

Animal traction in Cuba: an overview of survey results, issues and opportunities

by

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Summary

This chapter summarises the results and conclusions of surveys and collaborative investigations initiated in 1999 into the use of animal traction in Cuba. IIMA (Instituto de Investigaciones de Mecanización Agropecuaria) coordinated the work that involved five universities and the Ministry of Transport. Funding came from the British Department for International Development (DFID), with technical support from Paul Starkey and Brian Sims.

Cuba is a tropical archipelago with a strong agricultural sector and a population of about 12 million. Within Latin America, it is known for its high levels of road infrastructure, urbanisation, education and the provision of affordable utilities and social services, achieved despite a long-standing embargo.

There are about 400 000 oxen, 300,000 horses, 30 000 mules and 5000 donkeys in use in Cuba. Numbers of work animals had been slowly decreasing during the period 1960-1990, as tractors and motorised transport became increasingly common. During the Special Period that followed the collapse of the Soviet-supported Comecon trading block, fuel, spares and raw materials became scarce, and there was a revival of the use of oxen for cultivation, and horses for rural and urban transport. While the energy crisis of the early 1990s has passed, the Special Period continues, and this encourages the continued use of animal power to complement the energy provided by tractors and motor vehicles.

Pairs of oxen are used for plowing (mainly on smaller farms) and for weeding (on large and small farms). They also pull harrows and agricultural carts. Horses are mainly used for transport, including important urban transport services in several cities. Mules are used for packing in the hills, and donkeys are maintained to breed mules. The health and husbandry of animals is generally good. Suggestions are made for developing feed resources for urban horses and participatory studies on multipurpose animals (equids, cows) and light equipment in periurban and hillside situations.

Soil tillage implements are basic and robust, with a wide range of modifications produced by farmers. Recent designs developed by IIMA have reached few farmers, partly because the market is constrained by the new requirement to purchase raw materials in hard currency. There is a need for seeders, and participatory methods are recommended to evaluate animal-drawn implements, including environmentally-friendly conservation tillage and hillside systems.

Animal traction is generally associated with men and older people, and a younger, modern and more gender-neutral image should be developed, using television, education and training. The complementarity of animal power and motor power should be further planned and developed.

A national animal traction network, RECTA, has been formed, and this should work to increase collaboration within Cuba and information exchange with other countries, including Bolivia and Central America. Action research programmes to be implemented by IIMA and the participating universities are suggested.

Introduction and methodology

Animal power is a renewable and sustainable energy source for agriculture and transport. Animal traction plays a significant role in the rural economy of Cuba and it also makes a major contribution to urban transport in several provinces. Animal traction will remain important for smallholder farmers in the Caribbean region and Latin America for the foreseeable future. There was a time when the technology received little attention, as planners and institutions thought animals would be rapidly replaced by tractors. There is now more interest in animal traction in Cuba, but progress has been limited by insufficient institutional understanding concerning this neglected field and the relative isolation of professionals working in this area. There is potential to improve systems for using animal draft power in Cuba, so benefiting the economy, the people and the work animals themselves. This chapter provides an overview of the recent initiative to learn about the current animal traction situation in Cuba, the limiting factors and potential for improvement.

This overview has been prepared as part of a Cuban animal traction research programme planned and implemented between 1999 and 2003. This was supported by the British Department for International Development (DFID) and coordinated by the Instituto de Investigaciones de Mecanización Agropecuaria (IIMA). The survey and follow up work was coordinated in Cuba by Arcadio Ríos Hernández (IIMA) with support from Paul Starkey of Animal Traction Development and Brian Sims of Silsoe Research Institute. The aim of the programme was to understand and describe the present systems of using animal power in Cuba, to identify constraints and potential for greater productive and social benefits (for men and women, young and old), to develop capacity within Cuban institutions using participatory methods and synergetic networking cooperation, to address key issues and improve efficient use of work animals in Cuba.

The research programme was proposed in 1998, at the time of the third international congress on animal traction arranged by IIMA in Havana. It was planned that the project would be coordinated by IIMA, the national agricultural engineering research institute of the Ministry of Agriculture. Universities with faculties concerned with agricultural mechanisation or related topics would undertake participatory survey work in all provinces of the country. Responsibility for work in the various provinces was delegated to:

- Universidad de Pinar del Río (Pinar del Río)
- Universidad Agrícola de La Habana, UNAH (Habana, Matanzas)
- Universidad Central de las Villas, UCLV (Villa Clara, Cienfuegos, Sancti-Spíritus)
- Universidad de Ciego de Avila, UNICA (Ciego de Ávila, Camagüey, Las Tunas).
- Universidad de Granma (Granma, Holguín, Santiago de Cuba, Guantánamo).

Guidelines for the survey work were prepared (Starkey, 2003). An inclusive and participatory methodology was envisaged, that would involve additional institutions besides IIMA and the five Universities.

Following approval of the modest budget by the British Embassy in Havana, a small planning and training workshop was held in September 1999, coordinated by Arcadio Ríos and Brian Sims. During 2000, all the collaborating institutions undertook survey work and were visited by Paul Starkey and IIMA staff in June 2000. As part of the inclusive approach, and in recognition of the great importance of work animals in Cuba's transport systems, Group IT, a development research group of Ministry of Transport, was invited to contribute to the research.

Initial reports and follow up actions were discussed at a national workshop held in Ciego de Avila in December 2000, attended by all the main collaborators. The subsequent chapters are based on the research reports produced for this workshop. The names of all the researchers and collaborating institutions are found in the subsequent chapters and appendices.

The context

Agro-ecological environment and farming systems

The Republic of Cuba (Map 1) is a Caribbean archipelago, located between Mexico (to the west), Florida and the Bahamas (to the north), Hispaniola (Haiti and Dominican Republic, to the east) and Jamaica (to the south). Cuba's 1600 islands and islets total about 110,000 square kilometres. The main island is about 1250 km long and varies from about 30 to 190 km wide.

Most (77%) of the land is flat or undulating and below 100 m above sea level. This land is used for sugar production (45% of the agricultural area), ranching (35%), rice (6%), citrus (5%) and other crops. The east of the country is quite mountainous, with the *Sierra Maestra* range rising to about 2000 metres. There is also the *Sierra de Trinidad* range in the central area and the *Guaniguanico* chain in the northwest, comprising the *Sierra de los Órganos* and the *Sierra del Rosario*. Overall about one quarter of the country is hilly (over 100 metres in altitude). In the lowland areas, most fertile land is already under cultivation or ranching, or is in a reserved area. In the hills and mountains, despite large areas of designated reserves, a small amount of land clearance is still taking place. Erosion is a matter of concern in hill farms. Ríos and Cárdenas (2003) and Vento, Pacheco, Romero and Pimentel (2003) provide further information here on the agro-ecological context of Cuba and the different provinces.

Map 1. General map of Cuba and surrounding area



The tropical climate has a mean annual rainfall of between 1200 and 1500 mm, with most rain falling between May and October. The mean temperature is about 26°C.

Agriculture is very important in the Cuban economy, employing about one fifth of the workforce and providing more than 50% of foreign exchange earnings. Sugar is particularly important, in terms of cultivated area and export sales. Since colonial times, agriculture has been dominated by large-scale enterprises, with a relatively small proportion of the land being used as small-scale family farms. Most of the large private estates of the 1950s were converted to state farms in the 1960s, with some land being allocated to renters and share croppers. Then, in the 1990s, many of the state farms were put under the control of their workforces as Basic Units of Cooperative Production (UBPCs). The farming industry now has five main organisational categories:

- Basic Units of Cooperative Production (UBPCs), with 42% of farmed area
- State agricultural production farms, with 33% of farmed area
- Agricultural Production Cooperatives (CPAs), with 10% of farmed area
- Small-scale family farms, with 10% of farmed area
- Credit and Service Cooperatives (CCSs), with 5% of farmed area

The national herd comprises about 4.7 million cattle, 450 000 horses, 25 000 mules, 26 000 buffaloes and 6000 donkeys. Of these about 700 000 animals are used regularly for work. Work animals are used in all types of farming enterprises, but their importance is particularly great in the family farms and production cooperatives (CPAs) that together produce 40% of Cuba's domestic food production.

Population and administrative context

The Cuban population is 12 million, of which more than 80% is concentrated in urban areas. Two million people live in greater Havana. Cuba is divided administratively into 14 Provinces and one special municipality (Isle of Youth or *Juventud*). The provinces are shown on Map 2.

Map 2. The Provinces of Cuba



Special economic period

Cuba is still suffering from a critical economic situation known as the 'special period' (*el período especial en tiempo de paz*). Until 1990, around 85% of Cuba's trade was with the socialist countries of USSR and Eastern Europe. With the disintegration of the Comecon mutual bloc, Cuba was isolated from its main suppliers and markets. The situation was made worse by the economic blockade imposed by the USA. As Cuba now had to pay in foreign exchange for its imports, including petroleum products, there was a severe shortage of hard currency. This was exacerbated by the lack of investment capital, credit and trade from the United States, which was geographically close but economically and politically separated. There were initially major problems in 1990 as the supplies as fuel, spare parts and imported items declined rapidly. Valdés (2003) and Ríos and Cárdenas (2003) provide further details here of this economic period.

Continuing economic constraints

The 'special period' continues, although the overall economic situation is improving. Fuel and imported items are much more available, but often at prices determined mainly by world market forces and foreign exchange rates. The Cuban economy has some elements trading in US dollars and others in local pesos. Goods and services, such as fuel, fast transport and computer supplies are generally available in the US dollar sector. In the local peso sector, commodities are less readily available. Although US dollars can be readily bought, they are very expensive for most organisations and individuals that are primarily operating in the peso economy. This includes most farmers, transporters as well as government institutes and universities. While there is increasing access to small amounts of foreign exchange by certain

farmers (producers of export crops such as tobacco) and institutions, most transactions depend on the peso-based economy, with its on-going problems of shortages.

The research work reported in here, and in other chapters of this book, must be seen in the context of the 'special period'. The participating institutions and individuals have been working in difficult circumstances. Researchers have seldom had easy access to personal motorised transport. Using institutional and public transport requires much time and patience. Local peso allowances are generally insufficient for purchases on the free market, and so field visits often involve time-consuming arrangements to obtain affordable accommodation and meals. Basic research inputs, such as photocopies and the internet, are difficult and/or time-consuming to access. For these reasons, the research teams required much dedication to achieve the results presented here.

The conditions of the 'special period' will inevitably affect the implementation of the recommendations of this research. Any initiatives to manufacture implements are likely to require foreign exchange to purchase raw materials, particularly steel. If they are to be sustainable, they will have to sell in the US dollar economy to gain replacement foreign exchange. In such circumstances, and at present prices (in pesos) for produce, smallholder farmers (other than tobacco farmers) are unlikely to be able to afford newly manufactured implements. This situation is already occurring in the manufacture of horse-drawn carriages in Bayamo, where the local workshops have to sell new carriages and replacement wheels in dollars in order that they can buy raw materials priced in dollars. Cuban farmers and transporters are very resourceful, and in the medium-term they will adapt to the new economic situation (eg, the sale of a pig to purchase dollars to buy a new plow). However, in the short-term, there are likely to be further serious problems for farmers and local manufacturers.

Animal traction status

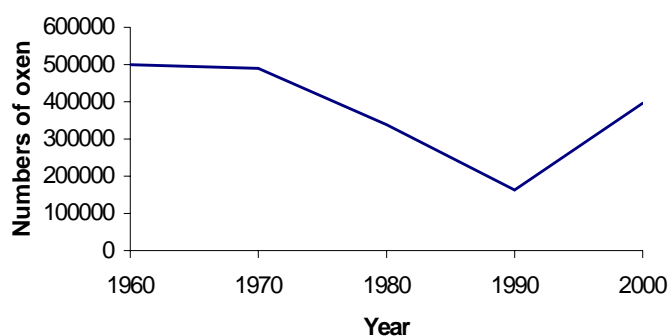
Animal power is very important for the small farm sector in Cuba and it provides vital local transport solutions in both rural and urban areas. Cuban agriculture is characterised by using all the three principal sources of farm power, human, animal and engine. Animal power has gained importance during the Special Period and the most commonly used unit is the *yunta*, or pair of oxen used mainly for tillage and the transport of agricultural products. Horses are transport animals, used for riding and for rural and urban transport. Other important work animals include mules that are mainly used in the hilly areas, for packing and riding, as well as in flatter rural and urban areas for pulling carts. Donkeys are mainly used to breed mules, and light transport in the mountains. A small number of water buffaloes used to be used for carting and yard scraping. A few goats pull carts to carry children for entertainment.

Oxen

'*Yuntas de bueyes*' (pairs of oxen) are the main unit of animal power in Cuban agriculture. The term 'oxen' (*bueyes*) generally refers to bulls that have been castrated. However, in both Spanish and English, the same term can be used to designate working cattle (regardless of sex), and since the majority of working cattle are castrated males, there is little confusion. In Cuba, while most work oxen (*bueyes*) are castrated males, many are intact bulls. There are no data on the ratio of bulls to castrates (in statistics they are simply '*bueyes*'), but both are common. Many young oxen are intact bulls, as farmers like their animals to acquire strong masculine characteristics before castration later in life. Some cows and heifers are used for work but this is not common.

There are about 400,000 oxen used in Cuba today (Ríos and Cárdenas, 2003). Prior to the revolution (1959), about 500,000 oxen were employed. With the tractorisation of the 1970s and 1980s, this dropped to a low of 160,000 in 1990, but numbers increased during the special economic period of the 1990s (see Figure 1).

Figure 1. Numbers of working oxen and bulls in Cuba, 1960 to 2000



Source: Ríos and Cárdenas, 2003

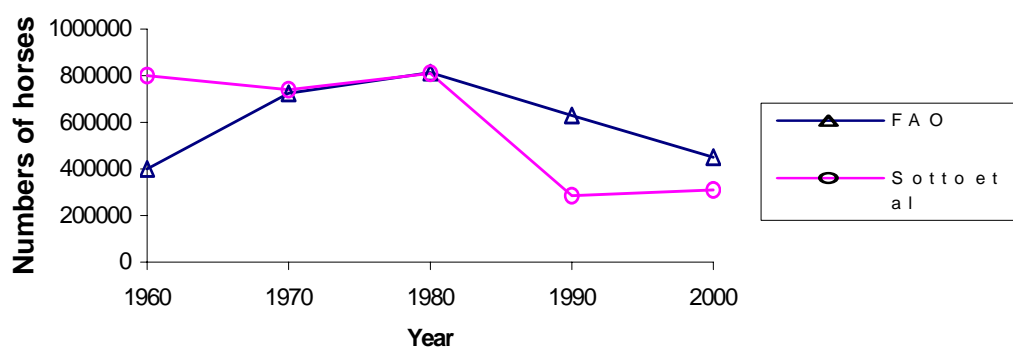
Ríos and Cárdenas (2003) describe in this book the main uses of oxen in Cuba. They are widely employed for plowing, using metal mouldboard plows (*Arados americanos*) or long-beamed ards (*Arados criollos*). They are also used for harrowing (spike-tooth harrows and some disc harrows and improvised harrows). Inter-row weeding, using ards or tine cultivators, is one of the most important operations, since this occurs even on farms where tractors are used for primary tillage. Large areas of sugar cane are weeded with oxen. Few, if any, farmers use seeders, but animals are often used for furrow opening (with manual planting), and also for covering planted material (eg, sugar cane, sweet potatoes). Some ox-drawn scoops are used for levelling and excavating. A number of oxen are used to haul timber in the forests and timber yards. A small number of ox-drawn mowers are used for cutting grass and maintaining road verges.

Oxen are important for on-farm and rural transport in Cuba, with two-wheel carts being widespread. Ox drawn sledges are also common, particularly in hilly areas, and on tobacco farms. These haul water drums, fuel wood, implements and harvested produce. A few oxen are used for riding and pack transport, notably in Guantánamo and Holguín.

Horses

Most horses in Cuba are ridden for work (such as ranching) and rural transport. Some are ridden for recreation or sport. Many horses are used for rural or urban transport, pulling two-wheel carts (for passengers and freight) and four-wheel wagons, carriages and buses. In a subsequent chapter, Valdés (2003) discusses their importance for public transport, reporting that in 2000 there were 16 000 registered service vehicles pulled by horses or mules. Although horses are not generally used for tillage, there have been some reports of this (Espinosa, Galbán, Madruga, Garrido and Pozo, 2003). In this book, Sotto, Wong and Armada (2003) discuss some options for greater use of horses in agriculture. The population of horses has been declining in recent years (Figure 2), although the use of horses for transport has been increasing. These trends are discussed later in this chapter.

Figure 2. Total numbers of horses in Cuba, 1960 to 2000

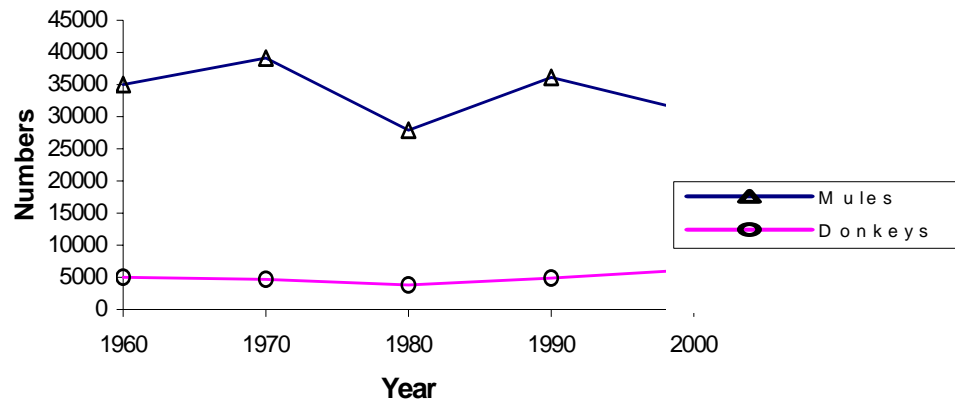


Sources: FAO, 2001; Sotto, Wong and Armada, 1999

Mules and donkeys

There are about 30 000 mules and 6000 donkeys in Cuba. The mules are used mainly in and around the hilly areas, for riding, for pack transport and for pulling carts. The donkeys are maintained to breed mules and some are used for pack transport and riding in and around the mountains. There are only a few donkey carts in use. The populations of mules and donkeys have been relatively constant over the past forty years, with a slow increase in the number of donkeys (Figure 3).

Figure 3. Numbers of mules and donkeys in Cuba, 1960 to 2000



Source: FAO, 2001

Institutional framework

There are many institutions directly and indirectly involved in Cuban agriculture. The industry itself comprises:

- Basic Units of Cooperative Production (UBPCs)
- State agricultural production farms
- Agricultural Production Cooperatives (CPAs)
- Small-scale family farms
- Credit and Service Cooperatives (CCSs).

These are described in more detail in subsequent chapters, notably Ríos and Cárdenas (2003) and Font (2003).

The various farms and cooperatives fall under the responsibility of the Ministry of Agriculture or the Ministry of Sugar. These Ministries have been responsible for a very wide range of services, including marketing, credit and the supply of farm inputs, such as implements. The veterinary department of the Ministry of Agriculture has been responsible for animal health services, the supply of some animals and the control of livestock marketing.

The State Sector has controlled most supply and marketing services (including the supply of animals and implements), but some small independent suppliers of goods and services from autonomous cooperatives and family farms have complemented these. The trend of recent years has been to emphasise the regulatory role of the State, and to encourage cooperatives to develop production and services.

The Ministry of Agriculture funds research and development studies relating to animal power. The Instituto de Investigaciones de Mecanización Agropecuaria (IIMA) is the lead organisation, and this institute collaborates with several universities, crop research stations, agricultural training institutions and cooperatives (Ríos and Cárdenas, 2003).

The ministries responsible for education and training are also involved in Cuban agriculture. They support agricultural training schools, polytechnic agriculture institutes and the university faculties of dealing with agriculture. The provision of rural training services in

Cuba is very high. In all provinces and municipalities, there is evidence of a close relationship between farmers, cooperatives and the various training institutes.

The Ministry of Transport is involved in the regulation of animal-powered transport, particularly public transport service. In addition to regulatory activities, it supports investigations relating to transport policies and practises relating to animal power. This is discussed in more detail in the chapter of Valdés (2003).

Many of the activities that in other countries would be undertaken by non-governmental organisations (NGOs) or the private sector, are performed in Cuba by wide range of cooperatives and associations. Government ministries have generally established these, although they may now operate with various degrees of autonomy, and undertake collaborative programmes with international NGOs. Such cooperatives and associations assist in production (carts, implements, mule breeding), research, training and support to farmers. Initially formed by an initiative of the Ministry of Agriculture, with whom it is very closely associated, the National Association of Small-holder Producers (ANAP) now has 232,000 members and provides advice and assistance to small-scale farmers (cooperatives and small independent farmers). The ACPA (Asociación Cubana de Producción Animal) is involved in research and development initiatives relating to animals (including buffaloes), with some work carried out in cooperation with international NGOs.

As a result of the animal traction research activities described here, a national network was launched: RECTA (*Red cubana de tracción animal*). This is not an institution as such, but it is an informal network of organisations that work together and exchange information without reducing their individual autonomy (Starkey, 1998; RECTA, 2003).

Discussion of issues and problems

Animal issues

Oxen

Oxen are the main working animals. Compared with working bovines used in many countries, Cuban oxen are large, well-fed and strong animals, often weighing in excess of 500kg. They are mainly Creole animals, containing a mixture of genes from humpless European breeds (*Bos taurus*) and humped zebu breeds (*Bos indicus*). Creole animals are usually the preferred option, but where they are available, some people use animals from international breeds such as Brahman, Brown Swiss and Holstein. Oxen are generally available throughout the island, and are perceived as strong and robust animals, that suffer from few problems (Vento *et al*, 2003; Ponce *et al*, 2003). Oxen that spend much time walking on hard surfaces may be shod.

Cows

Although few cows are used for work, many farmers know of someone who has used them. Some farmers who used cows or heifers did so because they had no oxen and/or because their animals had low fertility. Some thought that work could encourage cows to come on heat. However, a few farmers contacted were using cows as multipurpose work animals, providing milk, meat and some work. Many farmers thought that it was not right to use cows for work, and that it was discouraged or even prohibited. Some people suggested that there had been more use of cows before the revolution (1959).

Most people were surprised to learn that the use of cows is common in some countries and is growing in importance in the world. Work cows are common in Indonesia (80% of work animals may be female), Europe (most working bovines are now cows) and Bolivia (in the altiplano). In these countries, smallholder farmers find it difficult to justify maintaining costly oxen throughout the year as animal feed resources are extremely limited, particularly in the dry season or winter. As a result some farmers may switch to using transport equids (horse, mules or donkeys) for cultivation. Other farmers use work cows, which can provide a reasonable amount of work, while providing additional outputs (milk, calves) to justify the

year-round feeding. These strategies are employed in areas where farming systems are intensifying in response to shortages of suitable land and feed resources and/or where the demand for draft work is light and/or very seasonal. The trend is also strengthened in areas of increasing animal prices and stock theft (lost oxen cannot be replaced, and cows are generally at less risk as they have less meat value and are maintained close to human habitation). Where tractors are available for plowing, cows (or equids) can provide complementary power for weeding and light transport.

While oxen are likely to be the main work animals in the foreseeable future, there are some clear niches where cows could be used in Cuba. These include the small-scale private farms, particularly in marginal hilly areas, where it is difficult to justify the cost of owning and feeding oxen all year. There may be profitable roles for cows for light tillage on cooperatives where tractors are used for plowing. In peri-urban areas, smallholder farmers cannot afford to maintain oxen just for plowing small areas of land, but they might be able to use income-generating cows for such work.

The main constraints against using cows seem psychological, at all levels, including that of the universities and agricultural authorities. People argue that traditional Cuban 'machismo' requires the use of oxen, and that cow productivity and fertility would fall if they were used for work (Espinosa *et al.*, 2003; Vento *et al.*, 2003). In reality, farmer experience and scientific trials both show that the fertility and milk yield of work cows does not drop greatly, provided that food is adequate. In any case, work cows always give more milk and more calves than work oxen! Some farmers expressed interest in starting trials with working cows, and such trials should be encouraged and followed. There is also need for research to examine if there are local constraints to a greater use of work cows in Cuba. These might include redundant regulations, inappropriate extension advice, prohibitions or price disincentives.

Horses

Horses are widely used for transport, both riding and pulling carts. There have been some discrepancies in the estimates of the horse population in the past forty years (see Figure 2). FAO figures (based on data supplied by Cuba) suggested a major increase between 1960 and 1980, while the data presented by Valdés (2003) and by Sotto *et al.* (1999), indicated that the horse population was fairly stable at this time. All estimates agree that there was a large decrease in the horse population in the 1980s. This can be explained by the increasing access to motorised transport at this time and on-going urbanisation. The estimates presented by FAO and Valdés suggested the reduction in horse numbers was continuing during the 1990s, while those of Sotto *et al.* implied there was a slight increase in numbers. All estimates suggest the number of horses has halved in the past twenty years. There may have been official or unofficial culling of surplus horses in response to limited feed resources for horses and the market demand for meat. This survey did not find evidence of a significant shortage of horses. Nevertheless, supply and demand factors for transport horses need to be monitored, to ensure that the horse population can supply the numbers of animals required in the coming years.

Mules

The 30 000 mules in Cuba are mostly found in the *Sierra Maestra* mountains in the east, the Trinidad range in the central area and in the Guaniguanico hills of Pinar del Río. Here they play a vital role in supplying isolated farms and communities, and carrying produce, notably the coffee harvest and palm fruits. Mules may be ridden or used as pack animals. Mule trains are used at the time of coffee harvest and traditional competitions are staged to see how quickly a man can load, lead and unload a mule train. While horses are the preferred riding animals in most of Cuba, in the mountains people appreciate the sure-footedness of mules. Away from the hills, small numbers of mules are used to pull carriages (eg, Bayamo), buses and passenger wagons (eg, Pinar del Río), two-wheel carts (eg, Holguín) and four-wheel freight wagons (eg, Havana Province). Horses are more common in all these situations

(because they are widely available), but mules are appreciated for their robustness and long working life (twenty years is commonly cited).

During the survey, some people suggested that there was a shortage of mules, and that they were not easy to buy. However, this was not a universal problem. Mules are bred by cooperatives and individuals and on specialised breeding stations. Cooperatives and individuals reported a relatively high reproductive rate, implying that a mare put with a donkey would produce a young mule, almost every year. For example, five mules a year are 'normally' produced from five mares at the 'Republica de Chile' Cooperative (CPA) in Viñales, Pinar del Río. These horses were worked during the year, and were not retained solely for breeding. This is in contrast to the specialised mule-breeding stations, which maintain large numbers of horses that do nothing except breed replacement horses and mules. Despite this specialisation, the reproductive rate on the mule breeding stations can be low. For example at the Granja Mular Equino, at San Juan de Guacamaya in Pinar del Río, only 15-20 mules are produced each year from 66 mule-breeding mares, despite the presence of veterinary staff. The low reproductive rate may be related to poor animal nutrition, associated with low quality hillside pasture and lack of irrigation. Insufficient responsiveness to market opportunities and investment needs may also have played a role. Other mule breeding stations appear more efficient, including the Don Quixote enterprise in Manicaragua, Santa Clara, which has a permanent exhibition relating to mule breeding and management.

Donkeys

The population of donkeys in Cuba is low (about 6200), but has been rising in recent years. Donkeys are used to breed mules and for light transport operations, particularly in the mountain areas. Valdés (2003) notes that about 40% of donkeys are in the state sector. This is high, given that small numbers of donkeys are needed to breed mules and that donkeys are particularly suited to 'family level' transport tasks. Some donkeys are maintained for immunology studies and vaccine production in Granma (Cuesta, 2003). In Pinar del Río, the donkey improvement programme (Empresa Pecuaria Genética Camilo Cienfuegos at Consolación del Sur) had about 100 donkeys in 2000, including 40 breeding females and one large stud donkey from Canada. The aim of this programme is to distribute large donkey jacks to produce larger mules.

Most donkeys are used in the eastern provinces, in and around the *Sierra Maestra*. They are mainly used for pack transport and for riding (Cuesta, 2003). There is no tradition of using donkey carts, although a few simple ones have been made. Donkeys cost around 500 Pesos (US\$ 20). Although this is cheaper than mules (1500 Pesos) or horses (2000 Pesos), the price differential is not as great as in many parts of the world, where donkeys are relatively much cheaper animals.

The number of donkeys in Cuba is much lower than in neighbouring countries (Haiti, 215 000; Dominican Republic, 155 000; Jamaica, 26 000; Mexico, 3 200 000). In these countries, donkeys are more widely used for rural transport, including the collection of water and wood, marketing produce, trading and riding. Compared with neighbouring countries, donkeys may be less needed in Cuba, due to high levels of regular full-time employment for men and women, urbanisation, piped water, electrification, cooking with kerosene and centralised trading and marketing systems. However, lack of rural transport is a serious constraint in Cuba, and there are many situations where donkeys could be usefully employed to save time, to reduce human drudgery and to increase market efficiency. This is particularly important for the small-scale private farmers and rural households. Donkeys could also be used for light cultivation work in hilly areas and small farms. Existing users of donkeys are very positive about their advantages, but other people (including government officials and this research team) know little about donkeys. Cubans tend to ignore the potential for donkeys, on the grounds of 'it is not our tradition' and the low status of donkeys relative to mules, horses and oxen. This psychological constraint needs to be overcome, so that the use of donkeys can be considered as a serious option that is highly appropriate in some situations.

Buffaloes

There are about 26,000 water buffaloes in Cuba. These derive from animals imported mainly from Panama and Trinidad and Tobago in the 1980s. A few may have been imported from Australia. Some buffaloes are of the river or dairy type and there are now small dairy herds (of at least 26 animals) in all provinces. The majority of water buffaloes are of the swamp type, kept on ranches for meat production. Most buffaloes are maintained on farms within the state sector. On several farms in Cuba, buffaloes have been trained to work as single animals. They have been used to pull carts and manure scoops, as well as for some tillage. At one stage (around 1992) there were about 90 working buffaloes in the Province of Havana. Now there very few, or possibly none. In all cases, their work was subsequently taken over by oxen. People preferred working with oxen, and there seemed no overriding advantages of buffaloes to justify their continued employment.

The main issue is therefore not whether buffaloes are capable of working in Cuba (they are), but whether there is a clear 'niche' for them. The main advantages of buffaloes are that they are large, strong, docile and available (in some areas). They are good at digesting poor roughage and they can walk well in muddy conditions. The main disadvantage is that they have poor heat tolerance (only 10% of the number of sweat glands of oxen). This explains why they like to wallow in water, and are generally considered less suitable than oxen for heavy work of long duration. In Cuba, people found it difficult to work much with buffaloes after ten-o'clock in the morning, as the animals appeared to suffer from heat stress.

The parts of the world where farmers work with water buffaloes are often areas where large oxen are relatively difficult to obtain and smallholders keep buffaloes for multiple uses. Where both large oxen and buffaloes are readily available, farmers often work with oxen, even for the cultivation of rice swamps. Where there is a free market operating, buffaloes tend to be more expensive than oxen (being heavier and in shorter supply). Most Latin American countries have some water buffaloes. They are mainly ranched for meat (and become quite wild) or are milked for cheese production. In these situations, some surplus animals may be used for work, such as carting. Although some buffaloes are used for plowing work on university farms (eg, Honduras) and research stations (eg, Colombia), there is little (if any) evidence of the uptake of this technology by smallholder farmers in Latin America. The suggestion is that while water buffaloes can work well, people tend to use oxen if they are available. Therefore, their employment tends to be 'opportunistic', they are used in situations where they more readily available than oxen.

As buffaloes are increasingly available in many parts of Cuba, further investigation may be justified on their potential roles. Given the results of earlier work, and the widespread availability of well-adapted oxen, emphasis should be on objective on-farm assessment, and not on optimistic promotion. The work should be concentrated geographically in potentially favourable areas where they might have a comparative advantage (for example, areas of small-scale rice production) to encourage a 'critical mass' of users and supporting services.

Goats

A small number of goats are harnessed singly to pull carts in Cuba, for the entertainment of children (Espinosa *et al*, 2003). They are found in many locations including Havana's Malecon and the central square in Bayamo. In some countries, including Honduras and El Salvador, goat carts have a more serious role for collecting water in flat areas. Children are often responsible for this operation. On a good, flat surface, a pair of goats can pull a cart loaded with over 100 kg (100 litres of water). However, the present survey did not identify any situations in which greater use of goat carts seemed appropriate.

Animal nutrition

The quantity and quality of feed resources can be limiting factors for animal traction, particularly in countries with severe dry seasons (or winters) and for animals that have insufficient opportunity to graze themselves (such as transport horses in urban areas). While farmers mentioned the topic of limited feed resources, the great majority of work oxen appeared to be in good or reasonable condition. It is an important issue, but one where farmers are able to find local solutions.

The main problem appears to be with horses used for public transport. The horses may be harnessed for many hours a day (giving them little time for grazing), but they are seldom fed supplementary feed while resting and waiting. They often obtain their feed on rough grazing in peri-urban areas, where a combination of insufficient grazing time and poor quality pasture prevents them from obtaining sufficient nutrition. The lack of time for feeding is sometimes associated with problems of security, which prevents horses freely grazing at night. In many cases, the horses are maintained in a thin, but healthy, state, with the owner maintaining the horse at low, but acceptable, nutritional level. A small number of owners allow their animals to drop below a reasonable condition. Solutions to this problem may include developing a market for supplementary feed, allocating better and secure grazing land for transport horses, and regular inspection of horses used for public transport.

Security and theft

In all parts of the country, people reported that there was a serious risk of animals being stolen. This was cited as one of the most important problems facing farmers using work animals (Pérez, Alberto, Cárdenas, Sánchez and Borges, 2003). It is believed that animals are stolen to meet the demand for meat. This is sometimes in collusion with the owners, since the rewards for selling meat on the illegal market are much greater than for normal sales through official channels.

In response to the problem, the government has introduced new legislation designed to discourage fraudulent theft and increase security awareness among owners. This includes the provision that owners of stolen animals have to pay a fine equivalent to the value of the stolen animals. This measure should deter fraud and make farmers more conscious of the need for good security. However, it also increases the risk that honest farmers must bear, as these people are now penalised a second time, after they have had a severe loss. This might even discourage the ownership of animals, since their theft would cause a double financial loss.

Animal health

Animal diseases or parasites were seldom cited as significant constraints during the survey. Most animals that were seen during the survey appeared in good condition, although some were thin. Oxen, mules, donkeys and riding horses almost always appeared healthy. Only some horses used to pull carts and carriages looked unhealthy, and this was probably associated with insufficient nutrition for the required work.

Cuba has very good animal health services that are readily accessible. When people have problems with their work animals, they contact their local veterinary clinic, and treatment is arranged speedily. Veterinary services have been free or at very low cost. There is some suggestion that veterinary services are not as easy to obtain as they once were, and some farmers have reported that it is increasingly difficult to obtain veterinary drugs. For this reason, there may be value in testing objectively some of the traditional practices (ethno-veterinary medicine) used in Cuba (and possibly other countries) to provide locally available and effective alternatives to standard veterinary products.

Operations and equipment

Yokes and harnessing

Yuntas (pairs of oxen) are yoked with a wooden head yoke. Different yoke lengths are used for different working width requirements in the field, and for transport. IIMA has developed a yoke of variable length that can be used for several operations, but this is yet to become popular and available. The animals' foreheads are protected with a leather-covered pad or *frontil*. The use of *frontiles* is not common elsewhere in the world, but farmers argue that it improves the comfort and efficiency of the yoking system and allows animals to exert their strength effectively. While the great majority of tasks are carried out with pairs of animals (*yuntas*), single oxen are used for some lighter draft tasks such as weeding or transport. In this case a single head yoke, *frontil*, traces and swingle-tree are employed. There seem no major problems with the design of yokes and harness, but farmers did complain of the difficulty in obtaining materials, including (locally-produced) ropes and *frontiles*.

Horses and mules that are used to pull carts and carriages may be fitted with either breast band harness or collars together with a broad saddle strap and breechings. A quick inspection of horses used for public transport in any town in Cuba highlights the lack of standardisation of design and materials. This implies that many harnesses are made on an *ad hoc* basis by local artisans or the owners themselves, with emphasis on 'making-do' using locally available resources. There is little evidence of the pride and perfectionism associated with harness making in some countries. Transporters said that it was difficult to obtain harnesses and raw materials, such as good leather. For this reason, some people have started using inappropriate but available materials (such as polypropylene sacking). Despite the wide range of designs, and some problems with the size and fitting of the breast bands and collars, there seems little sign of harness sores or significant problems. While there is scope for improvements (through better access to raw materials, enhanced supply of cheap but good harnesses, training, regulation and enforcement), the health and husbandry of Cuban transport horses is quite good by world standards.

Soil tillage operations and implements

The main tillage operations using animal power are plowing, harrowing and weeding. The most common plow is the **metal mouldboard plow** known as the '*arado americano*', which comes in a range working widths and weights. There are two sizes for a single *yunta* (for use in light and heavy soil conditions) and two larger implements for working with four animals (two *yuntas*). These are chain-pulled from the center of the head yoke.

The **creole plow** (*arado criollo*) is also quite common. It is a traditional wooden-beamed ard implement with a metal share. This plow is now mainly used for secondary cultivation (weeding and ridging).

Clod-breaking and seedbed preparation are usually achieved with heavy, triangular-framed, spike-tooth harrows. Large rectangular spike-tooth harrows may also be used, pulled by one or two pairs of animals. Some animal-drawn disc harrows are also used, but these are not very common. Farmers without access to a harrow may use tree branches to perform a comparable operation.

Ridging and earthing up (of root crops and maize) are operations often performed using creole plows, and sometimes using metal ridgers that are available in a range of sizes.

Multi-tined weeders are used for row crop weeding. Some models are adjustable for working width. Creole plows (and occasionally mouldboard plows) may also be used for inter-row weeding.

Animal-powered seeders are not generally used. Crop planting is usually a manual task, although animal powered implements plows or ridgers can be used for the furrow opening and seed covering.

Root crop harvesting may be mechanised using a creole plow or a ridger. A few specialized root crop lifters are in use.

Some more specialised operations are also undertaken using animal power, although the numbers of implements is quite small. These include **crop sprayers** and **fertiliser applicators** (developed by IIMA), **mowers** and **earth-moving scoops**.

Further details of the main animal traction implements used in Cuba, including their working widths and depths are provided in the chapters of Sotto, Wong and Armando (2003) and Font (2003).

Implement design

Most of the common animal-drawn implements in use are basic and robust. Some may seem antiquated, but this does not stop them from being highly functional. There is a widespread familiarity and confidence in the designs, and much ability for their repair and maintenance.

Most animal traction implements are quite bulky, and generally heavier than comparable implements used in other tropical countries. Many animal-drawn carts are also quite heavy, although the common two-wheel horse-drawn carts (*arañas*) are generally light. The weight of both implements and carts is sometimes associated with the use of scrap materials and sometimes results from the adaptation of implements and trailers originally designed for tractors. Heavy harrows and cultivators are essentially scaled down versions of equipment more suited to tractor work. Given the size and strength of most *yuntas* (oxen) and *boyeros* (ox handlers), the weight of implements does not represent a problem, and provides strength and durability. However, if the use of work animals is to be diversified (greater use of horses, mules, donkeys and cows) and involve more women, then there should be better access to some lighter implements and carts.

The main types of draft animal equipment produced in factories in Cuba have not evolved greatly in design. This is probably due to three reasons. Firstly farmers have not demanded the changes and modifications that they have required (eg, increasing mouldboard length) since these have been implemented effectively in farm workshops (see below for comments on the huge diversity of local adaptations). Secondly new designs and materials have not been made readily available in any formal way. Until the Special Period, animal power was not seen as a pressing need for the economy. Recent design and testing work by IIMA has not yet been fully commercialised and so has not yet had a significant influence on the overall market. Thirdly, until the Special Period, there was little pressure for energy saving in the economy so that inefficient equipment and excessive use of raw materials was not perceived as a problem.

Implement diversity

There is a huge range of implements, although the range has some important gaps. Many implements are unique, being the result of local invention (and the scarcity of 'off the shelf' designs). Many examples of innovative equipment were seen in Ciego de Avila (Pérez, Alberto, Cárdenas, Sánchez and Borges, 2003). Overall, there may be well over one hundred variations in the design of cultivators, ridgers and harrows. However, there is no consensus concerning which innovations are good enough to copy, as they have not been objectively tested. There is much scope for visiting cooperatives and small farms to document innovative implement designs and to test those that seem particularly good. This might be a relatively quick and easy way to identify 'new' implements appropriate to Cuban conditions.

Implement production, price and marketing

The common animal-powered agricultural implements are manufactured in State-owned factories that now face the problem of having to pay in hard currency for their basic raw materials, mild and carbon steel. However, a large part of the potential market is operating

mainly in the Peso economy, and has difficulty in meeting prices based on hard currency. For this reason, the market is virtually stagnant, and very little new equipment is being produced or sold. Repair of used equipment, and use of scrap materials is therefore very common and is done at private, cooperative and State farm levels.

The situation is evolving, but it seems likely that some adjustment will be necessary in the future to ensure wider access to new implements at prices affordable to all draft animal users. The implement development programme of IIMA (which includes animal-drawn seeders that have been identified as a priority for the small-farm sector in Cuba) will not have a significant impact unless some arrangements can be made to start manufacturing and supplying the implements at an affordable cost.

In several provinces, the role of blacksmiths was noted. Blacksmiths are important for making and repairing certain equipment, and for making horseshoes (and some shoes for oxen). The number of blacksmiths appears to be declining and they suffer from problems of obtaining raw materials and mineral coal or charcoal (Espinosa *et al*, 2003).

Research and development

Formal research and development of innovations in draft animal equipment has been centered on IIMA in Havana Province, although there have also been important regional initiatives, led by the provincial universities. One of IIMA's principal achievements has been the multi-purpose tool (the *Multiarado, 6-in-1*) that combines conventional mouldboard plow, ridger and weeder designs with an innovative sweep for horizontal tillage. Demand for this carefully designed and relatively lightweight product is thought to be high, following some promotional efforts that IIMA has made in the provinces. Nevertheless, very few of these implements were seen in the field during the survey, and many farmers seemed unaware of their existence. Nearly all the information obtained concerning this equipment came from IIMA itself, or from collaborating engineers: there was little evidence detailed feedback from the farmers for whom it was designed.

While the regional surveys pointed to a demand for innovative equipment, especially the *Multiarado*, they also detected a widespread frustration with its very restricted availability. However scaling up the manufacturing and distribution process is made difficult by the need to cover manufacturing costs incurred in hard currency. Through a small Italian-funded project, IIMA has been able to make a small production run, which should start off the adoption process, and allow more feedback to be obtained (and product improvements to be effected). The most pressing need is for materials to be made available to implement manufacturers at a price that will enable end-users to purchase the products.

IIMA has also developed its own version a wheeled toolcarrier: a multipurpose ride-on chassis to which a variety of implements can be fitted. Such equipment has been 'perfected yet rejected' in many countries, with various designs developed on research stations that have not been widely adopted by farmers (Starkey, 1988). The present status is that the equipment has been to be developed by IIMA, and a small number of demonstration models have been made for testing and demonstration within the provinces. Although engineers speak highly of it, there is not yet evidence of realistic 'market demand'.

Participatory technology development

IIMA has only recently started to embrace the concept of participatory technology development. This methodology, that has proved successful in the development of animal-drawn implements in Honduras, Bolivia and elsewhere, considers farmers and scientists as partners in the process of developing technology. Through participatory problem-identification and analysis, involving both farm families and technical staff, priorities can be set, solutions can be designed and evaluation can select the best options, all on the basis of participation by all the appropriate stakeholders. Although not a panacea, the principles of participatory technology development have shown that, when honestly applied, they can

result in a far greater adoption rate of innovative technology than was the case under the previous, top-down, model.

Participatory technology development requires that new technology is available at an affordable price. At the moment this is not the case. However, if the problems outlined can be resolved, then there will be wide scope for developing equipment to answer the future needs of animal traction equipment in Cuban agriculture. Several needs have been identified as a result of the survey work reported in this book.

A pressing need highlighted has been for animal-drawn seeders. There are many successful, farmer-adopted designs available in the world. The possibilities should be studied and prototypes developed to satisfy current Cuban needs. A similar situation exists for lightweight equipment suitable for horses and mules. Through participatory procedures the most appropriate equipment designs should be constructed and evaluated with a view to batch production at a regional level. There is a wealth of technical information available in the world on these and other requirements that emerge from contact with end-users; for advances to be made, the changes discussed will need to be implemented

Transport

Both equids and bovines are extensively employed for transport, with the former playing a major role in satisfying the urban transport needs.

One of the simpler transport systems is the triangular wooden sledge or *rastra*, often with side stakes to increase the carrying capacity. Sledges pulled by oxen (or sometimes cows) are used for carrying a wide variety of crop produce and inputs, as well as water and fuel wood, over short distances. Water drums, carried on simple sledges, supply many rural houses that do not have piped water. Sledges are also commonly seen transporting implements to the field, although there is an increasing tendency to use old tyres instead of wooden sledges. In timber extraction, logs are generally pulled along then ground without specialist sledges or sulkies, although these do exist.

Two-wheeled carts, and four-wheeled wagons, pulled by *yuntas* are very common rural transport options for agricultural produce. They are usually of robust wooden construction with pneumatic tyres, although steel or wooden wheels are also used. Some carts, derived from tractor-trailers are extremely heavy.

Ox-carts were used for the large-scale transport of sugar cane to some cane-processing factories ('centrales azucareros'). In hilly areas (where few sugar-transporting railway lines were laid) up to three pairs of oxen were used to pull the large carts, and one pair was used behind as brakes as the cart descended. This use of oxen probably ceased in 2002, with the closing of a processing factory in the north of Pinar del Río, leaving most cane transport to tractors, lorries and railways.

Horses are used throughout Cuba for riding for personal transport. This is particularly important in mountain areas and areas of ranching. Horses are also used for pulling lightweight two-wheel passenger carts (*arañas*) and four-wheel carriages and buses for public transport. The diversity of horse-drawn carriages and buses is remarkable, with many towns and provinces having unique designs, with different layouts, wheel sizes, tyre types and coverings. Traditional carriages with large wooden wheels are famously used in Bayamo, but are also seen in some other towns. Single horses (or mules) are generally used for carriages and buses, but some transporters employ two horses. According to regulations, there should be a limit of eight passengers per horse (Valdés, 2003).

While some horse-drawn carriages used at night have small lanterns, many carts and carriages have neither lights nor reflectors. These present a significant safety hazard at night to themselves and to other road users. The encouraging (or enforcing) the use of low cost reflective materials on all transport devices would improve the situation.

Horses, donkeys and mules are all used for pack transport, especially in mountainous areas where they play a key role in coffee-bean transportation. Mules are the main pack animal, and they often transport two sacks of produce, tied to a simple saddle.

Complementarity

Human, animal and tractor power are all used in Cuban farming and transport systems. Although the different energy sources can replace each other (depending on their relative price and availability) they can also be complementary. During the Special Period, planners, farmers and transporters have been developing complementary combinations that maximise the benefits of the various technologies. During planting and harvesting, it is not unusual to see all three energy sources in use at the same time (eg, tractor tillage, human planting and oxen covering the planting material).

For the smallest farms, animal and human power are often sufficient. On medium- and large-scale farms, high-draft primary soil tillage (mouldboard or disk plowing) is usually done with tractor power so that this crucial task is completed on time for crop planting. Subsequent operations may be performed with tractor power or oxen. The adaptation and flexibility that have characterised Cuban agricultural sector development through the Special Period, have meant that increasingly, draft animals have replaced tractor power as a fuel-saving measure, particularly for lower draft, secondary tillage and weeding jobs. This has been true even on large-scale farms and estates. Although oxen are slower, such complementarity may have benefits in terms of fuel savings, employment, quality of work and environmental impact. Although there are undeniable indications that the Special Period conditions are on the wane, opinion is that this complementary use of tractor and animal power is set to remain for the foreseeable future.

Complementary transport technologies have also been developing, with human carrying for short distances, animal carts and buses for intermediate distances and motorised vehicles for long-distance transport.

Social and economic issues

Attitudes to animal traction

There are ambivalent attitudes towards animal traction at most levels in Cuba. In the period from 1960 to 1990, political emphasis was placed on rapid large-scale mechanisation. There were aspirations for 'modernisation' (ie, tractorisation) of agriculture, and there appeared to be much progress and accomplishment in this area. At this time animal traction was considered 'old fashioned' and was neglected in national policy and at all levels of education. The Ministry of Agriculture published a beautiful book on Cuban Agriculture, full of colour photos (Agricultura, 1987). This had numerous photographs of tractors and also many of manual labour. There was not a single photo of oxen (although these are very photogenic) and the only horses were for riding. The most interesting thing is that the book contained many photos of people weeding between rows with hoes and applying fertiliser by hand, operations that could be mechanised using animal power. The implication was that somehow there was more pride in communal human labour than in the use of animal power. Such ideas, and comparable portrayals on television and other media, influenced people's attitudes in all sectors of society, but particularly amongst those educated after 1960 (ie, the majority of the present adult population).

After 1990, the government placed new emphasis on animal power. Senior political figures were seen at events promoting the skills of ox handlers. Ministers of Agriculture were happy to support and actively participate in national and international events relating to animal traction. Animal traction became recognised as an element of Cuban development, and the survey work reported here found there was official support at all levels.

Despite the dramatically improved image that animal power has gained in Cuba, there remains much scepticism about its long-term future. In the rural areas, farming people generally thought animal power would continue to be important in the foreseeable future, and may even grow. However, in the offices of ministries and universities, many people assumed that when the United States blockade is finally lifted and the economy thrives, animal power would cease to be important. The implication of this is that it may not be necessary to invest in new animal power technologies, as these will not be used for long. This psychology is in line with a common, prevailing attitude in many parts of the world, all influenced by the power of the images of 'modern' agriculture and society from the United States. This negates the evidence from other countries (and from the Amish of the USA) that animal power will remain a valuable complementary technology that can continue to contribute profitably to modern agriculture.

Television

Television is a particularly important communication medium in Cuba. Due to the very high levels of access (relative to most Latin American countries) and limited choice of channels, broadcast programmes reach a large number of people: indeed almost all the population of Cuba watch some television. In one of the surveys, 64% of farmers said they owned a television (Ponce *et al*, 2003), but the proportion of people watching television on a regular basis would be higher than the ownership. During the survey, some farmers reported that they had taken particular actions (eg, trying out new techniques), having seen them on television. It may therefore be appropriate to use television to portray positive images of animal traction and help launch innovative technologies and alternative uses of animal power.

Education, training and capacity building

Cuban farmers are literate and well educated. They may be interested in 'precision agriculture' technologies, ecological and organic farming techniques and the complementarity between tractors and animal traction. Academics and agricultural engineers consider them reluctant to change, but observations and discussions during the surveys undertaken showed much evidence of farmers being knowledgeable, resourceful and innovative. They have strong traditions, but if alternative practices appear technically, economically and socially beneficial, they will adapt to the new situation. Interest in alternative technologies can be stimulated through the media (television, radio, publications), and through visits to rural education establishments. However, seeing the successful use of a technology on a comparable farm is likely to be the biggest stimulus for change. Therefore, the most likely way of diffusing innovations is likely to be through practical demonstrations and evaluation trials, with farmers given much responsibility for managing the technologies (whether tillage implements, seeders or different types of work animal). The technologies to be promoted should have been proved capable (for example, widely used in another country), farmers should have selected them for trial, and there should be a realistic possibility of farmers being able to obtain and afford the technologies that prove appropriate.

The academics and researchers involved with animal power are well qualified, with good technical knowledge. However, their training (mainly in Cuba and the former Comecon states) was often very discipline-based and did not emphasise multi-disciplinary 'farming systems' approaches and sensitivity to participatory processes and social, economic and gender issues. Capacity building in these areas would be beneficial, and might be obtained through in-service course and exchange visits with participatory research programmes elsewhere in the world (eg, Central America, Bolivia).

Issues of gender and age

Cuban society maintains quite a strong '*machismo*' tradition, despite a legal framework that ensures that women have equal rights and educational opportunities. Women have been among the main beneficiaries of Cuba's social programmes, with their lives improved through

the provision of housing, utilities (water, electricity) and social services (education, accessible health care, maternity provision and child care). However, men clearly dominate the animal traction sector, as most 'boyeros' and transporters are men, and most researchers in this field are also men. Wong, Sotto and Armada (2003) discuss this in a subsequent chapter. The 'machismo' culture is also said to influence farmers' attitudes to using cows as work animals.

Compared with the population as a whole, farmers tend to be quite old. In the surveys in Havana Province, three quarters of the farmers interviewed were over 40 (Ponce *et al*, 2003) while in the central provinces, half the *boyeros* were over 50 (Espinosa *et al*, 2003). Young people find it easier to obtain non-farm employment. While there is no suggestion that farmers are 'dying out', efforts need to be made to ensure young people are attracted to farming in general and animal traction, in particular.

Financial resources, credit and market development

Throughout the world, small-scale farmers have problems in accessing technologies, with problems of unaffordable technologies, lack of credit, and poor systems of linking supply and demand within the markets for farm inputs and outputs. The various influences of the 'Special Period' of the Cuban economy have created some problems of access to affordable technologies that were not apparent before. The problems attributable to the purchase of raw materials in hard currency have been mentioned in the paragraphs relating to implement supply. Their resolution in the medium term will be vital to the development of animal power in Cuba.

The overall macro-economic situation in Cuba will clearly be of overriding importance in determining the market for animal power services and technologies. However, individual farmers and cooperatives themselves should be able to influence the situation, by helping to improve information flows to link supply and demand. For example, mention was made during the survey, of local shortages of '*frontiles*', ropes and mules. These are all local products that should not be too seriously affected by the Special Period (although transport constraints influence everything). It seems likely that a key problem could be insufficient market awareness and lack of direct linkages between the potential users and suppliers. Provided they are sufficiently aware of the needs and opportunities, there exists much scope for small farmers and cooperatives to use available resources to meet supply and demand in these and other areas. It is therefore important to increase information exchange and discussion between the various stakeholders involved in animal traction.

Environmental issues

Hillside agriculture

Animal traction is particularly important in the mountains and hills of Cuba. These are areas of smallholder farming, where the use of tractors is made difficult by the slopes. They are also areas where erosion can be particularly serious, and various measures are needed to reduce the surface water runoff. These include maintenance of tree cover (forestry or tree crops such as coffee and cocoa), terracing, bunding and zero-tillage or reduced tillage systems. Animal power can assist with all these environmentally friendly systems. Animals are already used for forestry logging and for transport of produce. However, there is much potential to use animal power in the formation and cultivation of terraces and bunds. In Central America and Bolivia, hillside farming systems using animal power have benefited from lightweight reversible plows, tine tillage implements, seeders and earth-moving implements. These are used in conjunction with a range of multipurpose crops that provide human food, animal feed and/or soil stability. There is need for participatory research to build on these experiences and adapt the technologies and practices to the needs of Cuban farmers and environments.

Soil degradation and compaction

Several reports were received concerning soil degradation and compaction. This was a particular concern in the Havana province, where there has been a long history of tractor plowing (Ponce *et al*, 2003). Options might include the greater use of animal power and/or the development of reduced tillage systems that improve soil structure and fertility. In Brazil, much work has been done on conservation tillage systems using animal power. Among the innovations developed there have been animal-drawn rolling cutters that chop vegetation as a mulch cover and seeders that can work through mulch. This has resulted in widespread adoption, with significant improvements in soil quality. The Brazilian experience should be studied, and adaptive research carried out in Cuba, using techniques that seem appropriate to local farming systems.

Conclusions and recommendations

Importance of animal power

It is clear from the survey work, and from all chapters in this book, that animal power plays a very important role in Cuban agriculture and transport. Its role has increased during the special period. Given the structure of Cuban agriculture, there is much potential for continued use in farming and transport in the coming years, whatever the economic situation.

Animal power is complementary to motor power (tractors, motor vehicles) and this complementarity should be further developed and strengthened. In agriculture, tractors can be used for high-draft operations such as plowing, with oxen employed for low draft operations such as weeding. Oxen can also provide reliable low-cost, on-farm transport. Horses are excellent for medium-distance journeys in rural areas, as well as for simple, low cost urban transport. Good infrastructure and interchange facilities should be provided at long-distance transport hubs (key bus stops and lorry stands), so that animal powered buses and carts can provide efficient short-distance transport, for consolidating and dispersing the passengers and loads.

While the provision of public transport using horses has involved some appropriate regulation, there has been little attempt to optimise the operations. Given the importance of such transport (one estimate suggested 130 million passenger journeys are made each year), there is scope for working with transporters to determine ways to increase the efficiency of the services, for the benefit of the passengers, transport operators and the animals themselves.

In general, animal power has a positive image in Cuba, and people are quite proud of the role that animals (horses and oxen, in particular) play in production and transport. This image needs to be continued and developed, so that the public (particularly the young) remain aware of the value of animal power.

Animals

The use of work oxen for agriculture and horses for urban and rural transport is generally efficient, with suitable breeds, technologies and systems of utilisation. However in peri-urban areas, hillside agriculture and on more marginal lands, limiting factors may be animal feed resources, inadequate security and the cost of maintaining animals year round for relatively little work. In such circumstances strategies should be developed to optimise animal usage and motor/animal/human complementarity. Among the options to be evaluated using participatory methods, could be the use of transport equids for low-draft agriculture (as well as transport), the use of multipurpose cows (for light work as well as production) and greater use of single oxen. At the same time, ways of increasing the availability of low cost feed resources and animal security in such areas should be investigated.

Animal health and husbandry is generally very good. However, some horses used for urban transport might benefit from enhanced levels of feeding. One solution would be to develop an

active market for fodder in urban and peri-urban areas. Allocation of land for grazing transport animals should also be considered.

Donkeys are not widely used, although they provide great benefits in neighbouring countries. There is scope for investigating and/or promoting greater use of donkeys. Mules are greatly appreciated, particularly in the mountain areas, and promoting the wider use of donkeys should also assist local farmers to produce their own mules.

Water buffaloes have not yet proved superior to local oxen, but as the population of buffaloes increases, they may become a useful power resource in certain situations.

Implements

The main range of implements used in Cuba appear effective, although there are a large number of local variations and innovations that need to be documented and tested. There is an important need for a suitable seeder. Some lighter weight implements are required for possible use with equids. The implements developed by IIMA in recent years (such as the *Multiarado*), have not yet been widely disseminated.

The problem of the cost and availability of raw materials for implements and animal-drawn carts is very serious for the whole supply and distribution system. It is causing major problems of affordability for farmers, reducing the market, and influencing the long-term sustainability of workshops and blacksmiths. Solutions need to be found, and some forms of subsidy may be needed in the short term to stimulate the stagnant market.

A programme to extend the range of designs of animal-drawn implements in regular use in Cuba, should include participatory on-farm evaluation (including the IIMA range and local innovations) by groups of farmers, linked to the development of an affordable and sustainable system of implement production.

Environment

Areas of environmental concern include erosion in hilly areas and loss of soil fertility in regularly cultivated soils. Lessons should be learned (and where appropriate applied) from the experience of Brazil in conservation tillage and from Central America and Bolivia in relation to hillside agriculture using animal traction. A networking approach and participatory methodologies should be employed for such work.

Training, information provision and networking

It is clear from this publication that Cuba has much experience in animal traction that should be usefully shared within Cuba, and elsewhere in the world. Although some aspects of animal traction in Cuba are unique, the country can benefit greatly from ideas, technologies and methodologies that have been developed elsewhere in Latin America and the world. National and international networks can assist the process of exchanging information within a country and between countries. A national network, RECTA, has been formed. This should stimulate interchanges within Cuba, and between other countries.

Progress on all the recommendations made here will be more rapid if Cuba benefits from the experiences in other countries. National and international networking should be funded and should include, study visits, exchanges and collaborative action programmes.

Linking all the initiatives suggested is the need to train people and to share knowledge on key aspects of animal use and associated, technologies, skills and methodologies. There will be need for curriculum development (at all levels) and preparing (or obtaining) relevant resource materials for farmers, students and teaching staff. Information and resource materials should be exchanged, and made available through a wide range of media (books, posters, pamphlets, television, radio, internet) to suit the various audiences.

Research initiatives

While a wide range of possible initiatives could be undertaken, the researchers involved in this study made some suggestions for specific research-action programmes. These are summarised in the last chapter of this book (Sims and Starkey, 2003).

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