Poultry, pigs, hair sheep and guinea pigs in the livelihoods of small-scale, subsistence farmers in tropical Bolivia[1]

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Abstract

In forest margins in the Sara and Ichilo provinces of tropical Bolivia, a participatory programme of research was undertaken by a multi-disciplinary team of biological and social scientists and extensionists, working with participating farm families (parents and school-aged children), nominated by their communities. The objectives were to determine the problems faced, and the productivity of the principal, scavenging small animal species found in the largely subsistence farming systems, typical of the region. High levels of mortality of young animals were seen in all species, where natural predators and preventable accidents were responsible for many losses. In poultry, readily controllable diseases were important, while in pigs and sheep, internal parasites were implicated in losses and poor animal performance. Guinea pigs had few problems, except for losses due to predators and theft. During a validation period, farmers recognised that improved nutrition would be advantageous, but were unwilling to incur the regular costs of improved feeding. They chose instead to provide their animals with simple night shelters, vaccinations and improved hygiene. These simple measures increased the gross margin (cash and kind) of chickens, ducks, pigs and sheep by 30, 98, 16 and 63 per cent respectively. With guinea pigs, better housing made management easier, but this was not reflected in improved animal performance. On average, the improvements resulted in an annual increase of over US$ 200 in family income, which was normally in the range of US$ 1,000–1,200. The results attracted the attention of local authorities and similar work has been initiated in neighbouring areas.

Introduction

In the Bolivian Department of Santa Cruz, the Provinces of Sara and Ichilo lie some 100 km north-west of the city of Santa Cruz de la Sierra, where they occupy an area of about 21,000 km^2. Most of the region is a flat, alluvial plain, 350-450 m above sea level, with young soils prone to localised, seasonal waterlogging, although the land becomes undulating and rises to 800 m as it approaches the foothills of the Andes to the west. The soils are moderately fertile with pH values often in the range of 4.5 to 5.5. Rainfall increases from about 1,400 mm in the east to over 1,800 mm in the west, about three

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quarters of which falls between October and May. The natural vegetation is mostly tall, evergreen forest (Paterson *et al.*, 2001).

Some 55 per cent of the total population of 90,000 people live in about 300 rural communities in groups of 25 to 150 families (Roca, 1998). The farm families come from two quite distinct ethnic groups of almost equal size. The local lowland people make up just over half of the present population and are descended from Spanish immigrants, usually with some degree of genetic influence from the original lowland Indian population. The other group (46 per cent of the present day total) is composed of almost pure-blood Indians who have migrated into the area in recent decades, from the highland Departments of the country, mainly Cochabamba and Potosí. These ethnic origins are important in terms of attitudes, aspirations and lifestyles. Lowlanders tend to grow a wider range of subsistence crops than their neighbours, including native fruit trees and local vegetables. They are less market-orientated than the highlanders, favouring a more varied diet and a less hectic lifestyle over attempts to maximise their incomes (Román, 1999).

Within designated colonisation areas, usually after removal of the best, high-value tropical hardwood timber, the state assigns blocks of 30-50 ha of forest land to individuals or families, for agricultural use. The recipients are usually extremely poor, with access only to a few hand tools. They initially clear small areas of land to produce subsistence crops (rice, maize, vegetables, etc.) under a slash-and-burn (swidden) farming system, rotating the cropping area around the farm when falling fertility or increasing weed problems lead them to abandon the original area back to bush fallow. The farmers generally lack the capital to work more than a few hectares of their land at any one time (Thiele, 1991). Some of the immigrants from the highlands have experience of animal traction in their areas of origin, but the heavy soils and the presence of roots and trunks make these techniques impracticable in the lowlands, even if enough capital were available to finance the use of oxen. The agricultural activities are largely concerned with subsistence farming, although excess production, destined for the city, is sold locally.

In 1992, it was estimated that 74 per cent of the farming families in the region had total annual incomes below US$ 1,100, with 25 per cent of them receiving less than US$300 (Roca, 1998). Prices for farm produce have increased over the past decade, but casual labour is still paid at a rate of about US$ 5 per day and total family cash income is frequently in the range of US$ 1,000–1,200 per year (Román, 1999).

The heavy agricultural work on the farm (land clearance, land preparation) is usually undertaken by adult males, but in both ethnic groups, the whole family is involved in lighter field work (planting, weeding and harvesting). When present, cattle are generally managed by men, but milking of the cows and caring for small animal species are duties usually undertaken by the women and children. Small animal species appeared on the farms of members of both ethnic groups at a very early stage in the development of the system. These animals generally contribute to food security, although, in times of need, excess production not required for home consumption, is sold. Scavenging, local breed chickens are present on over 90 per cent of farms in the region (Román, 1999) and local ducks are common on farms where there are natural streams or ponds. Under traditional management, all poultry and most other small animal species scavenge for almost all of their feed, eating leaves, seeds, worms and insects. They receive very small amounts of supplements, usually cracked grain, surplus and over-ripe fruits and household scraps.

The lowlanders maintain a wider range of animal species than the immigrant highlanders, sometimes including native animals such as armadillos, which are captured in the surrounding forest and grown on to slaughter weight in captivity. Amongst their poultry, they often keep several varieties of chickens, together with ducks, geese and guinea-fowl. In contrast to this, the highlanders usually keep only chickens. The latter group do, however, have guinea pigs and tropical hair sheep, species which are seldom found on the farms of lowlanders. Prior to the mid 1990s, livestock research and development work in the region concentrated on cattle, since all the farmers of both ethnic groups repeatedly expressed their desire to become involved in either dairy or beef production. It was noted, however, that the poorest members of society were usually unable to afford the investment needed to establish a herd of more than one or two cows. Because of their long gestation period and low calving rates associated with poor nutrition and the presence of tick-borne diseases, these animals made little contribution to family income and consumption (Breinholt, 1982). The programme of work discussed in the following pages was undertaken to define the role of small animal species in the households in the region; to identify the major production limitations; and to promote their use in the farming operations conducted by poor people on small-scale farms in the forest margins.

Materials and methods

The work took place in a fully participatory manner, where farm families (both adults and children of school age) and local extension staff worked in full collaboration with a multi-disciplinary team of researchers in both biological and social sciences. When the research started, there was an almost complete absence of technical information on the performance of small animal species and the problems facing them in the target area. A programme of many months work was necessary to generate this vital information and so a conscious decision was taken to start the biological research first and to then follow this up with the socio-economic studies that would be necessary to complement the biophysical information.

Initial informal surveys in the target area identified chickens, ducks, pigs, hair sheep and guinea pigs as the most common livestock and subsequent work concentrated on these species. Monitoring of representative farms took place over a complete year (18 months for sheep), where all events (births, deaths, sickness, accidents, utilisation, sales, feed offered, etc.) were carefully recorded. This was done on 11 farms, located in the four distinct communities of Barrientos, San Rafael, San Miguelitos and Potrerito. Initially, technical staff visited each farm on a weekly basis to ensure that the records were kept up-to-date, but as the families became used to the routine, the period between visits was increased to two weeks. School-age children were often involved in the recording of the data, particularly where their parents were illiterate, or lacked confidence in their writing abilities. As far as possible, technical interventions were avoided during this period, to establish the production patterns of the chosen species under traditional management. The major production problems were determined, using, where appropriate, the assistance of a local diagnostic veterinary laboratory. The methodology employed during this phase of the work has been fully described by Paterson *et al.* (2001).

At the conclusion of this period, possible interventions were discussed in open meetings, held in each of the four communities, with the farming families and their neighbours. At the conclusion of a presentation of the results obtained in the initial stages, the technical staff withdrew to allow the communities to freely discuss the findings and to choose which animal species and interventions would be tested in a subsequent programme of

on-farm validation. The communities themselves nominated the individuals who would participate in this phase of the work, and neighbours were free to oversee the activities and to suggest modifications as they saw fit.

In parallel with the technical work on animal production, sociological and economic studies were also conducted in the same communities, using a range of participatory techniques, including semi-structured surveys, participatory rural appraisals, farm walks, maps, transects, resource flows and SWOT (strengths, weaknesses, opportunities, threats) analysis and wealth ranking (Román, 1999). This allowed an assessment of attitudes and aspirations in the communities, while measuring the contribution of traditionally managed small animal species to family livelihoods. The socio-economic methodology developed for this work was published for the benefit of other groups that may be interested in conducting similar work in other parts of the country or elsewhere (Chamón *et al.*, 2000).

Workshops and farm visits were arranged to publicise the findings and to confirm that the results, which had been obtained in a small sample of communities, were applicable to the region as a whole. During the course of the work, results were published in a range of media, including technical fact-sheets, newspaper articles, extension booklets and scientific papers for submission to conferences and journals.

Results

Average holdings of breeding animals varied widely between farms and over time, in response to family preferences and needs for cash and meat, but typically consisted of about 15 chickens, 6 ducks, 1 or 2 sows, up to 10 ewes and 15 guinea pigs. However, no single farm had all of these species. Chickens and pigs were kept by both highland immigrants and lowlanders, while ducks were only kept by lowland people and sheep and guinea pigs only by highlanders.

Attempts were made to identify cultural differences in the management practices used for small animal species on farms belonging to either highlanders or lowlanders. These failed to define large differences, although, because of access to accumulated knowledge, the lowlanders made more use of traditional and household remedies to treat disease problems than did their neighbours. The highlanders had lived in a harsher environment in their original areas and possibly because of this, they were more inclined to provide rustic shelter for their animals. This was noted particularly with sheep and guinea pigs, species that are not normally kept by lowlanders. In the sections that follow, no attempt is made to distinguish between the ethnic groups in terms of the management practices employed for their animals.

Under traditional management, poultry scavenge around the home compound for the bulk of their feed, receiving only occasional supplements of household scraps and cracked grain. Pigs also scavenge, while receiving occasional supplements of chopped cassava, etc., while sheep graze and browse along roadsides, in fallow-lands, or in small fields established for use by cattle. Guinea pigs are the exception, since they are usually kept in sheds, or in the family kitchen, where they receive their food as cut fodder and household scraps. None of the animals receive either vaccinations or veterinary treatment and most find their own shelter where they can.

As a result of the use of almost zero inputs, apart from the labour of women and children, which has a very low opportunity cost, any production in terms of eggs and meat from small animal species can be considered as profit, whether they are sold or eaten by the family. Under these conditions, calculations based on a series of in-depth interviews and a sound understanding of the incomes, yields and budgets of representative families showed that the return from small animal species can represent up to 30 per cent of annual family income, when home consumption is costed at the prevailing local market prices. This figure varied greatly between farms and even between seasons, since the holdings of small animal species were subject to large changes during the course of the study, but in view of their importance to family income and welfare, it was clear that any increases in their productivity would have a major effect on the small-farm sector.

Chickens

On most farms, eggs were collected for home consumption and occasional sale in almost all months of the year, with a peak in the period from August to November. Chicks hatched throughout the year, with the greatest numbers from May to July. Overall, the annual productivity was 5.8 chicks per mature hen, although there was great variability between farms, due to the trade-off between egg collection and the emergence of chicks. Typically, the annual sum of eggs collected and chicks observed (net egg production after losses to weather and predators) was in the range of 20-40 per breeding female. A number of native predators took both eggs and newly hatched chicks, but losses of older birds in this way were minimal. The heaviest mortality of chicks resulted from diseases such as Newcastle disease, fowl pox, infectious coryza, fowl cholera and pullorum disease (bacillary white diarrhoea), and the losses seemed to be aggravated by cold, wet weather. Both internal (roundworms) and external parasites (mites, mange) were common and although they did not normally lead directly to mortality, they had an effect on the general health and welfare of the birds.

Few mature birds were sold, but young males and older females were slaughtered throughout the year for home consumption. In most cases, two to four birds were consumed each month but holiday periods or family celebrations could increase this number.

During the on-farm validation period, farmers agreed to provide their poultry with rustic housing made of poles and palm thatch cut from the farm, together with purchased chicken wire. The adult birds rapidly accustomed themselves to sleeping in the shelters and laying eggs in the nest boxes provided, although they continued to scavenge during the day for the bulk of their food. Vaccination was practised against Newcastle disease and fowl pox, while antibiotics and traditional remedies were used to treat diarrhoea when it occurred. These measures increased the numbers of chicks observed and reduced losses, so that productivity per breeding female was increased by about 30 per cent (Table 1).

Table 1 *Annual productivity of small animal species in tropical Bolivia*

Species	Traditional management			Improved management		
	Live young per breeding event	Mortality before maturity (%)	Gross return per breeding female (US$/year*)	Mortality before maturity (%)	Gross return per breeding female (US$/year*)	Increase in productivity (%)
Chickens	7.1	30.5	13.29	18.2	17.21	29.5
Ducks	6.7	54.1	12.05	27.4	23.82	97.7
Pigs	8.1	38.2	260.34	28.3	302.05	16.0
Hair-sheep	1.2	30.8	13.82	19.5	22.51	62.9
Guinea pigs	2.3	10.5	8.91	11.0	9.30	4.4

* Returns calculated at constant 1999 prices, US$ 1.00 = Bs5.50

Ducks

Ducks are not kept by immigrants from the highlands, because they are considered to be dirty birds that foul the home compound with their droppings. Under traditional management, no eggs were laid during the colder months (May to July) and females bred only once per year, with most eggs hatching in the period from October to March. On average, 6.7 ducklings hatched from each clutch of eggs, but more than half were lost to diseases, usually involving diarrhoea (Table 1). No losses to predators were recorded during a monitoring period of a full year, although on one farm, two older birds died after being accidentally trampled by cows. There was no routine home consumption of either eggs or meat, but occasionally, a bird was slaughtered for a family celebration. Instead, there was a ready market for live or dressed birds, which often found their way, through intermediaries, to restaurants in the urban centres. Most birds were sold at a price set on sight, rather than by weight.

During the on-farm validation period, ducks were allowed entry into the shelters provided for the chickens and they received appropriate vaccinations and veterinary treatment with antibiotics as necessary. This resulted in a halving of the mortality rate of the ducklings and a doubling of the productivity of the species (see Table 1). During the course of the work, there was a growing trend towards setting the sale price by body weight, although this may have been a result of increasing sophistication in the market, rather than to any increase in the levels of production.

One urban farmer, in a small town in the region, developed a semi-intensive, back-yard system of duck production, which produced excellent technical and financial results, even though it was based on purchased, rather than home-grown feed. Immediately after hatching, the ducklings were removed from the mother and kept inside the family house for two days, to avoid any possible adverse effects of cold and damp conditions. They were then placed outside in a small, sheltered enclosure of their own, where they were provided with clean water and a commercial poultry ration, together with vegetable scraps obtained cheaply from the local market. As they grew, they were removed to larger enclosures and in this way, they reached a live weight for slaughter of about 2 kg in a period of 3-4 months. They were then sold, by weight, to intermediaries. Under this system, diseases were not a problem, as there was no ready source of infection and any sick duckling was separated from the rest as soon as symptoms were observed. All of the breeding females, kept with a drake in their own enclosure, laid two clutches per year and

although fairly variable, losses of ducklings were kept to a maximum of about 10 per cent. Annual returns per breeding female were estimated at about US$ 48 after taking the costs of purchased feed into consideration. The owner considered that her flock of 8-10 breeding females provided more profit for much less effort than she could earn by the alternative of taking in laundry. This is a low-cost management system that could readily be copied by other families in the region. The profit margin could be increased by replacing the purchased feed with a largely home-grown ration, based on commonly available feed resources such as maize, rice bran and a protein source, such as a meal made from soya or from the legume *Mucuna pruriens*.

Pigs

Many small farms run by both ethnic groups in the region kept one or two sows which scavenged for most of their food. They were free to roam around the home compound and nearby water courses for most of the year, although they tended to be tethered close to the house when nearby annual crops were at a vulnerable stage of their development. They received no veterinary treatment and, at best, only small amounts of chopped cassava tubers, chopped whole sugar cane and vegetable wastes to supplement what they could find for themselves. The fallen fruits from naturally occurring palm trees (*Attalea* and *Scheelea* species) formed an appreciable proportion of the diets of scavenging pigs, together with earthworms and roots obtained from low-lying areas or the banks of water courses.

Only one or two farmers in each community kept a boar, which was readily lent to neighbours when required. Under these conditions, the average period between farrowings was calculated at 265 days. Litters were concentrated in the period from April to June, and again from September to November, with an average of 8.1 live piglets per litter, irrespective of the month of farrowing. Losses of piglets were generally high (up to 67 per cent) and were attributed by farmers to accidents (crushing, drowning), cold weather and the lack of maternal milk. Research showed that where internal parasites were routinely controlled in mothers and offspring, losses over the first few months of life could be reduced to about 10 per cent (Table 1).

Young animals of up to 40 kg live weight were in great demand, particularly at times of public holidays (Carnival, Easter and Christmas) and for major family celebrations. Typically, of a litter of six pigs surviving to slaughter weight at from four to six months of age, one or two would be consumed by the family, but most would be sold locally, usually to intermediaries. Where sows farrowed twice in a year, an annual cash income of up to about US$ 400 could be derived, equivalent to the income from over three months of casual, daily paid work.

During the on-farm validation period, rustic enclosures were built, using poles and palm thatch, cut on the farm. A separate, shaded farrowing pen was included, to protect the newly born piglets from contact with other, larger animals. The pigs were vaccinated against classical swine fever and routinely treated to control both internal and external parasites. The result was to reduce the mortality of the piglets and to increase their growth rates (Table 1), although the improvements were limited by the unwillingness of the owners to provide adequate amounts of supplementary feed, particularly while the animals were confined in their pens. Although mortality of piglets was reduced in the first two weeks of life, losses continued after this initial period as a result of accidents and an apparent lack of milk. More attention to the feeding of the dams in mid-lactation should allow a greater proportion of the litter to reach slaughter weight.

Hair sheep

Tropical hair sheep were kept only by highland immigrants, many of whom had a tradition of raising conventional wool sheep in their original homelands. Lowland people have never been used to sheep, nor have they developed a taste for the meat, since wool sheep are poorly adapted to life in the humid tropics. For lowlanders, sheep are a totally new species and only a few families have recently started to express an interest in learning to care for them. Sheep are normally grazed and browsed on poor quality, volunteer pasture on fallow land and along roadsides, although occasionally, they are given access to better quality pastures which have normally been established for cattle. These planted pastures are usually sown to *Brachiaria decumbens*, *B. brizantha* or *B. humidicola*, although occasionally, areas are planted to a mixture of *Panicum maximum* with the pasture legumes *Macrotyloma axillare* cv. Archer, or *Pueraria phaseoloides* (tropical kudzu). The sheep receive neither veterinary attention nor supplementary feeding, except for occasional access to a salt lick. Under this traditional management, where rams are constantly with the ewes, twinning is common, but mortality in the lambs prior to maturity is about 30 per cent (Table 1). On four farms monitored over the course of 18 months, a total of 16 ewes lambed more than once. The average *inter partum* period was 251 days (range 144-424 days), including three ewes with more than a year between births. The average was 1.30 live young born per lambing.

The high level of lamb mortality was attributed by the farmers to accidents and lack of maternal milk, although technical staff was convinced that internal parasites were implicated in the problem. Diarrhoea also caused some losses, as did infections contracted by new-born lambs through an untreated navel. Some animals were slaughtered for consumption at times of family celebrations, although most were sold. Some farmers complained of difficulties of marketing animals for slaughter, because of the limited demand for mutton in the region, although others stated that there were no problems in selling young stock for breeding purposes.

Interventions included the provision of pens with a sheltered area to protect the animals at night from wind and rain, together with simple, veterinary treatments. These included: the application of iodine to the navels of the new-born lambs; the treatment of diarrhoea with rehydrating salt (sugar and common salt in clean water); the use of anti-biotics to treat footrot; and routine treatments to control internal and external parasites. These measures reduced the mortality of young animals to about 20 per cent, with a consequent increase in productivity and profitability of the flock (see Table 1). There appeared to be a reduction in the average *inter partum* period since ewes seemed to come into season faster after lambing, but the validation period was too short to provide the data needed to confirm this suggestion.

Guinea pigs

Guinea pigs are traditionally kept in the Highlands of Bolivia and many immigrant families continue to raise these animals for home consumption in their new environment. Lowlanders have shown little interest in the species, because of their perceived similarity to rats. They are usually allowed to run free in the kitchen building of the house, although on some farms, they are confined in a separate, small shed. As well as receiving household scraps, they are also regularly given freshly-cut, or partially wilted forage, often of tropical kudzu, or of leaves of the mulberry tree (*Morus alba*).

When monitored, the average *inter partum* period for guinea pigs was 190 days, with an average of 2.28 live births per litter and mortality of 10.5 per cent. No diseases were recorded and the low level of losses was attributed to accidents, sometimes involving dogs of neighbouring families. Theft of semi-mature animals was an occasional problem.

Suitable designs for pens were made available, which were raised to keep the animals 90-100 cm above the ground. This provided them with ventilation, while protecting them from dogs and other potential predators. Internal divisions in the pen separated the sire from the growing animals and so reduced the danger of injury through fighting. The provision of pens made management of the animals easier and allowed them to grow slightly faster in more secure surroundings, but had little effect on the productivity or profitability of the enterprise (Table 1). No veterinary practices were considered necessary, because diseases and parasites did not appear to have a measurable effect on the productivity of this species.

Discussion

Monitoring showed that the productivity of chickens and ducks was reduced largely by the attacks of a range of controllable diseases and natural predators, while losses from pigs and sheep were mainly due to avoidable accidents and to the effects of internal parasites. Guinea pigs had few identifiable problems, with low levels of losses.

Although it was recognised that inadequate nutrition was probably limiting the growth rates of all species, farmers were reluctant to adopt improved feeding regimes as part of their strategy of better management, since this would substantially increase their production costs. Instead, they opted for the provision of rustic, night-time shelters, which would protect poultry and guinea pigs from attack by dogs and wild predators. Chickens were to be vaccinated, particularly against Newcastle disease, and hygiene measures and treatments would be employed to lessen the impact of problems such as diarrhoea in both chickens and ducks. Pens would be constructed to confine pigs during times when they could damage crops and farrowing bays would be included in the design, to reduce the danger of piglets being crushed by their mothers, or by larger animals in the herd. Pigs and sheep would be regularly dosed or injected to control internal parasites. Participatory evaluation showed the positive impact of these measures through reduced losses of eggs (leaving more to be harvested by the family) and young animals, together with a suggestion of decreased intervals between births for all species except guinea pigs.

When home consumption was valued at market prices, simple improvements in the management of existing animal resources resulted in increased average annual incomes of about US$ 213 and 207 for lowland and highland families respectively. These sums are equivalent to about two months of casual work at the normal rate of US$ 5/day and represent a large increase over the typical family annual income in the region of US$ 1,000-1,200. The increases do not tell the whole story, however, since they were used differently by the two distinct ethnic groups. Lowlanders used most of the additional product to increase their consumption of animal protein, in terms of both eggs and meat. The numbers of chickens slaughtered on a regular basis increased from two or three, up to four or more each month, while both duck meat and pork, usually reserved for family celebrations, figured more prominently on the family menu. It could be suggested that an improved diet in terms of both quantity and variety of animal protein would contribute not only to family satisfaction, but also to an improvement in health, although it was

beyond the scope of the project to attempt to quantify this. In contrast, the diets of highlanders suffered little change, since they sold most of the increased production, generally in order to invest, either in other productive enterprises on the farm, or in better health care or education facilities for members of the family. As a group, they are often prepared to forego increased present consumption and satisfaction in favour of future family welfare.

In neither group was there a tendency to increase the size of their holdings of small animals, since almost all of the increased production was either consumed or sold. As productivity of the existing animals increased, a few lowland families chose to experiment with new species, such as guinea pigs or sheep, although this was the exception, rather than the rule. No changes were noted amongst the immigrant families, either in terms of animal numbers or species.

During the course of several workshops conducted amongst farmers in the target area as part of project activities, participants claimed that improved productivity of small animal species made it less necessary for the males of the family to hunt in the surrounding forest in order to provide meat for the table. It was claimed that the stability of the farming enterprise was improved by better small animal production, since there was less competition for time between hunting and agricultural activities. More timely completion of land preparation, weed control and harvesting gives better crop yields and an improved standard of living. Although not formally measured as part of the project, this could be an important aspect of the improved productivity of small animal species. For years, it has been recognised that lack of capital and income has led to the sale of small farms and the movement of families further into the forest to start again (Thiele, 1991). These new settlements are usually beyond the reach of health and educational facilities, resulting in greater hardship and sacrifice. Improved stability of the small farm sector would reduce pressure on the remaining virgin forest and make it easier for the state to provide needed infrastructure (clinics, schools, roads, public utilities, etc.) to the residents at the forest margin.

Small animal species are almost exclusively managed by the women and children of the family. Increases in the availability of foods of animal origin in the family diet are immediately obvious and this tends to improve the social status of women and children, both in the family and in the wider community. In immigrant families, the women tend to sell all farm produce and to administer the income generated, but amongst the lowlanders, the men generally undertake most sales and purchases. The traditional viewpoint in the former group is that there is no income to be had from small animal species, so the men tend to ignore them, being content to leave their management to the women. At present, the sale of a small surplus provides the more marginalised members of the family with a modest income that they can dispose of as they see fit. It is not known if this will continue, but at the present time, it provides women and children with a measure of independence that has not previously existed.

Increased productivity from small animal species, which has previously been ignored by agricultural research and development bodies in the tropical regions of South America, has been shown to be easily achievable and this has attracted attention from local and national authorities and from foreign aid organisations. Demand for work with small animal species has spread into the drier areas of Bolivia and even into the Salta region of northern Argentina, where goats are an important species.

At the conclusion of the work, mindful of the limited reading ability of many of the target farmers, CIAT (International Centre for Tropical Agriculture) published (in Spanish) a series of three extension booklets on small animal production. These were based on illustrations and drawings, with a minimum of text, so that school-age children would be able to help their parents to understand the information presented. These booklets discussed the prevention and control of common diseases (Choque *et al*., 2002a), the construction of simple, rustic installations to protect the animals from predators and the elements (Choque *et al*., 2002b), and the use of commonly available feed resources (Lizárraga *et al*., 2002). These have recently been translated and their expected publication in English will enable them to be used in other parts of the developing world with similar conditions and production systems.

Conclusions

The implementation of simple, cheap, readily available recommendations for vaccination and parasite control and the provision of simple, rustic shelters, largely built from materials available on the farms, were shown to reduce losses of young animals and to increase the productivity and profitability of the holdings. This, in turn, increased the stability of the farming enterprises and reduced the need to hunt in the forest. In general, lowland families consumed more of the animal products, thus enjoying a better and more varied diet, while immigrant families tended to sell more produce to provide for an increased cash income. This was often treated as capital to be invested in other productive activities on the farm. Small animals are cared for almost exclusively by women and children and their social status was improved as a result of their increased contribution to family welfare.

The programme of research has attracted much attention, leading to requests for promotional work with small animal species in a number of other provinces of Bolivia and elsewhere. The possibility of an international impact cannot be ignored, since similar conditions and problems occur in neighbouring countries, particularly in Brazil, Argentina and Peru, as well as in parts of Africa and the Indian sub-continent.

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