation of intradomiciliary

populations. Besides, some houses were not improved. The sprayed locality had a recuperation rate of only 2.4% at month 21, probably due to the surveillance.

This work allowed us to establish the sensitivity and feasibility of the surveillance procedures performed. The manual capture showed a low sensitivity in comparison to the calendar and plastic bag methods. Besides, the manual capture is an expensive system due to the transport cost and the necessity of trained personnel. When triatomine density is low, it is very difficult to make captures in short visits (10).

Marsden *et al.* (1983) demonstrated that a high percentage of houses with indirect evidence of infestation were then declared positive showing that the exclusive use of manual capture is not sufficient.

The use of calendars has the limitation of covering a small area inside a room. Nevertheless, their exposition for long periods of time showed to be an effective detection procedure.

In the present study, community participation was assessed by the involvement of people in triatomine capture and in the use of plastic bags during the post-intervention period. Undoubtedly, this was the most sensitive method. Garcia Zapata et al.(1988) have obtained similar results by using white paper sheets fixed to the wall of the main bedroom. This author also proposed the combination of the use of bags and paper sheets as surveillance procedures in national programs of triatomine control.

Generally speaking, all the interventions performed in this project drastically reduced the triatomine density in the three localities. Therefore, a national program of control of Chagas' disease vector should involve control tasks at two different stages:

a. A drastic control of the vector density based on the systematic spraying of the communities combined with a vector surveillance performed by the community itself.

b. A long-term control which should include that incorporates housing-improvement, not only as an alternative for the control of Chagas' disease vector, but as an alternative to improve the standard of living in rural populations located in endemic areas for Chagas' disease.

4.2.3 Residual effect of the insecticide.

1. A drastic reduction of triatomine population was observed after one application of lambdacyhalothrin (Icon WP10). Domestic infestation rates pre and post-treatment were statistically significant ($p<0.0001$, Chi-square test, Yates corrected). In the peridomestic environment, positive infestation was recorded in four out of 45 houses during the pre-intervention survey. Peridomestic environment remained uninfested six, 12 and 21 months after spraying.

2. A 4% infestation was observed after two years of insecticide application.

3. The residual effect measured in this bioassay conditions was insufficient, although a powerful lethal effect of lambdacyhalothrin was observed *in situ* on *T. infestans* adults and nymphs.

4. Wood was the most suitable material to keep the insecticide residual effect. The low persistence of the insecticide on porous materials (mud, non-plastered bricks) should be carefully considered due to the high proportion of houses built of these materials in the rural areas of Paraguay.

5. The residual effect was better related to the type of treated surface rather than to the applied dose because higher doses did not correspond to a higher residual effect.

6. Remarkable differences were seen in the comparative assay of the residual effect of lambdacyhalothrin and deltamethrin.

7. The applied dose of lambdacyhalothrin (31.5 mg m.a./m^2) was enough to maintain a low reinfestation rate even after two years of application, in spite of the low residual effect.

8. Neither complaints about adverse effects of the insecticide application nor cases of domestic animals mortality attributable to the insecticide application were recorded.

9. It should be underlined the difference between insecticide effect, residual effect measured in bioassay and no reinfestation, which are related but do not correspond directly.

4.3 Social Component

Very different tasks were assigned to the social component which produced a weakening of its specific role, specially because the design did not include a community where only the education variable was evaluated in order to measure its action. Besides, there was a trend to enunciate everything concerning participation without an appropriate knowledge or practice involving this subject. The overlap of specific professional competencies was a corollary of this fact in some cases. A similar circumstance occurred with the meaning of the term "interdisciplinary approach". Some members of the Technical Staff considered it as the sum of different specific contributions without any other link to other approaches. It should be mentioned that the optimal situation is represented by the interrelated construction of sense connections.

Several activities involving participative diagnosis were carried out in each community, although different approaches were used to detect the necessities of each population. It was attempted to fulfill these needs as long as the project approach and the relative capacity of the Technical Staff. The Social component mobilized local resources and linked them with official institutions (i.e. Ministry of Public Health and Social Welfare, Ministry of Public Services and Communication, Electric National Company, etc.) with power and institutional responsibility to solve specific problems.

Simultaneously, active local organizations within the community were searched. Such structures were created by the initiative of the communities to solve specific problems. In this way, the community of Ypa'ú created a neighboring committee to repair and maintain local roads, which facilitated the product outlet and commercialization. The Social Component of the Technical Staff acted in this case as an intermediary between the community and the Ministry of Public Services and Communication which agreed to provide technical staff and machinery, while

the community would be responsible for fuel, supplies and support work, finishing tasks and some maintenance activities.

The community of Cañada focused their efforts at the improvement and widening of the school and to build a chapel. The most significant and achieved participative diagnosis was performed in this community, but it wasn't followed by both identification and execution phases directed to the solution of the problems. The analysis was surprisingly lucid and it revealed an acute comprehension of the problems, but it did not resulted in the design of interventive actions directed to modify the reality in a desired sense. Many factors, working simultaneously, could explain this behavior, such as the distrust on the group capacity to execute successful actions and the ancestral fatalism of farmer societies which is historically consolidated. Also, there were different groups far apart due to either familiar or political reasons that hindered communitary work.

Apparently, those activities related to the church had more consensus and differences were relegated. Nevertheless, such activities were only related to the construction or improvement of a chapel and liturgical celebrations, generally conducted by laymen due to the almost permanent absence of priests. In fact, most meetings summoned by the Social Component of the project were held in the church yard, because it was a "noble space" for the community gathering.

On the other hand, some summons to perform electrocardiograms to the seropositive in certain houses were rejected for some people that claimed: "What does he have that I do not have?. Why don't you come to my house which is bigger?" (Cañada's inhabitant, whose daughter was seropositive). Therefore, the election of a gathering place became an eventual element of friction, which occurrence is difficult to foresee. Though this fact does not have to be overdimensioned, it is a clear indicator of the kind of relationships present in this community and the complexity of the underlying relational structure.

Finally, none of the communities had stable and consolidated organizations that attempted to fulfill the deep aspirations of the population. Those existent ones limited their work to specific and circumstantial goals, such as road repair, school support or building or repairing a chapel. These activities were socially and politically allowed by the authorities within the framework of more than three decades of dictatorship, whose effects were particularly harmful in the rural areas. The subjection to the government was a style of life which comprise a relevant component of the survival strategy of the families from farmer communities.
In summary:

a. It was demonstrated the deficiency of fragmentary approaches in the treatment of farmer health problems. An integral and intertidisciplinary design, more than carrying out disconnected activities, is necessary to solve such problems.

b. It is a must the deep and systematic study of participative experiences in order to identify social determinants of Chagas'disease and to establish reasonably consolidated links between knowledge, attitude and life styles. The life quality mainly rises through participation, which is accomplished by community organization.

c. There is a notorious imbalance between the systematic efforts devoted to increase the knowledge about biological aspects of the vector, the parasite and the pathology, and the participation modalities of farmer communities in the health care. Since there is no effective treatment for chagasic patients, this inefficacy of medical practice is added social inefficacy. This fact results in a situation that tends to persist.

d. The existence of bilingualism makes urgent the search of appropriate systems of transmitting specific information to children and adults, specially

in issues related to health. It is necessary to construct a "communicative matrix" to identify the cultural characteristics of the different groups to whom the messages will be directed.

e. Although the people improved their knowledge about Chagas' disease in this project, housing improvement should not be promoted just as a system for vector control. The farmer, as any other human being, would improve his house moved by the desire of having more comfort and by the aspiration, explicit o implicit, of improving his life quality. Besides that, information alone is not capable to generate attitudes, which should be complemented by social proficiency allowing an appropriate behavior. Such changes are restricted by the framework imposed by the situation of poverty.

f. The interdisciplinary approach does not become a real entity just by verbalization.It is necessary a deliberated effort to construct it in such a way that the approaches are mutually implicated. This should result in a scheme that surpasses the simple juxtaposition of opinions.

g. Poverty is the main hindering factor for a good health situation in the rural communities. However, this fact tends to be hidden by several factors such as the structure of land ownership and livestock availability, and the ancient reluctance of the people to reveal indigence. This should be added to the limited capacity of the instruments to collect information on income and life quality.

5. GLOBAL RECOMMENDATIONS

These recommendations were formulated by the three components - Housing, Health and Social - as a corollary of the project.

1. The approach to the health problems of the farmer through separate components (housing, social, health) it is not an adequate strategy. A more comprehensive and multidisciplinary methodology is necessary, because the problems related to poverty are solved by improving the life quality. Such result won't be obtained through activities from specific sectors.

2. The three different intervention methods were efficient, considering the results related to the diminution of infestation and reinfestation rates. Very few cases of seroconversion were observed only in the community where fumigation was not applied (Ñanduá). Differences concerning the permanency effect of the intervention were observed. In this analysis it should be considered that the interventions are different in both scope and time schedule. In other words, they were applied to a variable number of dwellings in each community, interventions had application terms substantially different (a considerable number of houses may be fumigated before concluding the improvement of one house) and they were applied in different periods after the baseline study.

3. Baseline data allow the selection of the most appropriate intervention to each community based on both serological and infestation situations. Fumigation should be applied in communities where active transmission is detected, thus requiring an immediate control. House improvement would be convenient for a second control phase (consolidation of primary control) or for communities where the infection risk is moderate. This last intervention adds to its persistence the benefits of a permanent educational character in the communities. Education, through the school in all cases, would provide the intervention of highest persistence and the highest time of latency to see

the results. It should be emphasized that neither education nor improvement kill vectors *per se*. Therefore, these interventions should be applied to communities with low infection risk or which have been prior subjected to a vigorous vector control.

4. There is a notorious imbalance between the systematic efforts for getting information about the vector biology, the parasite and the pathology of the disease, and the absence of specific studies on community participation related to farmer's health care.

5. Research designs should allow participative elaboration with the involved communities, if technically pertinent. Improvement tasks should involve peridomicile, and not just the habitat or domiciliary environment. Both environments should be incorporated to epidemiological surveillance programs. The surveillance of peridomicile, which is an environment more difficult to control, should be a competence of the communities themselves in the post-intervention stage.

6. It is necessary to construct a "communicative matrix" to identify the cultural characteristics of the different groups to whom the messages will be directed. Bilingualism makes this approach particularly urgent.

7. The comparison between housing improvement and fumigation can not be made only in terms of costs, even knowing that improvement costs are higher (15 times fumigation cost, in net cost). Other aspects should be considered in order to evaluate both direct and indirect contributions of improvement versus fumigation. Housing improvement has a higher impact on comfort an quality standard, surpassing the benefits related to vector control.

8. It has to be considered that the performance of the fumigation, as a health policy, is a competence of the Ministry of Health while housing improvement corresponds to the National Housing Council (CONAVI). Concerning this aspect, housing improvement should be considered a more convenient alternative to housing substitution, due to both costs and cultural aspects.

9. The social causality of community health and the poverty compel to formulated and performed programs for the promotion of life quality in rural communities. Such initiatives must be established within a clear self-management framework.

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