Final Technical Report

Livestock Production Programme (LPP)

Project Number R6774

Strategies for Integrating and Optimizing Livestock Production in Forest Margin Farming Systems

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Acronyms

IBD	Inter-American Development Bank
BTAM	British Tropical Agriculture Mission
CIAT	Centro de Investigación Agrícola Tropical
CORDECRUZ	Corporación Regional de Desarrollo de Santa Cruz
DFID	Department for International Development
EEAS	Estación Experimental Agrícola de Saavedra (of CIAT)
FMVZ	Facultad de Medicina Veterinaria y Zootécnia (of UADY, Mexico)
LPP	Livestock Production Programme (of DFID)
NGO	Non-governmental organization
NRI	Natural Resources Institute
ODA	Overseas Development Administration (now DFID)
PASA	Programa de Apoyo a Seguridad Alimenticia (funded through IBD)
SWOT	Strengths, weaknesses, opportunities and threats (a technique for subjective analysis of proposals
UADY	Universidad Autónoma de Yucatán (Mérida, Mexico)
UAGRM	Universidad Autónoma Gabriel Rene Moreno (Santa Cruz, Bolivia)

EXECUTIVE SUMMARY

The project operated in the Bolivian lowland Provinces of Sara and Ichilo from September 1996 to October 2001, although, because of administrative problems, no DFID funding was available in the period from March to September 2000. The aim was to improve the livelihoods of small-scale farm families in forest margin farming systems. The stated objectives were to define the role of livestock; to develop feeding strategies that promote the improved integration of livestock into the systems; to promote technologies which improve the seasonal availability of feed; and to develop participatory methods for on-farm, livestock research. All farm families in the target area kept small animal species, while only the most prosperous owned cattle. Small animals were managed by women and children, who benefited directly from income that they produced. The work therefore concentrated on the most common species, chickens, ducks, pigs, tropical hair sheep and guinea pigs.

Technical project activities included participatory on-farm monitoring and trials, together with researcher-managed investigations under the control of thesis students. At the conclusion of the formal research, the techniques and recommendations developed by the project, were validated on farms located in four communities. Socio-economic work included participatory appraisals, group and individual interviews and case studies. During the validation phase, full, economic costs of production were determined. Direct dissemination was conducted through technical tours arranged for farmers and through workshops and frequent, personal contact with a range of NGOs. All project findings were documented through the production of leaflets, booklets, student theses, scientific articles and press releases.

Under existing management, the gross annual return from a single breeding female, was about US$ 13; 12; 260; 14; and 10 for chickens, ducks, pigs, sheep and guinea pigs respectively. The combined value of home consumption and sales of these animals was about 30% of the total income (cash and kind) of poor people, where families earned less than US$ 1,000 per annum. As prosperity increased, the absolute value of small animal production remained relatively constant, although the proportion of total income fell. Guinea pigs had few problems apart from theft by neighbours and predators but the other species showed high levels of mortality amongst young animals. The major problems of chickens were diseases, for which recommendations existed for either prevention or treatments. Duckling mortality was associated with cold and damp conditions, which could be overcome by the provision of rustic shelters. Pigs and sheep suffered from internal parasites, although lack of either feed quantity (pigs) or quality (sheep) sometimes presented problems which could be addressed by increased, on-farm production. Highland immigrants, (about half the population), are more market oriented and exploitative than the original lowland population, so it is likely that the two groups will require different extension messages and mechanisms to serve their needs. Effective participatory research methods were developed and documented.

Participants claimed that the project had reduced their need to hunt or to contemplate selling their land, demonstrating an immediate impact on natural resource conservation. Practical measures were developed to reduce mortality and increase productivity of small animal species, without diverting large amounts of capital or effort from other farm enterprises. These should improve both food security and family income in the poorest sector of the region. By addressing all aspects of the DFID capital pentagon (human, social, natural, physical and financial), better productivity of small animal species will contribute substantially to improved family livelihoods.

The project attracted much attention, both in other areas of the Santa Cruz Department and elsewhere in the Bolivian tropics, because of its poverty focus and the effective methods which it developed to conduct participatory work with small-scale producers. By the end of the research, the counterpart organization had received a large number of requests from local government authorities for development activities with small animal species. These bodies were prepared to provide dedicated staff and financial assistance if CIAT could contribute technical support for the work. The impact of the project has already been considerable, but is certain to grow over the course of the next few years. It is strongly recommended that DFID should undertake a full impact assessment of the work, preferably at the end of 2004, when the activities in other areas have had time to come to fruition.

There is considerable scope for expanding the work on a geographic basis, to include the drier areas of the Santa Cruz, Chuquisaca and Cochabamba Departments, where goats are of major importance to the livelihoods of poor people. At present, little is known about this species, apart from its potential to survive under extremely difficult conditions. Because of poor management practices, it is responsible for considerable environmental degradation and research would be necessary to design suitable production techniques to overcome this problem.

BACKGROUND

Until the mid 1970's, although there had been both national and internationally funded programmes intended to support the agricultural sector in the Bolivian Department of Santa Cruz, these had generally taken the form of local promotion of technologies developed elsewhere and little original, or applied research was undertaken. In 1975, a new organization, the Centro de Investigación Agrícola Tropical (CIAT), was formed specifically to undertake systematic agricultural research and development within the whole of the Department. At the same time, the Bolivian government sought technical assistance from the Overseas Development Administration (ODA) of the British Government and this request led to the formation of the British Tropical Agriculture Mission (BTAM). The two bodies worked in total collaboration for a period of two decades until, given the availability of a large number of well-trained nationals, it was considered that full-time, resident British technical assistance was no longer necessary to support research activities. In 1996, the nature of the bilateral foreign aid was therefore modified, in order to provide for institutional strengthening of CIAT, rather than for direct technical assistance. In conjunction with this change, access was made available to competitive, British, strategic research funds, in order to conduct specific, agreed projects.

At the time of the formation of CIAT and BTAM, national priority was given to increasing the agricultural production of the region. In order to achieve this within the existing limitations of staff and facilities, a conscious decision was taken to place most emphasis on commercial crops (maize, rice, cotton, etc.) and on cattle (mainly dairy and dual purpose animals). It was not the declared intention to ignore small-scale farmers and some of the programmes, such as those devoted to pasture development, plant protection and weed control, were considered to be largely scale-neutral. Nevertheless, it must be accepted that the early years of the research activities benefited the medium and large-scale producers of the commercial sectors of the Department, rather more than the predominantly subsistence farmers which were then found in increasing numbers in the designated colonization areas. At this time, the small-scale sector received assistance from a range of non-government organizations (NGOs), including charity and church-based groups. These bodies carried technical information from the research entities to the farmers, but there was little adaptive research conducted to specifically address the most pressing problems of the small-scale production systems.

By the end of the 1980's, as evidenced by a number of the policy and planning documents that emerged from CIAT at that time (eg. CIAT, 1989; Gibbon, 1993), local authorities became concerned at the obvious commercial bias in the programmes. Amongst the practical steps taken to address this recognised failing, was the establishment of a CIAT/BTAM agroforestry programme, which concentrated many of its activities in the area of Yapacaní (Ichilo Province). It promoted a range of tree species for diverse purposes, such as fruit, shade, fodder, live fences, etc. (Saldías *et al*., 1994). Since agroforestry techniques are known to be labour-intensive, they are generally considered to be more suitable for small-scale farms than for larger, commercial production systems.

Socio-economic evaluations and comparisons had been conducted in the colonization areas of Santa Cruz since the 1970's, by a number of organizations, including CIAT/BTAM, CORDECRUZ and a range of NGOs (eg Maxwell and Pozo, 1981). All of these studies recognised that the small-scale farmers were amongst the poorest people in the region and that the generation of sufficient capital to enable the use of efficient farming methods was one of their most intractable problems. A range of species of domestic livestock had major importance within the existing, mixed farming systems, particularly for the poorest members of the society. The animals were seen to serve two main purposes. Primarily, they contributed to diets, food security and social obligations, through consumption within the family and by valued visitors. Where a surplus was produced, however, they filled a cash-generation role, since there was usually a ready market for animal products in the rural settlements. The small size and low price of small animal species made them suitable for covering modest expenses, such as the cost of medicines, school fees and transport for visits to the town.

At that time, however, livestock were out of favour, both with the general public and also, to some extent, with aid donors. Special interest groups were, often erroneously, blaming animals, particularly cattle, for many of the problems of the world, including global warming, poverty, deforestation, contamination of water and desertification (Huss, 1993). As a result of the adverse publicity, despite the recognised importance of livestock to the food security and income generation of poor people, it was often difficult to obtain funding for activities that concentrated on the animal component of the farming system.

Later, in the mid 1990's, with competitive research funding from the Systems Programme of ODA, a farming systems project was initiated in the Sara and Ichilo Provinces of the Department as a collaborative activity between CIAT and NRI. This project (R6382, *Sustainable Agriculture in Forest Margins*) concentrated on providing a menu

of annual and perennial cropping systems that would then be validated through participatory research on farms in the target area (Pound *et al*., 1999). While it included activities with cover crops, several of which had, at least some potential for use as fodder (CIAT, 1999), it was not designed to include a livestock component. As opposition to work with animals was by then losing momentum, the project which is the subject of this report, was proposed as a complementary activity, for funding through the Livestock Production Programme (LPP) of ODA (which evolved into the Department for International Development, DFID, in 1997, shortly after the start of the project), in order to define and enhance the role of livestock within the existing farming systems.

The project under consideration was originally conceived to work with all of the main species of domestic animals in the target area. Subsequently, with increased emphasis on the alleviation of poverty, policies clearly stated by both the Bolivian and the British governments from 1997 onwards, it was decided to work exclusively with small animal species. This was justified from three perspectives. Firstly, although it was recognised that most farmers aspired to cattle ownership, only the more prosperous members of the small farm sector owned them at the time of project inception. It was therefore considered inappropriate to devote efforts to large ruminant production. Secondly, while cattle are generally managed by the man of the family, small animal species are under the control of the women and children, who often administer any income that accrues from them. There is therefore an element of gender sensitivity involved in work with small stock. Finally, there was already some information available on the performance of dairy cattle on small-scale farms in the target region. From as far back as the early 1980's, these animals had been the subject of research (eg. Breinholt, 1982), while another, simultaneous LPP project had been started, which, in part, was to study dairy production in the Yapacaní area (eg. Herrero *et al*., 1999). These considerations were used to justify the current project emphasis on small stock.

At the time of planning of the new project, it was known that small animal species were found on all of the small-scale farms in the target area, but that their importance was probably greatest for the poorest families. Some NGOs had independently started to promote the use of improved breeds, particularly of laying hens, even though these are recognised to be more delicate than local (*criollo*) strains. It is well accepted that genetically improved animals require high standards of health care, feeding regimes and general management techniques, if they are to realise their undoubted production potential. Nevertheless, there was a total lack of local information on the productive performance of small stock in small-scale farming systems in the Provinces of Sara and Ichilo. Indeed, the only documentation that could be found concerned two CIAT/BTAM studies conducted in the Chané area to the north of Santa Cruz. One related to pig production (Wilkins and Martínez, 1983), while the other was concerned with tropical hair sheep (Wilkins *et al*., 1983). In both cases, the species were considered to have shown potential, although animal health issues, particularly internal parasite, were cited as potential sources of difficulty. Although the soils, vegetation and farming systems in Chané are broadly similar to those of the target area, the northern colonization zone has a longer and more severe dry season. It was feared that this climatic difference may prevent extrapolation of results to the new area, since the parasite problem could be aggravated by the higher rainfall in the Provinces of Sara and Ichilo. There was no published information regarding the performance of poultry or guinea pigs within small-scale farming systems anywhere in the Bolivian tropics. This was seen as a major limiting factor to the promotion of small stock in the target area.

The project was therefore designed to conduct research in order to improve the livelihoods of the poorest members of the resource-poor farming sector, through improvement in the productivity of small animal species. The primary target was the area of colonization in the Bolivian Provinces of Sara and Ichilo, although, by extrapolation and local validation, it was expected that the results could be applicable to other areas of the country and possibly to the wider Latin American region, in the humid tropics of countries such as Peru, Brazil and Ecuador, where similar physical conditions and farming systems were to be found.

PROJECT PURPOSE

The original proposal stated the project purpose as follows:

> 'Seasonal availability of feeds in small-scale livestock production improved and promoted, and potential for livestock-use diversification identified and appraised in forest/agriculture interface systems'.

This purpose was amplified in the statement of project outputs, which was as follows:

- The role of livestock in mixed smallholder farming systems in forest margins determined and documented.
- Management and feeding strategies for greater integration of the livestock component in farming systems developed and promoted.
- Technologies to improve the seasonal availability of feeds developed and promoted.
- Participatory methods for on-farm research involving livestock developed, tested and documented.

As a result of political initiatives soon after the start of the project, both in UK and in Bolivia, there was a need to place increased emphasis on poverty reduction and rural livelihoods. Within the target area, even the poorest farm families kept a range of small animal species, including chickens, ducks, pigs, tropical hair sheep and guinea pigs, while only the more prosperous sectors owned cattle. Project activities were therefore concentrated on small animals, as this was expected to have an impact on the livelihoods of poor families, in terms of both food security and income generation.

Because of the range of species chosen and the complete lack of background information on them available at the time of project inception, it was difficult to generalize with regard to their most important problems. Only pigs, for example, were likely to experience seasonal shortage of feed supply, although sheep might suffer from a lack of nutritional quality in the available feed resources, particularly during the dry season. It was necessary, within the project activities, to identify the major problems with each of the five important animal species, in order to develop management techniques, including health measures, carefully designed to increase the productivity of each of the animal species and consequently, the welfare of the poorest farm families.

RESEARCH ACTIVITIES

The project was conducted by a multi-disciplinary team. Project management was supplied by NRI, together with technical expertise in research techniques, pasture agronomy and animal production. Execution of the work in the field was the responsibility of CIAT, through a number of professional staff, including experts in pastures and fodder plants, animal production, veterinary medicine, socio-economics, anthropology and communications. Thesis students from universities in Santa Cruz and Cochabamba brought knowledge of veterinary medicine, sociology and agricultural economics, while several consultants were invited to contribute a regional and international perspective to the work.

The Farming System

The work was conducted fully within the Provinces of Sara and Ichilo, in the interface zone between humid forest and agriculture. In this area, the majority of the farms, which carried an original vegetation of tall forest, are of 30 or 50 ha. Although the individual land holdings are relatively large, the farming systems are small-scale, because the farmers are resource-poor, without the capital necessary to fully develop their farms. In order to plant crops, either for home consumption or for sale, farmers employ a swidden system of shifting agriculture within the boundaries of their holdings. Initially, the system is largely subsistence, producing the staple crops of maize, rice, cassava, etc. Each year, new areas are cleared from forest and the felled vegetation is burned. They are cropped for two or three years, until reducing soil fertility and increasing problems with annual weed species, force the abandonment of the area to bush fallow (*barbecho*). With the passing of time, as larger areas are cropped, the fallow period is reduced to the point where it is no longer able to restore the productive capacity of the area. At this time, termed, rather dramatically, the '*barbecho* crisis' by Maxwell and Pozo (1981), the farmers have to choose between a number of alternatives. Some plant pastures, in order to concentrate on cattle production, while others establish permanent crops, such as bananas and citrus. Others de-stump the cleared land to facilitate mechanization of larger scale, annual crop production, often with rice. The families that are less successful in the early stages, often seek to sell their land, in order to take up new blocks further into the forest, thereby contributing to the advance of the agricultural frontier, with its consequent destruction of the natural resource base and the potential loss of genetic diversity. Although, with this move, the families suffer from absence of infrastructure such as schools and health clinics, the funds generated from the sale of the first block can provide the capital necessary to develop the second, thereby increasing the chances of financial success at the second attempt.

Even on new farms, small animal species, such as poultry and guinea pigs are always present. They are used mainly for family consumption, although they also offer the opportunity for the generation of small amounts of cash, through the sale of meat and eggs. As the family consolidates its operations over time, other animal species, such as pigs and tropical hair sheep, are introduced. When the inevitable soil fertility crisis arrives, the sale of these latter species can generate the funds needed for de-stumping, or for the initial purchase of dairy cows. Nevertheless, even in the most successful, specialist dairy operations in the region, some small animals are always found, primarily to provide animal products for the table.

Methods

The initial project ran from the start of September 1996 until the end of February 2000. For reasons of cash flow within the LPP, funding for operational expenses in the initial stages was restricted, to the extent that the limited capital purchases necessary for the field work (project vehicle and computer), could not be made until the end of the financial year, in March 1997. Although the counterpart organization did its best to fill the gap, it was itself short of transport and computing facilities at the time and the lack of dedicated equipment presented a severe handicap to the project. The first six months of the project life can therefore be considered largely as a planning phase, since few of the field activities could be initiated during this time. The active research work during this phase was, therefore, effectively restricted to a period of just short of three years, from the beginning of April 1997 to the end of February 2000.

Because of the slow start to the field activities and the lack of prior, documented results with small animal species in the target area, a follow-up to the project was proposed to the donor. Initially, due to the nature of the call by LPP for research projects to start in April 2000, which emphasised dissemination mechanisms, a concept note was submitted to cover a period of three years. This was divided into two parts, where the first would allow for on-farm validation of the results obtained during the first phase of the project, while the second part would be devoted to preparation of extension material, scaling-up and dissemination. The concept note was approved and a full-scale, project proposal was then prepared. Before this could be evaluated, DFID recognised the need to formulate a coherent policy on dissemination and promotion of research results in general. New dissemination activities were therefore put on hold, pending the commissioning and preparation of a comprehensive policy statement. Together with several other projects that included a dissemination element, the new project proposal was therefore rejected, but it was suggested that the existing project might be extended for a year, to allow the necessary on-farm validation to take place. After an unavoidable delay occasioned by the preparation of a new proposal to cover the extension period, funding was finally approved for the agreed work to take place in the period from November 2000 to October 2001.

In the seven months between the conclusion of the first phase in February 2000 and the initiation of the extension in October of that year, CIAT did everything possible to continue with the work in the field, but because of its own financial crisis, activities during this period were basically limited to a continuation of on-farm monitoring and the supervision of on-going thesis work. The institute was, however, successful in obtaining the support of local government authorities for the initiation of work with small animal species in provinces which were not part of the DFID-funded research project. Although not a part of the research activities supported by DFID, these activities resulted directly from the present project, utilising many of the techniques developed during the course of the work. For this reason, they are briefly described below, in a separate section.

From the time of its inception, the project developed and employed a totally participatory methodology, always seeking the full involvement of both NGOs and farmers in all stages of the work. As an integral part of the planning process, the first major activity was to hold a workshop in the region (Yapacaní) in September 1996. The participants included representatives of the target group of farmers, together with almost all of the NGOs which were then working in agriculture and rural development in the target provinces. Each organization gave a presentation on its past and current work with small animal species and the project explained its plans for the future. In the discussions that followed, the NGOs were able to comment on the ideas presented and these points were taken into consideration during the course of final definition of the project. In this way, the regional players were made aware of the work to be done and were offered a degree of ownership over it.

During the course of the same workshop and afterwards, the NGOs were consulted regarding the identity of farmers with interest in small animal species, who might be prepared to participate in project activities. These farms, together with others known to CIAT, were then visited, in order to determine the animal species present and the level of interest of the farm families. It was never the intention to introduce new animal species or improved breeds, whose husbandry and management would be unfamiliar to the farmers, but rather to work with the existing livestock, where there was already some practical knowledge and experience.

As a result of the farm visits, amongst a range of domestic livestock, the most common animal species were identified as chickens, ducks, pigs, hair sheep and guinea pigs. In order to determine the productivity of these animals in the existing systems, a total of 12 farms were monitored over a full year, with a minimum of technical intervention. All events regarding the animal species of interest were recorded, including births, illness, deaths, sales and home consumption, together with any other observations considered by the owners to be of importance. Initially, project staff attempted to visit each collaborating farm on a weekly basis, to ensure that data recording was going to plan. Later, when the process became routine, such frequent visits were no longer necessary and, in order to avoid excessive dependence on project staff, the visits were made on a fortnightly basis.

During the first year of monitoring, through the recording process, the farmers themselves became more aware of the major problems encountered with each of the animal species under consideration, together with seasonal trends. On completion of this initial period, simple interventions were promoted, such as vaccinations against the most common diseases of poultry, and dosing to reduce the effects of internal parasites in pigs and sheep. During this period, regular monitoring continued, in order to assess the effects of the interventions on animal productivity. The aim was to promote a logical evolution of the production process, rather than to seek a technological revolution. As productivity increased over time, it was felt that an estimation of the potential of each animal species within the existing system would emerge.

Since small animals are almost always under the control of the women and children of the family, the project collaborators were seen as the whole family, including both parents and the older children, rather than as one individual within the group. This was important, since the man of the family was sometimes away from the farm for extended periods when he had to sell his labour in times of need. In some cases, the women were unable to write and so the children of school age carried much of the responsibility for recording the desired information. Later, when technical tours and field days were arranged for the collaborators, almost invariably, both parents participated in the events. Where they did not clash with educational obligations, the older children were also included. In this way, nobody was marginalized and the whole family felt themselves to be an integral and important part of project activities. This was a departure from standard practice both in CIAT and in the region, which was enthusiastically endorsed by all members of the collaborating families. The women were pleased to be involved in such activities, while the men were delighted that the women had been given the opportunity to improve their technical knowledge. The children generally took their recording duties very seriously and obviously enjoyed the chance to visit other communities and research plots.

Apart from the monitoring process, other on-farm, technical research was conducted with the collaboration of the farm families, but under the control of the researchers. Three undergraduate student theses fell into this category. One was concerned with the effect of feeding of perennial peanut (*Arachis pintoi*) to milking cows, which was undertaken to complement the cover-crops activities of the DFID-funded project number R6382, entitled *Sustainable Agriculture in Forest Margins* (Ayala, 1999). The second was designed to assess the diets selected, and the productivity of scavenging pigs (Burgos, 2001), while the objective of the third was to identify the most important animal health issues in poultry, pigs and sheep and to design a programme of preventative veterinary practices (Choque, 2001). Also in this category were some simple trials, conducted by farmers under the direction of project staff, which were designed to measure the growthrates of poultry and guinea pigs.

At the conclusion of the monitoring and participatory research phase of the project, a series of potential interventions were defined, which could be expected to address the defined problems and to improve the productivity of small animal species. Although the details varied with the species of livestock, these included the provision of installations to offer protection from the elements and natural predators and to assist in animal management; animal health measures, including sanitation and vaccination against common diseases; and the provision of additional feed resources. Evening workshops were then arranged in four communities, two of lowlanders and two of immigrants from the highlands of the country, where the research findings of the project and the potential interventions were described. These were generally attended by about 15-20 representatives, almost equally divided between men and women. After the presentation and a time for discussion, the attendees in each community were given the opportunity to select the two or three animal species of most interest to them. At that time, project staff withdrew, to allow free discussion amongst the group, who then selected three families that would work with the project in the validation phase of the project. The nominated families were the primary point of contact with CIAT, but other members of the community were fully aware of the activities to be undertaken and were on hand to observe the effects of the interventions and to offer opinions and help as necessary. On-farm validation therefore took place on a total of 12 farms, of which five were concerned with poultry; five with pigs; and two with guinea pigs. Although highland immigrants rarely keep ducks, because they consider them to be too dirty to keep near the house, in the two lowland communities, the installations designed for chickens were also used for this species. Strangely, given the

obvious importance of hair sheep, particularly to immigrant families, no community chose to work with these animals. Project staff believe that this may be due to the slower rate of economic return from sheep, compared with the species which were selected by the communities.

The project then worked closely with the chosen collaborators to establish the improved systems on a shared-cost basis. In general terms, the farmers contributed those materials which were available in the community (posts, palm thatch, etc.) and their labour, and maintained the necessary records, while the project provided purchased inputs (wire netting, vaccines, seeds, etc.) and arranged for veterinary assistance as necessary. While CIAT provided technical advice, the installations to house the animals were built according to the wishes of the farmers, with regard to position and form. This resulted in a series of designs, incorporating different features. In general, the housing for poultry and guinea pigs was much larger than necessary to accommodate the existing numbers of animals, suggesting a desire to increase the sizes of the holdings in the future. Installations for pigs were basically adequate for the existing number of sows and expected piglets, thus providing little scope for future expansion of the enterprise. All materials and labour inputs were carefully measured, to permit a full economic analysis of the cost of production (Riveros, in prep.). Regular technical visits were arranged to ensure that monitoring was sufficiently rigorous to generate valid data on the effects of the interventions.

During the course of the project, there was a growing interest in the use of guinea pigs. Initially, these animals were kept only by immigrants from the highlands, since the lowlanders considered that they appeared too similar to rats to be kept as domestic livestock. Towards the end of the project, however, some lowland families began to express interest in the species. In view of the difficulty in obtaining breeding animals in Santa Cruz, it was then decided to establish a small herd at the CIAT research station in Saavedra, to supply the growing demand for healthy breeding stock. It had never been the intention to introduce new animal species to the farms of project collaborators, because of the inherent risks involved in placing animals in the hands of inexperienced families. In the case of guinea pigs, however, experience showed that they were easy to manage and that health problems were minimal. It was therefore felt that the dangers were small, compared to the large potential benefits of providing an additional source of animal protein to resource-poor families.

On visits to the collaborating farms during the early stages of the project, the restricted range of available fodder species was noted as a potentially limiting factor to livestock production. In order to address the possible shortage of fodder quantity and quality at critical times of the year, vegetative material of a range of fodder species was provided to participating farmers, who were then at liberty to share the material with other members of their communities. Tall grasses, such as varieties of *Pennisetum purpureum*, were introduced for the establishment of fodder banks, to complement pastures during periods of feed shortage. These are being used mainly for cattle, sheep and pigs. In recognition that one of the limiting factors to sheep production could be the lack of nutritional quality in dry season feeding, stakes of the tree *Morus alba* (mulberry) were also distributed to participating farmers. Although this species is not a legume and therefore requires high levels of soil fertility, it is known to be of exceptionally high quality, palatability and digestibility for almost all species of livestock. The trees were established on most farms, where the farmers have generally chosen to offer the foliage mainly to animals that appear to be unthrifty or sickly. Where necessary, seed of leguminous species (mainly *Mucuna pruriens*, *Pueraria phasioloides* and *Macrotyloma axillare*) was supplied to farmers to establish small-scale, introduction plots. In several cases, where successful, these plots were later extended, in order to increase the availability of the high-quality forage.

At the time of inception of the project, the importance of socio-economic aspects was recognised. Since the technical studies were relatively long-term and would take many months to complete, however, it was decided to start them first, before undertaking the socio-economic activities, each of which would be of shorter duration. In studies of livestock systems, it is clearly necessary to consider the aspirations and desires of family members, since these will influence the species of animals found on the farm, together with the success of the operation. Participatory appraisals were conducted on each of the collaborating farms, using the tools which are commonly employed for these studies, including informal interviews; maps; transects; calendars of activities; diagrams of income and resource flows; and SWOT (strengths, weaknesses, opportunities and threats) analysis. At least two members of project staff (a socio-economist and an animal production specialist) spent two full days working closely with each family, to prepare a detailed evaluation of the farm. Once the reports were prepared, the family was given a copy of their own study, which served as a snap-shot of the farm at the time of the evaluation and as a medium-term development plan. Further, the document helped to define family hopes and desires for the future and the role of small animal species within those plans. Some collaborators valued them as official documents that might help them to obtain titles for their farms. This was seen as an important step which could lead to future access to credit. Because of the rather personal nature of the information generated, it was not considered suitable for general publication, although it had potential value for reference purposes. The 12 individual studies were therefore bound

into a single volume for lodgement in key libraries, both in the region and in Santa Cruz (Chamón, 1999), where they would be available to research and development agencies.

In addition to the participatory appraisals, an undergraduate thesis study was undertaken to evaluate the effect of differences in family background on farm development. In the project area, there were two main ethnic groups: the lowland people who had been in the area for generations, and the more recently arrived immigrants from the highlands of the country. The study was conducted in two communities exclusively of lowland people, two of highland origin and one where there was a mixture of both ethnic groupings. It utilized a combination of group meetings, informal interviews and case studies with families nominated by the members as being representative of the lower, middle and upper wealth classes in each individual community. While accepted wisdom has always noted large, social differences between the two groups, this was based on anecdotal evidence, rather than on systematically collected data. This study confirmed substantial divergence in aspirations; attitudes to work and income; sustainability of farming practices; and in the species of livestock maintained by the two groups (Román, 1999).

As a follow-up to the sociological study, during the extension phase of the project, further work was conducted to define differences in small animal management practices between the two ethnic groups (Rojas *et al*., 2001). For this purpose, four communities of lowlanders and four communities of highland origin were studied. In comparison with the immigrants, the lowland communities made greater use of home-remedies for poultry and of home produce for pigs, but few had any experience with sheep. Generally, the highland communities tried to apply their experience with conventional, wool sheep in their areas of origin, to the management of tropical hair sheep. Results were mixed, since the ingredients for traditional, home remedies for parasites and diseases were unavailable in the tropics and the immigrants had insufficient knowledge of the native flora to choose replacement ingredients.

Near the conclusion of the project, during the on-farm, validation exercise, a further thesis study was undertaken to determine the costs of production of small animal species and to estimate the break-even point of mortality, below which the activities could be shown, by conventional analysis, to be profitable (Riveros, in prep.). The field work was concluded during the lifetime of the project, by the end of which, much of the thesis had been drafted. The date of the defence and the subsequent publication of the thesis will be determined by the university and are, therefore, beyond the control of the project. At the time of writing, it is conservatively expected that the defence could take place in March 2002, at which time, the thesis will be published.

To include an element of strategic research that would be applicable to other areas within the Latin American region, the project was expected to develop methodologies which could be employed elsewhere. Based upon direct experience of the project and the collaborating NGOs in the target area, the first draft of a methodological guide was developed for participatory research with small animals in small-scale farming systems. While not ignoring the technical side of the project, this guide placed emphasis on the social aspects. It was circulated to interested parties for comments and suggestions before being re-drafted into a second, improved version. In the light of additional project experience and further comments that had been received regarding the second draft, a third version was then prepared. Shortly before the conclusion of the first phase of the project, this was published to allow for wider distribution, both nationally and in the region (Chamón *et al*., 2000).

It had been the intention to form a network of organizations with the aim of sharing experiences in the field of on-farm work with small animal species and, if required, to provide training in the methodologies developed by the project. Repeated attempts with the NGOs failed to attract formal interest in this initiative, however, probably because, at least in the Santa Cruz context, CIAT is the only institute which is charged with conducting such research. In view of this failure, CIAT offered itself as a permanent repository and distribution point for information and experiences generated by other bodies. In the future, this information will be made freely available to parties with an interest in research or development work with small animal species.

On an annual basis during the first phase of the project, international consultancies were arranged, where recognised, regional experts in small animals and small-scale farming systems were invited to share their experiences with CIAT and to comment on the development of project activities. Consultants from Cuba visited Santa Cruz in 1998 and 2000, while in 1999, the invitee came from Costa Rica. Also in 1998, non-project, DFID funds (see the section below on Linkages) were used to allow the project to benefit from the experiences of two other consultants from Mexico. The consultants all prepared reports on their observations and conclusions and these were taken into consideration by project staff in the planning and execution of subsequent activities. It is believed that the international perspective provided by these visits were of great technical benefit to CIAT. In addition, they also provided for a measure of regional publicity for the project, which has attracted interest in the possibility of further collaborative work in the future.

The last consultancy, in February 2000, was timed to coincide with two final project workshops. The first, held in Yapacaní, was for farmers and field officers of NGOs in the area. Results were highlighted, three of the collaborating farmers spoke of their experiences with small animals while working with the project, and the strengths and weaknesses of the project were discussed from a field perspective. The second workshop was held in Santa Cruz, for decision-makers, including local and national politicians and senior officers of NGOs. Three of the collaborating farmers from Sara and Ichilo took part as nominated representatives of the group. The participants concluded that a further research phase was needed to complete the work started by the project, and that this would require international funding. There was, however, enough information already available to mount a development project to promote small animals. It was believed that this could best be done using funds channelled through national, or local government.

Project results have been disseminated in a variety of ways and a list of published information and internal reports is included below. A series of technical tours was arranged for all members of the participating farm families, where they were taken to visit the CIAT research station at Saavedra (EEAS), or to the farms of other members of the participatory research group. During the farm visits, project staff acted only as facilitators, while the host farmers demonstrated the techniques they had used and explained the results obtained. The participants were extremely enthusiastic about farmer-to-farmer extension, which was a completely new concept in the small-scale farming sector. Extension pamphlets were prepared and distributed by the project at the time of the tours, to remind the participants of what they had seen. Where possible, these used diagrams, together with simple language, since there is a degree of illiteracy in the target area and in some cases, school children would have to read the pamphlets to their parents. A series of five booklets and three workshop proceedings are already available and, funds permitting, several more publications should be made available shortly. These explain the project results in more technical detail and are designed for use by field officers and NGOs in the region. Finally, in order to ensure wider national and international coverage, articles have been published in recognised, peer-reviewed journals, while CIAT has arranged for a series of press releases to inform the general public.

CIAT plans to produce a booklet which will describe the development and use of all of the participatory methodologies, both technical and social, employed by the project. This will not be finished until the second half of 2002 and it will be necessary to seek additional funding in order to publish it. Nevertheless, it is believed that it will be a valuable document for many research and development institutes in the region, both in Bolivia and in neighbouring countries.

Linkages with Mérida, Mexico

In 1997, it became obvious that there were many points of convergence between the CIAT small animals work and the activities of the veterinary faculty (Facultad de Medicina Veterinaria y Zootécnia, FMVZ) of the University of Yucatán (Universidad Autónoma de Yucatán, UADY), based in Mérida, Mexico. Similarities included emphasis on small animal species in small-scale farming systems; a combination of technical and socio-economic activities; and receipt of financial support from LPP. Initially, in Mexico, greater emphasis had been placed on the socio-economic aspects of the project, while the technical studies came later. Conversely, in Santa Cruz, initiation of the technical studies had preceded the social studies. Complementary funding was sought from DFID through the programme of bilateral aid, to establish close linkages between the two programmes, since it was felt that the difference in approach would provide useful synergies. This funding, approved for three years from the start of the 1997/98 financial year, was administered through the British Embassy in La Paz.

As a first step, two CIAT officers visited Mexico to see their work and to discuss possible points of contact. Later, in a reciprocal visit, two officers from UADY visited Santa Cruz in February 1998 to participate in an international workshop on participatory research methodologies for small farm systems. Over the following two years, there were a number of inter-changes of personnel to address specific points. Apart from the small animal species (poultry, pigs and small ruminants) that were the original reasons for establishing linkages, other subjects of mutual interest included the use of leguminous grains from cover crops (mainly *Canavalia ensiformis* and *Mucuna pruriens*) for feeding to livestock, and the development of local (*criollo*) cattle breeds. The linkages with Mexico played an important part in the decision to send a member of CIAT staff to UADY to study animal nutrition at the level of MSc. This, in its turn and to mutual benefit, strengthened the relationship between the two research entities. The visits of Mexican professionals to Santa Cruz have served to complement the programme of consultancies established by the project, bolstering the international perspectives of the work.

Small Animal Work in Other Provinces and Departments of Bolivia

During the course of the first final workshop held in Yapacaní in February 2000, the proceedings of which have been recently published (CIAT, 2000), collaborating farmers claimed that increased productivity from small domestic animals had positively influenced the environment in their areas, by decreasing reliance on hunting for the provision of meat for the table. They further stated that increased sales of small animal products had increased both family income and stability, thereby reducing the temptation to sell or abandon their farms in order to seek their living either on new blocks further into the forest, or in the urban centres. When asked to describe their perception of the weaknesses of the project, the participants highlighted the small number of direct beneficiaries, which, in contrast to development work, was a logical characteristic of the research activities. They believed that with the existing level of knowledge, it was the time to undertake development activities to carry the findings to other communities in the region. They also recognised that the research was not yet complete and that a second phase would be necessary to allow for further validation of new recommendations on a range of farms.

Representatives of both local and national government attended the second final workshop of the project, held in Santa Cruz for decision-makers. The Vice-Minister for Rural Development (Ing Waldo Tellería), who had previously indicated his enthusiasm for the project, stated his desire to see a follow-up, development project funded through his ministry of national government. He believed that an application for funding for validation of the technologies developed in Sara and Ichilo in other areas, and extension of the results to the wider, small-scale farming sector, should be directed to the *Programa de Apoyo a Seguridad Alimenticia* (PASA, Programme for Food Security). This entity already had assured funding through IBD (the Inter-American Development Bank) and it was interested in supporting worthwhile projects. A proposal along these lines, led by CIAT and supported by NGOs and local governments was, therefore, submitted in April 2000. The Vice-Minister believed that such a project, with full support from local authorities, would have a good chance of success and he volunteered to shepherd the proposal through the bureaucratic system in La Paz. He was subsequently moved to another office in a government re-shuffle and was, therefore, unable to lobby for approval of the proposal. As a result of changing personnel and priorities in PASA, the opportunity was lost. Since that time, PASA appears to have become more interested in small-scale road improvement activities than in agricultural production and, at the conclusion of the project, there seemed to be little point in submitting a small animals proposal for their consideration.

Since that time, however, several other related activities have been requested, which are currently in varying stages of preparation and execution (F. Rojas, pers. comm). These have resulted directly from the activities described in this report and serve to demonstrate the impact of the project, outside of the initial target area. They are briefly described below.

- Shortly after the demise of the PASA initiative and as a direct result of increasing publicity regarding the results of the small animals project, CIAT was approached by local government authorities in a number of different Prefectures in the Department. It was agreed that, in order to promote activities with small animal species, the Prefectures would provide staff and their transport, to work with selected communities in their areas of influence, under the technical guidance of CIAT. An application was then made to DFID to use some of the surplus funds from the FORCIAT project, to cover a modest amount of institutional expenditure (US$ 30,000 over one year) in terms of personnel and indirect costs. This was approved and work commenced at the start of the 2001/2002 financial year in the municipalities of Mineros, Warnes, Comarapa and San Ignacio de Velasco. It had been planned to also work in the region of Pailón, but severe floods at the beginning of 2001 diverted municipal attention and funding away from productive activities and into flood relief. Work with small animal species is expected to take place at a later date, when the situation in the area improves to accommodate technical activities. The participatory methodology employed by the present project, including rapid rural appraisals for the setting of priorities and fully participatory research, was being used in the new activities and the work was proceeding apace at the time of preparation of the present report.
- PRODISA is an NGO which has been active for a number of years in rural development in the Provinces of Sara and Ichilo. Although they have not worked much with small animal species themselves, they have been enthusiastic participants in all of the workshops organised by the project and have actively disseminated the results to many small farmers in the region. They have recently received funding from the Government of Belgium to expand their activities with the poorest members of the agricultural sector. At the time of writing, CIAT was about to sign a contract with the Belgian PRODISA project to provide expertise for training and technology transfer in small animal production and agroforestry techniques to 20 communities in the target provinces.
- An association of six municipalities in the region of Vallegrande (regions of Vallegrande, Trigal, Moro Moro, Postervalle, Pucará and Quirusillas) has asked for assistance from CIAT in the preparation of a proposal to seek

funding from the National Government under the HIPC-II programme, which enjoys international support. If accepted, CIAT would provide technical support to the activities of local government staff. The proposed work, with both cattle and small animal species, is expected to benefit 2,021 families in a total of 53 communities, all of which are officially categotised as poor.

- CIAT has had a telephonic request from an association of municipalities in the Cordillera region of the Santa Cruz Department, for activities similar to those described above for the Vallegrande area. Shortly after the concluding visit to Bolivia of the Project Manager, CIAT expected to receive a formal, written proposal, which would be the basis for a memorandum of understanding.
- Representatives of the municipalities of Muyupampa and Monteagudo, in the Department of Chuquisaca, have visited the project activities in the Provinces of Sara and Ichilo. They hope to start similar work in their own areas, with the technical support of CIAT. Although no inter-departmental agreements have yet been signed, CIAT, together with BTAM, has a long history of involvement with *criollo* cattle in the Chuquisaca Department and small animal work would be a logical extension of these activities.
- There is much interest at the national level, in the identification of alternative agricultural activities in the Chapare region of the Cochabamba Department, which might help to alleviate some of the adverse, economic effects of the programme to eliminate illegal plantations of coca. The control of this crop, the source of cocaine, is a demand of the international community, led by USA, but has met with bitter opposition from the farmers, who have few viable alternative, profitable agricultural activities with which to replace it . While serious work is currently impossible, because of civil unrest in the region, it is felt by central government authorities, that small animals represent a potential source of legal income for small-scale farmers. Once peace returns, it is likely that CIAT will be approached to conduct development activities in the region, using the experience gained in similar, nearby areas of the Santa Cruz Department.

OUTPUTS

Most of the results of the project have already been published in one form or another and a list of written outputs is included at the conclusion of this section.

Animal Production Studies

The project was aimed directly at local, *criollo* breeds of the most common small animal species found in the region, as identified during preliminary visits to the farms, ie. chickens, ducks, pigs, hair sheep and guinea pigs. Initially, the participatory research work was designed to measure animal productivity within the existing system and to identify the major problems encountered with each species. The results obtained over the first few months of monitoring were published as a project booklet (Ugarteche *et al*., 1998), while the results obtained over a full year were published in a scientific journal (Paterson *et al*., 2001). The results presented here are a summary of those obtained over the whole life of the project.

Chickens: It is hard to find a farm that does not have a number of chickens scavenging around the home. They are provided with no artificial shelter, but frequently roost at night in fruit trees close to the house. Their general diet consists of foliage, seeds and insects that they find around the farm buildings and in the surrounding bush. They are occasionally given a supplement of home-grown grain or kitchen wastes, but receive no veterinary treatments or vaccinations. Maintenance costs almost nothing and so any production obtained by the family (meat and eggs) can be considered as profit. The farm family consumes from 2 to 4 birds in almost all months of the year, about 40% of which are old breeding birds and the rest young animals. Some families also occasionally sell a few birds to cover the need for small amounts of cash. Consumption and sale of eggs is more seasonal than the slaughter of grown animals. Total off-take per family averages about a dozen eggs per month, with some 80% or more destined for home consumption.

The greatest problem of chickens lies in the loss of chicks due to a range of diseases, where Newcastle is endemic and diarrhoea and bronchitis are common ailments. Of a sample of 12 farms, all tested positive for a range of gastric, respiratory and reproductive diseases and parasites, with Mycoplasma, Salmonella and Viruela being the most common (Choque, 2001). Mature birds are occasionally lost to predators, or to accidents. There are large differences in chick mortality between families and although there are exceptions, immigrant highland families generally lose more birds than lowland people. Veterinary recommendations exist to control the disease problems, but they are not

used in the area, sometimes because of lack of awareness, but more often because of the logistical difficulties involved in obtaining the medications. Although relatively cheap, some vaccines are only available in quantities much greater that that required by one family. The smallest packages frequently contain 500, or even 1,000 doses. These will only be bought where a community agrees to vaccinate all of their birds.at one time. Some families, particularly those of lowland origin, use local, traditional remedies, but the efficacy of these treatments is unknown. It would be necessary to demonstrate the efficiency and profitability of recommended animal health measures before farmers will be prepared to adopt them.

The annual biological and economic performance of chickens within the existing system is shown in Table 1. The number of clutches per breeding female varied widely, being influenced by the number of eggs taken by the family, or destroyed by predators, and adverse weather conditions. Survival of chicks also varied greatly, depending upon the care given to them. Farms 1, 6 and 7 belonged to immigrant families and with the exception of farm 7, they showed much greater chick mortality than on the farms owned by lowland families. The value of the gross returns (sales plus consumption of both eggs and meat) from the species were largely determined by these two parameters.

Table 1. Annual productivity of scavenging chickens in the existing system

Farm number and community	Productivity Data				Financial Data (US$)			
	Initial No. of females	No. of clutches	Chicks per clutch	Mortal-ity of chicks (%)	Initial value (IV)	Gross return (GR)	GR as % of IV	GR per breeding female
1. Barrientos	7	7	7.9	48.0	80.00	140.55	176	20.08
6. San Rafael	24	12	7.5	68.9	184.55	107.09	58	4.46
7. San Rafael	15	7	7.1	8.0	144.55	127.09	88	8.47
8. San Miguelitos	13	16	6.8	19.0	103.64	286.18	276	22.01
9. Potrerito	12	6	5.8	20.0	76.36	106.36	139	8.86
10. Potrerito	5	14	7.1	12.0	49.45	242.73	491	48.55
Total or Average	76	62	7.1	30.5	638.55	1010.00	158	13.29

After the initial period, health management interventions (vaccinations and control of diarrhoea by adding antibiotics to the drinking water) were promoted on farms 1 and 6. Although the application of these measures was incomplete, mortality levels in the following year dropped to 34.6 and 21.3% respectively for the two farms. In the validation phase, all collaborators reported increases in the numbers of eggs collected, since they were laid in nest-boxes located within the shelter, rather than hidden in the bush surrounding the house, where they were exposed to wild animals. It was also perceived that the recommended health measures reduced mortality of the chicks. The economics of provision of shelter is still under evaluation, but, in view of the low cost, it is believed that an installation for 12 hens will pay for itself in terms of increased production, in a period of from 12 to 24 months. It is considered that, in most cases, with reasonable care of the chicks, 20% mortality is a readily attainable target. This would produce an annual gross return of about US$ 20 per breeding female.

Ducks: This species is kept almost exclusively by local, lowland people, because the immigrant group consider that they foul the environment. As with chickens, they are kept around the homestead, without any special care or veterinary treatment. They find their own shelter and food where they can and suffer from a similar range of gastric, respiratory, reproductive and parasite problems to those found in chickens (Choque, 2001). During the day, they often spend their time near a stream or pond, if there is one nearby, where they consume insects and worms. They receive occasional supplements of household wastes and grain produced on the farm. The people do not appear to eat duck eggs and while some birds are consumed by the family, most of the produce is sold, often at the farm gate, to intermediaries, who take them to the city. There is an active demand for both live and dressed ducks, which are popular with the urban population. Recently, duck meat is being offered as an alternative to chicken, in fast-food outlets in the city of Santa Cruz. Farmers are becoming used to selling their produce by weight, although some intermediaries still offer a flat rate payment per bird.

The annual biological and economic performance of ducks in the existing system is shown in Table 2. There was a large difference in duckling mortality between farms, which had a large influence on gross returns. Survival of the young birds appeared to be related to the amount of shelter which the birds could find to protect themselves from rain and wind. Once the birds pass the first, critical phase of life, they become quite hardy and the only losses of larger birds observed during the monitoring phase were due to accidents, including trampling by cattle.

Table 2. Annual productivity of scavenging ducks in the existing system

Farm number and community	Productivity Data				Financial Data (US$)			
	Initial No. of females	No. of clutches	Duck-lings per clutch	Mortal-ity of duck-lings (%)	Initial value (IV)	Gross return (GR)	GR as % of IV	GR per breeding female
8. San Miguelitos	6	5	6.4	78.1	45.45	25.45	56	4.24
9. Potrerito	6	6	7.0	35.7	87.27	119.09	136	19.85
Total or Average	12	11	6.7	54.1	132.72	144.54	109	12.05

Following the initial monitoring period, simple management techniques were suggested, which resulted in a reduction of duckling mortality on Farm 8 to about 30%. While still not good, this represented a considerable improvement over the previous year. About 75% of sales were of mature birds, while the remainder were sold at 4-5 months of age. The same proportion also applied to home consumption, which increased to about half of the offtake after the first year of monitoring. It appears that sales remained relatively stable when reduced duckling mortality increased the availability of birds on the farm. The increased production resulted in higher consumption within the family, where it made a considerable contribution to food security and to increased variety in the family diet. This is consistent with earlier observations that lowland families place greater emphasis on quality of life than on the generation of income (Román, 1999).

In contrast to the situation with unprotected birds, in a semi-intensive system where the ducklings are separated from the mothers at hatching and kept warm and dry in the first few days, mortality can be very much reduced. With care, losses of about 10% have been observed between hatching and sale at 3-4 months of age, at a liveweight of 3-4 kg. Even in this system, however, careless management can result in over 20% losses in the early stages. Separation of the ducklings from their mothers results in two or three clutches per year, while under the traditional, scavenging system, one clutch per year is the normal level of productivity.

During the validation phase, where installations were provided for chickens, farmers chose to use the housing for ducks as well, keeping both species together under the same management system. This should provide the shelter necessary to reduce duckling mortality to reasonable levels, even with largely scavenging birds. Although not part of the original plan, the inclusion of ducks in the chicken run should improve the economics of the provision of housing for poultry. With good management and care at critical times, including the use of rustic installations and shelter, it is clear that duck production would be substantially improved in comparison with existing levels in the target area. Annual gross returns of over US$ 30 per breeding female should be attainable within the modified system.

One of the collaborating farmers installed a rustic, semi-intensive poultry production system during the course of the study. A trial was mounted to compare the performance of chicks and ducklings when kept together in the installation and fed *ad libitum* on a diet of farm produce, including rice, maize, grain legumes and foliage, with permanent access to water. Eleven birds of each species were used, entering the trial at 2 days of age. The study ran for 6 weeks in the early part of the wet season (October to December).

One duckling died between 2 and 4 weeks into the trial and two others were lost in the final fortnight, giving an overall mortality of 27.3%. All appeared to die of cold and damp, due to the season. The losses were less than those observed in clutches hatched without the provision of shelter (40-80%), but greater than in a similar system run by a more experienced operator (10-20%). With the chicks, four died in the first 2 weeks and another between 2 and 4 weeks, totalling 45.5% losses. Again, the deaths appeared to be due to the weather, although the losses were greater

than the averages observed over the whole of the monitoring period, in the absence of installations. This could be due to the owner's lack of experience with semi-intensive systems. The liveweights of the birds are presented in Table 3.

Table 3. Liveweights (means and standard deviations) of chicks and ducklings raised in rustic installations

Age of birds (days)	Chicks		Ducklings	
	Weight (g)	sd (±)	Weight (g)	sd (±)
2	31	6.6	45	9.5
16	62	2.7	60	8.5
29	118	22.3	92	15.3
44	296	66.7	116	22.0
Average daily gain (g)	6.3		1.6	

Chicks were smaller than ducklings at hatching and mortality was almost twice as high, but they doubled their liveweight in the first fortnight of life, and then doubled it again in the second fortnight, before growing even faster in the third two-week period. In contrast to this, ducklings took almost a month to double their hatching weight. This may not be indicative of the growth potential of the species, however, since, in a semi-intensive system in Portachuelo, ducks regularly reach liveweights of 3-4 kg in a growing period of about 4 months.

The average daily gain of chicks over the first six weeks of life in this trial was almost four times as great as for ducklings. This shows the potential for raising chicks in confinement, particularly if excessive mortality can be controlled. Because of higher body weights and greater demand relative to supply, the value of slaughter weight ducks in the market (about US$5) is much greater than that of chickens (US$3). The economic differences between the two species may not be great, however, although since it was impossible to measure feed intake individually for the two groups, the results available give no estimate of the relative profits from ducks and chickens. This point requires further research before recommendations can be made regarding the most profitable way to utilize rustic installations. It may be indicative of trends that, a year after this trial, the farmer decided to abandon poultry in favour of pigs, which were expected to provide higher margins.

Pigs: Some farmers have given up on pigs because of the difficulties of confining them during the cropping season and the problems that this can cause when they enter the fields of neighbouring farms. Nevertheless, they are still present on over 60% of farms in the area. There is some home consumption of pork at times of public holidays or of family celebrations, but the majority of the produce (up to 80%) is sold. There is a lively seasonal demand, particularly for the holidays at the end of the year, or at carnival time. In some cases, the breeding season is controlled in order to have animals ready for sale at peak market times and in extreme cases, this is achieved by borrowing a boar only for limited periods of the year, rather than by keeping one permanently on the farm. There are large differences between farms in the survival of the piglets and also in the number of litters born per year, but on the farms studied, the average interval between litters was 255 days. There are some endemic diseases (eg. foot and mouth) in the area and accidents (crushing) cause some losses of piglets, but the most severe veterinary problems, both for young and mature animals, seem to come from gastric conditions, often associated with internal parasites (Choque, 2001). When this is compounded by seasonal feed shortage, it may manifest itself as a shortage of milk in the sows, leading to mortality in the piglets.

The biological and economic performance of pigs within the existing system are shown in Table 4.

Table 4. Annual productivity of largely scavenging pigs in the existing system

Farm number and community	Productivity Data				Financial Data (US$)			
	Initial No. of females	No. of litters	Piglets per litter	Mortal-ity of piglets (%)	Initial value (IV)	Gross return (GR)	GR as % of IV	GR per breeding female
1. Barrientos	3	2	8.5	41.2	292.73	216.36	74	72.12
2. Barrientos	1	1	12.0	66.7	269.09	161.82	60	161.82
7. San Rafael	1	2	7.5	65.2	283.64	395.45	139	395.45
8. San Miguelitos	3	6	6.3	10.5	927.27	1309.09	141	436.36
Total or Average	8	11	8.1	38.2	1772.73	2082.72	117	260.34

The two farms where sows farrowed twice during the year (farms 7 and 8) had much higher gross returns than the others and with good control of piglet mortality, the potential gross return from a sow is of the order of US$ 500 per year. Mortality rates were unacceptably high on three of the four farms. The farmers tended to blame lack of maternal milk for the deaths and certainly at least one of the sows had a number of blind teats. An excessive parasite burden could potentially reduce milk production, but cases of in-breeding were observed in the area, which could be responsible for both genetic defects and also the small litter sizes seen on three of the four farms studied. The quality of the breeding stock should be considered in any wider study of pig production in the region.

In the San Miguelito community, growth of piglets was measured from birth to sale at about five months of age. In three litters, losses during the first 3-5 weeks were 33%. The owner blamed accidents for almost all of the deaths, but since they took place in the cold season, there may have been some climatic influence in the level of mortality. Growthrates of all piglets in the three litters averaged 159 ± 39.3 g/day (mean ± standard deviation) over the suckling period, with a range from 141 ± 22.6 g/day in the females of the youngest litter to 187 ± 65.5 g/day in the females of the middle litter. In all cases, the males grew slower than the females during this period.

Natural weaning took place at about three months of age and from then on, the piglets scavenged for their food, eating what they could find on the farm and in a swampy area close to the house. Each day, they received a small supplement of fresh cassava. They were treated against internal parasites at about four months of age, when a sow died from an excessive parasite burden. From birth to sale at five to six months of age, the growthrate averaged 172 ± 22.7 g/day, but in the month of January, when there were plentiful fallen fruits of native palm trees (*Attalea* and *Scheelea* species), the rate more-than-doubled to 456 ± 97.8 g/day (Ugarteche *et al*., 1998).

To build upon this experience, a more detailed undergraduate thesis study was mounted in the following year (Burgos, 2001), to evaluate the contribution of the palms and other components in the diets of scavenging pigs. The defence of the thesis was delayed, firstly by the closure of the university and later, by the need of the student to seek paid employment, but finally took place at the time of the conclusion of the project. In the future, CIAT plans to highlight the principal findings in a technical leaflet, but the main conclusions of the study were as follows:

- The individual fruits from a single palm inflorescence fall over a period of several weeks. Pigs avidly consume the pulp, which is rich in edible oils and metabolizable energy.
- The animals dig in the swampy area, searching for small vertebrates and worms, which make an important contribution to the protein intake. They also eat a range of native herbaceous plants that grow in the swamp.
- On many farms, a small supplement of fresh cassava is offered daily to pigs and on the farm studied, a total of about 30 animals of all sizes received an average of 22 kg/day of this feed.
- Periodic parasite control resulted in growthrates almost twice as great (average over the whole period of 320 g/day) as had been observed in the previous year with piglets from the same sows and receiving similar management. While a direct comparison between the two years is not strictly valid because of possible changes in the amount of cassava offered, it is likely that a large part of the difference in growth was due to control of the internal parasites.

During the validation phase, some pigs were kept permanently confined within the housing provided. This represented a departure from normal management practices, since the animals were no longer able to scavenge for a substantial part of their nutritional requirements. While the benefits of confinement were seen in the elimination of the problem of damage to crops on the home farm or on neighbouring properties, the change of management implied total reliance on feed provided by the farm family. In some cases, feed resources were inadequate for this purpose and this was reflected in extremely thin animals, despite routine treatment against internal parasites. Efforts have been made to persuade the farmers to plant additional crops (cassava, maize, etc.) to increase their feed resources, but this was hampered by unseasonally dry conditions towards the end of the project. It is cause for concern that some farmers confined their animals without considering how they would provide sufficient feed to keep them in good physical condition.

Hair Sheep: Tropical hair sheep are found only on the farms of the immigrant highlanders, since generally, the lowland people have not yet developed a taste for mutton. The animals graze along roadsides and on planted pastures, and browse on land in bush fallow, receiving neither supplementary feeding nor veterinary treatment, except for routine vaccination against foot-and-mouth disease. Most of the produce is for home consumption, although there are occasional sales, largely of young animals for breeding purposes. It is a prolific species, as it produces an appreciable proportion of twins and, occasionally, even triplets. It suffers, however, from high levels of lamb mortality, which the farmers often attribute to lack of milk in the ewes. In other parts of the Department of Santa Cruz, the species was known to experience severe problems with internal parasites (Wilkins *et al*., 1983) and this was confirmed in the target area, where sheep on all four farms evaluated were shown to have worms, coupled with other gastric problems (Choque, 2001). It therefore seems likely that the shortage of milk reported by collaborating farmers could be related to animal nutrition, agravated by the presence of a high parasite burden. Some losses of new-born lambs are due to post-natal infections which could be easily avoided, if the farmers practiced routine treatment of the navels with iodine solution (Choque, 2001).

The biological and economic performance of hair sheep in the existing system is shown in Table 5.

Table 5. Annual productivity of hair sheep in the existing system

Farm number and community	Productivity Data				Financial Data (US$)			
	Initial No. of females	No. of lamb-ings	Lambs per lambing	Mortal-ity of lambs (%)	Initial value (IV)	Gross return (GR)	GR as % of IV	GR per breeding female
3. Barrientos	4	3	1.00	33.3	203.64	43.63	21	10.91
4. Barrientos	7	6	1.33	37.5	356.36	130.91	37	18.70
6. San Rafael	11	7	1.14	25.0	432.73	104.18	24	9.47
7. San Rafael	3	5	1.40	28.6	163.64	64.55	39	21.52
Total or Average	25	21	1.24	30.8	1156.36	343.27	30	13.82

After the initial period of monitoring, during which no interventions were promoted, the animals were then regularly dosed to control internal parasites. This appeared to result in a reduction in lamb losses, probably related to an improvement in milk production in the ewes. In the second year of monitoring, the four farms shown in Table 5 recorded pre-weaning losses of 42.9; 27.3; 23.1; and 6.7% respectively. Three of the four farms continued to show high lamb mortality, although on two of them, there was an improvement over the results of the previous year. Due to careful management of the flock, farm 6 reduced lamb mortality to a very acceptable figure. There is clearly the potential to reduce losses to well below 20% through good animal husbandry, including periodic control of internal parasites in all animals and post-natal treatment of the navels of lambs with iodine solution. This would lead to a substantial improvement in the annual gross returns, to an achievable figure of perhaps US$ 30 per breeding female. A further health problem worthy of note is foot-rot, resulting from excessively humid conditions in the wet season. While this does not lead to animal mortality and is easily controlled by regular attention to the hooves, animals that cannot walk properly will suffer from low feed intake and this will result in production losses. Foot-and-mouth disease is endemic in the region, but all sheep are routinely vaccinated against this disease.

The data presented in Table 5 suggest a period of over a year between lambings (21 births from 25 mature females in 12 months), but these figures include mature animals that did not lamb, or only lambed once during the monitoring period. There were few animals and thus the overall data tend to under-estimate flock fertility. The interval between lambings for those animals that bred more than once during the course of the research was 272 days (37 births), with a range from 144 to 525 days. Overall, 65% of ewes showed intervals of 242 days, or less, between lambings and the elimination of one farm (three lambings) with particularly long intervals of over a year (average 412 days), reduced the average over the other three farms to 260 days (about 8.5 months). If only those intervals of less than one complete year are calculated, the average of the remaining 29 intervals (78% of all the figures) falls to 229 days (about 7.5 months). Although it may be optimistic to apply this figure to all flocks in the area, it shows an achievable potential prolificacy of three lambings in two years. With an average of 1.3 lambs per birth, the species is capable of producing an annual average of almost two lambs per breeding ewe. With good management, including careful health control, leading to mortality of about 10%, annual production could reach 1.75 weaned lambs per breeding female. This is considered to be a realisable target in more sophisticated, commercial systems in the region (Wilkins *et al*., 1983). It also appears to be technically feasible in the colonization areas. At current prices, this would result in an annual gross return in excess of US$ 50 per breeding female.

Guinea pigs: Work with this species during the monitoring period was restricted to a single farm in the Barrientos community and since there appeared to be no major health or management problems, no interventions were proposed. The animals were kept in the kitchen building, where they were fed on vegetable scraps and cut pasture, generally of the legume *Pueraria phaseoloides*, which was readily consumed. They were free to leave the building during the days, to supplement their diets through scavenging around the house. Considering all of the mature females in the group, the interval between births was 190 days, with an average of 2.3 live young per birth. Apart from theft and animals taken by predators, including the dogs of the neighbours, mortality was 10%, indicating the absence of major health problems. In a period of 28 months from September 1997 to January 2000, the family ate 29 guinea pigs of more than four months of age and 13 smaller ones, for an average of almost 1.5 animals per month. Using the values assigned to the meat by the owners, the return per breeding female was in the range of US$ 5-9 per year, but this could be substantially increased by the use of cages to protect the animals from night-time predators. Slaughter and preparation of guinea pigs is easier than for chickens, which would be the most common alternative. They also cook faster, requiring less fuel wood. This is an important consideration at busy times on the farm.

During the validation phase of the work, a lowland family in the community of Potreritos was found, who had a few guinea pigs, provided by an NGO. They already had a small installation, so assistance was provided to extend the cage, to accommodate a growing number of animals. A new sire was also provided and the old one was slaughtered, to avoid in-breeding. The family has eaten some of the animals and states that they find the meat highly acceptible, according to the taste of lowland people. The productivity of the species and the absence of health problems, has attracted the attention of the neighbours, who have expressed interest in trying to raise guinea pigs. It appears that, as a result of project activities, at least some of the lowlanders are now re-evaluating their long-held prejudices regarding this species. If so, guinea pigs will make a growing contribution to the home economy in the region. The efforts of CIAT to ensure the availability of breeding stock will be of great importance if the demand increases, as appears likely.

To try to measure growthrates, individual, newly born animals were marked with ink. This was unsatisfactory because the marks quickly vanished and plastic, poultry leg rings proved to be more suitable. During the monitoring period, there were 12 litters born. Birthweights are shown in the following table.

Table 6. Birthweights (means ± standard deviations) of guinea pigs in Barrientos community

Litter size (live births)	Number of litters	Range (g)	Mean weight (g ± sd)
1	1	200	200
2	8	95 – 120	107 ± 8.0
3	2	95 – 120	108 ± 11.0
4	1	80 – 95	88 ± 6.5
Average (12 litters) 2.3			108 ± 21.3

Post-natal birth was rapid, with animals averaging 275 g at 18 days and 300 g at one month, giving an average daily gain of 6.5 g/day, a figure similar to young chicks kept in semi-intensive systems. The diet of the guinea pigs was cheaper than for the chicks, however, since they require only cut pasture, without a grain supplement, to achieve this growthrate.

Milk Production from Cows: As noted previously, the DFID-funded systems project (number R6382) worked with a series of leguminous cover crops to assess their effects on cropping systems. The adoption of this technique was slow, however, and it was reasoned that if the animal production capacity of the legumes could be demonstrated, farmers may be more willing to utilize them. Dairy cows could be expected to respond rapidly to changes in the quality of their diets and so a thesis study was mounted to evaluate the effect of limited access to *Arachis pintoi* on milk production. The work was conducted on two farms in the Yapacaní area, using a cross-over design, so that the same cows had periods both with and without a supplement of freshly cut fodder twice per day. The basal diet consisted of normal pasture (mainly *Brachiaria* spp.), while a small amount of concentrate was fed throughout the experiment, at the time of milking.

On one farm, where there was plenty of pasture, the cows ate about 3 kg/day of the fresh legume, while on the other, where fodder was in shorter supply, the average consumption of the legume was 8 kg/day. The cover crop was clearly of high palatability, although the cows attempted to select only the green material where possible, leaving behind the 20.6% of senescent leaves and dead material. Since the legume was managed as a cover crop and not as fodder, it had a high proportion of stem (51.3%) and a correspondingly lower proportion of fresh leaf material (28.1%). This reduced the nutritive value of the fodder, as typified by a crude protein (CP) content of 13.0% in the consumed fraction, an amount that would have been adequate as a basal diet for milk production, but was insufficient to act as a supplement for animals grazing normal pastures. As a result of this, it had no significant effect on milk yields (general mean 7.6 ± 0.62 kg/day), even when consumed at the higher level. For the legume to serve as a supplement in the region, it would be necessary to cut it more frequently, to stimulate the production of the leaf fraction, which had a CP content of 16.5%, considerably higher than the 11.5% found in the stems. Alternatively, direct grazing of the fodder would give the cows the opportunity to select the more nutritious fraction, which may influence milk production (Ayala, 1999). This theory could not be tested, since no farmers had sufficient area of the legume to allow direct grazing.

Socio-economic Studies

As noted above, these activities took place at two levels. Firstly, individual appraisals were conducted with each of the collaborating families, and secondly, the influence of ethnicity on farm development was studied at the level of the community. Most of the collaborators had spent many years in the area and even the immigrants intended to stay there, having no desire to return to their regions of origin in the highlands. Families were large, with up to 10 children. The immigrant families had larger land holdings than the lowlanders (averages of 64 ha compared with 21 ha) and generated almost twice the income in cash and kind. The immigrants were the only ones to keep sheep and guinea pigs, while only the lowlanders kept ducks. All members of both groups had chickens and cattle, while most also had a few pigs. Apart from the value of home consumption, the immigrants received an average of 79% of their

cash income from livestock, but only about 6% from small animal species, mainly pigs. In contrast to this, the lowlanders received 32% of their cash income from livestock, with 13% coming from small animals, mainly pigs and ducks. Home consumption from livestock averaged about US$ 30 per month for immigrant families, of which 56% was from chickens, 18% from pigs, 21% from sheep and 6% from guinea pigs. In the case of the lowlanders, the value of consumption of livestock almost doubled this total at US$ 57 per month, of which 35% came from chickens, 26% from ducks, 12% from pigs and 27% from cattle.

The immigrants hired and sold little labour, while the lowlanders sold their specialised labour for more technical work (thatching, fencing, etc.), while hiring in workers at minimal wages for routine tasks such as weeding and harvesting. Even though, in terms of income, the immigrants were apparently more prosperous than their neighbours, the different aspirations of the lowlanders probably gave them a higher standard of living in terms of more varied diets, better human health and lack of obvious signs of stress (Chamón *et al*., 1999).

Within the five communities which were studied as part of the undergraduate thesis of Román (1999a), the residents classed 52% of themselves as belonging to the poorer stratum, with little chance of aspiring to sustainable development of their farms. This compared with 26% in the middle category and the remaining 22% in the upper stratum, where there was an opportunity to generate the capital necessary to affect considerable improvements in their livelihoods.

Almost half of all children received a full, basic education, while 18% reached an intermediate level. Only 3.2% of immigrant children and no lowlanders reached higher education. Even though the lowland women participated in almost all stages of the productive processes, they had no role in the selling of the produce, or in the administration of the proceeds. Immigrant women played an important part in the family financial decisions and in many cases they administered most of the income of the family. Immigrants made more intensive use of their farms, having more land under mechanization. For this reason, they produced more rice, cassava and citrus fruits. The lowlanders had a wider variety of perennial crops and also had more pasture land and cattle, although they produced less milk, since they tended to concentrate on beef production, rather than dairy.

Agriculture of the lowlanders was based on home consumption with a wide range of traditional crops, while the immigrants aimed mainly at the market. The highlanders received better support from development agencies, probably because they were prepared to seek out help and technical advice when needed. Nevertheless, they used an extractive philosophy in the search for ways to capitalize the farm. In contrast to this, the lowlander administration was more sustainable, using a wide range of both crops and animal species. The study concluded that the two ethnic groups had very different development needs and aspirations, which would require different extension messages and techniques to produce an impact on farm development. Ideally, the immigrants should adopt some of the sustainable strategies of the lowlanders, while in order to make material progress, the lowlanders should adopt a more aggressive and monetarist strategy in the future.

During the period of validation, a study of the full, economic cost of production of small animal species was conducted as a thesis study by Riveros (in prep.). Rustic installations were constructed to facilitate management of the species and the collaborators chose to work with poultry (the facilities were provided for chickens, but were shared by ducks where these were present on the farm), pigs and guinea pigs. Because of the nature of the work, the shelters were provided on a shared cost basis, where the farmer contributed about 60% of the cost, in terms of posts, thatch, etc. found on the farm and provided the labour for the building work. Purchased inputs (wire, nails, etc.) were supplied by the project. In general, although the total cost varied with the size of the installation and the species for which it was intended, the full, economic cost was about US$ 200 per installation. The cost as perceived by the collaborators was much lower than this figure, however, since the farmers place no economic value on their labour, or on inputs which are cut on-farm.

With the infrastructure installed during the study, the full economic cost of monthly maintenance has been tentatively calculated at US$ 0.44 - 0.88 for poultry, $ 2.94 - 3.67 for pigs and $ 1.32 - 2.06 for guinea pigs, the main variable in the data being the type and quantity of feed offered to the animals. The calculated cost for guinea pigs is particularly high, being somewhat distorted by the small numbers of animals which the collaborators currently keep on their farms (2 – 3 breeding females each). This is expected to fall as the herds grow to the 5 – 10 mature animals which they plan to maintain, to provide meat for home consumption. Again, because of the extremely low opportunity cost of the labour of the women and children who generally care for small animal species, farmer perception of the costs of production are much lower than the preliminary, calculated figures shown here (Riveros, in prep.). Final data will not be available until the thesis is presented and defended by the author. At the time of writing, this is expected to take place at the end of the first quarter of the 2002 calendar year.

Dissemination of information

The project always sought to disseminate results as they became available, both for the benefit of the farmers and to inform national and international professionals. A series of press releases was published in a number of local newspapers, while local television channels covered each of the project workshops and the release of most of the project booklets (see below). In addition to this, the project was actively promoted through the use of a number of techniques, which are briefly described in the following paragraphs.

Workshops: A total of four major workshops were held, the proceedings of which are already available. These are briefly described in the following paragraphs:

- Start-up workshop held in Yapacaní in September 1996. The objective was to receive information on past and present NGO activities with small animal species and to discuss project plans. Even though some NGOs were promoting improved breeds of small animals, they had no information on the productivity of either local or improved bloodlines. NGO opinion was taken into account in the planning of project activities.
- International workshop on participatory research with small animal species in small-scale farming systems, held in Santa Cruz, February 1998. The objective was to obtain and share information on relevant research being conducted in the region and to discuss participatory research methodologies in small-scale farms with experienced practitioners, principally from Cuba and Mexico.
- Final workshop with producers, held in Yapacaní in February 2000. The results were presented and discussed and farmers had the opportunity to define the strengths and weaknesses of the project, as they perceived them. They expressed extreme enthusiasm for the participatory methodology, which worked with the whole family in both research and extension, while demanding further research and development activities to promote the husbandry of small animal species.
- Final workshop for decision-makers, held in Santa Cruz in February 2000. Participants hoped and expected that external donors would fund further small animal research, while it was believed that a parallel development programme should receive funding from PASA, channelled through the Vice Minister of Rural Development in the national government.

Technical tours: When research had generated sufficient results that could be extended, four technical tours were held for project collaborators (normally whole families). These are noted below:

- April 1999: a visit to Portachuelo to see a semi-intensive duck production system developed by one of the collaborating farmers. There were 30 participants from 12 families and in the following months, three families copied the system on their own farms.
- May 1999: members of a mothers' club (*club de madres*) in one of the collaborating communities (San Rafael) were taken to the Saavedra experiment station of CIAT to see the work with annual and perennial crops and with *criollo* cattle and tropical hair sheep. The participation was by 25 women, representing some 18 families.
- November 1999: a visit to a semi-intensive poultry production system in Potrerito, installed following the first technical tour. There were 35 participants from more than 20 families.
- December 1999: a visit to San Rafael to inspect production systems for chickens and sheep. The host was the collaborating farmer who had obtained the best results with these species. Although it rained so much that the organizers considered cancelling the tour at the last minute, the farmer was able to explain her practices to 27 participants from 18 families. This was taken as an indication of the value which the farming community placed on the technical tours.

Publications: During the course of the project, many publications were produced and at its conclusion, several others were in varying stages of planning and preparation. Published dissemination mechanisms fell into four broad categories. Firstly, there were extension pamphlets and fact-sheets, aimed at farm families, where reading skills were sometimes limited. Where possible, these used drawings and dialogue, rather than standard text, therefore being in a format that was completely new for CIAT. One was produced towards the end of the initial project, while a second was prepared during the course of the extension, although, because of unavoidable delays in the provision of funding from UK, it did not emerge from the printers until after the formal conclusion of the project. A further six pamphlets, based on project results with poultry, pigs,

hair sheep and guinea pigs, are planned for the coming year, if funding can be obtained to cover the cost of publication. Secondly, a total of five technical booklets was prepared and two others are planned, to cater for wider distribution to NGOs and other similar bodies within Bolivia and elsewhere in neighbouring countries. Thirdly, four undergraduate student theses were completed and defended, while a further one was nearing completion at the conclusion of the project. Three of these were submitted through the faculty of veterinary science of the local university (UAGRM), one in sociology through the Universidad Mayor de San Simón in Cochabamba, and the final one, in economics, will go through UAGRM, thereby highlighting the multi-disciplinarity and regional perspective of the project. These activities were seen as an important contribution to the local academic community, through participation in the training of the next generation of professionals. Lastly, in terms of the scientific literature, a poster on project activities and preliminary results was presented to the Latin American Veterinary Congress in Santa Cruz in November 1998. Following that, three articles, two in national, and the other in an international journal, were accepted for publication. Unfortunately, one local journal ceased its activities before the article could be published, by which time, because of advances achieved in the field, it was already too dated to offer to an alternative journal. The second local article was published in September 2000, while the paper submitted to the international journal appeared in January 2001.

The following is a listing of all project written outputs, in chronological order, split between those publications that were already available; those in preparation and in press at the conclusion of the project; internal project reports; and administrative reports submitted to colleagues and donors by the project manager following his regular, routine visits to Bolivia.

Publications already available (in chronological order):

1. March 1997. *Estratégias para Integrar y Optimizar la Producción Pecuaria en Sistemas de Producción de Interfaces Bosque Húmedo / Agricultura: memorias de un taller informativo*. Yapacaní, Septiembre de 1996. CIAT: Santa Cruz. 77p. (workshop proceedings).

2. August 1998. *Metodologías de Investigación Pecuaria en Sistemas de Producción de Pequeños Productores. Seminario Taller Internacional*. Santa Cruz, Febrero de 1998. CIAT/NRI: Santa Cruz. 170p. (workshop proceedings).

3. August 1998. *Proyecto de investigación con especies menores en sistemas de producción de pequeños productores en las provincias Ichilo y Sara*. CIAT/NRI: Santa Cruz. (publicity brochure).

4. November 1998. Ugarteche, J., Paterson, R. y Joaquín, N. *El comportamiento productivo de especies menores en el sistema de producción del pequeño productor en las provincias Ichilo y Sara del Departamento de Santa Cruz - Bolivia*. XVI Panamerican Congress of Veterinary Sciences, Santa Cruz, November 1998. (poster presentation).

5. November 1998. Ugarteche, J., Paterson, R. y Joaquín, N. *Especies Menores en Sistemas de Producción de Pequeños Productores: Provincias Sara e Ichilo*. Avance de Investigación Series. CIAT/NRI: Santa Cruz. 52p. (booklet).

6. November 1998. Román, M.A. *Influencia Cultural en el Desarrollo Agropecuario de los Pequeños Productores de Santa Cruz.* Tesis de grado. Facultad de Ciencias Económicas y Sociología, Universidad Mayor de San Simon: Cochabamba. 159p. (undergraduate thesis).

7. February 1999. Ayala, L. Arachis pintoi *en la Alimentación de Vacas Lecheras en Pequeñas Fincas (Provincia Ichilo, Departamento de Santa Cruz - Bolivia).* Tesis de grado. Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma Gabriel Rene Moreno: Santa Cruz. 38p + apendices. (undergraduate thesis).

8. February 1999. Anon. (later versions attributed to authors) *Guía Metodológica de Investigaciones con Especies Menores de Animales en Fincas de Pequeños Productores*. First Draft for discussion with NGOs. 27p. (mimeo).

9. May 1999. Chamón, K., Joaquín, N. and Ugarteche, J. *Guía Metodológica de Investigaciones con Especies Menores de Animales en Fincas de Pequeños Productores*. Second version. 34p. (mimeo).

10. May 1999. Chamón, K. (Ed). *Diagnósticos Participativos de Doce Sistemas de Producción en las Provincias Sara e Ichilo.* (mimeo, copies lodged in key libraries).

11. July 1999. Román, M.A. *Influencia Cultural en el Desarrollo Socioeconómico de Pequeños Productores en las Provincias Sara e Ichilo.* CIAT/NRI: Santa Cruz. 46p. (booklet).

12. November 1999. Chamón, K., Joaquín, N. and Paterson, R. *Síntesis y Análisis de Diagnósticos Participativos con Productores de Pequeña Escala en las Provincias Sara e Ichilo*. CIAT/NRI: Santa Cruz. 28p. (booklet).

13. November 1999. Sección Producción Pecuaria. *Manejo de Patos*. Carpeta Técnica. CIAT/NRI: Santa Cruz. 7p. (extension pamphlet).

14. February 2000. Chamón, K., Joaquín, N. and Paterson, R. *Guía metodológica para la Investigación con Especies de Animales menores en Fincas de Pequeños Productores.* CIAT/NRI: Santa Cruz. 41p. (booklet).

15. March 2000. Paterson, R.T. Draft Final Technical Report (Phase 1). NRI: Chatham Maritime.

16. March 2001. Paterson, R.T., Joaquín, N., Chamón, K. and Palomino, E. The productivity of small animal species in small-scale mixed farming systems in subtropical Bolivia. *Tropical Animal Health and Production* **33(1):**1-14. (article).

17. September 2000. Chamón, K. Cria de patos criollos. *Visión Agropecuaria,* **3(10):**36. (article).

18. May 2001. Choque, J.C. *Diagnóstico de las principales Enfermedades en Especies Menores en Fincas de Pequeños Productores.* Tesis de grado. Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma Gabriel Rene Moreno: Santa Cruz. 49p + appendices. (undergraduate thesis).

19. June 2001. Burgos, D.A. *Evaluación de la Productividad de Cerdos en Sistemas Tradicionales de Pequeños Productores (San Miguelito, Provincia Ichilo, Departamento de Santa Cruz).* Tesis de grado. Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma Gabriel Rene Moreno: Santa Cruz. 48p + appendices. (undergraduate thesis).

20. August 2001. Rojas, F., Chamón, K., Choque, J.C., Lizárraga, H., Fernández, W. and Palomino, E. *Diferencias del Sistema de Manejo en Especies de Animales Menores Entre Comunidades Orientales y Andinas de las Provincias Sara e Ichilo.* CIAT/NRI: Santa Cruz. 44p. (booklet).

21. November 2001. *Investigación Pecuaria y Perspectivas para el Desarrollo con Pequeños Productores: Memorias, Seminario Taller.* Yapacaní and Santa Cruz, February 2000. Santa Cruz, Bolivia: CIAT/NRI. (workshop proceedings). Dated April 2000, but not published until November 2001.

22. November 2001. Paterson, R.T. Final Technical Report. NRI: Chatham Maritime.

Publications in Preparation:

1. Student thesis on costs of production of small animal species (Riveros, J.C., in prep., *Proyecto de Alternativas Tecnológicas de Producción y Crianza de Especies de Animales Menores en la Provincia Ichilo*, expected March 2002).
2. Extension pamphlet on animal diseases and parasite problems (in press, expected December 2001).
3. Extension pamphlet on feeding of small animal species (expected February 2002).
4. Extension pamphlet on rustic installations for small animal species (expected March 2002).
5. Extension pamphlet on the breeding and management of guinea pigs (expected June 2002).
6. Extension pamphlet on general management of small animal species (expected December 2002).
7. Technical leaflet based on the Burgos thesis on scavenging pigs (expected July 2002).
8. Technical leaflet based on the Riveros thesis on costs of production (expected August 2002).
9. Booklet on participatory methodology (expected September 2002).
10. Booklet on management and production of hair sheep (expected December 2002).

Project Internal Reports:

1.	March 1998.	Ortuño, F. Socio-economic case-study of duck production in Portachuelo.
2.	June 1997.	Ugarteche, J. Visit report, Cochabamba (guinea pigs).
3.	March 1998.	Muñoz, Eulógio. (ICA, Cuba). Consultancy report.
4.	January 1999.	Benavides, Jorge (CATIE, Costa Rica). Consultancy report.
5.	April 1999.	Joaquín, N. and Chamón, K. Report on a technical tour to a semi-intensive duck production system on farm of Dila Saucedo.
6.	October 1999.	Fernández, W. and Palomino, E. Report on a technical tour to FMVZ/UADY, Mérida, Mexico. 8p. (mimeo).
7.	November 1999.	Peña, R. Report on technical tour to a semi-intensive duck production system on the farm of Eduardo Roca.
8.	December 1999.	Peña, R. Report on technical tour to a chicken and sheep production system on the farm of Paulina Maigua.
9.	February 2000.	Hernández, Alejandro. (Universidad Agraria de La Habana, Cuba). Consultancy report.

Reports on Routine Visits to Bolivia by the Project Manager:

1. August - October 1996
2. February - March 1997
3. May - June 1997
4. September 1997
5. February 1998
6. April - May 1998
7. July - August 1998
8. November 1998
9. January - February 1999
10. April - May 1999
11. July - August 1999
12. October - November 1999
13. January - February 2000
14. August 2000 (in conjunction with a separate visit to Bolivia for non-project purposes)
15. November 2000
16. May 2001
17. October – November 2001

CONTRIBUTION OF OUTPUTS

The stated purpose of the LPP forest-agriculture interface production system (the goal of the project), as modified in late 1999, was to benefit poor people by the application of new knowledge on the improved performance of livestock. The work described in this report was designed to improve the livelihoods of small-scale farmers through increased production of small animal species, since at least some of these species are owned by even the poorest rural families in the region, where they make an obvious contribution to both food security and income.

Current thinking in sustainable development assistance refers to the asset pentagon (DFID, 1999). To improve the livelihoods of poor people, all of the five identified forms of capital (human, social, natural, physical and financial) need to be increased, and where possible, this should be achieved simultaneously. After a number of years in which livestock seemed to be perceived primarily as destroyers of the natural environment, it is now being re-accepted that they perform vital functions in the societies and economies of poor people. Depending on the way in which they are used, they are capable of addressing all of the identified forms of capital, as noted below:

- Human capital: improved animal production, when used for home consumption, can have an important effect on family health and welfare. In addition to this, the modest amounts of cash realised from the sale of

small animals, which often accrue to the women and children who manage them, are appropriate for the payment of medical expenses and school fees. Such uses improve both human welfare and the knowledge base within the family.

- Social capital: the management of small animals and the degree of financial independence conferred by the income therefrom, often lead to an improvement of the social status of poor people. Since women and children often manage such enterprises, promotion of small animal species can improve the welfare and prestige of marginalized groups within society.
- Natural capital: unlike cattle, scavenging species of small animals require minimal changes to the natural environment, in order to thrive in a tropical, or sub-tropical environment, since they obtain most of their food from naturally occurring flora and fauna. While this may do little to actually improve the environment, it favours conservation, since it does not lead to destruction of the native vegetation and its replacement, by either crops or permanent pasture. Where the husbandry of small animal species reduces the need to hunt in order to provide meat for the table, it can have a significant effect on the conservation of native fauna.
- Physical capital: because of their short gestation periods, small animal species can provide a rapid return to invested capital. As the returns are available in small increments and almost all year round, sales can be readily adjusted to meet particular purposes. The returns from these species are, therefore, appropriate for funding such activities as the purchase of hand-tools, incremental improvements in housing for animals or humans, and occasional journeys away from the farm in order to obtain inputs or information.
- Financial capital: again, because of the rapid returns that can be obtained from small animal species, they are capable of generating the capital needed for alternative family enterprises. Examples of this would be the sale of small animals to purchase saplings for the establishment of an orchard, or to buy a dairy cow. This would diversify the pattern of farm production and thereby, reduce risk and vulnerability.

Starting in 1996 from a position of zero availability of information regarding the problems and performance of small animal species in the Bolivian Provinces of Sara and Ichilo, the project has achieved all of the objectives that were stated in the project documentation. The role of small livestock in the existing farming systems has been documented and management strategies have been developed which will allow for improved productivity and better integration of the animals into the farming system. Technologies for year-round feeding of animals have been promoted by the distribution of planting material and participatory research methods have been developed and documented. The experimental information obtained during the work has been formulated into packages of interventions, for on-farm validation. In more specific terms, the project has worked in a fully participatory manner to measure the productivity of the most important small animal species (chickens, ducks, pigs, hair sheep and guinea pigs) within the existing farming systems. It has helped farm families to identify the major problems encountered with these species. Appropriate management and animal health interventions have been designed, tested and shown to improve the productivity of each of these species. Further, it has evaluated the economics of the target species and has described the aims and aspirations of the two main ethnic groups in the research area, with regard to small animals. The methodologies used have been documented and the findings published in a number of fora, for widespread distribution to farmers, advisers and policy-makers.

Local NGOs have participated in all stages of the project activities, so there has always been general awareness of the results within the target institutions of the technology transfer and agricultural extension community. This has been reinforced by the availability of a range of extension and technical publications that detail the findings of the project. Dissemination pathways were put in place at the inception of the project and the level of local awareness shows that they have been effective. This has led to a huge demand for small animal activities in other areas of the Santa Cruz Department and elsewhere in the Bolivian tropics, which has received the enthusiastic support of local, Departmental and National Government authorities.

The achievements of the project directly address the development goals of DFID. All are directly aimed at improving the livelihoods of the poorest members of society, through increases in the availability of animal products which can either be consumed within the family to improve diets, or sold to provide small amounts of income and to improve cash-flow. At the present time, however, although the project has generated a considerable amount of valuable data and tremendous interest over a wide area of the country, it must be noted that the impact on the tropical farming community as a whole, has so far been limited. Because of the nature of project, which has been dedicated to research, rather than development, relatively few farmers have directly benefited through personal involvement in the work. Those participating farmers, their local organizations and authorities at all levels, perceive the achievements of the project as being both important and practical. Within a relatively short time frame, the profile of small animal species has been raised considerably and widespread interest has been generated in their potential to alleviate poverty. Nevertheless, it remains for complementary development activities to implement the

findings of the project for the benefit of a much wider group of small-scale, resource-poor farmers in other parts of the country.

As described in a separate section above, this is in hand and CIAT is currently under considerable pressure to provide technical support to local authorities in a number of provinces and municipalities, both in Santa Cruz and elsewhere, with local and international funding. The impact of the project is confidently expected to grow for several years to come, as the work is extended into the areas which are currently demanding such activities.

The project has established fruitful linkages at an international level, particularly with research institutes and consultants from Cuba and Costa Rica, and with UADY in Mexico. This regional perspective has spread awareness of project activities to a number of countries, but much remains to be done in this regard. It is believed that many of the project results and methodologies would be useful in a number of other countries with similar physical and economic conditions, such as Brazil, Peru and Ecuador. With the funds available to it from local sources, CIAT is not in a position to extend the findings to neighbouring countries, even though it is in the forefront of participatory research with small animal species. DFID could, however, consider using consultants from CIAT to provide these services to relevant institutions in countries where the British Government is concerned with the use of small animal species to combat poverty in the small-farm sector.

While the results so far obtained can be widely applied, because of differing climatic conditions in some of the new areas, further, complementary research work is still required. This should address the husbandry of goats, pigs and hair sheep in the drier regions of the Bolivian tropics, such as the Chaco and the Mesothermic Valleys. The first two of these species are already present in large numbers, while interest in the latter species is growing. Because of unsuitable management practices, goats, kept even by very poor families, are currently responsible for substantial environmental damage. Improved husbandry would, therefore, address both poverty issues and environmental degradation.

Project participants noted that one of the strengths of the project was that increased production of small animal species reduced the need to hunt bush-meat to provide animal protein to the family. This activity has become increasingly difficult in recent years, as the favourite species, including jochi (a large rodent) and tatú (an armadillo), have become scarce in the colonisation zone and hunters have had to travel further into the forest to find their prey. In any further small animal research in the target area in the future, thought should be given to the small-scale husbandry of these species, for which there would be a great demand, not only within the family, but also for sale to local, specialised, bush-meat restaurants, which serve visitors from the city, particularly on weekends and holidays. Commercial production of these species would reduce the pressure on the native populations and, therefore, contribute to their conservation in an area from which they have almost disappeared in recent years.

As already noted, a range of documentation has been produced to ensure the dissemination of the results to the widest possible audience. For a variety or reasons beyond the control of the project, however, there are several publications that were still in varying stages of preparation when it came to an end. There is a need to seek a small amount of supplementary funding in the period up to the end of the calendar year 2002, to ensure that project documentation is complete. This is seen, not only as a contribution to Santa Cruz and other areas of Bolivia, such as the tropics in the Chuquisaca, Cochabamba and Pando Departments, but also to other countries of DFID interest in the region, including Brazil, Peru, Ecuador and Mexico.

CONCLUSIONS

During the course of the project, suitable methods were developed for participatory work with small animal species in small-scale farming systems in the Bolivian tropics. Small animals are important to both food security (mainly chickens, sheep and guinea pigs) and to income generation (ducks and pigs). The work has shown that under existing management, these species contribute some 30% of the total annual income (cash and kind) of the poorest, small-scale farmers in the Provinces of Sara and Ichilo. On-farm validation indicated that with improved management and minimal investment, the contribution could be greatly increased. This would significantly improve the livelihoods of the poorest members of the rural society. As a result of involvement in the project, families have less need to hunt, are more secure in their farming enterprises and feel more confident about their future in the target area. There are, however, large differences in farming strategies and family aspirations between the two main ethnic groups in the region and this will demand differing extension messages and dissemination techniques to effectively serve the two sectors of the community.

While the initial project, which ran until February 2000, was successful in terms of generation of information, a severe initial limitation was the complete lack of background data on the performance of small animal species in the region. It was, therefore, as a result of the short time scale, unable to have a measurable impact on the small farm sector in general, even though the direct collaborators reported perceived benefits. For this reason, a 12 month extension was requested, which was approved from November 2000 to October 2001. During this time, on-farm validation of existing veterinary and management recommendations, was conducted, while dissemination material was prepared. Before the conclusion of the extension, requests were received by CIAT from all parts of the Department of Santa Cruz (Mesothermic Valleys, Chiquitania, etc.) and from neighbouring regions in the Chuquisaca Department, with a further possibility of future involvement in Cochabamba Department, for assistance in the promotion and development of activities with small animal species. It is gratifying to note that local government authorities offered to cover direct costs, if CIAT could provide the necessary technical support, since this indicates the impact that the project has had, over wide areas of the Bolivian tropics and sub-tropics, even though direct project activities were confined to a small and well-defined area within the Provinces of Sara and Ichilo.

As a result of five years of intense activity within the project, CIAT has placed itself in the forefront of participatory research with small animal species in the small farm sector. In view of its experience in the field, it has several members of staff, in both technical and social disciplines, who would make ideal consultants to similar activities in the region.

RECOMMENDATIONS

It is obvious that the impact of the project is growing and that it will continue to do so for some time to come. For this reason, it would be premature to attempt to assess its overall effect at the present time. It is strongly recommended that LPP budget for a full-scale, impact assessment of the project in the future, not only in the initial target area, but also in other provinces and Departments where similar activities have been carried out by CIAT. This should be delayed long enough to allow for recently requested activities to work their way through the system and to be implemented. Since LPP may be radically changed at the conclusion of the present funding phase in March 2005, it is suggested that the impact assessment should be conducted at the end of 2004, to maximise the time available for secondary activities to come to fruition.

The work has led to the production of a substantial body of both technical and socio-economic data which has been published in a variety of forms. There are, however, some outstanding items, mainly relating to extension and dissemination documents, which it has been impossible to publish within the finite lifetime and the limited budget of the project under consideration. These items are listed above as publications in preparation. It is strongly recommended that CIAT should be given a contract by DFID to complete and publish these items by the end of the 2002/03 financial year. A budget is already available and the sum involved would be of the order of £6,000. The writer believes that this is a very modest request and that the results would be of considerable value, both in the wider area of the Bolivian tropics and also in neighbouring countries, where small animal species make a substantial contribution to the poorer sectors of the rural society.

The project has already made a considerable contribution to the welfare of both the human and the small animal populations in the target area and elsewhere in the Department of Santa Cruz. It has developed a methodology in both technical and social fields, which is being successfully applied at a number of sites. From a technical viewpoint, however, it has concentrated on chickens, ducks, pigs, hair sheep and guinea pigs, the major animal species in the target area. There are notable gaps in the available information on existing domestic animals, particularly with regard to the drier areas (Chaco and Mesothermic Valleys) of the Department. Climatic and altitudinal differences will ensure that the animal health and nutrition issues will be very different in comparison with the target area of the present project. In addition to this, poor people in these areas commonly keep goats, rather than sheep, which have different problems, habits and requirements. It is recommended that LPP should consider a new, three-year research project to concentrate on goats and other small animal species, such as pigs and sheep, in these dry areas, which are recognised as being amongst the poorest in the country.

Within the target area of the original project, families using improved production techniques for small animal species have stated that one of the advantages of the work has been to improve their food security and, therefore, to reduce their reliance on hunting to provide meat for the table. It is recognised that the numbers of edible, wild

animals (jochi, tatú, etc.) in the region have decreased significantly in recent years and that now, the hunters have to travel far from the centres of population, in order to find their prey. There continues to be a demand for bush-meat, not only by the resident population, but also by visitors from the city, who travel to the region on weekends and public holidays, specifically to eat the local delicacies. Although not in danger of extinction at a national level, if the situation continues as it is, the most popular species will completely disappear from large areas of the tropics of Santa Cruz. One way to combat this genetic erosion would be through the commercial production of bush-meat in small-scale operations in the region. It is suggested that research should be conducted to define suitable techniques for breeding and rearing of native species, particularly jochi and tatú. This could be a suitable subject for LPP, or possibly for other initiatives within the assistance portfolio of the British Government, concerned more with the conservation of native populations.

It is suggested that DFID should consider the use of CIAT staff members as consultants within the Latin American region. In view of their experience in participatory research and production methods with small animal species, they are ideally placed to provide guidance and support to other projects where small animals are used in the fight against poverty, for both food security and the regular generation of small amounts of cash income.

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