World Bank Discussion Papers

The Balance between Public and Private Sector Activities in the Delivery of Livestock Services

Dina L. Umali
Gershon Feder
Cornelis de Haan

Recent World Bank Discussion Papers

No. 105 *Redefining the Role of Government in Agriculture for the 1990s.* Odin Knudsen, John Nash, and others

No. 106 *Social Spending in Latin America: The Story of the 1980s.* Margaret E. Grosh

No. 107 *Kenya at the Demographic Turning Point? Hypotheses and a Proposed Research Agenda.* Allen C. Kelley and Charles E. Nobbe

No. 108 *Debt Management Systems.* Debt and International Finance Division

No. 109 *Indian Women: Their Health and Economic Productivity.* Meera Chatterjee

No. 110 *Social Security in Latin America: Issues and Options for the World Bank.* William McGreevey

No. 111 *Household Consequences of High Fertility in Pakistan.* Susan Cochrane, Valerie Kozel, and Harold Alderman

No. 112 *Strengthening Protection of Intellectual Property in Developing Countries: A Survey of the Literature.* Wolfgang Siebeck, editor, with Robert E. Evenson, William Lesser, and Carlos A. Primo Braga

No. 113 *World Bank Lending for Small and Medium Enterprises.* Leila Webster

No. 114 *Using Knowledge from Social Science in Development Projects.* Michael M. Cernea

No. 115 *Designing Major Policy Reform: Lessons from the Transport Sector.* Ian G. Heggie

No. 116 *Women's Work, Education, and Family Welfare in Peru.* Barbara K. Herz and Shahidur R. Khandker, editors

No. 117 *Developing Financial Institutions for the Poor and Reducing Barriers to Access for Women.* Sharon L. Holt and Helena Ribe

No. 118 *Improving the Performance of Soviet Enterprises.* John Nellis

No. 119 *Public Enterprise Reform: Lessons from the Past and Issues for the Future.* Ahmed Galal

No. 120 *The Information Technology Revolution and Economic Development.* Nagy K. Hanna

No. 121 *Promoting Rural Cooperatives in Developing Countries: The Case of Sub-Saharan Africa.* Avishay Braverman, J. Luis Guasch, Monika Huppi, and Lorenz Pohlmeier

No. 122 *Performance Evaluation for Public Enterprises.* Leroy P. Jones

No. 123 *Urban Housing Reform in China: An Economic Analysis.* George S. Tolley

No. 124 *The New Fiscal Federalism in Brazil.* Anwar Shah

No. 125 *Housing Reform in Socialist Economies.* Bertrand Renaud

No. 126 *Agricultural Technology in Sub-Saharan Africa: A Workshop on Research Issues.* Suzanne Gnaegy and Jock R. Anderson, editors

No. 127 *Using Indigenous Knowledge in Agricultural Development.* D. Michael Warren

No. 128 *Research on Irrigation and Drainage Technologies: Fifteen Years of World Bank Experience.* Raed Safadi and Hervé Plusquellec

No. 129 *Rent Control in Developing Countries.* Stephen Malpezzi and Gwendolyn Ball

No. 130 *Patterns of Direct Foreign Investment in China.* Zafar Shah Khan

No. 131 *A New View of Economic Growth: Four Lectures.* Maurice FG. Scott

No. 132 *Adjusting Educational Policies: Conserving Resources While Raising School Quality.* Bruce Fuller and Aklilu Habte, editors

No. 133 *Letting Girls Learn: Promising Approaches in Primary and Secondary Education.* Barbara Herz, K. Subbarao, Masooma Habib, and Laura Raney

(Continued on the inside back cover.)

5/92

World Bank Discussion Papers

The Balance between Public and Private Sector Activities in the Delivery of Livestock Services

Dina L. Umali
Gershon Feder
Cornelis de Haan

The World Bank
Washington, D.C.

ISSN: 0259-210X

Dina L. Umali is a consultant to the Agriculture Technology and Natural Resources Division of the World Bank's Agriculture and Rural Development Department. Gershon Feder is chief of this division, and Cornelis de Haan is livestock adviser in this division.

Library of Congress Cataloging-in-Publication Data

Umali, Dina L.
The balance between public and private sector activities in the delivery of livestock services / Dina L. Umali, Gershon Feder, Cornelis de Haan.
p. cm. — (World Bank discussion papers ; 163)
Includes bibliographical references.
ISBN 0-8213-2119-6
1. Livestock—Services for. I. Feder, Gershon, 1947–
II. Haan, C. de. III. Title. IV. Series.
SF140.L63U53 1992
338.1'4—dc20 92-12850
CIP

FOREWORD

Agricultural support services, such as livestock services, are an essential element of agricultural development because they can greatly influence the sector's level of productivity. As the food requirements of growing populations escalate, compounded by the need to generate highly valued foreign exchange, increasing agricultural productivity will continue to be a vital national concern in developing countries. In the past, a major component of government strategies for ensuring growth in agricultural output has been public provision of agricultural support services. Recently, however, as countries have struggled to achieve higher levels of economic efficiency--and spurred by growing fiscal deficits and pervasive organizational inefficiencies--governments have had to reconsider such strategies. This development has also highlighted issues regarding the potential role of the private sector in the delivery of these services.

This study was initiated in response to the need to understand the appropriate roles of the public and private sectors in the delivery of agricultural support services. It is the first in a series of studies focusing on this issue; forthcoming studies will discuss public and private sector roles in agricultural research, agricultural extension and seed production and distribution. The present study analyzes the economic nature of each livestock service, the results of which are used to generate a framework for establishing the appropriate government and private sector roles in livestock service delivery. A review of worldwide experiences shows that while the public sector still dominates the delivery of livestock services, particularly in developing countries, successful transfers of livestock service functions such as vaccination, diagnostic support, vector control and livestock extension have been achieved in several countries, albeit with some public monitoring and regulation. Some livestock services, due to their public good nature or the externalities and moral hazard problems associated with their delivery, will require public-sector intervention; although this may frequently be in the form of regulation and price policies rather than direct government control.

Michel Petit
Director
Agriculture and Rural Development
Department

ACKNOWLEDGEMENTS

This report benefitted significantly from insightful and detailed comments by John McIntire, Dirk van der Sluijs and David Leonard (University of California at Berkeley). We would also like to thank Mark Cackler, Isabelle Girardot-Berg and Michael Saddington for their helpful comments on the country case studies.

The authors wish to express their gratitude to Mark Wilson and Richard Fite (USDA) for their valuable contribution in both knowledge and time to this report.

TABLE OF CONTENTS

LIST OF TABLES

Appendix Table — Page

LIST OF FIGURES

Figure — Page

SUMMARY

Livestock services play a vital role in sustaining the productivity and viability of the livestock sector. The value of livestock services derives from the reduction of production losses, the protection of society from livestock diseases that are transmissible to people, and the improvement of livestock productivity and livestock product quality. These services can be grouped into two major functional categories: health and production services.

Health services include curative and preventive services and the provision of veterinary pharmaceuticals. Curative services involve the provision of veterinary care to sick animals, while preventive services consist of vaccination, vector control, and eradication programs, livestock health care research and extension, and other disease control measures such as quarantines, the slaughter of diseased animals, and movement restrictions. Livestock diseases are prevented from being transmitted to humans through veterinary inspection and control of animal products. Production services include research and extension relating to improved livestock husbandry and the provision of input supplies such as seeds, feeds, and artificial insemination. The major actors who shape the structure and behavior of the livestock services sector are the providers of livestock services such as the veterinarians and veterinary drug manufacturers, stock owners and herders, consumers, the government, and the inter-governmental and non-governmental donors (developing countries).

The livestock services sector in the 1990s in most developing countries is clearly dominated by the public sector. In general, private-sector involvement was significant only in the production and distribution of veterinary supplies. The private provision of clinical care was predominant only in the developed countries. Nevertheless, there is growing recognition worldwide of the important role that the private sector can play in the provision of livestock services.

In establishing the appropriate roles for the public and private sectors in the livestock services industry, it is necessary to obtain a clear understanding of the economic nature of each of the services. Not only will the economic nature of the service determine whether private delivery will be feasible, but also whether private provision will result in a socially optimal level of supply. This involves classifying each service on the basis of its public or private good character, while taking into account any externalities, moral hazard problems, or free-rider problems that may accompany the production or consumption of the service.

Vaccines, semen for artificial insemination, and veterinary drugs and supplies are private goods. Private-sector investments in the production and distribution of these commodities will depend on the returns from these ventures, which are determined by factors such as the appropriability of returns, the size of the market, input prices, and the availability of the technology. Government policies also influence private participation to the extent that they affect the economic incentives faced by the private sector. Restrictions on private importation of veterinary inputs and the subsidization of and price controls on these products result in price distortions which create barriers to entry for the private sector. Moreover, competition in the market for these commodities has shaped the pattern of delivery of other livestock services. As a result of increasing competition among private firms involved in the marketing of veterinary pharmaceuticals and supplies, these firms are providing extension services as a complementary service.

Vaccinations, diagnostic support, and vector control (tick and tse-tse) are similarly private goods, but their consumption involves externalities. The effectiveness of vaccination campaigns and vector control depends on the degree coverage of the livestock population; non-compliance by some farmers can jeopardize the whole program. Diagnostic support provides information to other farmers on the prevalence of certain diseases in the vicinity. Unless these externalities are internalized, there will be underconsumption (or no consumption) of these services by farmers. Thus, in order to raise farmer investment in these services to socially optimal levels, governments find it necessary to intervene. In the case of vaccination and vector control programs, governments in various countries insure farmer participation either by imposing regulations for compliance, by subcontracting the services to the private

sector, or by providing the services themselves. Tse-tse control in open ranges, however, is a public good.

Clinical diagnosis and treatment are generally private goods. The exception is clinical intervention pertaining to the treatment of infectious diseases; this involves externalities. Nonetheless, clinical intervention should exclusively remain a private sector responsibility. Despite the externalities associated with the treatment of infectious diseases, public intervention is still most cost effective if directed at preventive measures such as vaccination or slaughter of afflicted animals.

Several factors influence the farmer's incentive to avail of clinical intervention, vaccination, diagnostic support and vector control services. The first factor is the nature of the disease and the economic losses associated with it. The risk of economic losses is greater for some diseases than for others (e.g. FMD vs brucellosis); thus if the disease is not economically threatening, a farmer may forgo clinical care or the undertaking of preventive measures. The second factor is the degree of homogeneity of the livestock population, specifically the relative proportions of traditional and improved breeds. In general, traditional and improved breeds exhibit different productivity characteristics, and thus economic values, and different degrees of susceptibility to specific diseases. Consequently, the potential economic losses from the same disease may vary according to the type of production system. The third factor is the intensity of the production system. As in the Argentinean case (Appendix A), farmers in the extensive breeding areas displayed a lower demand for preventive services than farmers in the intensive cattle-fattening areas, because the former faced lower risks of losses from disease outbreaks. In summary, diversity of the livestock population and production systems results in differential risk of losses and net returns to clinical care, vaccination, diagnostic support, and vector control, which subsequently affects the economic incentives faced by different farmers. Adequate treatment of sick animals or full compliance with vaccination and vector control programs, therefore, may not be achieved if it were left to pure market forces to direct farmer behavior.

At the same time, the profitability and sustainability of private veterinary practices providing clinical care, diagnostic support, and vaccinations are influenced by the size of the livestock enterprises,

the value of the animals in the production system, and the density of the livestock population. Since the provision of veterinary services involves significant fixed costs (e.g. transportation, buildings, and veterinary equipment), the demand for the veterinarian's or veterinary health personnel's services must be sufficient enough to make private practice economically profitable. Therefore, the existence of large-scale high density livestock enterprises will favor private-sector participation since these enterprises will have the capacity to generate such a volume of demand. In predominantly smallholder and low density areas, the demand is often insufficient to sustain private practice. This arises because the private practitioner's transactions cost per animal may exceed the smallholder's perceived returns from the service. Finally, in areas where publicly provided livestock services are available, private practitioners may not be able to compete if public services are highly subsidized.

The externalities associated with the prevention of some diseases may be so extreme that the government may find it necessary to undertake the preventive measures itself so as to insure their optimal supply. These diseases may be of greater economic, social, and political importance than others, not only as a result of the production losses they cause, but also because of their adverse effect on humans and livestock product exports. Anthrax, brucellosis, tuberculosis, rabies and some parasitic diseases are transmissible to man; thus, the impact of these diseases transcends beyond their effect on livestock farmers to the rest of society. The control of FMD, for example, is given primary attention because of the additional hazard it poses to beef exports. Consequently, the effective implementation of control programs for these diseases take on greater public significance and the state will generally assume responsibility for their provision.

Smallholder livestock farmers are basically at a disadvantage because they face a higher per unit cost of livestock services. In many developing countries, smallholders are totally dependent on government services which are often poor, inadequate or nonexistent. The establishment of producer organizations and cooperatives has proven to be an effective approach for surmounting this handicap in many countries (e.g. India, Indonesia, Kenya and South American countries). Small farmers can take advantage of economies of scale through increased coordination and pooling of their livestock services needs under the auspices of these organizations. For example, producer organizations can set up clinical

routes and designated field stops where farmer members can obtain veterinary services. Furthermore, producer associations provide the mechanism for overcoming the externalities associated with the provision of some livestock services so that livestock services supply and consumption are raised to socially optimal levels. Since the veterinarian or veterinary health personnel is employed by the producer association and all members equally provide financial support for the organization, free-rider problems are eliminated. From the veterinarian's and veterinary health personnel's perspective, producer associations provide for greater income and job security, which increases the attractiveness of private practice.

Veterinary surveillance is a purely public good. Due to the free-rider problem associated with its delivery, there will be a tendency towards under-production or no production of this service when the production decision is profit motivated. Animal quarantine is a public-sector policy intervention to overcome externalities arising from easy disease transmission between animals, while drug quality control and food hygiene/inspection are public-sector policy responses to moral hazard problems associated with the processing and distribution of veterinary pharmaceuticals and livestock products. Of the different strategies open to the state for handling these market failures, governments often choose to assume responsibility for the provision of veterinary surveillance, quarantine services, drug quality control and food hygiene inspection in order to insure their optimal supply. The risks to society and the economy of disease outbreaks more than outweigh the cost of the programs. Although the delivery of these services may be subcontracted out to private entrepreneurs, the appropriate levels of their supply continue to be a public-sector decision.

Extension may be a private or public good, depending on the medium used and the ease with which information flows to other farmers. Similarly, the products of veterinary research may be public or private goods depending on whether property rights have been defined. Thus, the appropriate sectoral channel will depend on the type of service produced and the medium employed.

There is wide disparity in the effectiveness of delivery of livestock services in developed and developing countries. Livestock services in developed countries are in general adequately and efficiently

supplied. Many developing countries, on the other hand, are characterized by a shortage of skilled veterinary manpower. In other developing countries, overstaffing led to shortages of operating funds, since large proportions of the organizational budget have to be allocated to staff salaries. Inadequate operating budgets subsequently reduced or prevented investments in required veterinary infrastructures, disease control and veterinary information services, and transport, communications, and veterinary equipment. Inadequate operating budgets, in particular, largely explain the ineffectiveness of many government livestock health programs in developing countries. As noted earlier, the public sector dominates the delivery of livestock services. Due to the public good character and externalities and moral hazard problems associated with the provision of these services, the majority of livestock services were subsidized or provided free. As the livestock population expanded in the developing countries, their livestock services requirement correspondingly increased, causing greater pressure on operating budgets that were not increasing at the same pace. This subsequently resulted in rationing and/or deteriorating quality of service as governments were forced to accommodate more clients in the context of diminishing resources.

Taking into account the economic character of each of the livestock services, privatization, therefore, cannot and should not be undertaken as one broad strategy. Instead, a policy of selective privatization should be pursued. As a first step, the transfer of livestock services that are basically private goods to the private sector should be promoted. In the case of the livestock services whose consumption involves externalities or whose delivery has associated moral hazard or free-rider problems, there is a need for mechanisms to correct these market failures to insure that the private sector will provide them at socially optimal levels. Otherwise, public-sector intervention will remain essential.

Vaccines, semen for artificial insemination, and veterinary drugs and supplies are private goods; thus, their production and distribution can be feasibly and efficiently undertaken by the private sector. Privatization will be one way to improve the efficiency of the delivery of these commodities. To insure that these veterinary products are up to standard specifications, government certification of these products may be pursued.

Unless mechanisms can be set in place to account for the externalities associated with vaccinations for diseases, diagnostic support and vector control (e.g. issuance of vaccination certificates as in Argentina; the organization of strong producer organizations as in India; effective use of tse-tse fly screens and traps as in the Central African Republic), some degree of public-sector intervention will have to be maintained if optimal consumption of these services is to be guaranteed.

Clinical intervention is generally a private good and should remain a private sector activity. In some cases, however, clinical intervention may not be completely separable from other activities, such as vaccination and diagnostic support. In such a special case, a subsidy to promote diagnostic support and vaccination (e.g. a transportation cost subsidy) may unavoidably spillover to that of clinical intervention. This should **not** be perceived, however, as a justification for subsidization of clinical intervention. Clinical intervention should exclusively be a private sector activity and public sector intervention should concentrate on the more cost effective preventive measures such as vaccination and diagnostic support.

The financing of publicly provided livestock services is an issue that is drawing increasing attention and concern. Many developing countries are currently faced with serious fiscal constraints and the overall policy of subsidization of these services has often resulted in tradeoffs between the quantity and quality of services provided. Cost recovery has been recommended to insure the sustainability of public-sector programs (De Haan and Nissen, 1985; De Haan and Bekure, 1991). However, this strategy should be pursued only after farmer response to the additional cost involved has been carefully studied. Past studies (Sandford, 1983; World Bank, n.d.) tend to indicate that cost recovery measures have to be pursued on a case by case basis and one of the most important factors that influences farmer response to cost recovery measures is the risk of economic loss, which varies according to the type of the animal, the value of the animal, the nature of the disease, the homogeneity of the livestock population, the intensity of the production system, and livestock density.

Governments should explore other alternatives besides direct provision of livestock services. These include promoting private practice by removing barriers to entry and establishing an effective legal framework for enforcement of particular activities (e.g. vaccination certificates in Argentina), subcontracting services to the private sector, promoting livestock insurance schemes, and fostering the development of producer organizations.

Veterinary auxiliaries can play an important role in providing preventive services, the performance of simple clinical procedures, and extension. Although they cannot substitute for veterinarians, they supplement the veterinarian's work and thus expand the geographic area covered and the number of farmers serviced. Because their opportunity costs are lower than the veterinarians, their services will be more affordable to farmers. More importantly, since the time required for and the cost of their training are significantly lower than that required of the veterinarian, veterinary auxiliaries can provide developing countries a means of accumulating veterinary manpower in a shorter period of time and at lower costs.

Finally, the promotion of private-sector research in the livestock services industry can further ease the financial burdens of the government. However, private-sector research is largely determined by the potential returns from the research activity and the appropriability of those returns; these two factors will determine the type of new products and technologies private firms will generate. Research areas that do not meet these conditions will be neglected by the private sector and such a selective research agenda will therefore necessitate the continued participation of non-private institutions (e.g. domestic and international public institutes and non-profit organizations) to insure that socially optimal levels of research are conducted (Umali, forthcoming). In particular, non-private involvement will continue to be essential if only to insure veterinary and production research into socially beneficial, but privately unprofitable areas.

INTRODUCTION 1

Livestock products constitute a significant portion of world agricultural output. In 1988, they accounted for over 40 percent of the value of agricultural output in North and Central America, Western and Eastern Europe, and the USSR, and over 22 percent in the rest of the world (USDA, 1990). Almost one hundred percent of livestock products (meat, milk, eggs, and fiber) are produced by six species groups: cattle, buffalo, sheep, goat, pig, and poultry. The first four are ruminant species, which convert forages unsuitable for human consumption into animal products; the latter two are monogastric and are competitors with humans for grains (Cunningham, 1989).

The livestock sector plays a crucial role in the economies of developed and developing nations not only for the livestock products it supplies, which are an important source of protein, but also for the other roles it plays. It is a vital generator of employment; in Sub-Saharan Africa, it provides employment to approximately 58 percent of the population (de Haan and Nissen, 1985). It is also a source of much valued foreign exchange. In 1988 alone, world trade in meat products totalled $27.9 billion, in wool $6.2 billion, and in dairy products and eggs $19.8 billion respectively (USDA, 1990).[1] South American and Eastern European countries were the major net exporters of meat products in 1988, while Western Europe dominated the export market in dairy products and eggs. In other regions, on the other hand, imports of livestock products are a serious drain on foreign exchange reserves. This is particularly critical to developing countries in Africa and Asia, many of whom are already plagued with current account deficits. To the majority of farmers in the developing world, livestock also provides a means for storing wealth, a cushion for food shortages, a source of fertilizer and/or fuel, a means of transportation, and a source of traction in agricultural production.

The ability of the livestock sector to attain its full productive potential, however, is often constrained by the availability and quality of livestock support services such as livestock health and

[1] Dollar values are in US dollars. Billion = 1,000 million.

production services. Indeed, the importance of livestock services in livestock production cannot be overstated. They play a vital role in sustaining the productivity and profitability of livestock enterprises as well as the viability of the livestock sector as a whole. The value of livestock services derives from the reduction of losses through the provision of veterinary care and the increase in productivity and product quality arising from breed and husbandry improvements. Veterinary care directly reduces production losses by reducing the rate of mortality and indirectly by reducing morbidity losses in terms of the impact of disease on growth, fertility, product quality, and work output (de Haan and Bekure, 1991). The lack of accurate information on disease occurrence has made it difficult to obtain precise assessments of the losses involved. There is some evidence that these losses are substantial. FAO (1985) estimated that direct and indirect losses due to animal diseases amount to about $2 billion per year in Sub-Saharan Africa. Losses in Latin America due to five diseases--foot and mouth disease (FMD), hog cholera, tuberculosis, brucellosis, and rabies have been placed at $900 million annually (FAO, 1990). In Argentina alone, the National Animal Health Service concluded that approximately $455 million could have been saved in 1984 if the main diseases in cattle, sheep, and horses had been eradicated (FAO, 1989). Of these losses, cattle diseases represented 87 percent, with FMD accounting for a third of all losses. Specialized programs, such as artificial insemination and feed/forage analysis, on the other hand, upgrade livestock productivity and performance.

The provision of livestock services has often been in the domain of the public sector. Over time, a growing diversity has developed in the manner in which livestock services are delivered in individual countries. In most developing nations, livestock services still remain a government responsibility, while in the more developed countries, some support service functions of the government are being performed in partnership with, or have been transferred to, the private sector. This trend raises several important questions. How and to what extent has this transition occurred? What factors affect this transition? Is there an optimal combination of public and private-sector participation? Which functions should remain in the public domain and which should be carried out by the private sector?

This study seeks to find answers to these questions. The study is divided into six chapters. Following this introduction, chapter 2 presents an overview of the nature of livestock services and the

major actors in the livestock services sector. Chapter 3 lays out the economic concepts relevant to livestock services delivery, while chapter 4 surveys the global patterns of delivery of livestock services with primary focus on the institutions involved and the factors contributing to the structural changes occurring in the livestock services sector. Case studies of the livestock services sector in Argentina, Brazil, the Central African Republic, the People's Republic of China, Germany, India, Indonesia, Kenya, and the United States are presented in Appendix A to illustrate the diversity in livestock services delivery. Selected global statistics on the livestock and livestock services sector are presented in Appendix B. Finally, chapter 5 summarizes the major findings of the study and examines the policy implications of these results in terms of the suitable roles of government and international donors in promoting the development of the livestock services sector.

OVERVIEW OF THE LIVESTOCK SERVICES SECTOR 2

FUNCTIONAL CLASSIFICATION OF LIVESTOCK SERVICES

Livestock services can be grouped into two major functional categories: health and production services. Health services consist of curative and preventive services and the provision of veterinary pharmaceuticals; while production services include research and extension services relating to improved livestock husbandry and the provision of input supplies such as seeds, feeds, and artificial insemination. Curative services involve the provision of veterinary care to sick animals. It primarily entails the diagnosis of the illness and its treatment, usually through the provision of appropriate drugs. Preventive services serve to stop the new occurrence of disease. There are three basic methods: (i) immunization of animals with sera or vaccines, (ii) eradication or control of carriers or vectors (such as ticks and tse-tse flies), and (iii) disease control measures (such as quarantines, slaughtering, and movement restrictions). The prevention of some human diseases (like tuberculosis, tapeworms, and other parasites) is accomplished through veterinary inspection and control of animal products (Leonard, 1990). Table 2.1 presents a catalog of some of the major diseases of livestock and their curative and preventive treatments. It should be noted that in the battle against some of these major diseases, prevention is the only option because disease infection is fatal. However, vaccines which provide short-term or permanent immunity have been developed for most diseases and their utilization is a major component of most livestock health programs. Standard control measures such as dipping, quarantine, slaughter, movement restrictions, and livestock product export and import controls are also employed to contain these diseases. Preventive services also include livestock health care research aimed at the development of vaccines and disease-resistant or disease tolerant breeds and livestock health care extension.

The third category of health services is the provision of veterinary supplies; this consists of the production and distribution of veterinary pharmaceuticals. In general, veterinary supplies are provided

Table 2.1: Major diseases of livestock and their treatments.

DISEASE	HOST	TRANSMISSION	VIRULENCE	TREATMENT	PREVENTION	CONTROL
VIRAL						
African Swine Fever	Pigs	Contact, ticks, and garbage feeds	Fatal		No vaccine	Slaughter, quarantine
Foot and Mouth Disease	Cattle, sheep, goats, pigs	Saliva, urine, feces, milk products, meat and bones	Fatal to young, debilitating to adults	Antiseptics	Vaccination every 6 mos-1 yr	Slaughter, quarantine import ban[a/]
Hog Cholera	Pigs	Hog urine, meat, mice, manure, horse flies, earthworms	Fatal to young, chronic for adults	Sulpha drugs and antibiotics for secondary invaders	Vaccination for short-term immunity	Compulsory slaughter
Newcastle Disease	Chickens	Contact, wild birds	Fatal (up to 100%)		Vaccination for permanent immunity	Burning or burying in quick lime
Peste des Petit Ruminants	Goats, sheep	Contact with infected animals	Fatal		Vaccination for permanent immunity	
Rinderpest	Cattle, buffalo sheep, goats, pigs	Meat, skins, offals, manure, food, contact with infected animals	Fatal (20-100%) or chronic		Vaccination for permanent immunity	Slaughter, quarantine
BACTERIAL						
Anthrax	Cattle, sheep, pigs, humans	Soil, food, inhalation of spores, meat and bone meal	Fatal, sudden death-cattle, sheep; 2-4 days-pigs	Antibiotics	Vaccination for short-term immunity	Slaughter
Black leg	Cattle, sheep	Soil, food	Fatal (1 day)	Antibiotics	Vaccination for permanent immunity	
Brucellosis	Cattle, goats, sheep, humans	Fetal and placental tissues, uterine discharges, unpasteurized milk, genital system of bull	Induces abortion	Antiseptics, irrigation of uterus	Vaccination for permanent immunity, milk pasteurization	Control of sale of aborted cows, slaughter
Contagious Bovine Pleuro-Pneumonia (CBPP)	Cattle	Recovered animals, respiratory droplets, urine, milk	Debilitating, 50% fatality in early stages, chronic	Antibiotics	Vaccination for permanent immunity	
Hemorrhagic Septicemia	Cattle, buffaloes	Soil, stagnant water	Fatal (85-95% in <3 days)	Sulpha drugs and antibiotics	Vaccination for short-term immunity	
Mastitis	Cattle	Contact	Reduced milk production	Antibiotics	Good hygiene and milking practices	

Table 2.1 cont'd: Major diseases of livestock.

DISEASE	HOST	TRANSMISSION	VIRULENCE	TREATMENT	PREVENTION	CONTROL
RICKETTSIAL						
Heartwater	Cattle, sheep, goats	Ticks	Fatal (50-90% in <7days)	Antibiotics and sulphadimidine	No vaccine, natural exposure + antibiotic treatment gives 6-18 month immunity	Dipping
PROTOZOAL						
Anaplasmosis	Cattle	Ticks, flies	Fatal or long recovery period		Natural exposure of young, vaccine + tetracycline gives 1 yr immunity	Dipping
Babesiosis (Tick Fever)	Cattle, sheep, goats, horses, pigs	Ticks	Fatal to susceptible breeds (50-90%) or debilitating up to 3 wks	Acparin	Natural exposure of young	Dipping
Theilerosis (East Coast Fever)	Cattle, buffalo	Ticks	Fatal to unexposed cattle, weakness		Recovered animals have permanent immunity	Dipping, quarantine, slaughter
African Trypanosomiasis (African Sleeping Sickness)	Cattle, sheep, goats, pigs, horses, camels humans	Tsetse fly	Fatal or chronic weakness	Trypanocides	Prior treatment with prophylactic trypanosomidal drugs	Vector control
PARASITIC DISEASES						
Liver Fluke	Cattle, humans	Snails, grass	Poor performance	Drug treatment	Rotational grazing	Vector control
Schistosomiasis	Cattle, pigs, humans	Snails, canals and slow moving waters, grass	Poor performance in adults, fatal to young	Drug treatment	Vaccination for cattle	Vector control
Tapeworms	Cattle, pigs, humans	Manure, infected meat	Poor performance, sometimes fatal	Drug treatment		Meat inspection freezing, thorough cooking
Intestinal parasites	All species	Feeds	Poor performance	Drug treatment	Rotational grazing	

[a] Countries completely free of FMD will only import meat from other FMD-free countries because the virus can be transmitted in fresh and frozen meats.

Sources: McCauley (1982) and Miller and West (1978).

in conjunction with the provision of curative, preventive, and production services by veterinarians and other livestock health personnel.

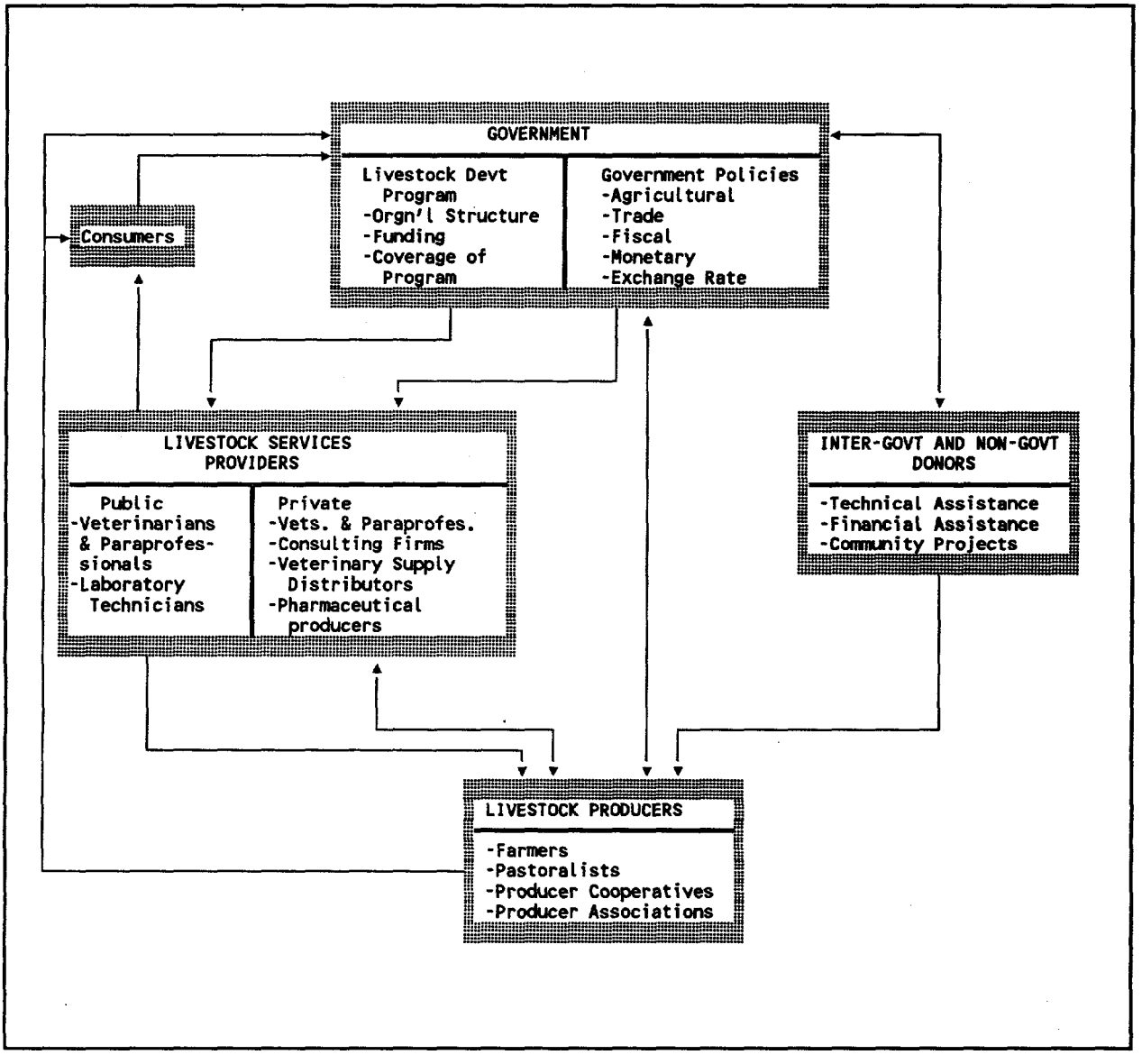
Production services improve livestock productivity by such means as the genetic upgrading of livestock through artificial insemination, the improved formulation of feeds, the use of improved forages, and changes in management practices. Livestock extension plays a big role in transmitting these new developments to farmers. Artificial insemination, which is widely used in cattle and pig production in the developed nations, provides farmers the option of rapid improvement in the quality and quantity of output of their stock while obviating the need to import sires from other areas (Miller and West, 1970). It thus saves the farmer the expense of buying, feeding, and looking after pedigree sires.

MAJOR ACTORS IN THE LIVESTOCK SERVICES SECTOR

The major players that shape the livestock services sector are: the veterinarians and veterinary para-professionals, the stock owners and herders, consumers, government, inter-governmental and non-governmental donors, and private entrepreneurs providing specialized services to the sector (Figure 2.1). Veterinarians and other livestock services personnel deliver health and production services either through private channels or as part of a government-sponsored program. Veterinary paraprofessionals (e.g. field technicians, field vaccinators, producer representatives/auxiliaries) assist veterinarians with their duties; the extent of veterinary care they provide covers a whole spectrum, from simple tasks such as teaching farmers about proper animal care and sanitation to increasingly more complicated responsibilities such as the immunization of animals, assisting the veterinarian in surgical procedures, the treatment of minor diseases, to the diagnosis of disease and the application of appropriate treatments (de Haan and Nissen, 1985; Leonard, 1990; de Haan and Bekure, 1991). Because of the limited number of trained veterinarians in some countries and their unwillingness to serve in rural areas, paraprofessionals are relied upon to supplement the work of veterinarians thereby expanding the total area covered and the number of farmers serviced as well as freeing more time for the veterinarians to treat the more serious cases.

The stock-owners and herders are the direct consumers of livestock services; they consist of large-scale farmers, sedentary (mixed farm) producers, pastoralists, and small

Figure 2.1
Major Actors in the Livestock Services Sector



backyard raisers (Leonard, 1990). Livestock farmers may be organized into producer associations, cooperatives, and other forms of collective organizations, whose functions may include the provision of livestock services.

Consumers also have a direct involvement in the livestock services sector because several livestock diseases infect humans as well. These include anthrax, brucellosis, African sleeping sickness and some parasitic diseases which are transmitted through animal products. Because of the serious health

risks posed by these diseases, their control and/or eradication is a major public concern. At the same time, consumers benefit indirectly from livestock production services as a result of the increased availability of higher quality output and lower prices from livestock producers.

Government officials determine the structure and state allocation of resources to livestock health programs. In particular, the Ministry/ Department of Agriculture and the specialized livestock bureaus are principally charged with setting the priorities, planning, and implementing livestock development programs. These programs may include the provision of curative, preventive, and production services and veterinary supplies to farmers. In addition, they provide the institutional framework for monitoring and regulating the performance of the industry (e.g. quality control and food/hygiene inspection). Meanwhile, members of the Ministries of Finance/Budget, the Central Bank, and the executive and legislative bodies of government determine the financial support the programs will receive. In addition, the executive and legislative bodies of government formulate the domestic policies that shape the economic and institutional environment in which the livestock services sector operates. This economic and institutional environment subsequently creates the incentives or disincentives to private-sector activities.

Inter-governmental and non-governmental donors assist national governments by providing technical assistance and contributing from partial to complete financing of livestock sector development programs. Non-governmental donors mainly extend technical assistance and provide for the establishment of community livestock projects. Inter-governmental donor assistance, on the other hand, is generally directed at providing funding for national livestock services programs or national livestock programs with livestock services components. Financial assistance is channeled through governments, thus predicating the role of government in the delivery of the services (De Haan and Bekure, 1991; Leonard, 1990). Inter-governmental donors with major involvement in the livestock services sector include the African Development Bank (ADB), Asian Development Bank (ADB), *Caisse Centrale de Cooperation Economique* (CCCE), *Deutsche Gesellschaft fur Technische Zusammenarbeit* (GTZ), European Economic Commission (EEC), French Cooperative Ministry (FAC), Food and Agriculture Organization (FAO), Inter-American Development Bank (IDB), International Fund for Agricultural

Development (IFAD), Overseas Development Association (ODA), United Nations Development Program (UNDP), and the World Bank.

Private entrepreneurs are playing an increasingly important role in the livestock services sector of most countries; the range of services they offer cover the spectrum of curative, preventive and productive services. They also engage in the production and distribution of livestock supplies such as veterinary medicine, vaccines, seeds, and fertilizer as well as conduct extension programs.

The livestock services sector covers a broad area of activities and involves many different actors pursuing different agendas. How efficiently these activities and agendas have been harmonized is discussed in Chapter 4. To facilitate such a review, an economic framework for analyzing the livestock services sector is presented in the next chapter.

ECONOMIC ISSUES IN THE DELIVERY OF LIVESTOCK SERVICES 3

PRIVATE AND PUBLIC GOODS

Products, whether they are commodities or services, can be classified in economic terms as either private or public goods. A product is categorized as a private good when the individual who consumes it captures exclusively its full benefit. A pure private good is characterized by both the exclusion and rival principles. The exclusion principle applies when access is denied to those who have not paid for the product, and the rival principle is operative when no two consumers can both enjoy a specific benefit at the same time (Samuelson, 1954; Head, 1974; Leonard, 1990). An example of a pure private good is an apple; its consumption provides satisfaction exclusively to the individual consuming it. On the other hand, a good is public when its consumption by one individual does not reduce its availability to other individuals; the standard example is that of national defense. The consumption of a public good is a case wherein the exclusion and rival principles do not operate. If a public good is available to one person, it is available to many or all; there is no practical way for one person to appropriate it exclusively for his/her own personal use. Often, due to the non-exclusive character of public goods consumption, the providers of pure public goods are unable to restrict use to people who pay for the services giving rise to the "free rider" problem. Because of their non-exclusivity and non-rivalry (and associated free-riders), those who deliver goods with these characteristics cannot recoup their full earning potential. In such situations, there will be a tendency towards under-production (or no production) of such goods if the production decision is profit motivated. Consequently, it is usually left to the state to undertake the provision of public goods. Often the state can use its powers of taxation to force all beneficiaries to pay for it (Head, 1974; Feldman, 1980; Leonard, 1990). While purely private and purely public goods occupy opposite ends of a spectrum, in between these limits there are commodities that display varying degrees of private and public good characteristics.

EXTERNALITIES

When the actions of one person affect the environment of another other than by affecting prices, then an externality exists. Externalities (also referred to as "spillover", "third-party", or "external" effects) arise when an individual in the course of rendering (or consuming) some service for which payment is received (is made), coincidentally also renders services or disservices to other persons for which payment cannot be exacted from the benefitted parties or compensation enforced on behalf of the injured parties (Pigou, 1932). An essential characteristic of an externality is the unenforceability of compensation for these incidental services (Head, 1974). The typical example of an externality is when a coal-burning electricity generating facility spews smoke and other pollutants into its surrounding environment. Unlike a public good, these incidental services arising from the externality need not be descriptively identical in nature or quantity to the service for which the payment is made. Furthermore, the incidental service may extend to only one or a few persons. Typically, the individual causing the externality will not take the positive or negative effects of his/her actions into consideration when deciding what levels of services he/she should produce or consume; thus, the free operation of a market in the presence of externalities will lead to a non-optimal allocation of resources. In the absence of a price mechanism that will account for the value of these "incidental services," either too little (in case of positive externalities) or too much (in the case of negative externalities) is produced or consumed.

Internalizing externalities so as to bring optimal resource allocation requires measures that will incorporate the benefits or costs of the incidental services back into the decision-making process. In situations where property rights are well-defined, the agent causing the externality and the individual(s) affected by the externality can negotiate among themselves for appropriate compensation for the incidental services (Coase, 1960). Often, it is left to the state to impose taxes on agents causing negative externalities to account for the real social costs of their decisions or to provide subsidies to agents producing positive externalities to reflect the social benefits arising from their actions and thus insure optimal supply (Feldman, 1984). The state may also regulate activities that embody externalities (e.g. imposition of quotas); in cases of extreme externalities, the interests of the public may require that the state assume absolute control of the activity.

MORAL HAZARD PROBLEM

In a competitive market, it is assumed that consumers are rational and well-informed about what commodities are available, the prices being charged and the quality of the commodity. In some cases, however, there is asymmetry of information. Consumers are unaware or are unable to assess visibly and directly the quality of the good they are purchasing; for example, the difference between an active and inactive vaccine is visibly undetectable. This asymmetry of information leads to the moral hazard problem. If the quality of a good cannot be readily and visibly evaluated, the differential quality may not be reflected in the price of the good. Because the producer knows the true quality of his/her output, but the consumer does not, there is an incentive for the producer to underinvest, particularly in cases when the origin of a commodity cannot be traced. A producer will have the incentive to change his/her behavior and pass on sub-standard goods to the consumer who is unable to tell the difference at the time of purchase.[2] To overcome the moral hazard problem, the state generally monitors such sectors and/or imposes regulations governing quality standards. In situations of critical public significance, the state may assume full control of the sector and engage in the activity itself. Several concerns arise from the moral hazard problem. First, will the deficiencies in the operations of a public supplier still be preferable to the problems involved in private-sector supply? Second, will regulation and monitoring by an independent entity be sufficient to counter the moral hazard problem? Third, can such functions be relegated to private-sector entities? And lastly, are there other measures available for minimizing the scope of moral hazard?

ECONOMIES OF SCALE

The delivery of livestock services is subject to economies of scale in several respects. Economies of scale exist when the average cost of production decreases as output increases; this characteristic is highly relevant when enterprise operations involve a large proportion of fixed costs. The provision of clinical and preventive care requires veterinarians and veterinary auxiliary personnel to travel to the points of service delivery (e.g. farm, veterinary posts, or a designated stop) and the larger the

---

[2] Blankart (1987) suggests that markets can develop devices to overcome the deficiency of quality uncertainty. For such goods, which he refers to as 'experience goods,' "the customers can extrapolate their experiences of previous transactions, and the suppliers accumulate goodwill in order not to disappoint the consumer's expectations." Brand loyalty developed through guaranteed quality of products is an example.

number of units of service provided to clients at each point of service delivery, the lower will be the cost per unit. Specifically, the veterinarian's fee, transport and other transport-related costs can be spread over a larger number of animals and thus reduce the per unit cost of the service. Since the provision of veterinary services entails significant indivisible fixed costs, veterinarians will not set up private practices unless the market for their services is large enough to sustain profitable operations. Thus, high density livestock areas will favor private-sector participation, because these localities can generate a volume of demand sufficient to sustain private veterinary practice.[3] From the farmer's perspective, this cost differential can become a screening device as to who can afford veterinary services. Farmers with large herds can take greater advantage of veterinary services than small farmers since their cost per unit is smaller and thus makes the services more affordable. Small farmers, however, can overcome this handicap through membership in producer organizations/cooperatives that provide livestock health and support services. As a result of the pooling of the livestock services needs of smallholder farmers under these organizations, they are able to take advantage of economies of scale in the delivery of the services.

Other areas where economies of scale operate are in the research and production of vaccines and veterinary drugs and supplies. Their production requires substantial fixed investments (e.g. production plant, laboratory equipment) and a relatively small proportion of variable costs. This characteristic becomes critical when the local livestock population and market demand for these veterinary products are small, which raises per unit costs of research and production. Unless other markets can be tapped (as with the case of multinational firms), the cost of research and production will result in product prices that may make them uneconomical for farmers to use or require high and sometimes unsustainable government subsidies.

BARRIERS TO ENTRY

Barriers may exist to prevent private entrepreneurs from entering into the livestock services industry. Barriers to entry include control of the source of raw materials, the holding of patents

[3]Private sector participation will be sustainable despite low livestock densities and high per unit costs if high-value animals (e.g. dairy cows and purebred horses) are involved. The high value of the animals and thus the risk of enormous economic losses provides sufficient incentives for the livestock farmer to insure that the animals receive the required livestock services.

preventing other firms from duplicating the product, underpricing, official legislation and licensing, and the existence of a natural monopoly. In the livestock services sector, this may take the form of exclusive rights for the importation and/or distribution of veterinary drugs and veterinary-related supplies granted by the government to a single entity, the free or subsidized public provision of livestock services, and official legislation which bans private practice or layman application of veterinary drugs.[4]

ECONOMIC CLASSIFICATION OF LIVESTOCK SERVICES

The various livestock services discussed in the previous section occupy different points in the private-public goods spectrum (Table 3.1). Veterinary surveillance is a public good. The benefits derived from veterinary surveillance cannot be exclusively appropriated by an individual livestock farmer; they are available to the whole community. Thus, there are free-rider problems associated with its delivery. Vaccines are an example of a purely private good; private entrepreneurs producing vaccines can capture exclusively the full benefit from the sale of their products. The same holds true for semen production, artificial insemination and the production and distribution of veterinary pharmaceuticals. Veterinary and production extension services may be private or public goods depending on the medium used and the ease with which information flows to other farmers. Extension conducted through public channels (e.g. radio broadcasts) is a public good, whereas extension services tailored and provided exclusively to an individual or a select group such that the information cannot be easily transmitted to other farmers will be a private good. Similarly, the products of veterinary research may be public or private goods depending on whether clear property rights have been defined; for example, research output protected by patents are private goods.

Clinical intervention involves two activities: the diagnosis of the illness and its treatment. Clinical diagnosis and treatment are both private goods, whether their provision will involve externalities depends upon the clinical problem being corrected. For example, the diagnosis and treatment of a broken leg is a purely private good; the farmer who owns the injured animal is the sole beneficiary of the procedure. There are, however, externalities associated with the diagnosis and treatment of an infectious

[4] Layman application of veterinary drugs is restricted in some countries due to concerns regarding improper use of the drugs.

Table 3.1: Economic classification of the types of livestock services.

LIVESTOCK SERVICE	TYPE OF ECONOMIC GOOD Public	Private	MEASURES TO CORRECT FOR Externality	Moral Hazard	SECTORAL DELIVERY Public	Private
I. CURATIVE						
A. Clinical intervention						
Diagnosis		X*				YY
Treatment		X**				YY
B. PREVENTIVE						
Vaccination		X*			Y	YY
Vaccine production		X				YY
Vector control						
Tick control		X*			Y	YY
Tse-tse control	X	X*			Y	YY
Veterinary surveillance	X				YY	
Diagnostic support		X*			Y	YY
Quarantine			X		YY	
Drug quality control				X	YY	
Food hygiene/inspection				X	YY	
Veterinary research	X	X			YY	YY
C. PROVISION OF VETERINARY SUPPLIES						
Production		X				YY
Distribution		X				YY
II. PROMOTIVE						
AI - semen production		X				YY
AI - insemination		X				YY
Extension	X	X			YY	Y

Note: * - private goods with externalities; ** - private good with externalities only in the case of infectious diseases; YY - economically justified; Y - economically justified under special circumstances.

disease. Through diagnosis, the farmer is informed about the infectious disease afflicting his/her animal(s), but at the same time, the process provides information to other farmers regarding the presence of the disease in the locality. Although the treatment provided by a veterinarian is a private good, because the livestock owner captures the full benefit of the veterinarian's services and no one else is able to benefit from the veterinarian during that time, the treatment received by the animal reduces the risk of disease transmission to other animals and subsequently the risk of further economic losses.

Vaccination programs, tick control, and diagnostic support also belong to the special category of private goods whose consumption involves externalities. Vaccination and dipping for tick control protect animals from disease, but at the same time, reduce the risk of exposure of other animals (and humans in the case of zoonoses) to the disease. Diagnostic support enables a farmer to discover the disease affecting his/her livestock as well as inform other farmers of the occurrence of a potentially dangerous contagion in the vicinity. It should be noted that the effectiveness and success of these

programs in controlling the outbreak of a disease or in totally eliminating it depend on the full compliance of the majority of livestock producers with the specifications of the program. The failure of several producers to follow the requirements of the program (e.g. to properly vaccinate all animals) can cause the resurgence of the disease and jeopardize the health and productivity of the stock of animals of all other farmers. As noted in Table 2.1, these preventive measures are often the only line of defense against some of the major diseases of livestock. Thus, their effective enforcement becomes of critical importance. Tse-tse control in open ranges is a public good, since its benefits extend to the whole community and is subject to the free-rider problem. In cases where the mobility of the carriers can be restricted through the installation of special screens and traps (already in use in the Central African Republic), tse-tse control is classified as a private good with externalities.

Animal quarantine is a public-sector policy intervention to overcome the market failure resulting from externalities arising from the easy transmission of diseases across animals. Measures such as vaccination, vector control, and eradication programs are aimed at reducing or eliminating the occurrence of transmittable diseases. But farmers are not likely to take into account the impact of these diseases on other farmers and will consequently underinvest in these measures. Quarantine thus serves as a second line of defense against the spread of diseases. Drug quality control and food hygiene/inspection are similarly public-sector policy responses to the moral hazard problems associated with the processing and distribution of veterinary pharmaceuticals and livestock products respectively, since their quality cannot be readily evaluated.

SECTORAL DELIVERY OF LIVESTOCK SERVICES

The various types of livestock services are classified above as purely public goods, purely private goods, private goods with externalities, or policy measures to correct for externalities and moral hazard problems. The last column of Table 3.1 lists the expected sectoral channels for each of these livestock services based on the economic principles discussed.

Vaccine and semen production, artificial insemination, and the production and distribution of veterinary pharmaceuticals are private goods, thus they can be provided feasibly and efficiently by the

private sector. Extension services and research can be performed by the public or private sector; the sectoral channel will be a function of the type of service provided and the medium employed. Veterinary surveillance, being a public good, will have to be performed by the public sector to insure its optimum availability. Similarly, quarantine, drug quality control, and food hygiene/inspection will be performed by the public sector, owing to the fact that they are policy measures to correct for the externalities associated with the delivery of other livestock services and moral hazard problems. Although veterinary surveillance, quarantine, drug quality control, and food hygiene/inspection may be subcontracted by the government to the private sector, such an arrangement will have to be accompanied by stringent monitoring and regulation by the government to ensure their effective performance and optimal supply. Consequently, the ultimate responsibility for their delivery is still vested upon the public sector.

Diagnostic support, vaccination, and vector control (tick and tse-tse) services can be provided by the private sector, although public-sector intervention is economically justified due to the externalities associated with the delivery of these services. So long as mechanisms exist to internalize or account for the externalities, these activities can be efficiently performed by the private sector. The extent of public-sector involvement in the delivery of these services therefore becomes a function of the degree to which the private sector is able to internalize these externalities and thus provide an optimal supply of the services. The nature of public-sector intervention will depend upon the type of externality involved and may range from monitoring and regulation to insure compliance, the imposition of penalties for non-compliance, subsidization of services to raise consumption to socially optimal levels, or in extreme cases (e.g. zoonotic diseases and FMD which affects exports), public provision of the service. In the special case of tse-tse control in open ranges, its public good character, with its associated free-rider problem, requires that this activity remain in the public domain.

Clinical diagnosis and treatment are generally private goods and their provision should remain a private sector activity. The exception is clinical intervention pertaining to infectious diseases. This involves externalities which justify public intervention, e.g. the subsidization of the activity. However, a small percentage of the animals, despite being cured of the infectious disease, will remain carriers of the disease. Due to the imperfect nature of clinical interventions, because subsequent disease outbreaks

can lead to substantial economic losses, preventive measures such as vaccination and the slaughter of diseased animals are the recommended strategy since they are more cost effective alternatives to clinical intervention. In the case of slaughtering diseased animals, remuneration of farmers for the slaughtered animals will require public subsidy.

Theoretically, public intervention is economically justified if the service involves externalities in order to reduce or raise utilization to socially optimal levels. In practice, however, some activities, such as clinical intervention (which can be efficiently provided by the private sector) and vaccination and diagnostic support (which may require public intervention), may not always be completely separable. For example, a veterinarian who provides all three services has to travel to a distant clinical post to provide them. If the transport costs to provide the latter two services require public subsidies, the separation of the transport costs associated with clinical intervention alone becomes administratively difficult. Thus, in such special cases, a subsidy to promote diagnostic support and vaccination (e.g. a subsidy of transportation costs) may unavoidably spillover to clinical intervention. This should <u>not</u> be perceived, however, as a justification for subsidization of clinical intervention. Clinical intervention should exclusively be a private sector activity and only private goods with externalities such as vaccination and diagnostic support should be subject to subsidization.

The effectiveness of public-sector provision of goods and services, however, tend to be constrained by several factors. In some nations, the pursuit of multiple objectives (e.g. the public employment of all local veterinary graduates, insuring the availability of all livestock services, supplying these services at free or subsidized prices to consumers, and/or promoting the interests of special livestock groups) causes severe strain on the limited budgetary resources of governments and results in trade-offs between the availability and quality of services rendered. Multiple levels of management, which characterize most government services, lead to excessive bureaucracy and reduces institutional ability to adapt to the changing economic environment. Furthermore, since government activities often seek to maximize output rather than profits, managers and workers generally are not concerned with keeping costs to a minimum, thus leading to operational inefficiencies (Vogelsang, 1990). This is often

further exacerbated by management structures that do not lend themselves to accountability for effective performance and reward systems that are often disassociated with levels of productivity.

Whether the provision of these services actually follow what economic theory prescribes is the subject of the next chapter. It describes the actual conduits for livestock services and how efficiently these services are being provided in different countries.

THE STRUCTURE OF THE LIVESTOCK SERVICES SECTOR 4

The sectoral channel of delivery of livestock services varies significantly across countries and within countries over time. This chapter focuses on how these services are functionally distributed between the public and private sectors in individual countries. The first section provides a brief overview of the availability and quality of livestock services worldwide. The second section presents a global survey of the sectoral channel of livestock services delivery and the degree of financial recovery pursued by each country. Nine country case studies supplement the global survey and these are presented in Appendix A. Finally, the results of the estimation of breakeven VLUs for a private veterinary practice in Cameroon, Guinea, Kenya and Uganda are discussed.

THE SUPPLY OF LIVESTOCK SERVICES

The availability and quality of livestock services are major determinants of the performance of the livestock sector. As noted in the first section of this study, livestock services perform the dual function of reducing production losses and improving animal performance and product quality. One important question then is, how available are they worldwide.

Data on the livestock services sector (both quantitative and qualitative) are scant and approximate measures have to be used in analyzing their availability and quality. A simple approach for measuring livestock services availability is estimating the number of veterinary livestock units (VLUs) per veterinarian and per veterinary auxiliary.[5] Since the veterinarian and the veterinary auxiliary personnel are the primary providers of livestock health services, these ratios provide a quick though very

[5] The veterinary livestock unit is an animal unit introduced to aggregate the work requirements for animal health care of different livestock species. A veterinary livestock unit is equivalent to 1 cow or 1 camel or 2 horses or 2 pigs or 2 donkeys or 10 small ruminants or 100 fowl (De Haan and Bekure, 1990).

approximate measure of the supply of livestock health services.[6] Sandford (1983, p.177) suggests 20,000 VLUs per veterinarian as the appropriate ratio for curative and preventive work in extensive production systems such as those found in Africa and the Middle East, 5,000 VLUs per veterinarian in intensive production systems found in Tropical Asia (in particular India), and 2,500 VLUs per veterinarian in intensive production systems as is found in European countries. For countries characterized by a combination of extensive and intensive production systems (North America, South America, Asia, and Oceania), the average of the recommended ratios for extensive and intensive systems (12,500 VLUs per veterinarian) is taken by the authors as the standard. It should be noted, however, that these ratios are very approximate estimates of optimal supply, because accurate ratios of optimal veterinary service supply require detailed information on veterinary practice cost and returns, which are not currently widely available. The last section of this chapter, nonetheless, presents a first attempt at estimating such a ratio in four African countries: Cameroon, Guinea, Kenya, and Uganda.

The results of this analysis are presented in Table 4.1. Countries in the Middle East displayed ratios ranging from 653 to 16,170 VLUs per veterinarian, all substantially below the recommended ratio of 20,000 VLUs per veterinarian, indicating a surplus of veterinary services. On the other hand, 27 of the 48 African countries (56%), exhibited a shortage of veterinarians; Mauritania registered the highest ratio of 229,607. Notably, as a counter measure to the smaller supply of trained veterinarians in Africa, greater reliance is placed on the services of veterinary auxiliary personnel. Their greater number, in comparison to other regions, is clearly manifested in the number of VLUs per veterinary auxiliary. Most of the African countries exhibited relatively low ratios from 2,000 to 15,000 per auxiliary.

India displayed a ratio of 10,861 VLUs per veterinarian, a figure significantly higher than the recommended 5,000 VLUs. While most of the European countries displayed ratios well within the standard of 2,500 VLUs per veterinarian, seven countries (Denmark, France, East Germany, Ireland, Netherlands, Poland, and Romania) displayed ratios above the standard indicating an excess demand for

---

[6] The values used in calculating this ratio are national average figures of livestock population and number of veterinarians and auxiliary personnel. Thus, it does not take into account intra-country locational differences in availability.

veterinarians. In contrast, North America and Oceania displayed a more than adequate supply of veterinarians with ratios (2,912 - 12,204) below the standard of 12,500 VLUs per veterinarian. Central America, South America, and Asia displayed a broad range of ratios, but most of the countries are within the standard of 12,500 VLUs per veterinarian.

Auxiliary personnel possess only a few years of formal veterinary training; their functions in most cases are limited to preventive care and the performance of simple clinical procedures. Although field experience can greatly enhance their capabilities, they largely complement but cannot substitute for the services of a veterinarian. Thus, the proportion of veterinarians relative to auxiliary personnel can serve as an indicator of the quality of veterinary services that are potentially available.[7] Based on such a standard, there exists a large disparity in the quality of livestock services available between Africa and all the other regions.

PUBLIC AND PRIVATE DELIVERY OF LIVESTOCK SERVICES

Veterinarians are the primary channel for the delivery of livestock health services. One indicator of the degree of privatization in the area of livestock health services is thus the rate of participation of private veterinarians; this can be measured by taking the ratio of the number of government to private veterinarians in each country. The results of this estimation are presented in Table 4.1. A ratio greater than 1 indicates public dominance in the livestock services sector.

Europe, North America, Oceania, and most of Central and South America and Asia registered ratios less than 1, indicating the highly dominant role played by the private sector. Twenty-six of the 58 countries (45%) in these regions had ratios of less than 0.50, while 11 countries (19%) had ratios of less than 0.20. In contrast, Africa (with the exception of South Africa and Zimbabwe) and most of the Middle East exhibited significantly high ratios, with the highest ratio, 45.3, registered by Jordan. Nevertheless, most countries displayed declining ratios between 1984 and 1989, indicating a trend towards

[7] The availability of veterinarians does not necessarily imply that they are able to practice their vocation to the fullest extent possible. Several factors may constrain their doing so, e.g. government restrictions, lack of access to veterinary supplies, and inadequate transport facilities and infrastructure.

Table 4.1: Selected data on livestock and the livestock services sectors.

COUNTRY	% LIVESTOCK/ AGRIC. 1988	% LIVESTOCK/ GDP 1988	VETERINARY LIVESTOCK UNIT (1989) PER VET	VETERINARY LIVESTOCK UNIT (1989) PER AUX. PERS.	RATIO OF GOVT/PRIV VETS 1984	RATIO OF GOVT/PRIV VETS 1989	RATIO OF AUX/ GOVT + PRIV VETS 1984	RATIO OF AUX/ GOVT + PRIV VETS 1989
AFRICA								
Algeria	41.50	1.70	7813	6105	309.00	8.00	4.25	77.78
Angola	31.80	2.90	53139	12382		11.67		8.13
Benin	20.76	6.52	22774	6927	30.50	32.00	5.48	3.98
Botswana	88.43	5.32	97483	1800	9.33	18.00	17.42	85.53
Bukina Faso	27.27	6.37	59981	11432		16.67		8.02
Burundi	5.68	0.36	10362	1438	21.00	21.50	0.09	9.29
Cameroon	15.79	1.77	55530	22914		29.33		2.96
Cape Verde			7788	1684			1.83	6.17
Central African Rep	31.68	10.28	126639	7363	6.00		45.57	86.00
Chad	38.99	20.52	90141	10527				11.18
Congo	9.68	0.68	2038	469		1.00		26.08
Côte d'Ivoire	5.14	1.32	16727	1776	10.00	13.33	16.06	12.05
Djibouti			56400	13271			5.67	4.25
Egypt	26.52	6.20	431	642	31.67	8.62	0.20	0.89
Equatorial Guinea			1589	2043				1.00
Ethiopia	40.06	22.85	117754	24363			33.90	5.50
Gabon	10.47	0.28	12680	3623		0.00		5.83
Gambia	15.15	7.08	31177	2316			17.92	25.00
Ghana	9.16	2.31	16185	2154	84.00	35.67	10.74	8.88
Kenya	37.51	9.81	26223	7086	7.08	20.16		4.38
Lesotho	69.47	15.47	46841	13212	7.00	16.00	6.13	4.59
Liberia	9.13		18900	4423	6.00	5.00	5.57	7.83
Libya	49.68	1.45	5256	2766		42.17	3.70	2.21
Madagascar	26.74	18.87	110243	11622		16.20		11.58
Malawi	11.79	7.07	43271	2230		17.00	11.64	37.72
Mali	44.07	17.90	13576	11247	52.00	29.00	19.74	10.78
Mauritania	84.04	16.18	229607	15454			11.41	14.86
Mauritius	13.19	1.16	2180	2378		5.00		1.38
Morocco	35.13		17082	4534	3.71	2.92	3.09	5.47
Mozambique	20.10	12.72	21505	5544			6.19	6.19
Namibia	81.67	12.93	84911	15587	4.71	2.63	11.73	7.14
Niger	47.08	13.47	111688	6556				25.11
Nigeria	17.88	5.88	11323	3942		3.30		4.07
Reunion	24.36		5743	4307		0.14		1.75
Rwanda	10.85	3.01	24435	1825	20.00	15.00	33.76	17.16
Senegal	21.05	3.45	59126	7558	30.50	9.75		12.37
Sierra Leone	11.67	3.06	24452	7034	11.00	8.50	4.00	3.84
Somalia	72.50	49.13	43577	9566				6.31
South Africa	49.20	3.78	11739	22336	0.21	0.19	1.03	0.65
Sudan	58.30	21.23	34390	36852			1.66	1.08
Swaziland	24.35	7.68	43810	3319	12.00	6.50	33.54	17.60
Tanzania	22.63	20.47	60962	6923		15.00		16.73
Togo	11.35	2.71	11238	6591		5.60		3.15
Tunisia	29.53	4.10	4499	5138	25.29	6.82	1.63	1.48
Uganda	14.23	8.25	13531	2708	26.62	23.47	15.12	5.71
Zaire	5.22	1.47	2737	1537	1.25	2.54	3.78	3.10
Zambia	32.07	4.67	28854	5723	6.00	30.00	10.69	15.61
Zimbabwe	22.87	4.41	21892	4162	0.95	1.31	21.29	6.86
NORTH AMERICA								
Canada	37.85	1.34	3306	4149	0.27	0.16	0.24	0.84
United States	46.70	1.33	2912	5660	0.13	0.06	0.26	0.66

Table 4.1 cont'd: Selected data on livestock and the livestock services sectors.

COUNTRY	% LIVESTOCK/ AGRIC. 1988	% LIVESTOCK/ GDP 1988	VETERINARY LIVESTOCK UNIT (1989) PER VET	VETERINARY LIVESTOCK UNIT (1989) PER AUX. PERS.	RATIO OF GOVT/PRIV VETS 1984	RATIO OF GOVT/PRIV VETS 1989	RATIO OF AUX/ GOVT + PRIV VETS 1984	RATIO OF AUX/ GOVT + PRIV VETS 1989
CENTRAL AMERICA								
Belize			8075	8972		5.00	1.50	1.50
Costa Rica	38.26	7.52	4489	19086	0.39	0.37	0.29	0.26
El Salvador	25.40	3.49	6871	18821	0.83	0.54	0.54	0.38
Guatemala	26.31	4.11	7300	14567	0.36	0.35	0.59	0.58
Honduras	27.07	4.26	23310	20175	0.77	1.67	1.40	1.39
Mexico	47.04	4.45	5694	4807	8.40	0.38	1.30	1.68
Nicaragua	33.79		22245	26694	3.06	0.80	0.93	1.00
Panama	44.53	4.83	4448	7623	1.23	0.89	0.90	0.63
SOUTH AMERICA								
Argentina	47.56	9.23	10748	53550		0.15		0.20
Bolivia	46.59	11.44	8362	273329	1.42	0.07	0.25	0.03
Brazil	30.14	3.93	7295	20307		1.79		0.58
Chile	41.30	4.80	2615	71209	0.87	0.23		0.04
Colombia	42.96	7.69	4708	70056		0.63		0.09
Ecuador	88.00	16.32	93967	44621			2.18	2.39
Paraguay	28.16	13.97	9556	5807	0.79	0.93	0.30	1.90
Peru	39.66	5.29	3588	22503	0.97	0.47	0.29	0.20
Surinam	24.49	0.19	16711	7520	4.00	8.00	4.40	2.22
Uruguay	78.83	17.16	7933	16691		0.19	3.21	0.48
Venezuela	59.59	2.99	4098	19077	0.40	0.14	0.14	0.24
ASIA								
Afghanistan	41.62		24828	13659		9.43		2.53
Bangladesh	15.13	5.63	31136		89.40	29.92	3.35	
Bhutan	25.58	7.77	31784	1847			35.50	65.40
Hongkong	73.86	0.12	5923	870	0.89	0.41	13.35	9.00
India	19.34	5.32	10861	5280	22.00	45.04	2.39	2.32
Indonesia	9.97	2.25	7630	17919		0.60		0.79
Japan	54.14	0.34	569		1.47	0.57		
Korea (Dem.)	14.25		508	106		0.46		5.06
Korea (Rep.)	33.44	1.14	839		0.34	0.62		
Laos	34.22	41.11	63231	1114				113.48
Malaysia	14.85	2.31	4607			1.07		
Mongolia	77.85		5899	2328				3.19
Myanmar	12.27		8008	19668	2.09	1.22	0.59	0.45
Nepal	31.10	14.72	63286	7699	39.50	26.83		8.51
Pakistan	41.67	14.91	20215	9241				
Philippines	20.58	3.52	3364	5517	0.36	0.34		1.34
Singapore	97.70	0.69	3189	1400	0.67	0.57	9.33	3.15
Sri Lanka	9.16	2.26	13393	3995	8.12	12.47	3.76	3.86
Thailand	16.84	3.17	14186	3258		1.20		6.23
Vietnam	22.47	23.90	5478	983		79.60		6.50
MIDDLE EAST								
Bahrain			653	1100	9.00	3.00	1.20	1.19
Iraq	34.68		1126	1839		18.20		1.31
Israel	44.65	1.30	1443	5232	1.55	1.00	0.71	0.52
Jordan	53.37	3.10	4786	18824	1.90	45.33	0.41	0.32
Kuwait			2843	2378	5.20	2.40	1.44	1.21
Lebanon	38.94		4806	8278	1.27	0.64	0.84	0.88
Oman			4840	3267		9.00		3.00
Qatar			1649	4829	0.73	7.50	0.11	0.41
Saudi Arabia	54.12	1.13	16170	10054				1.61
Syria	33.93	8.06	1238	2804		0.34	1.73	0.49
Turkey	22.71	5.15	6482			1.25		
United Arab Emirates			1965	3189	3.88	0.30	1.33	0.63

Table 4.1 cont'd: Selected data on livestock and the livestock services sectors.

COUNTRY	% LIVESTOCK/ AGRIC. 1988	% LIVESTOCK/ GDP 1988	VETERINARY LIVESTOCK UNIT (1989) PER VET	VETERINARY LIVESTOCK UNIT (1989) PER AUX. PERS.	RATIO OF GOVT/PRIV VETS 1984	RATIO OF GOVT/PRIV VETS 1989	RATIO OF AUX/ GOVT + PRIV VETS 1984	RATIO OF AUX/ GOVT + PRIV VETS 1989
EUROPE								
Albania	43.45		877	1612				22.23
Austria	66.66	1.81	1449			1.30		
Belgium	72.65	1.92	1773		0.03	0.06		
Denmark	69.51	3.25	3075	45071	0.56	0.42	0.03	0.11
Finland	75.28	1.23	2476	35564	5.58	3.57	0.04	0.11
France	51.62	1.88	5008	15468	0.08	0.09	0.24	0.37
Germany, D. R.	60.95		3015	4230		60.00		5.71
Germany, F. R.	69.36	1.27	2012	3209	0.20	0.15		1.23
Greece	28.14	2.82	1528	9739	1.77	2.56	0.22	0.20
Hungary	48.95	12.61	2089		0.74	0.60	0.37	
Ireland	85.98	8.78	4738		0.26	0.22		
Italy	37.38	1.00	1310		0.70	0.59		
Luxembourg					0.32	0.15		
Netherlands	77.92	3.42	3894	12181	0.19	0.15	0.12	0.52
Norway	78.23	0.99	1236		0.52	0.47		
Poland	45.24	12.54	2891	4693		105.36		0.77
Portugal	44.00	2.55	2199			3.34		
Romania	35.07		5286	1675			4.19	3.80
Spain	35.15	1.83	1384			2.94		
Sweden	60.47	0.88	1918	16207	2.94	1.96	0.19	0.39
Switzerland	76.63	0.94	2244	24687	0.15	0.15		0.16
United Kingdom	63.77	1.21	2489	7673	0.57	0.08		0.37
Yugoslavia	46.74	6.30	2405	1494				1.88
OCEANIA								
Australia	6.43	3.38	8173	14691	0.21	0.22	1.22	0.65
New Zealand			12204	14170	0.38	0.23	2.02	1.15

Note: One veterinary livestock unit (VLU) equals 1 cow, 1 camel, 2 horses, 2 pigs, 2 donkeys, 10 small ruminants, or 100 fowl.

Source: The veterinary livestock units (VLUs) were estimated using livestock numbers from Appendix B, Table B1.1. Livestock values as a percentage of the value of total agricultural production and GDP are from Appendix B, Table B1.2. The data used in estimating the ratio of the number of government to private veterinarians and the number to auxiliaries to government and private veterinarians are from Appendix B, Table B1.3.

increasing private-sector participation. Of the 126 countries studied, only 14 exhibited increasing ratios; 6 of the 14 countries showed a drastic rise in government involvement during the same period. In particular, the ratio of government to private veterinarians more than doubled in Kenya, Lesotho, Zambia, Peru, Hongkong, and Jordan.

Sectoral Channel of Livestock Services

Livestock services consist of several components and the channel through which each of these components is delivered varies significantly across countries. Although the public and private-sector distribution of responsibilities for these services is continually evolving over time, a global snapshot of how these services are currently being delivered serves as an important tool in understanding the public and private interactions within the sector. However, a major constraint in the study of the livestock services sector is the unavailability of quantitative and qualitative information on its structure and operations. Recent data pertaining to public and especially private-sector activities in the livestock services sector are very scarce. In the context of such cogent data limitations, livestock specialists were asked to rate the degree of public and private-sector participation in the delivery of the different types of services. The data collected are based on expert evaluation of the current status of the livestock services sector; however, it is recognized that there may be some degree of bias in the results. Nonetheless, any new information, such as the trends and patterns revealed by the survey, will help shed more light on this area.

The services studied include clinical care (CLIN), vaccine production (VAC-P), delivery of vaccinations (VAC-D), vector (tick) control (VEC), veterinary surveillance (V-SUR), diagnostic support (DIAG), quarantine services (QUAR), veterinary drug quality control (DQC), food hygiene and inspection (FH/I), semen production (AI-P), artificial insemination services (AI-D), extension (EXT), veterinary research (VRES), and veterinary pharmaceutical production (VET-P) and marketing and distribution (VET-D). The channels for these services were classified according to whether they were supplied purely by the government (gg), purely by the private sector (pp), mainly by the government with some private-sector participation (ggp), mainly by the private sector with some government participation (gpp), equally by both government and private sectors (gp), or were not provided by both public and

private sectors (na). The information on public and private-sector activities was compiled primarily by means of personal interviews with livestock and agricultural specialists in the World Bank, the United States Department of Agriculture, and various embassies, supplemented by information from recent literature on the topic. The results of the survey are presented in Table 4.2.

Veterinary surveillance is a purely public good, while quarantine services, drug quality control and food hygiene/inspection are public-sector policy measures designed to correct market failures arising from externalities associated with the provision of other livestock services (e.g. vaccination and eradication programs) or to surmount moral hazard problems associated with the production and distribution of livestock products and supplies. As predicted by economic theory, veterinary surveillance, is largely monopolized by the public sector. Quarantine services, drug quality control, and food hygiene/inspection, because of their very nature, are also predominantly a public-sector activity. Some countries (e.g. Chile, Denmark, Germany, Ireland, and the United Kingdom), however, are beginning to share the responsibility for food hygiene/inspection with the private sector. This function is subcontracted to private veterinarians on a part-time basis by the government. However, a distinction must be made in such special cases. Although food hygiene inspection is being performed by private veterinarians, their part-time employment by the government defines their status as civil servants. Consequently, the moral hazard problems are still surmounted because they function as extensions of the government.

Extension exhibits both public and private good characteristics. When its public good facet is dominant and the free-rider problem becomes a critical constraint, the incentive for private supply is obviated and public-sector intervention becomes essential to insure a socially optimal supply. In fact, extension continues to be monopolized by the government in Africa and most of Asia and Latin America. However, in other regions, the private sector has turned this liability into an asset. In North America, Western Europe, Australia, and the Philippines, livestock services extension is an integral component of private-sector marketing strategy. Information regarding livestock up-grading, improved production practices, hygiene and sanitation, and feeding is being provided by private veterinarians and sales agents of agribusiness and veterinary pharmaceutical companies as a complementary service. Due to increasing

Table 4.2 : Sectoral channel for delivering livestock services, 1991.

COUNTRY	NATURE OF INTERVENTION														
	CLIN	VAC-P	VAC-D	VEC	VSUR	DIAG	QUAR	DQC	FH/I	AI-P	AI-D	EXT	VRES	VET-P	VET-D
AFRICA															
Algeria	ggp	gg	gg	na	gg	gg	gg	gg	gg	na	na	gg	gg	na	
Angola	ggp				gg	gg	gg	gg	gg	na	na	gg	gg		
Benin	ggp	na	gg	na	gg	gg	gg	gg	gg	na	na	gg	gg	na	ggp
Botswana	gpp	pp	gp	gp	gg	gg	gg	gg	gg	na	na	gg	gg	pp	gp
Burkina Faso	ggp	na	gp	gp	gg	gg	gg	gg	gg	na	na	gg	gg		gp
Burundi	ggp	na	gg	ggp	gg	gg	gg	gg	gg	na	na	gg	gg	na	ggp
Cameroon	ggp	gg	gg	ggp	gg	gg	gg	gg	gg	na	na	gg	gg	na	ggp
C. African Rep.	gpp	na	gp	gpp	gg	gg	gg	gg	gg	na	na	gg	gg	na	pp
Chad	ggp	gg	ggp	gg	gg	gg	gg	gg	gg	na	na	gg	gg	na	gp
Congo	ggp	gg	gg		gg	gg	gg	gg	gg	na	na	gg	gg	na	ggp
Côte d'Ivoire	ggp	gg	ggp	ggp	gg	gg	gg	gg	gg	na	na	gg	gg	na	gp
Egypt	ggp				gg	gg	gg	gg	gg			gg	gg	na	
Ethiopia	gpp	gg	ggp	gp	gg	gg	gg	gg	gg	gg	gg	gg	gg	na	ggp
Gabon	gg	na	ggp	gp	gg	gg	gg	gg	gg	na	na	gg	gg	na	ggp
Gambia	ggp	na	ggp	ggp	gg	gg	gg	gg	gg	na	na	gg	gg	na	gp
Ghana	ggp	gg	ggp	ggp	gg	gg	gg	gg	gg	na	gp	gg	gg	na	gp
Kenya	gp	gp	gp	gp	gg	gg	gg	gg	gg	ggp	gp	gg	gg	pp	gp
Madagascar	ggp	gg	ggp	ggp	gg	gg	gg	gg	gg	gg	gp	gg	gg	na	gp
Mali	ggp	gg	ggp	ggp	gg	gg	gg	gg	gg	na	pp	gg	gg	na	gp
Mauritania	ggp	na	ggp	ggp	gg	gg	gg	gg	gg	na	na	gg	gg	na	ggp
Morocco	gp	pp	gp	gp	gg	gg	gg	gg	gg	ggp	gpp	gg	gg	na	gp
Niger	ggp	gg	gg	gg	gg	gg	gg	gg	gg	na	na	gg	gg	na	ggp
Nigeria	ggp	gg	ggp	ggp	gg	gg	gg	gg	gg	gg	gg	gg	gg	na	gp

Table 4.2 cont'd : Sectoral channel for delivering livestock services, 1991.

COUNTRY	NATURE OF INTERVENTION														
	CLIN	VAC-P	VAC-D	VEC	VSUR	DIAG	QUAR	DQC	FH/I	AI-P	AI-D	EXT	VRES	VET-P	VET-D
AFRICA cont'd															
Rwanda	ggp		ggp	ggp	gg	gg	gg	gg	gg			gg	gg	na	gg
Senegal	ggp	gg	ggp	ggp	gg	gg	gg	gg	gg	gg	ggp	gg	gg	na	gpp
Somalia	ggp		ggp	ggp	gg	gg	gg	gg	gg	na	na	gg	gg	na	
Sudan	gg	gg	gg	ggp	gg	gg	gg	gg	gg	ggp	gp	gg	gg	na	gg
Tanzania	ggp	gg	ggp	ggp	gg	gg	gg	gg	gg	ggp	gg	gg	gg	na	gpp
Togo	ggp		gg	gg	gg	gg	gg	gg	gg			gg	gg	na	gp
Tunisia	ggp	gg	ggp	gg	gg	gg	gg	gg	gg	ggp	ggp	gg	gg	na	ggp
Uganda	gp	gg	gp	gp	gg	gg	gg	gg	gg	gp	gp	gg	gg	na	gpp
Zimbabwe	gp	gg	gg	ggp	gg	gg	gg	gg	gg	gp	gp	gg	gg	na	pp
NORTH AMERICA															
Canada	pp	pp	pp	pp	gg	gpp	gg	gg	gg	pp	pp	gpp	gpp	pp	pp
United States	pp	pp	pp	pp	gg	gpp	gg	gg	gg	pp	pp	gpp	gpp	pp	pp
OCEANIA															
Australia	pp	gpp	gpp	gp	gg	gg	gg	gg	gg	pp	pp	gpp	gpp	pp	pp
SOUTH AMERICA															
Argentina	gp	pp	ggp	gpp	gg	gg	gg	gg	gg	pp	pp	gpp	gg	pp	pp
Brazil	gp	gpp	gpp	gpp	gg	gg	gg	gg	gg	gp	gp	gp	gg	pp	gp
Chile	gp	pp	pp	ggp	gg	gg	gg	gg	gp	pp	pp	gpp	gp	pp	pp
Peru	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	pp	pp
Uruguay	pp	gp	pp	pp	gg	gp	gg	gg	gg	pp	pp	gp	gp	pp	pp
ASIA															
China	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg
India	ggp	gg	gp	gp	gg	gg	gg	gg	gg	ggp	ggp	ggp	gg	pp	gp
Indonesia	ggp	gg	gg	ggp	gg	gg	gg	gg	gg	gg	gg	gg	gg	pp	ggp
Malaysia	gp	gg	gg	ggp	gg	gg	gg	gg	gg	gg	gg	ggp	gg	pp	ggp

Table 4.2 : Sectoral channel for delivering livestock services, 1991.

COUNTRY	NATURE OF INTERVENTION														
	CLIN	VAC-P	VAC-D	VEC	VSUR	DIAG	QUAR	DQC	FH/I	AI-P	AI-D	EXT	VRES	VET-P	VET-D
ASIA cont'd															
Pakistan	ggp	gg	ggp	ggp	gg	gg	gg	gg	gg	ggp	ggp	ggp	gg	pp	ggp
Philippines	gpp	gg	ggp	gpp	gg	gg	gg	gg	gg	ggp	ggp	gpp	gg	pp	gp
Thailand	ggp	gg	gg	gp	gg	gg	gg	gg	gg	ggp	ggp	ggp	gg	pp	gp
Vietnam	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg		gg
EUROPE															
Denmark	pp	gg	gp	pp	gg	gp	gg	gg	gp	pp	pp	pp	ggp	pp	pp
France	pp	pp	gpp	pp	gg	ggp	gg	gg	gg	gg	gp	gp	ggp	pp	pp
Germany	pp	pp	gp	pp	gg	gp	gg	gg	gp	gp	gp	gp	gp	pp	pp
Hungary	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg
Ireland	pp	pp	gp	pp	gg	gp	gg	gg	gp	gp	gp	gp	gp	pp	pp
Poland	gp	gp	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg
Romania	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg
United Kingdom	pp	gp	gp	pp	gg	gp	gg	gg	gp	pp	pp	gp	gp	pp	pp
Yugoslavia	gp	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg	gg		gg

Notes: CLIN - clinical care; VAC-P - vaccine production; VAC-D - delivery of vaccinations; VEC - vector control; VSUR - veterinary surveillance; DIAG - diagnostic support; QUAR - quarantine; DQC - drug quality control; FH/I - food hygiene and inspection; AI-P - semen production; AI-D - artificial insemination; EXT - extension; VRES - veterinary research; VSUP-P - veterinary drug production; VSUP-D - veterinary drug marketing and distribution. Sectoral channels: gg - purely government; pp - purely private; ggp - mainly government with some private participation; gpp - mainly private with some government participation, gp - active participation of both government and private sectors; na - not applicable.

Source: Livestock services survey.

competition in the livestock services market, complementary livestock services extension is designed to promote and strengthen customer loyalty and expand market shares. In Argentina and Brazil, however, the structure of the livestock industry has enabled private consulting firms specializing in the provision of technical and extension services to flourish.[8] These private consulting firms thrive because their services are so tailored to the needs of a specific farmer or group of farmers that the services they offer may not necessarily be relevant to other producers, thus minimizing free-rider problems. Moreover, there is a growing tendency towards market segmentation in extension services in the two countries. Private consulting firms cater to the specialized technical and extension needs of the large-scale farmers, while government efforts have concentrated on the medium and small-scale enterprises. Such an industry structure may be attributed to that fact that because of their sizeable operations, the large-scale farmers can take advantage of economies of scale in the use of the services offered by the consulting firms.

Similarly, veterinary research exhibits both public and private good characteristics and the sectoral performance of this function will depend on the type of research performed. The survey shows that veterinary research remains a government function in most developing countries. Such public-sector dominance of veterinary research is partly attributable to the fact that the market for new livestock products (e.g. new breeds and drugs) in many developing countries is still small or undeveloped and thus makes private research unprofitable. In developed nations, agribusiness (e.g. feed suppliers) and veterinary drug companies and privately-funded research institutes also conduct research on the development of improved breeds, feeds, and husbandry management, and new vaccines and drugs. These firms generally cater to larger markets (domestic and/or foreign), thus they are able to take advantage of economies of scale. Furthermore, because they usually hold proprietary rights to their research output, they are able to appropriate the returns on their investments. Consequently, there is adequate incentive for private research.

Most clinical interventions are private goods. The only exceptions are activities pertaining to the treatment of infectious diseases, which involves externalities. Nonetheless, public intervention is

[8]Refer to the casestudy "Livestock Services Delivery in Brazil" in Appendix B for details on the extension activities of private consulting firms.

most cost effective if directed at preventive measures such as vaccination or slaughter of afflicted animals. Thus, it is expected that clinical interventions should be predominantly private. The survey results, however, show mixed results. Clinical intervention was largely private in developed countries and largely public in developing countries.

Clinical care is only exclusively provided by the private sector in Uruguay, Australia, New Zealand, North America, and the Western European countries; in the rest of the world, public-sector involvement varies significantly. In most countries classified as "ggp", the private sector primarily provides clinical services to the medium and large-scale livestock enterprises, while the government supplies the clinical needs of the small-scale farmers. The segmentation of the market largely derives from the fact that medium and large-scale enterprises can take advantage of economies of scale when it comes to livestock services. Although they require greater amounts of livestock health services, they are able to spread their costs over a greater number of animals so that their per units costs are lower. Health services are therefore more affordable to these farmers. In fact, a survey by Wise (1988a) of 894 beef producers, 338 hog producers, and 395 sheep producers in the United States show that the cost of veterinary services per animal for beef cattle, dairy cattle, sheep and hog operations generally declines as herd size increases (Table 4.3). The cost of animal health products and veterinary services per animal decreases from the small to large-scale beef, hog, and sheep operations, indicating economies of scale. The hog and sheep enterprises, however, display a slight increase in the cost of veterinary service and animal health products respectively in the medium scale. Dairy production, on the other hand, exhibits diseconomies of scale in animal health products and economies of scale in veterinary services. In all cases, livestock farmers spend proportionately more on livestock health products and less on veterinary services as their scale of operation increases.

Vaccinations are classified as private goods, but at the same time, their consumption involves externalities. According to economic theory, the presence of these externalities will lead to an underinvestment in these services, thus necessitating public involvement in these activities to insure their optimal use. The survey results confirm this hypothesis. Public-sector intervention ranged from mere regulation to complete public-sector vaccination coverage of the livestock population.

Table 4.3: Livestock health expenditures in the United States, 1985.

VARIABLE	HERD SIZE					
	1-49		50-99		≥100	
I. BEEF						
Times used veterinarian/yr	3		4		6	
Ani. Health Expenses/animal						
Animal health products	$6.35	55%	$5.38	64%	$4.65	69%
Veterinary service	$5.19	45%	$3.08	36%	$2.10	31%
Total	$11.54	100%	$8.46	100%	$6.75	100%
II. DAIRY CATTLE						
Times used veterinarian/yr	15		20		25	
Ani. Health Expenses/animal						
Animal health products	$13.16	50%	$13.38	50%	$14.49	57%
Veterinary service	$13.16	50%	$13.31	50%	$10.87	43%
Total	$26.32	100%	$26.69	100%	$25.36	100%
III. HOGS						
Times used veterinarian/yr	5		6		6	
Ani. Health Expenses/animal						
Animal health products	$13.33	73%	$12.92	69%	$5.27	83%
Veterinary service	$5.00	27%	$5.83	31%	$1.08	17%
Total	$18.33	100%	$18.75	100%	$6.35	100%
III. SHEEP						
Times used veterinarian/yr	4		5		6	
Ani. Health Expenses/animal						
Animal health products	$5.67	60%	$7.08	69%	$4.12	70%
Veterinary service	$3.73	40%	$3.12	31%	$1.76	30%
Total	$9.40	100%	$10.20	100%	$5.88	100%

Note: All values are median values.

Source: Wise, (1988a).

In African and Asian countries, vaccinations are predominantly (ggp's) or exclusively (gg's) conducted by government veterinarians and veterinary auxiliaries. In Brazil, Argentina, Morocco, and the West European countries, the government partially "subcontracts" its vaccination functions to the private sector particularly for vaccinations for the more critical infectious diseases such as FMD and brucellosis; these veterinarians serve as extensions of the public health programs. However, when farmers undertake vaccinations privately, compliance is strictly monitored by the government by such means as the issuance of vaccination certifications or the inspection of vaccination receipts (issued by the private veterinarian). Furthermore, private veterinarians in these countries undertake vaccinations for infectious diseases that are not included in the critical list by the government. In Canada, the United

States, Chile, and Uruguay, routine vaccinations are performed by private veterinarians or the livestock farmers themselves. The government veterinarians take on this function only when a new major disease is identified and an eradication campaign is set into motion. It is also generally the case in Africa, Asia, and Latin America that medium and large-scale farms raising improved breeds utilize the services of private veterinarians to vaccinate their animals, while small-scale farmers rely on the government for the same service. The inadequacy of coverage and/or occasional unreliability of government services have been inducements for medium and large-scale farmers to undertake their own vaccination programs.

As noted in the previous chapter, the effectiveness of vaccination campaigns depends on the degree of coverage of the livestock population; non-compliance by some farmers can jeopardize the whole program.[9] Similarly, farmers who leave their sick animals untreated can spur a disease outbreak in their locality. Several factors, however, contribute to reduce incentives for farmers to vaccinate or clinically treat their animals. First is the nature of the disease and the economic losses associated with it. The risk of economic losses is greater for some diseases than for others. For example, brucellosis causes abortions in cattle which leads to significant losses in production, whereas the lesions from FMD may be debilitating but treatable. Thus, losses from FMD may be less critical, especially in less intensive systems. At the same time, the economic losses from the same disease may vary depending on the production system. Production losses of dairy cattle due to FMD, which above all affects milk production, are generally significantly higher than for beef cattle. Given the differential risks of economic losses and subsequently differential net returns to clinical care or vaccination, some farmers may have less or no demand for clinical or vaccination services. Thus, adequate treatment of sick animals or full compliance with vaccination programs may not be achieved if it were left to market forces to direct farmer behavior. To illustrate the diversity in rates of return to vaccinations, Felton and Ellis (1978) reports a cost/benefit ratio 1:8 for the Rinderpest campaign in Nigeria, while Domenech *et al.* (1981) calculated an internal rate of return between 12 and 53 percent for Brucellosis control in Chad.

[9]The degree of coverage required for a successful vaccination program varies according to the disease targeted. For example, 60 percent coverage for Rinderpest campaigns is generally considered sufficient.

The nature of the disease also interacts with a second factor, the degree of homogeneity of the livestock population, specifically the relative proportions of traditional and improved breeds. The demand for clinical care and compliance with vaccination programs are complicated by the degree of homogeneity of the livestock population because traditional and improved breeds exhibit differential susceptibilities to specific diseases. Furthermore, improved breeds are generally of higher economic value than the traditional breeds. Since traditional breeds, in general, exhibit less susceptibility to some of the major infectious diseases, the potential losses from disease outbreaks are less. On the other hand, the greater economic value and higher susceptibility of improved breeds to some diseases implies greater the potential losses from diseases. Therefore, diversity in the population and the resulting differential risk of losses affects the economic incentives faced by different farmers. Owners of more disease tolerant breeds will have lower (or no demand) for clinical care or preventive services relative to owners of more susceptible breeds. In the African and Asian countries, the externality deriving from the diversity of the livestock population has been one of the major inducements for governments to undertake the vaccination program themselves.

A third factor which influences farmer incentives to invest in clinical care or vaccination services is the intensity of the production system. The intensiveness or extensiveness of the production system influences the demand for these services. For example, in Argentina, farms in the breeding areas generally follow extensive production systems. These producers find the gains to vaccination for FMD to be less than the cost of assembling the animals and inoculating them. On the other hand, in the intensive cattle fattening farms, where animals from the breeding farms are subsequently sent, producers face larger risks of losses from disease outbreaks and thus find vaccinations imperative. In order to insure that farmers in both the breeding and cattle fattening areas vaccinate their animals, the Argentinean government intervenes by monitoring compliance through the issuance vaccination certifications.

At the same time, from the private practitioner's point of view, the profitability and sustainability of private practice are determined by factors such as the size of the livestock enterprises, the density of livestock population per unit area, and public-sector livestock health service activities. Taking advantage of economies of scale, large-scale high density livestock enterprises have the capacity

to generate sufficient volume of business to sustain private practice. In predominantly smallholder and low density areas, the demand is often insufficient to sustain private practice. This arises because the private practitioner's transactions cost per animal may exceed the the smallholder's perceived returns from the service. Finally, in areas where publicly provided livestock services are available, private practitioners may not be able to compete with public services if these services are highly subsidized.

The "national" significance of the disease may necessitate government intervention to insure the effectiveness of a vaccination program or adequate use of clinical services. Some diseases are of greater economic and political importance than others, not only as a result of the production losses they cause, but also because of their adverse effects on humans and livestock product exports. Anthrax, brucellosis, tuberculosis, and rabies are transmittable to man; thus, the impact of these diseases transcends beyond their effect on livestock farmers to the rest of society. It is therefore no surprise that vaccination programs against these zoonoses in the countries surveyed are undertaken by the public sector, primarily to safeguard public health. FMD poses an additional hazard to beef exports; thus governments of beef exporting countries (e.g. Brazil and Argentina) find it in their best interest to assume control of FMD vaccination programs to insure their effectiveness.

Unless externalities vaccinations against diseases are internalized, there will be underinvestment in these services by farmers. Thus, in order to ensure that farmer participation in vaccination programs reaches socially optimal levels, governments in various countries have found it necessary to intervene either by imposing regulations for compliance or by directly providing and/or subsidizing the services.

Vector control (tick and tse-tse) similarly embodies externalities; consequently, public-sector involvement may be required to insure a socially optimal supply of the service. The survey showed that vector control is largely the shared responsibility of the public and private sector worldwide, although there is increasing private-sector participation. In Kenya, for example, the medium and large-scale livestock enterprises generally manage their own dip or spraying facilities, while the small-scale enterprises mainly rely on government-operated dip facilities. The risk of exposure to diseases resulting

from herd-mixing, the cost of moving animals to government dip facilities, the inadequacy/unreliability of government facilities in addition to economies of scale of large scale operations provide economic incentives for medium and large-scale farmers to operate their own facilities. In North America and Oceania, farmers generally operate their own dip or spraying facilities. Tse-tse control over open rangelands in severl African countries remains in the public domain due to its public good character. In some African countries, however, livestock farmers find it economical to install special screens and traps to control the tse-tse flies.

As a result of the externalities associated with their delivery, diagnostic services are predominantly performed by the public sector in Africa, Asia and South America. In Canada, the United States, Uruguay, Denmark, the Federal Republic of Germany, Ireland, and the United Kingdom, private veterinarians supplement government diagnostic services; they are an integral component of their veterinary practice. Increasing competition in the livestock services market to some extent explains private provision of these services.

Vaccines in most developing countries are produced by government research laboratories, although private companies (mostly subsidiaries of multinationals) have set up local plants for their production. In many cases, vaccine production is integrated with the production of veterinary drugs by the same private companies. In Kenya, Australia, Brazil, Uruguay, and the United Kingdom, the domestic vaccine requirement is supplied by both the public and private sectors; whereas domestic supply is exclusively produced by private firms in Botswana, Morocco, Canada, the United States, Argentina, Chile, and Western Europe.

Semen production and artificial insemination (AI) in countries whose livestock sectors are in their early stages of breed improvement are largely a public activity (e.g. Africa and Asia); private-sector semen production and AI activities are confined to the few established and usually large-scale farms or vertically integrated livestock cooperatives raising improved breeds (countries categorized as "ggp"). Often, these two services are integral components of livestock development programs initiated by the respective governments. Although semen production and AI are private goods, public-sector dominance

in these countries may be due to the fact that the demand for these services may not yet be sufficient to support private-sector investment. In countries with highly developed and technologically advanced livestock industries (e.g. Western Europe, Canada, the United States and most Latin American countries), semen production and artificial insemination is a standard component of livestock herd management and their provision tends to be shared by the government and private sector or is exclusively private.

The production of veterinary drugs is highly privatized and is dominated by several multinationals. These corporations generally establish local subsidiaries to supply the domestic veterinary drug requirements. Where local production plants are not present, these drugs are imported as is the case in most African and Asian countries. The marketing and distribution of these drugs in all countries are largely dependent on the channel through which the clinical services are provided. The veterinarians, publicly or privately, primarily dispense the veterinary drugs. Where the private sector is allowed to operate, veterinary pharmacies, veterinary sales agents, and livestock cooperatives are alternative sources for these items.

Membership in producer associations/cooperatives has been an effective measure taken by small farmers to overcome the handicap of higher per unit costs. Small farmers can take advantage of economies of scale through increased coordination and pooling of their livestock services needs under the auspices of these organizations. For example, producer organizations can setup clinical routes and designated field stops where member farmers can seek the services of the association's veterinarian or veterinary health personnel. Furthermore, producer associations provide the mechanism for overcoming the externalities associated with the provision of some livestock services. Since the veterinarian or veterinary health personnel is employed by the producer association and all members equally provide financial support for the organization, free-rider problems are eliminated.

The range of services these organizations offer varies across countries and institutions. On the one end of the livestock services supply spectrum are producer organizations in Western Europe which provide a full range of support, input supply, and marketing services (Meyn, *et al.*, 1991). These support services include private consultant veterinarians and cooperative livestock services, quality

control, applied research, farmer training and extension in animal management, feeds and feeding, animal registration, performance recording, type classification, genetic evaluation, artificial insemination, modern biotechnologies as well as breeding extension, the organization of shows in animal breeding, milk quality control, market monitoring and advertising, and the promotion of livestock products. Improved input supplies provided by Western European producer organizations (mainly cooperatives) include veterinary pharmaceuticals, farm equipment and materials, feed-making equipment as a hire service through machine rings, concentrate feed supplies, improved breeding stock through marketing channels of breed societies or farmer cooperatives, semen and embryos, and dairy inputs. They also provide marketing assistance; in particular, dairy and meat cooperatives collect, process and sell the produce of their members. In addition, they serve as outlets for improved breeding stock and embryos (breeding societies and farmer cooperatives). Table 4.4 lists the areas of involvement in livestock services of producer organizations in Western Europe. Livestock producer organizations and cooperatives have also been organized in other developed and developing countries from Canada to the Central African Republic to Brazil to India and Indonesia. The combination of services offered in developing countries, however, are generally less comprehensive. Case studies of the Indian and Central African Republic's livestock services sector in Appendix A provide a detailed look into the operations of such cooperatives.

Financial Cost Recovery of Livestock Services

Due to externalities associated with the delivery of livestock services and the absence of private-sector enterprises resulting from the private unprofitability of the activity in some areas, public-sector intervention in the delivery of livestock services becomes essential. Thus a critical issue in the public delivery of livestock services is whether the costs of these services are fully recovered. In the livestock services survey described above, the livestock and agricultural specialists were asked whether the charges for clinical care, the delivery of vaccinations, vector control, artificial insemination, extension, and veterinary drug sales covered for the financial cost of the service (c), were subsidized (s), or were provided free (f). The results of the survey are presented in Table 4.5.

Table 4.4: Producer Organizations in Livestock Health Services in Western Europe, 1991.

TYPE OF SERVICE	PRODUCER ORGANIZATION Denmark	France	Germany	Gr.Britain	Italy	Netherlands
1. Disease Control	*Disease fund *Insurance *Health service association *Ag. Advisory Service	*Disease funds (subsidized) *Health service association *Chambers of Ag. *AI centers *Natl technical institutes	*Disease funds (subsidized) *Health service association *Chambers of Ag. *AI centers *Milk recording orgn	*Brucellosis test on bulk milk samples (MMBI) *Cooperatives	*Farmers unions	*Health service association
2. Input Supplies	*Cooperatives *Voluntary feed control (ag. societies)	*Cooperatives *Machine rings *Voluntary feed control (ag. societies) *Chambers of Ag. * Ag. professional laboratories	*Cooperatives *Machine rings *Voluntary feed control (ag. societies) *Chambers of Ag.	*Cooperatives *farmer syndicates *Published quality declarations	*Cooperatives *Provincial livestock asso.	*Cooperatives *Voluntary feed control (ag. societies) *Central farmers organizations
3. Breeding & Genetic Evaluation	*Meat & milk farmer orgns *Milk recording association *Danish agric. advisory	*Natl technical institutes *Milk recording association *Meat recording association *Computer centers	*Milk recording association *Meat recording association *Regional computer centers	*Milk recording association *Meat recording association *Breed associations *Computer centers	*Breed associations *Livestock farmers asso. and breed societies *Breed computer centers	*Milk recording association *National breeders syndicate
4. Breeding	*AI cooperatives *Farmers orgns. *Advisory services *Breed societies	*AI cooperatives *Breed societies *Performance recording asso. *Ag. societies	*AI cooperatives & organizations *Breed societies	*AI cooperatives & organizations *Breed societies *Ag. societies	*Provincial livestock farmers associations *National livestock farmers associations *Natl breed society	*AI cooperatives *National breeders syndicates *Breed asso.

Source: Meyn et al., 1991.

Table 4.5: Financial cost recovery of livestock services, 1991.

COUNTRY	NATURE OF INTERVENTION					
	CLIN	VAC-D	VEC	AI-D	EXT	VET-D
AFRICA						
Benin	s	c	c	na	f	c
Botswana	c	f/c	s/c	na	f	c
Burkina Faso	s	c		na	f	c
Burundi	s	f/s	f	na	f	s/c
Cameroon	c	c	f/s	na	f	c
C. African Rep.	c	c	s	na	f	c
Chad	s	f/s	f/s	na	f	c
Congo	s			na	f	s/c
Côte d'Ivoire	f/s	f/s	f/s	na	f	s/c
Egypt	s	s		s	f	
Ethiopia	c	f/c	f/s	s	f	c
Gambia	c	f/c		na	f	c
Ghana	s	f/c	s	na	f	c
Kenya	s	f/s/c	s	s	f	s/c
Madagascar	s/c	f/s	f	s/c	f	s/c
Mali	s/c	s/c			f	c
Mauritania	s/c	s/c	na		f	s
Morocco	c	f	s	s/c	f	s/c
Niger	s	f/s	na		f	f/s
Nigeria	s	f/s/c	f		f	s/c
Rwanda	s	f	f/s		f	s
Senegal	s	f/s		c	f	c
Somalia	f	f/s	na	na	f	c
Sudan	s	f/s	f	s/c	f	c
Tanzania	s	f/s	s		f	c
Togo	s	f/s	s		f	s

Table 4.5: Financial cost recovery of livestock services, 1991.

COUNTRY	NATURE OF INTERVENTION					
	CLIN	VAC-D	VEC	AI-D	EXT	VET-D
AFRICA cont'd						
Tunisia	s	f	s	s/c	f	s
Uganda	s/c	s/c	s	s/c	f	c
Zimbabwe	s	f/c	f	s	f	c
NORTH AMERICA						
Canada	c	c		c	f	c
United States	c	c		c	f	c
OCEANIA						
Australia	c	c		c	f/c	c
SOUTH AMERICA						
Argentina	s/c	s/c	s/c	s/c	f/c	c
Brazil	f/c	s/c	s/c	s/c	f/c	f/c
ASIA:						
China	s/c	f		s/c	f	
India	s/c	f		s	f	s/c
Indonesia	s/c	s	f	s	f	s
Malaysia					f	c
Philippines	s/c				f	c
Thailand	s/c				f	c
EUROPE						
Denmark	c	s/c		c	f/c	c
France	c	s/c		c	f/c	c
Germany	c	s/c		c	f/c	c
Hungary	c	s/c		f/c	f	c
Ireland	c	s/c		c	f	c

Table 4.5: Financial cost recovery of livestock services, 1991.

COUNTRY	NATURE OF INTERVENTION					
	CLIN	VAC-D	VEC	AI-D	EXT	VET-D
EUROPE cont'd:						
Poland	s/c	f/s		s	f	s/c
Romania	s/c	f/s		s	f	s/c
United Kingdom	c	s/c		c	f	c
Yugoslavia	c	f		s	f	s/c

Notes: CLIN - clinical care; VAC-D - delivery of vaccinations; VEC - vector control; AI-D - artificial insemination; EXT - extension; VET-D - veterinary drug marketing and distribution. Cost recovery: f - free; s - subsidized; c - full financial cost recovery.

Source: Livestock services survey.

Clinical services are predominantly subsidized or provided free in Africa, Latin America, and Asia.[10] Similarly, charges for AI services tend to be subsidized. In Africa and Asia, vaccinations and vector (tick) control are generally provided free or subsidized. In developed countries, compulsory vaccinations are generally provided free or are subsidized, while fees covering vaccination and vaccine costs are levied for non-compulsory vaccinations. With the exception of Argentina, Brazil, and most West European countries, extension remains a free good in most parts of the world. Lastly, the costs of the veterinary drugs are fully recovered in most countries with a few exceptions in Africa.

In the delivery of livestock services, the poultry industry deserves special mention. Large-scale vertically integrated and highly efficient poultry production and processing systems developed in Western countries have been successfully transplanted to the rest of the world. Often established as joint-ventures with Western poultry companies, these enterprises operate hatcheries, poultry farms, feed mills, processing plants, and marketing organizations. The maintenance of in-house full-time veterinarians and other technical personnel to oversee its production activities and provide for its health services needs is an integral component of the system. The highly privatized provision of health services in this production system derives from economies of scale in their delivery as well as the sequestered nature of the production system which enables it to minimize the extent of externalities. Consequently, regardless of the country, health services under this production system are generally privatized.

The results of this brief survey indicate that the opportunities for private-sector entry are currently limited to the production, marketing, and distribution of veterinary drugs, for this sector singularly provides for the possibility of earning economic profits. The fact the other services tend to be subsidized or are provided free of charge serves as a strong disincentive for private-sector participation. At the same time, the extent of government subsidization draws attention to the increasing budgetary allocations that livestock services programs will entail and the sustainability of such allocations. The increasing financial burdens entailed by government provision of these services combined with the

[10] Although full cost recovery may be practiced by the government, this does not account for the implicit subsidies to the government agencies, e.g. the cost of government funding may be subsidized.

tight fiscal situation in most countries will lead to rationing and declining quality of services. Such trade offs are illustrated in the case study of the livestock services sector in Kenya (Appendix A).

Private Practice Breakeven VLUs

Private entry into the livestock services sector depends on whether an economically profitable practice can be sustained. An important concern for private practitioners then, is the minimum number of animals that need to be serviced in order to breakeven (profits = 0). The following discussion presents the results of the estimation of breakeven VLUs under three different production systems (traditional, intermediate, and high intensity) in four countries in Africa (Cameroon, Guinea, Kenya, and Uganda). The traditional production system is characterized by smallholder/pastoralist farming and low productivity (e.g. less than 500 li. of milk per year and less than 12% offtake), while the intermediate production system is typified by more capital intensive operations and higher productivity (e.g. from 500-2500 li. of milk per year and 12-18% offtake). The high intensity production system includes feedlots, ranching, and intensive dairy production; it is very capital intensive with levels of production greater 2500 li. of milk per year and greater than 18% offtake. In this study, it is assumed that the average fee per animal is $2, $12, and $20 under the traditional, intermediate, and high intensity systems, respectively, and that additional revenue may be generated through mark-ups on drug sales amounting to 25 or 50 percent. The costs involved in operating a private practice include depreciation of the vehicle and office equipment, rent, insurance, supplies, utilities, fuel and maintenance, and interest cost of capital. The sources of revenue are the consulting fees and mark-ups on drug sales. The costs and returns calculations for each country are presented in Appendix B, Tables B2.1a to B2.4c.[11] It should be noted that there are other alternative veterinary operational set-ups, such as a veterinarian/paraprofessional combination or a single paraprofessional practice. However, due to data limitations, this analysis will only examine the cost and returns to a veterinary practice operated by a single veterinarian.

[11] It should be noted that a consistent set of cost items across countries could not be obtained due to data constraints. This poses limitations on cross-country comparisons.

Kenya exhibits a high breakeven number of VLUs per production system, primarily due to the high costs of operations in the country, compounded by low returns from drug sales (Table 4.6). The results also imply that assuming 25% margin on drug sales, a private veterinarian in Kenya must treat an additional 500 VLUs per year under the traditional system, 83 VLUs per year under the intermediate system, and 50 VLUs per year under the high intensity system to earn an income of $1000. For an income of $10,000 per year, assuming 50 percent margin on drug sales, the private veterinarian will require livestock densities of 14,720 VLUs for the traditional system, 2,453 VLUs for the intermediate system, and 1,472 VLUs for the high intensity system. Drug sales in Cameroon, on the other hand, are so lucrative that a 50 percent margin on drug sales more than covers total operating costs. Overall, the results of the analysis clearly illustrate the importance of drugs sales in private veterinary business. In all countries, the returns from drugs sales significantly reduced breakeven levels.

The breakeven VLUs per sq. km. under the three productions systems were also estimated (Table 4.7). In relation to the actual VLUs per unit area, Cameroon, Guinea, and Kenya display potential profitability for private practice, since the breakeven number of VLUs per sq. km under all productions systems is significantly below actual VLUs per sq. km. Private practice in Uganda, however, is only sustainable under the intermediate and high intensity production systems and under the traditional system assuming 50 percent margin on drug sales. These results further highlight the importance of livestock density in sustaining private veterinary practice.

In summary, the breakeven number of VLUs varies across production systems and countries. Moreover, the margin on drug sales significantly decreases breakeven levels in all systems. Thus, livestock density is a major determinant of the profitability and sustainability of private practice; the actual VLUs per unit area sets the upper bound for breakeven levels and thus feasible private operations.

CONCLUSIONS

The delivery of livestock services in the 1990s continue to be dominated by the public sector, although there is growing recognition in most countries of the important role that the private sector can play in their provision. The balance between public and private-sector involvement is largely determined

Table 4.6: Breakeven VLUs for private veterinary practice in Cameroon, Guinea, Kenya, and Uganda by production system.

PRODUCTION SYSTEM	COUNTRY Cameroon (1986)	Guinea (1986)	Kenya (1988)	Uganda (1990)
TRADITIONAL				
Pure vet service	6,775	3,997	11,281	5,352
Vet service + 25% margin	3,413	3,672	10,500	4,014
Vet service + 50% margin	51	3,347	9,720	2,677
INTERMEDIATE				
Pure vet service	1,129	666	1,880	892
Vet service + 25% margin	569	612	1,750	669
Vet service + 50% margin	NA	558	1,620	446
HIGH INTENSITY				
Pure vet service	677	400	1,128	535
Vet service + 25% margin	341	367	1,050	401
Vet service + 50% margin	NA	335	972	268

Note: Fees are assumed to be--traditional = $2, intermediate = $12, and high intensity = $20; 240 trips per year. NA - at 50% margin, drug sales exceed total costs of operations. Refer to Appendix B, Tables B2.1a to B2.4c for calculations of breakeven VLUs.

by the "public good" character and the externalities and moral hazard problems associated with the individual livestock services. As a result of these three factors, public-sector intervention either through regulation of the industry or the provision and subsidization of services, becomes indispensable so as to insure socially optimal levels of supply. Furthermore, the intensity of the externalities and moral hazard problems that accompany the provision of some services (e.g. vaccinations, vector control, and veterinary surveillance) are significantly influenced by the nature of the disease, the economic value of the animal, livestock density, the homogeneity of the livestock population, and the size of the livestock enterprises. The incentives for private practice, on the other hand, are improved by the margins that veterinarians receive from drug sales. In addition, livestock density can serve as an important constraint to the profitability and sustainability of private practice.

Table 4.7: Breakeven VLUs per square kilometer for private veterinary practice in Cameroon, Guinea, Kenya, and Uganda by production system.

PRODUCTION SYSTEM	COUNTRY Cameroon (1986)	Guinea (1986)	Kenya (1988)	Uganda (1990)
TRADITIONAL				
Pure vet service	8.5	5.0	14.2	42.0
Vet service + 25% margin	4.3	4.6	13.2	31.5
Vet service + 50% margin	-	4.2	12.2	21.0
INTERMEDIATE				
Pure vet service	1.4	0.8	2.4	7.0
Vet service + 25% margin	0.7	0.8	2.2	5.2
Vet service + 50% margin	-	0.7	2.0	3.5
HIGH INTENSITY				
Pure vet service	0.9	0.5	1.4	4.2
Vet service + 25% margin	0.4	0.5	1.3	3.1
Vet service + 50% margin	-	0.4	1.2	2.1
Actual VLUs/sq.km.	12.5	13.9	24.1	24.0

Note: Area of coverage by veterinarian in Cameroon, Guinea, and Kenya = 796.23 sq. km, Uganda = 127.48 sq. km. Breakeven VLUs per sq. km. = (breakeven VLUs/area of coverage). Breakeven VLUs are from Table 4.5.

CONCLUSIONS AND POLICY IMPLICATIONS 5

The delivery of livestock services in developing countries continues to be the domain of the public sector; however, there is growing recognition in most of these countries of the important role that the private sector can play in their provision. **In establishing the appropriate roles for the public and private sectors in the livestock services industry, it is first necessary to obtain a clear understanding of the economic nature of each of the services. Not only will the economic nature of the service determine whether private delivery will be feasible, but also whether private provision will result in a socially optimal level of supply.** The first section of this chapter examines the economic determinants of the sectoral channel for each of the livestock services; the second section discusses the policy lessons derived from this study.

ECONOMIC DETERMINANTS OF PUBLIC AND PRIVATE SECTOR PARTICIPATION

Vaccines, semen for artificial insemination, and veterinary drugs and supplies are private goods. Private-sector investments in the production and distribution of these commodities will depend on the returns from these ventures, which are determined by factors such as the appropriability of returns, the size of the market, input prices, and the availability of the technology. Government policies also influence private participation to the extent that they affect the economic incentives faced by the private sector. Restrictions on private importation of veterinary inputs and the subsidization of and price controls on these products result in price distortions which create barriers to entry for the private sector. Moreover, competition in the market for these commodities has shaped the pattern of delivery of other livestock services. As a result of increasing competition among private firms involved in the marketing of veterinary pharmaceuticals and supplies, these firms are providing extension services as a complementary service.

Vaccination, diagnostic support, and vector control (tick and tse-tse) are similarly private goods, but their consumption involves externalities. The effectiveness of vaccination campaigns and vector control depends on the degree coverage of the livestock population; non-compliance by some farmers can jeopardize the whole program. Diagnostic support provides information to other farmers on the prevalence of certain diseases in the vicinity. Unless these externalities are internalized, there will be underconsumption (or no consumption) of these services by farmers. Thus, in order to raise farmer investment in these services to socially optimal levels, governments find it necessary to intervene. In the case of vaccination and vector control programs, governments in various countries intervene to insure farmer participation either by imposing regulations for compliance, by subcontracting the services to the private sector, or by providing the services themselves. Tse-tse control in open ranges is a public good, therefore it is subject to free-rider problems.

Most clinical diagnosis and treatment are private goods; the exceptions are activities pertaining to the treatment of infectious diseases. These involve externalities. Nevertheless, clinical intervention should remain an exclusive private sector responsibility. Despite the externalities associated with the treatment of infectious diseases, public intervention is still most cost effective if directed at preventive measures such as vaccination or slaughter of afflicted animals.

Several factors influence the farmer's incentive to avail of clinical intervention, vaccination, diagnostic support and vector control services. The first factor is the nature of the disease and the economic losses associated with it. The risk of economic losses is greater for some diseases than for others (e.g. FMD vs brucellosis); thus if the disease is not economically threatening, a farmer may forgo clinical care or the undertaking of preventive measures. The second factor is the degree of homogeneity of the livestock population, specifically the relative proportions of traditional and improved breeds. In general, traditional and improved breeds exhibit different productivity characteristics, and thus economic values, and different degrees of susceptibility to specific diseases. Hence, the potential economic losses from the same disease may vary according to the type of production system. The third factor is the intensity of the production system. As in the Argentinean case (Appendix A), farmers in the extensive breeding areas displayed a lower demand for preventive services than farmers in the intensive cattle-

fattening areas because the former faced lower risks of losses from disease outbreaks. In summary, diversity of the livestock population and production systems results in differential risk of losses and net returns to clinical care, vaccination, diagnostic support, and vector control, which subsequently affects the economic incentives faced by different farmers. Adequate treatment of sick animals or full compliance with vaccination and vector control programs, therefore, may not be achieved if it were left to pure market forces to direct farmer behavior.

At the same time, the profitability and sustainability of private veterinary practices providing clinical care, diagnostic support, and vaccinations are influenced by the size of the livestock enterprises, the value of the animals in the production system, and the density of the livestock population. Since the provision of veterinary service involves significant fixed costs (e.g. transportation, buildings, and veterinary equipment), the demand for the veterinarian's or veterinary health personnel's services must be sufficient enough to make private practice economically profitable. Therefore, the existence of large-scale high density livestock enterprises will favor private-sector participation since these enterprises will have the capacity to generate such a volume of demand. In predominantly smallholder and low density areas, the demand is often insufficient to sustain private practice. This arises because the private practitioner's transactions cost per animal may exceed the smallholder's perceived returns from the service. Finally, in areas where publicly provided livestock services are available, private practitioners may not be able to compete if public services are highly subsidized.

The externalities associated with the prevention of some diseases may be so extreme that the government may find it necessary to undertake the preventive measures itself so as to insure their optimal supply. These diseases may be of greater economic, social, and political importance than others, not only as a result of the production losses they cause, but also because of their adverse effect on humans and livestock product exports. Anthrax, brucellosis, tuberculosis, rabies and some parasitic diseases are transmissible to man; thus, the impact of these diseases transcends beyond their effect on livestock farmers to the rest of society. The control of FMD, for example, is given primary attention because of the additional hazard it poses to beef exports. Consequently, the effective implementation of control

programs for these diseases take on greater public significance and the state will generally assume responsibility for their provision.

Unable to take advantage of economies of scale, smallholder livestock farmers are basically at a disadvantage because they face a higher per unit cost of livestock services. In many developing countries, smallholders are totally dependent on government services which are often poor, inadequate or nonexistent. The establishment of producer organizations and cooperatives has proven to be an effective approach for overcoming this handicap in many countries (e.g. India, Indonesia, Kenya, and South American countries). Small farmers can take advantage of economies of scale through increased coordination and pooling of their livestock services needs under the auspices of these organizations. For example, producer organizations can set up clinical routes and designated field stops where farmer members can obtain veterinary services. Furthermore, producer associations provide the mechanism for overcoming the externalities associated with the provision of some livestock services. Since the veterinarian or veterinary health personnel is employed by the producer association and all members equally provide financial support for the organization, free-rider problems are eliminated. From the veterinarian's and veterinary health personnel's perspective, producer associations provide for greater income and job security, which increases the attractiveness of private practice.

Veterinary surveillance is a purely public good. Due to the free-rider problem associated with its delivery, there will be a tendency towards under-production or no production of this service when the production decision is profit motivated. Animal quarantine is a public-sector policy intervention to overcome externalities arising from easy disease transmission between animals, while drug quality control and food hygiene/inspection are public-sector policy responses to moral hazard problems associated with the processing and distribution of veterinary pharmaceuticals and livestock products. Of the different strategies open to the state for handling these market failures, governments often choose to assume responsibility for the provision of veterinary surveillance, quarantine services, drug quality control and food hygiene inspection in order to insure their optimal supply. As discussed earlier, the risks to society and the economy of disease outbreaks more than outweigh the cost of the programs. Although the

delivery of these services may be subcontracted out to private entrepreneurs, the appropriate levels of their supply continue to be a public-sector decision.

Extension may be a private or public good, depending on the medium used and the ease with which information flows to other farmers. Similarly, the products of veterinary research may be public or private goods depending on whether property rights have been defined. Thus, the appropriate sectoral channel will depend on the type of service produced and the medium employed.

EFFECTIVENESS OF LIVESTOCK SERVICES DELIVERY

There is wide disparity in the effectiveness of delivery of livestock services in developed and developing countries. Livestock services in developed countries are in general adequately and efficiently supplied. Many developing countries, on the other hand, are characterized by a shortage of skilled veterinary manpower. In other developing countries, overstaffing led to shortages of operating funds, since large proportions of the organizational budget have to be allocated to staff salaries. Inadequate operating budgets subsequently reduced or prevented investments in required veterinary infrastructures, disease control and veterinary information services, and transport, communications, and veterinary equipment. Inadequate operating budgets, in particular, largely explain the ineffectiveness of many government livestock health programs in developing countries. As noted earlier, the public sector dominates the delivery of livestock services. Due to the public good character and externalities and moral hazard problems associated with the provision of these services, the majority of livestock services were subsidized or provided free. As the livestock population expanded in the developing countries, their livestock services requirement correspondingly increased, causing greater pressure on operating budgets that were not increasing at the same pace. This subsequently resulted in rationing and/or deteriorating quality of service as governments were forced to accommodate more clients in the context of diminishing resources.

POLICY IMPLICATIONS

Taking into account the economic character of each of the livestock services, privatization, therefore, cannot and should not be undertaken as one broad strategy. Instead, a policy of selective privatization should be pursued. As a first step, the transfer of livestock services that are basically private goods to the private sector should be promoted. In the case of livestock services whose consumption involves externalities or whose delivery has associated moral hazard or free-rider problems, there is a need for mechanisms to correct these market failures to insure that the private sector provides them at socially optimal levels. Otherwise, public-sector intervention will remain essential.

Vaccines, semen for artificial insemination, and veterinary drugs and supplies are private goods; thus, their production and distribution can be feasibly and efficiently undertaken by the private sector. Privatization will be one way to improve the efficiency of the delivery of these commodities. To insure that these veterinary products are up to standard specifications, government certification of these products may be pursued. Vaccination for diseases, diagnostic support and vector control are also private goods, but their consumption involves externalities. Thus, unless a mechanism can be set in place to account for these externalities (e.g. issuance of vaccination certificates), some degree of public-sector intervention will have to be maintained if optimal consumption of these services is to be guaranteed. Clinical intervention is generally a private good and should remain a private sector activity. In some cases, however, clinical intervention may not be completely separable from other activities, such as vaccination and diagnostic support. In such a special case, a subsidy to promote diagnostic support and vaccination (e.g. a transportation cost subsidy) may unavoidably spillover to that of clinical intervention. This should <u>not</u> be perceived, however, as a justification for subsidization of clinical intervention. Clinical intervention should exclusively be a private sector activity and public sector intervention should concentrate on more cost effective preventive measures such as vaccination and diagnostic support.

Transferring the responsibility for the provision of these "private goods" to the private sector will ease the financial burdens of the government. To promote these sectors, governments should work toward removing any barriers to private development of these industries. These actions may include a reform of government policies (e.g. removal of price subsidies and trade barriers, elimination of

restrictions on private practice, and the abolition of input monopolies) that bar private-sector participation as shown in Kenya (Appendix A). Private enterprises will only respond if appropriate economic incentives exist; allowing supply and demand forces to determine market prices will provide the correct signals to the private sector.

The financing of publicly provided livestock services is an issue that is drawing increasing concern. Many developing countries are currently faced with serious fiscal constraints and the overall policy of subsidization of these services has often resulted in tradeoffs between the quantity and quality of services provided. Cost recovery has been recommended to insure the sustainability of public-sector programs (De Haan and Nissen, 1985; De Haan and Bekure, 1991). However, this strategy should be pursued only after farmer response to the additional cost involved has been carefully studied. The few studies of farmer responses to cost recovery policies show disparate results and further study is required. For example, Sandford (1983) found that a dipping fee created a disincentive for regular and widespread dipping in Kenya, while under the Uasin Gishu Project in Kenya (financed by IFAD and the Danish government), it was found that farmers were willing to pay for dipping services, provided these services were guaranteed to be effective (de Haan and Bekure, 1991). In the vaccination campaign against rinderpest in 10 countries in Africa, the preliminary results of a World Bank study found no significant depressing effect from cost recovery: rinderpest vaccination coverage in the countries where a vaccination fee was introduced was 58 percent compared to 60 percent where vaccination was provided free (De Haan and Bekure, 1991).[12] This result may be largely attributed to the fact that rinderpest is fatal and thus the risks of economic losses and therefore, the economic incentives for participating in the vaccination program are greater. In the case of FMD, where the debilitating effects of the disease are less significant, farmer responses in the Brazilian case have been less than satisfactory, given that farmers are made to pay the full cost of the vaccination. These results indicate that policies regarding cost recovery have to be pursued on a case by case basis and an important factor that influences farmer response to cost recovery measures is the risk of economic loss, which varies according the type of the animal, the value

[12] The countries where vaccination fees were charged included Burkina Faso, Cameroon, CAR, Mali, Mauritania, while vaccinations were provided free in Benin, Chad, Côte d'Ivoire, Ghana, and Senegal.

of the animal, the nature of the disease, the homogeneity of the livestock population, the intensity of the production system, and livestock density.

Governments should explore other alternatives besides direct provision of livestock services. These include promoting private practice by removing barriers to entry and establishing an effective legal framework for enforcement of particular activities (e.g. vaccination certificates in Argentina), subcontracting services to the private sector, promoting livestock insurance schemes, and fostering the development of producer organizations.

Veterinary auxiliaries can play an important role in providing preventive services, the performance of simple clinical procedures, and extension. Although they cannot substitute for veterinarians, they supplement the veterinarian's work and thus expand the geographic area covered and the number of farmers serviced. Because their opportunity costs are lower than the veterinarians, their services will be more affordable to farmers. More importantly, since the time required for and the cost of their training are significantly lower than that required of the veterinarian, veterinary auxiliaries can provide developing countries a means of accumulating veterinary manpower in a shorter period of time and at lower costs.

Finally, the promotion of private-sector research in the livestock services industry can further ease the financial burdens of the government. However, private-sector research is largely determined by the potential returns from the research activity and the appropriability of those returns; these two factors will determine the type of new products and technologies private firms will generate.[13] Research areas that do not meet these conditions will be neglected by the private sector and such a selective research agenda will therefore necessitate the continued participation of non-private institutions (e.g. domestic and international public institutes and non-profit organizations) to insure that socially optimal levels of research are conducted. In particular, non-private involvement will continue to be essential if only to insure veterinary research into socially beneficial, but privately unprofitable areas.

---

[13]Umali (forthcoming) provides a detailed discussion of public and private sector roles in agricultural research.

REFERENCES

Aharoni, Y. 1981. "Managerial Discretion," in R. Vernon and U. Aharoni (eds.), State Owned Enterprise in Western Economies. New York: St. Martin's Press. pp. 193-194.

Ahmed, I. and V. W. Ruttan. 1988. Generation and Diffusion of Agricultural Innovations: The Role of Institutional Factors. Aldeshot, England: Gover Publishing Company, Limited.

Anteneh, A. 1983. "Financing Animal Health Services in Some African Countries." LPU Working Paper No. 1. International Livestock Center for Africa.

Blankart, C.B. 1987. "Limits to Privatization." European Economic Review. No. 31, pp. 346-351.

Bos, D. 1987. "Privatization of Public Enterprises." European Economic Review, No. 31, pp. 352-360.

Coase, R.H. 1960. "The Problem of Social Cost." Journal of Law and Economics. Vol. 3: pp. 1-44.

Cunningham, E.P. 1989. "Cost-Benefit Studies in Livestock Improvement" in Proceedings of the Seminar on Animal Health Administration and Economics sponsored by the Economic Development Institute (EDI), Inter-American Institute for Cooperation on Agriculture (IICA), International Office of Epizootics (OIE), and Secretaria de Agricultura, Ganaderia, y Pesca de Argentina (SENASA), Buenos Aires, Argentina.

-----. 1989. "Public and Private Support Services for the Livestock Production Industry" in Proceedings of the Seminar on Animal Health Administration and Economics sponsored by the Economic Development Institute (EDI), Inter-American Institute for Cooperation on Agriculture (IICA), International Office of Epizootics (OIE), and Secretaria de Agricultura, Ganaderia, y Pesca de Argentina (SENASA), Buenos Aires, Argentina.

De Haan, C. and N. J. Nissen. 1985. Animal Health Services in Sub-Saharan Africa. World Bank Technical Paper No. 44. Washington, D.C.: The World Bank.

De Haan, C. and S. Bekure. 1991. Animal Health Services in Sub-Saharan Africa, Initial Experiences with Alternative Approaches. World Bank Technical Paper No. 134. Washington, D.C.: The World Bank.

Domenech, J.L., J. Coulomb and P. Lucet. 1981. Brucellosis in Chad: Impact of Animal Disease Control in Africa. Berlin.

Doornbos, M. *et al.* 1990. Dairy Aid and Development, India's Operation Flood. New Delhi: Sage Publications India Pvt Ltd.

Head, J. G. 1974. Public Goods and Public Welfare. Durham, North Carolina: Duke University Press.

Evangelou, P. 1984. Livestock Development in Kenya's Maasailand, Pastoralists' Transition to a Market Economy. Boulder: Westview Press.

Farbenfabriken Bayer AG. n.d. Book for Farmers Stock Diseases. Leverkusen, Germany: Veterinary Department, Farbenfabriken Bayer AG.

Felton, G. and P. Ellis. 1978. Studies on the Control of Rinderpest in Nigeria. Study No. 23, Reading University.

Fite, R. 1991. Veterinary Medical Officer, Animal and Plant Health Inspection Service, United States Department of Agriculture. Personal communication.

Food and Agriculture Organization. 1990a. "Livestock Services." Working Paper No.6 in China Agricultural Support Services Project. Rome: FAO.

-----. 1990b. "Strengthening animal health services in developing countries." FAO expert consultation. Rome: FAO.

-----. 1989. Argentina Agricultural Services Project Annexes. Report No. 90/89 CP-ARG-12 PB. Rome: FAO/World Bank Cooperative Programme Investment Centre, FAO.

-----. nd. Animal Health Yearbook 1984. Rome: FAO.

Food and Agriculture Organization, World Health Organization, and International Office of Epizootics. 1990. Animal Health Yearbook 1989. Rome: FAO.

Feldman, A. M. 1980. Welfare Economics and Social Choice Theory. Boston: Kluwer Nijhoff Publishing.

Gloy, G. 1991. Agricultural Attache of the Embassy of the Federal Republic of Germany. Personal communication.

Henderson, J. M. and R. E. Quandt.1980. Microeconomic Theory, A Mathematical Approach. New York: McGraw-Hill Book Company.

Jones, L.P. and E.S. Mason. 1982. "Role of economic factors in determining the size and structure of the public-enterprise sector in less-developed countries with mixed economies," in L. Jones (ed.), Public Enterprise in Less-Developed Countries. New York: Cambridge University Press, pp. 17-48.

Kuil, H. *et al.* (eds.) 1990. Livestock Production and Diseases in the Tropics. Wageningen, The Netherlands: International Agricultural Centre.

Leonard, D. K. 1990. "Draft Research Proposal on the Organization of Animal Health Services in Africa" presented at the International Livestock Centre for Africa.

-----. 1985. "The Supply of Veterinary Services." Development Discussion Paper 191, Harvard Institute for International Development, Harvard University, 1737 Cambridge Street, Cambridge, Massachusetts.

Leonhardt, H.G. 1990. "Animal Health System of the Federal Republic of Germany." mimeo. 14 pp.

McCauley, E. H. 1982. "Animal Diseases in Developing Countries: Technical and Economic Aspects of Their Impact and Control." Paper prepared for the World Bank.

Meyn, K., J.A. Craven, J.C. Mocquot, H. Nygaard, E. Talstra, and F. Tirelli. 1991. "The Role, Possible Evolution, and Future Structure of Producer Organizations." Paper presented during round table on the "Livestock Production Sector in Eastern Europe as Affected by Current Changes" in Budapest, April 14-17, 1991.

Miller, W. C. and G. P. West. 1978. Black's Veterinary Dictionary. 9th ed. London: Morrison and Gibb Limited.

Ministry of Agriculture of the Netherlands, Veterinary Service. 1990. Veterinary Health Care in the Netherlands. The Hague: Ministry of Agriculture.

Pigou, A. C. 1932. The Economics of Welfare. 4th ed. London: Macmillan.

Samuelson, P.A. 1954. "The Pure Theory of Public Expenditure." Review of Economics and Statistics, Vol. 36: pp. 387-389.

Sandford, S. 1983. Management of Pastoral Development in the Third World. New York: John Wiley and Sons.

Shah, T. and M. Bhargava. 1982. "Impact of India's Dairy Cooperatives: Analysis based on an in-depth study of six villages in the districts of Sabarkantha (Gujarat), Periyar (Tamil Nadu), and Bikaner (Rajasthan), IRMA, and Anand."

Tillman, A. D. 1981. Animal Agriculture in Indonesia. Morrilton, Arkansas: Winrock International.

Umali, D.L. forthcoming. "Public and Private Sector Roles in Agricultural Research: Theory and Experience." World Bank discussion paper. Washington, D.C.: World Bank.

United States Department of Agriculture. 1990. World Agriculture Trends and Indicators 1970-89. Statistical Bulletin No. 815. Washington, D.C.: Economic Research Service, United States Department of Agriculture.

Varian, H. R. 1984. Microeconomic Analysis. 2nd ed. New York: W.W. Norton & Company.

Vogelsang, I. 1990. Public Enterprises in Monopolistic and Oligopolistic Industries. New York: Harwood Academic Publishers.

Winrock International Institute for Agricultural Development. 1986. "A Review of the Livestock Sector in the Republic of Indonesia," a report prepared for the Asian Development Bank and the Republic of Indonesia. Morrilton, Arkansas: Winrock International Institute for Agricultural Development.

Wise, J. K. 1988a. "Animal health expenditures by livestock producers," Journal of the American Veterinary Medical Association, Vol. 2, pp. 236-238.

-----. 1988b. "Food animal veterinarians' service and product revenues, 1985." Journal of the American Veterinary Medical Association, Vol 192, pp. 1118-1120.

World Bank. 1987. China The Livestock Sector, Washington, D.C.: World Bank.

-----. 1989. Sub-Saharan Africa: From Crisis to Sustainable Growth. Washington, D.C.: World Bank.

APPENDIX A

SELECTED COUNTRY CASE STUDIES OF THE LIVESTOCK SERVICES SECTOR

In order to attain a fuller understanding of the mechanics of the livestock services sector, this section presents nine different case studies. The countries studied include Germany, the United States, Brazil, Argentina, the Central African Republic, India, Kenya, Indonesia, and China. These case studies illustrate the diversity in the manner of livestock services delivery in highly developed (Germany and the United States), moderately developed (Brazil), and developing livestock industries (Indonesia); the role of government, donors, and the private sector in molding the channels of delivery (Kenya, Argentina, Central African Republic, and India); and livestock services cost recovery in a socialist economy (People's Republic of China).

LIVESTOCK SERVICES DELIVERY IN GERMANY

INTRODUCTION

The livestock sector in developed countries are generally characterized by technologically advanced industries, their technological superiority is evidenced by their higher output per animal unit. At the same time, their highly developed livestock sectors are supported by health services predominantly provided by the private sector. The government retains its disease prevention and regulatory roles, but even some of these responsibilities are being delegated to and financed by the private sector. The livestock services delivery system in Germany is a good illustrative example of this close working relationship between the public and private sector. The first section of this study provides a brief overview of the livestock sector in Germany. The second section describes the roles of the public and private sector in the delivery of livestock services.

THE LIVESTOCK SECTOR

Livestock production dominates the agricultural sector in Germany; it contributed almost 70 percent of the value added in agriculture in 1988 (USDA, 1990). The hog and cattle industry accounts for a significant portion of the output of the sector; in 1988, pork and beef production amounted to 3.3 million mt and 1.6 million mt respectively. Germany is also a major net exporter of dairy products and eggs ($1.7 billion), but a net importer of meat ($1.5 billion) and wool products ($464 million).

THE LIVESTOCK SERVICES SECTOR[1]

The delivery of livestock services in Germany in the late 1980s was the shared responsibility of the public and private sectors. Public-sector activities focussed on the prevention and control of animal diseases, the protection of society from zoonotic diseases, and the safeguarding of the quality and safety of food of animal origin. Private-sector involvement, on the other hand, concentrated on the provision

[1] This section is drawn from Hans-Gunter Leonhardt (1990), "Animal Health System of the Federal Republic of Germany," mimeo and personal communications with Dr. G. Gloy, Agricultural Attache of the Embassy of Germany.

of prophylactic, therapeutic, and curative measures to farm animals and the great number of pets in German households. At the same time, the private sector assisted the government with its responsibilities by performing some of its preventive and food hygiene control tasks.

The Public Sector

At the federal level, livestock services activities were administratively under the jurisdiction of the Ministry of Agriculture, while veterinary public health was under the Ministry of Health. Veterinary services at the state level were under the Department of Veterinary Affairs and Food Control Services. In 1989, 568 state veterinary officers were employed in the 306 rural or urban state veterinary offices and their 44 outposts. The activities of the state veterinary offices covered the prevention and control of epizootics and zoonoses; ante- and post-mortem inspection of slaughtered animals; hygiene aspects at abattoirs; supervision of animal waste disposal; disinfection procedures against epizootic and zoonotic diseases; the control of traffic in animals and animal products; extension activities covering animal feeding, breeding, and animal production hygiene; and the protection and promotion of animal welfare. In Germany, the control of food of animal origin also belonged to the state veterinary officers. This task also included the inspection of all establishments where such food was produced, processed, transported or stored, distributed or sold to the consumer, or prepared for consumption in restaurants. The state veterinary officers also supervised full-time and part-time veterinarians working as civil servants at slaughter houses. These civil servants delegated some of their duties and responsibilities to private practitioners, such as the collection of samples from animals which were taken on a regular basis in accordance with the epizootics act and the ante- and post-mortem inspection of home slaughtered animals.

Para-governmental Organizations

Para-governmental institutions, such as the Animal Health Service Club in Bavaria and the Animal Health Service Oldenburg in Lower Saxony, were organizations which focused on the provision of preventive and clinical care against diseases other than the epizootics and zoonoses. They provided species specific services such as programs for proper calf-rearing and programs to overcome livestock infertility, metabolic disorders, and mastitis (udder health service). The Bavarian Animal Health Service, for example, was a registered association and was set up by farmers as a self-help institution. Its organizational purpose was to maintain the high level of health and yield in animal herds and to contribute to the production of high quality food of hygienic value. Funding for the organization came from several sources. In the case of the Bavarian Animal Health Service, only 36 percent of its budget was self-financed, the remainder was funded by the government (24%), the Bavarian Epizootics Insurance Scheme (36%), and research grants (4%).

The Private Sector

The activities of private veterinarians primarily centered on the provision prophylactic, therapeutic, and curative services that were designed to maintain the standard of health and productivity of livestock and pet animals. They also provided artificial insemination services and extension covering such topics as sanitation procedures and animal nutrition to livestock owners. The fees charged for these services were regulated by law. In mixed and large animal practices, a portion of the private veterinarian's income derived from the tasks delegated by the state veterinary officer; standard rates were paid for the performance of such activities.

Animal Insurance Schemes

The Enzootics Control Fund (ECF) was an instrument to officially enforce measures for the control of enzootic diseases and to compensate livestock owners from losses; its legal base derived from

the Enzootic Control Act. Normally, 50 percent of the compensation for losses sustained due to epizootics were covered by the fund, while the balance was paid by the state. Compensation, however, was subject to the condition that the livestock owner had demonstrated his/her cooperation with the epizootics control program; for example, the livestock owners and private veterinarian had reported notifiable diseases to the state veterinary officer and had performed all the subsequent measures ordered by the officer. The ECF also supported financially measures against infectious diseases. It paid for diagnostic examinations in state veterinary investigation centers and compensated private practitioners for their participation in the epizootic control programs. Fixed fees were set by the fund for blood collection, tuberculinization, and vaccination. The fund subsidized the expenses for the disposal of the carcasses and the cost of losses arising from diseases of interest to the state but not classified as notifiable. As noted above, it also contributed funding to para-governmental organizations.

Financing of the ECF was based on the obligatory payment of fees by livestock owners in all 11 states in Germany. The fees, which varied according to species, were calculated annually on the basis of the risks encountered by the fund during the past year and were collected on a per animal basis. Table A2.1 lists the fees paid by farmers to the Epizootic Insurance Fund in 1987.

State-level insurance schemes were also implemented; the Bavarian Slaughter Animal Insurance was one example. After passing the ante-mortem inspection, slaughtered animals in Bavaria were automatically insured under this scheme for any damage they may suffer while at the slaughterhouse and against any financial losses incurred if post-mortem inspection condemns the whole or part of the carcass.[2] For this type of insurance, the owner paid a fixed fee, depending on the animal species and age. This insurance scheme had been particularly popular with small livestock farmers.

[2] Slaughtered animals judged unfit for consumption due to antibiotic or hormone residues were not covered under the program.

Table A2.1: Farmer fee schedule for the Epizootic Insurance Fund.

ANIMAL SPECIES	SIZE OF FLOCK	FEE PER ANIMAL
Horses	1-10	DM 4,00
	>10	DM 5,00
Cattle	1-30	DM 5,80
	>30	DM 6,50
Sheep, >1 year	1-50	DM 1,20
	>50	DM 1,30
Pigs	1-50	DM 0,70
	>50	DM 0,80
Laying Hens Farms	<=20 hens	DM 1,00/farm
	<=60 hens	DM 3,00/farm
	<=100 hens	DM 0,05/animal
Broilers		DM 0,04
Turkey	1-50	DM 0,10
	>50	DM 0,15

Source: Hans-Gunter Leonhardt (1990), p.14.

LIVESTOCK SERVICES DELIVERY IN THE UNITED STATES

INTRODUCTION

The delivery of livestock services in the United States is also characterized by a high degree of private participation and is similar in nature to that of Germany. The case of the United States, however, provides an interesting example of how public-sector involvement continually narrowed in scope as the private sector assumed greater responsibility for providing livestock services. The first section of this case study presents a brief overview of the livestock sector; the following section describes the livestock services sector in the United States.

THE LIVESTOCK SECTOR

The United States has one of the biggest livestock populations in the world; in 1988 it totalled 99 million cattle, 10 million dairy cows, 10 million sheep, 55 million pigs, and 1.5 billion chickens (FAO-WHO-OIE, 1989). The value of total livestock output amounted to $64 billion in the same year or 46.7 percent of the total value of agricultural output (USDA, 1990).

THE LIVESTOCK SERVICES SECTOR[3]

The livestock services sector in the United States in the early 1990s was an example of one of the most highly privatized sectors in the world. Increasing competition in the livestock services sector led the private sector to pursue strategies that promoted customer goodwill and loyalty, an example of which was the provision of extension as a complementary service. Private veterinarians rendered clinical care, supplied most of the veterinary drug requirements of the livestock farmers, and provided extension services. Large vertically-integrated agribusiness corporations conducted research on new vaccines and drugs and engaged in the marketing and distribution of these products. They employed veterinarians to sell their products and these veterinarians, at the same time, provided extension services to farmers as part of their drug sale packages. Vaccinations were performed by private veterinarians or livestock farmers, while vector control (e.g. dipping) was performed by livestock farmers themselves. Wise (1988a) conducted a survey of 894 beef producers, 417 dairy producers, 338 hog producers, and 395 sheep producers in the United States in 1985. Table A3.1 presents the percentage animal health product expenses by supplier as an illustrative example of the options open to livestock farmers in the procurement of veterinary products. Livestock farmers purchased animal health products mainly from veterinarians and feed store/dealers, mail order distributors, cooperatives, travelling salesmen, and other suppliers provide the remainder.

The role of the federal government in the delivery of livestock services had been continually narrowing in scope. Livestock extension, which prior to the 1900s was singularly provided by the Cooperative Extension Service, was in the 1990s primarily the domain of private veterinarians, veterinary salesmen, and feedmills. Furthermore, since most of the major livestock diseases in the United States had been eradicated and livestock farmers were taking their own precautions to prevent any disease outbreaks, the role of the Animal and Plant Health Inspection Services evolved from domestic disease control functions to primarily the screening out of foreign diseases.

---

[3] Based on personal interviews with Dr. Richard Fite, Veterinary Medical Officer of the Animal and Plant Health Inspection Service, United States Department of Agriculture.

Table A3.1: Percentage livestock health product expenses by supplier in the United States, 1985.

SUPPLIER	BEEF	DAIRY	HOG	SHEEP
Veterinarian	42	53	34	28
Feed store/dealer	34	22	40	25
Mail order distributor	8	11	8	35
Cooperative	10	8	10	6
Travelling distributor	4	4	6	2
Other supplier	2	2	2	4
Total	100%	100%	100%	100%

Source: J. Karl Wise (1988a), p. 237.

Federal public-sector involvement in livestock services increasingly concentrated on its monitoring and regulatory roles. Disease surveillance was performed by the Center for Disease Control; veterinary pharmaceutical and food and feed additive quality control was undertaken by the Food and Drug Administration. The Food Safety and Inspection Services was responsible for inspecting and certifying the quality of meat products from slaughterhouses, while the Agricultural Research Service undertook basic science research as well as some research on new vaccines. State-level public-sector involvement in livestock services followed that of the federal government; the main difference was the geographic area of operation. State agencies confined their interventions to state-related disease monitoring and regulation activities and the control of inter-state movement of livestock and livestock products.

Wise (1988b) also collected information on private veterinary service and product revenues. The survey respondents included 398 beef, 437 dairy, 92 swine, and 9 sheep veterinarians. The results indicated that across all primary practice areas, professional services generally contributed about 60 percent of the average gross income of veterinarians, the remainder consisted of revenues from product sales (Table A3.2).

Table A3.2: Gross revenue of food animal practitioners by type of revenue in the United States, 1985.

TYPE OF REVENUE	PRIMARY PRACTICE TYPE							
	Beef US$	%	Dairy US$	%	Swine US$	%	Sheep US$	%
Professional Services	23816	62	39162	69	23137	40	3422	70
Product Sales	14597	38	17595	31	34706	60	1467	30
Total	38413	100	56757	100	57843	100	4889	100

Source: Wise (1988b), p.1119.

LIVESTOCK SERVICES DELIVERY IN BRAZIL

INTRODUCTION

The livestock sectors of many countries in the world are characterized by great diversity in the scale of operations and technological sophistication. In these countries, a great diversity in the distribution of public and private-sector responsibility in the delivery of livestock services is similarly found. Brazil's case provides an example of livestock services delivery in a livestock sector with a small proportion of medium and large but technologically advanced enterprises (owning the majority of livestock) combined with a large proportion of smallholders following more traditional practices. This case study begins with a brief overview of the livestock sector. The second section explains the more important features of the livestock health delivery system in Brazil as of the late 1980s.

THE LIVESTOCK SECTOR

Brazil has a large livestock sector. Its output, which is dominated by milk and beef production (76% of the sector's output), accounts for almost 40 percent of agricultural GDP. More than three-fourths of the country's utilized agricultural land, or close to 200 million ha, is under pasture and of the total agricultural workforce, about 26 percent is absorbed by the livestock sector. Livestock exports, averaging $1 billion per annum in recent years, account for about 10 percent of the total value of agricultural exports, increasing from about 6 percent in the early 1980s. In 1980, about one third of all farm establishments in Brazil were classified as livestock enterprises, with the bulk (78%) producing mainly cattle, followed by pigs (15%), poultry (3%), and other animals (4%); this is not expected to have changed much in the 1980s. Land concentration is equally high among livestock and crop producers, with only about 3 percent of the enterprises in each subsector accounting for just over 50 percent of the respective total farm areas. With over 135 million heads of cattle, Brazil has the world's fourth largest cattle herd.

LIVESTOCK SERVICES SECTOR[4]

Livestock services in Brazil in the late 1980s were provided by both the public and private sectors, with the public sector playing the dominant role in the provision of clinical and preventive care, disease control, veterinary research, and livestock extension. Moreover, the bulk of these services were provided free. The government's basic rationale for providing the services was that the livestock sector was a very important sector in the economy and the economic and social returns to the country as a whole were sufficiently high to warrant the provision of these services. The sector's prominence derived from the fact that exports of livestock products were a major source of foreign exchange and domestically, meat and milk products accounted for a substantial portion of the budgets of households at all income levels. Public-sector involvement in the delivery of livestock services also stemmed from the belief that the private sector would not find providing these services profitable enough to undertake, either at all or to the level that would be economically or socially justified.

The Public Sector

Until March 1990, when the new government came into office, the federal government provided livestock services through two departments: the Department of Animal Health (SDSA) and the Department of Veterinary Laboratories (LANARA). SDSA's main duties included programming and coordinating activities in the fields of animal disease control, epidemiological surveillance, control of

[4] Information used in this case study was drawn from World Bank internal documents.

international and inter-state transit of animals and animal products, and quality control of veterinary products. LANARA, on the other hand, comprised a network of federal diagnostic laboratories and was responsible for the diagnosis of animal diseases, quality control of foods of animal origin, livestock feed, vaccines, and pharmaceutical products, and the limited production of vaccines, antigens, and serums. The Secretariat of Product Quality Control was responsible for safeguarding the standards of animal products for human consumption.

The main weaknesses of the livestock services organization were the lack of financial resources and institutional deficiencies. There was excessive fragmentation at both the federal and state levels. This contributed to poor communication and coordination at all levels: between the two levels of governments; at each level, among the large number of secretariats and departments; and within these, among the vast number of units and sub-units. For example, under the ministerial structure for animal services (as of November 1989), disease diagnosis, research, and control were performed by three separate organizations, making it extremely difficult to have a well-coordinated and effective control program.

Until March 1990, the public extension service operating in each state was supported at the federal level by the Brazilian Technical Assistance and Rural Extension Company (EMBRATER), a federal public company attached to MINAGRI. The new government in March 1990 abolished EMBRATER under its reform program, but the state companies (the 25 EMATERs) continued to function. EMBRATER was responsible for the overall coordination of the national extension system. Most of the state public extension services had not been very effective in the livestock area due to staff inexperience, high turnover, and low morale. Table A4.1 presents a listing of EMBRATER's activities in 1988.

The public system was unable to give adequate coverage or relevant messages to the small and medium-scale farmers. The deficiencies mainly related to: the preponderance of poorly paid and inadequately trained staff resulting in high turnover and poor morale; the dilution of effort due to the multipurpose role assigned to the field extension agents (community services, statistics, etc.); the absence of an effective link between extension and research resulting in technical recommendations which were often ill-matched to farmers' needs; and the rigidity of bureaucratic procedures. On the other hand, the large-scale livestock producers, who could afford to obtain the extension services of the private sector, were increasingly able to have their needs met by the growing cadre of private extension agents and pharmaceutical companies.

In 1990, the government declared its commitment to promote decentralization and greater private sector involvement. LANARA's activities were classified into three categories: essential, strategic and supplemental. In the long run, only the essential activities are to remain under direct federal responsibility. For example, the activities of LANARA laboratories will mainly concentrate on diagnostic and food and drug quality control activities. The production of oil-adjuvinated FMD vaccine, a strategic activity, will remain in the public sector so long as private industry does not fully demonstrate the willingness and capacity to meet demand. Supplemenatal activities such as routine diagnosis and the production of some antigens will remain with the public sector until a viable private sector alternative emerges.

Table A4.1: EMBRATER's activities, 1988.

ACTIVITY	NUMBER	PERCENT
Technical Assistance (Farmers visited)		
Small-scale	1,038,000	92.68%
Medium-scale	64,000	5.71%
Large-scale	18,000	1.61%
Total	1,120,000	100.00%
Training		
Technical staff	2186	15.73%
Admin. Staff	127	0.91%
Refresher courses	11531	82.95%
Post-grad courses	57	0.41%
Total	13,901	100.00%

Source: EMBRATER.

The Private Sector

Despite the preeminence of government operations in the delivery of livestock services, there was increasing private sector involvement. Private-sector participation included the provision of veterinary care, vaccination of animals during disease control campaigns, the funding of veterinary research, the production and distribution of veterinary drugs, and broad-based extension activities. It should be noted, however, that private-sector activities mainly catered to the medium and large-scale enterprises for these firms were the only ones who could afford to pay for their services.

Vaccines and drugs were sold to farmers through commercial channels, and private veterinarians vaccinated the animals. For example, the purchase and application of FMD vaccines were left entirely in the hands of the farmer, with public control exercised through the inspection of purchase receipts by government veterinarians. Many cattle farmers particularly in the extensive farming areas in the North, Northeast and Centerwest, however, evaded vaccinating their animals because they perceived the costs to them outweigh the benefits of disease control.[5] For these farmers the cost of vaccinating their animals not only include the cost of the vaccine and the veterinarian's fee, but also the cost of repairing the cattle crushes, the labor required to assemble the animals, and the weight losses associated with moving and gathering the animals for vaccination. In addition, farmers found that mortality rates from FMD were normally low. Thus, when assessing the total costs of FMD vaccination relative to the risk of losses due to the disease, farmers under extensive production systems found it uneconomical to participate in the vaccination campaigns. This has become a serious constraint to the government's disease control program. In general, public-sector control of FMD was adequate, but compliance by the farmers was less than what it should be.

The farmers' inadequate cooperation with the government's vaccination campaign can be partially attributed to government policies which shaped the structure of the livestock sector towards the

[5] Cattle in Brazil are vaccinated for FMD three times per year.

development of extensive livestock production systems.[6] First, government control of livestock product prices to protect urban consumers resulted in the implicit taxation of the sector. This resulted in lower profitability and consequently discouraged investment in more input-intensive production systems and livestock health services.[7] Second, credit and fiscal subsidies artificially lowered the costs of occupying and developing the country's frontier regions. In addition, land tenure laws and their uncertain administration further encouraged the expansion of livestock, since livestock production occupies large tracts of land at relatively low fixed costs and little labor. Lastly, private returns to beef production in the Amazon were very low so that producers found the additional expense of vaccinations uneconomical.

Private extension services were provided by companies that sell agricultural machinery, inputs, and pharmaceutical products to the farmers. In addition, there were many agricultural consulting firms that provided extension services; many of them belonged to the Brazilian Association of Agricultural Consulting Firms (ABEPA). Notably, the number of agricultural consulting firms that provided extension services have been growing steadily. Table A4.2 presents the number of consulting firms in Brazil. Although consulting firms cater to the needs of small farmers, small farmers rely primarily on the public extension service.

A small number of multinationals and a few Brazilian companies dominated the livestock health products market. The main products included FMD vaccine, which was produced by four companies with a total annual production of 221 million doses and anthelminthic and acaricide products with a market value of around $100 million a year. Seven companies produced vaccines, most of whom were subsidiaries of large multinationals. These private companies, however, have not found the production of the more thermo-stable long duration vaccines profitable enough, so that its production remains in the hands of the public sector. The government controlled the prices of most pharmaceutical products. Through the use of heavy import duties (mostly over 100%) on these products, the government pursued a strong import substitution policy. The result has been very high prices compared to those abroad and a highly concentrated oligopolistic market structure.

Private-sector participation in livestock research has been mainly limited to providing financial support to EMBRAPA. Roughly 35 of EMBRAPA's total funds came from private sources.

---

[6]The traditional and still dominant beef production system in Brazil is an extensive, low cost one, based largely on natural pastures of low productivity. Stock rates vary between 0.2 to 2 animal units per hectare depending on the amount and quality of improved pasture on the farm. Most of the cattle herd (74%) is found on medium to large size farms, and it is not uncommon to find ranches in the Center-West and North regions that exceed 20,000 ha with some as large as 100,000 ha.

[7] The low input characteristics of the system is highlighted by the predominantly variable cost structure of the typical extensive beef production system. The most significant costs are labor and management, which account for over 50 percent of the costs. Transport accounts for 16 percent, while the animal health products account for 7 percent.

Table A4.2: Statistics on the Brazilian Association of Agricultural Consulting Firms (ABEPA), 1988.

STATES	NUMBER OF FIRMS	PROFESSIONALS
Acre	3	11
Alagoas	7	46
Bahia	164	738
Ceara	73	448
Distrito Federal	12	52
Espirito Santo	12	77
Goias	169	829
Maranhao	23	112
Mato Grosso	77	372
Mato Grosso do Sul	121	600
Minas Gerais	136	898
Para	11	118
Paraiba	34	196
Parana	324	2,810
Peranambuco	54	285
Piaui	19	97
Rio de Janeiro	8	51
Rio Grande do Norte	20	112
Rio Grande do Sul	320	2,860
Rondonia	5	21
Santa Catarina	86	448
Sao Paulo	179	2,110
Sergipe	14	66
Tacantins	33	161
Total	1,904	13,518
Number of contracts with farmers		
Small-scale	153,725	65.00%
Medium-scale	61,489	26.00%
Large-scale	21,284	9.00%
Total	236,498	100.00%

Source: ABEPA.

LIVESTOCK SERVICES DELIVERY IN ARGENTINA

INTRODUCTION

Livestock services in Argentina are provided both by the public and private sectors and the division of responsibilities between the two sectors parallels that of Brazil. Argentina's dairy sector, however, provides an interesting illustration of two private dairy processing enterprises' initiative to help rescue a declining industry by taking on the responsibility of providing productive health services.

THE LIVESTOCK SECTOR

The livestock sector plays an important role in Argentina's economy, contributing nearly 50 percent of the value added in agriculture; in 1988, this amounted to approximately $9 billion (USDA, 1990). Livestock production in Argentina is low-cost and enjoys a large comparative advantage in international trade; livestock exports, mainly beef and wool, traditionally have supplied about 30 percent of agricultural export value. The Pampas is the focal point for Argentina's livestock industry, containing about 70 percent of the national cattle herd, 30 percent of the sheep, and most of the pigs and poultry. The beef industry has been the pillar of Argentina's development for over a century. Despite its decline in recent decades, it is a subsector that continues to be very important in the domestic economy. Argentina is the largest milk producer in Latin America with an annual output of 5.5 to 6 billion liters per year, over 90 percent of which is consumed domestically.

LIVESTOCK SERVICES[8]

Livestock services in Argentina in the early 1990s were jointly provided by the public and private sector. Government activities centered on the provision of clinical and preventive care and production services such as veterinary research and extension. Private sector involvement encompassed the production and distribution of vaccines and veterinary supplies and the provision of clinical care and productive services (eg. artificial insemination and extension). The private sector, however, mainly catered to the clinical and productive services needs of the medium and large scale farmers; government activities focused on the smallholder clients.

The Public Sector

The National Animal Health Service (SENASA) and the National Meat Board (a parastatal) were government agencies under the Secretariat of Agriculture, Livestock and Fisheries (SAGyP) responsible for providing livestock services in Argentina. SENASA was responsible for the control of animal diseases and the regulation of the quality of animal products, by-products, pharmaceuticals, and biological products used in animal production. SENASA was well funded; 80 percent of its operating budget ($19 million) was financed by levies collected by its services for meat inspection and field and laboratory services. In 1991, SENASA was making plans to begin charging for all its services on a cost plus overhead basis, beginning with full service charges for cattle truck inspection and vaccination certification. In 1992, as part of the restructuring program of public institutions, SENASA was going to be transformed into a financially autonomous institute while the Meat Board was going to be abolished.

The Private Sector

Veterinary services in Argentina were also provided by private professionals. Coordination between SENASA, the provincial veterinary services and the private sector (particularly for vaccination

[8] Information used in this case study was drawn from World Bank internal documents.

campaigns) was ensured by a National Animal Health Commission (CONASA). The production, distribution, and importation of vaccines and veterinary pharmaceuticals were carried out by private companies. About 60 companies produced vaccines and veterinary supplies and these were sold by private retailers. During vaccination campaigns, producers paid for the cost of the vaccine; producer expenditures on vaccines amounted to $70-80 million annually.

The private sector provided the greatest range of alternative technical services. Participants included commercial seed companies, chemical and fertilizer suppliers, rural cooperatives and societies, and private advisory services. The cooperatives employed 500 professional extension advisers to service members and about 1,000 private consultants provided specialized services to medium- to large-scale farmers.

The Dairy Sector: A Successful Example of Private Sector Initiative

During the 1970s, the dairy sector was plagued with several serious problems: low productivity, unstable milk supply due to seasonal influences, and low milk quality. These problems were mainly the result of poor animal nutrition and inadequate farm hygiene. In 1976, a recession hit the dairy industry; farmers began moving out of dairy production as the real prices of milk declined, input prices rose, and other farm activities became more lucrative. Dairy processors realized that their own growth would be constrained if they did not take action to address the problem. They felt that the technology available to farmers had to be improved, that inputs at reasonable prices had to be made accessible to farmers, and that the farmers needed to be better organized if support was to be channelled to them. The two largest dairy plants, the Santa Fe-Cordoba United Cooperatives (SANCOR) and La Serenisima decided to act and undertake their own "dairy development projects."

SANCOR formed an extension department with a central office staffed by 7 professionals and 8 regional offices, each managed by an agronomist assisted by middle-level technicians. Each office dealt with almost 40 cooperatives using two basic approaches: providing extension to the cooperatives and assisting small group of farmers (usually 6-15) to meet monthly on their farms to discuss the visited farm's progress and problems. SANCOR initially assisted in financing the group's technical assistance, but after 30 months, each group of farmers paid for the professional agronomist itself. As of 1990, SANCOR had 120 farmer groups participating in the program. SANCOR also published its own magazine and bulletins and broadcasted radio and television programs. Artificial insemination circuits as well as accelerated heifer-rearing programs aimed at getting heifers calving at less than 36 months of age were also organized by SANCOR. In addition, SANCOR supplied and financed a varied list of farm inputs. As an indicator of the success of the SANCOR's program, milk production increased by 15 percent between 1976-85 despite a 24 percent decrease in the number of dairy farms participating.

La Serenisima also formed a strong technical assistance department to tackle the same three problems faced by SANCOR. La Serenisma, a private company, deliberately targeted medium- to large-scale farmers. Its staff consisted of over 60 professionals, 30 administrative staff, and 50 milk-quality inspectors working on technical assistance, including three social scientists. La Serenisima established five regional offices, each with five zone offices. Each zone office worked with a group of up to 25 farmers. Magazines, bulletins, radio and television programs were all part of the development effort. During 1978-85, although the dairy farm areas feeding La Serenisima shrank by more than 6 percent, production increased by almost 50 percent.

Several factors contributed to SANCOR's and La Serenisima's success. First, motivation originated from firms seeking to preserve their economic position, thus there was total commitment to

run the operation as efficiently and profitably as possible. Second, the nature of the milk industry allowed results to be seen and quantified more rapidly relative to other industries such as beef production; this increased the incentives for both the firm and the farmer to participate in the program. Third, given the total dependence of the farmer on the dairy plant, the latter could exert more pressure on the farmer to adopt the technology more rapidly than in the case of other agricultural products. Lastly, commercial funding for the projects was facilitated by the two firm's scale of operations and economic prominence.

LIVESTOCK SERVICES DELIVERY IN THE CENTRAL AFRICAN REPUBLIC

INTRODUCTION

The inducement for increasing private sector participation in the livestock services industry originates from several sources. In Argentina, private sector initiative filled the gap in government services in the dairy sector. The case of the Central African Republic (CAR) presents an example of donor-motivated transfer of the distribution of veterinary drugs and inputs from the government to an independently operated farmer's association. Its successful transition provides a useful paradigm for other countries.

THE LIVESTOCK SECTOR

The livestock industry is one of the fast growing sectors in the CAR. Its expansion was largely due to the dramatic increase in cattle migration from Cameroon, Nigeria, and Chad over the last two decades, particularly during the early 1980s, when drought and civil unrest in Chad and the efficient vaccination campaign against rinderpest in the CAR brought in several thousands of herders from neighboring countries. In 1988, the livestock population totalled 1.5 million cattle, 1.3 million sheep and goats, 397,000 pigs, and 2.7 million chickens (FAO-WHO-OIE, 1989). During the same year, the livestock sector contributed $115 million or 31.7 percent of value-added in agriculture (USDA, 1990).

Almost all cattle in CAR are kept by the nomadic M'bororo (20,000 families) and the settled Foulbe (2,000 families), who together make up the Fulani ethnic group. The Fulanis form a highly structured society, clearly distinct from the rest of the population by their pastoral vocation, migratory lifestyle, language and religion. Herd ownership ranged from 40 to 1,000 heads of cattle per family, with 55 percent of the families owning less than 100 heads. Cattle for the Fulanis served as a source of income, but also as a store of wealth. Differences in family wealth was found to significantly influence herd management strategy. A World Bank sponsored socio-anthropological study (1985) found that poorer herders cared more for their animals as shown by their higher expenditures per animal on veterinary drugs (Table A6.1); this is the direct opposite of farmer expenditures in the United States (Table 4.3, Chapter 4).

LIVESTOCK SERVICES[9]

The delivery of livestock services in the CAR in the early 1990s was increasingly being shared by the government with farmer associations. This evolution in structure has been facilitated by technical and financial assistance from international donors, in particular, the European Development Fund, the French Fund for Aid and Cooperation, the International Fund for Agricultural Development, and the World Bank. The government as represented by the National Agency for Livestock Development (ANDE) still retained the functions of vector control, vaccinations, veterinary surveillance, diagnostic support, drug quality control, food hygiene inspection, extension, and veterinary research, but it had completely transferred the responsibility for drug importation and distribution to the National Federation of Central Livestock Producers (FNEC). In addition, farmer members of the FNEC were being trained as auxiliaries to supplement the clinical and preventive services provided by the government veterinarians

[9] Information used in this case study was drawn from World Bank internal documents.

Table A6.1: Animal health expenditure patterns by herd size in the Central African Republic, 1985.

HERD SIZE	EXPENDITURE PER HEAD OF CATTLE All Inputs ($/yr)	Drugs ($/yr)
0-50	3.75	0.95
50-100	2.50	0.50
100-150	2.25	0.40
150-200	1.75	0.30
>200	1.35	0.30

Source: World Bank, 1985.

and other veterinary personnel.[10]

The government of CAR pursued a policy of automatically recruiting veterinary school graduates to work for the public sector. By 1986, this staff structure resulted in 99.5 percent of the agency's $1.4 million budget being apportioned to staff salaries and ANDE's dependence on external financing for operational expenditures. Moreover, ANDE had a high proportion of junior staff who were quite inexperienced, which made effective information transfer from management to the grassroots level very difficult. A project study in 1984 found that only 50 percent of the ANDE staff could recognize the main animal diseases and only 20 percent could calculate the correct drug dosage against trypanosomiasis.

ANDE's capacity to provide veterinary services to farmers had been seriously constrained by several factors. A large communication gap between the herder population and the ANDE staff, due to language and ethnic differences, hindered effective delivery of veterinary services. ANDE personnel policies did not provide adequate incentives for agents to go to the field. Lastly, the inadequate experience in veterinary treatments of many government personnel further reduced farmer confidence and trust. Some measures had been taken to correct these problems; field training programs had been reoriented and candidates for veterinary auxiliaries were being drawn from the herder associations as a means of bridging any language or ethnic differences.

The National Federation of Central African Livestock Producers

The National Federation of Central African Livestock Producers (FNEC) was organized by livestock producers to provide veterinary services after being faced with an almost complete collapse of the government livestock service in the seventies.[11] Poor leadership in the late 1970s severely affected its operation and was rehabilitated in 1981 with the help of technical assistance provided by international donor agencies. FNEC represented the herders at the national level and distributed the necessary inputs, mainly veterinary drugs. Over 60% of all herders were fee-paying members. It was governed by a General Assembly and a Board of Directors, chaired by an elected

[10] As can be seen in Appendix B, Table B1.3, there are no private veterinarians in the CAR.

[11] FNEC was originally established as the National Association of Central African Livestock Producers. In 1986, it was reorganized and renamed into the FNEC.

President. A Coordination Committee comprising the President and Secretary General of FNEC and the Director General of ANDE planned and supervised its day-to-day operations and coordinated them with the livestock service. At the field level, FNEC was represented by 15 provincial representatives who were mostly wealthy cattle owners or traders appointed by FNEC's Secretary General. These representatives leveled membership fees and organized the producers' participation in the vaccination against rinderpest. Furthermore, grassroot producer associations were being established to broaden FNEC's base.

Prior to 1982, ANDE had a monopoly of veterinary drug marketing and distribution. But due to public-sector operational problems and upon recommendation by donors, the responsibility for veterinary drug marketing and distribution was transferred to FNEC in 1982. International assistance was also provided to FNEC, which included equipment, vehicles, and infrastructure necessary for this activity. At the same time, government sponsored training programs were reoriented towards teaching herders the proper use of these drugs.

The FNEC sales price covered the drug price plus direct distribution costs. Donor funding provided a subsidy to FNEC to create the necessary working capital. Initially, sales were channelled through FNEC's provincial representatives, but mobile sales trucks were later increasingly used. Total sales of veterinary drugs increased dramatically after being taken over by FNEC; from $9,000 in 1981, it jumped to $5.7 million in 1988 (Table A6.2). Moreover, the frequently expressed fear that herders would underdose and thus induce drug resistance was not borne out. A World Bank (1986) survey showed that 90% of the herders correctly used the drug against internal parasites, 65 percent and 85 percent correctly treated trypanosomiasis and piroplasmosis respectively. Vaccinations against anthrax and blackleg were generally carried out as well. FNEC's general success in its drug importation and distribution activities encouraged individual herder associations to expand into the sales of other inputs such as concentrate feeds and medicine. Furthermore, a strong demand from other herders for assistance in forming additional associations developed. In 1989, FNEC began providing extension services and education programs for its members.

Although FNEC's drug distribution activities were self-sustaining by 1988, it was hampered by problems in other areas. These included a lack of adequate organization at the field level; strong government pressures to finance other activities, thus threatening FNEC's financial viability; and a lack of herders with educational levels allowing effective participation in management.

Table A6.2: Value of veterinary drug sales, 1980-1988.

YEAR	SALES ($000)	AGENCY
1980	9	DGLAI
1981	49	
1982[a]	42	
1982[b]	99	FNEC
1983	144	
1984	316	
1985	668	
1986	4332	
1987	5324	
1988	5708	

Note: a - January to September, b - October to December

Source: World Bank data and De Haan and Bekure (1991).

LIVESTOCK SERVICES DELIVERY IN INDIA

INTRODUCTION

Farmer associations can serve as an important channel for the delivery of livestock services. This case study is about the cooperative societies in the Indian dairy industry. Unlike the case studies prepared for the other countries, this case study focuses less on the mechanisms for the delivery of livestock services, but on the institutions and the different roles these institutions play in successfully bringing these cooperatives into existence. The case of dairy cooperative development in India deserves special attention because it is a paradigm of effective collaboration between the government, the private sector (as represented by farmers and private veterinarians), and international donors (such as the World Bank, Danish government, European Economic Community, and the World Food Fund). Their cooperative efforts not only assisted farmers in establishing vertically integrated cooperative enterprises (involving processing and marketing activities and support services covering livestock health, extension, and input supply), but they also spurred system-wide development of the dairy industry. This case study begins with a brief overview of India's livestock and dairy sector. It is followed by a description of the AMUL Model, the dairy cooperative model which formed the basis of the Indian Dairy Development Program. The last section describes the roles that each of the participants (the government, private sector, and donor agencies) played in the conception of these cooperatives.

THE LIVESTOCK SECTOR

India's livestock sector in 1988 contributed approximately 20 percent of the value of total agricultural output (USDA, 1990), about two-thirds of the value of which is accounted for by animals in small herds of one to three. India holds one-sixth of the world's cattle and about one half of the world's buffaloes; in 1989, the national herd numbered approximately 200 million cattle (including 29 million dairy cows) and 74 million buffaloes[12] (FAO-WHO-OIE, 1989). The Indian dairy industry produces about 40 million mt of milk per year and is the third largest milk producer in the world. Despite its sizable production of milk, India remains a net importer of dairy products; imports amounted to $52.4 million in 1989 (FAO-WHO-OIE, 1989).

Dairying in India in the 1970s was a subsidiary activity for small farmers, yet it was often the farmer's only source of cash income. Dairy animals were mainly low yielding native types. Cross-breeding of cattle through artificial insemination was initiated in the mid-sixties, but the effectiveness of artificial insemination and health services was limited due to a shortage of qualified personnel and facilities. Because milk and milk products are a major source of protein for Indian society and the only acceptable source of animal protein for the large vegetarian segment of the Indian population, their availability has been a top priority of the government. Consequently, the Indian government undertook to commit itself to the development of the dairy sector by launching a series of livestock development projects, the focal point of which was the dairy cooperative.

[12] India's buffalo population is the largest in the world.

THE AMUL MODEL[13]

The provision of livestock services was an integral component of India's dairy cooperatives. These cooperatives were patterned after the producers' organizations that evolved in Gujarat and commonly referred to as the AMUL model. AMUL is the acronym for Anand Milk Union Ltd.; it is a milk marketing cooperative in the Kaira District of Gujarat organized by a group of dairy producers in 1946 for the purpose of obtaining better prices and access to the Bombay markets. The AMUL model consists of a three tier cooperative structure owned and managed by the member farmers. At the base is the Dairy Cooperative Society (DCS), a village-level cooperative which receives milk twice a day, pays producers regularly based on the quantity and quality of milk delivered, and organizes production services to farmers. These support services included the sale of cattle feed concentrate, the promotion of fodder seed, artificial insemination, the provision of veterinary health services, and training programs for members. The DCS's are subsequently organized under a Milk Producer's Union, with usually one union per district. The union organizes milk collection for and milk processing at the Union dairy (pasteurization and packaging of fresh milk, and production of other dairy products), engages in distribution and marketing in urban centers, and provides production inputs and technical services to the DCSs. The unions in most states are members of a federation. Aggregate planning of cooperative-sector input services, milk marketing, pricing policy, and participation in the National Milk Grid for transport and storage of milk is organized at union and Federation levels. In the AMUL model, the Boards of the DCSs, the unions, and the federation are composed of farmer representatives elected by members and have full autonomy over operations, pricing and marketing policy, with all technical management personnel appointed by and responsible to the boards.

OPERATION FLOOD

Operation Flood was first initiated in 1970; it consisted of projects implementing the AMUL model in three states: Karnataka, Madhya Pradesh, and Rajasthan. Subsequent projects aimed at duplicating the model in other areas followed. The National Dairy Project (Operation Flood II) was initiated in 1980 and involved the further expansion of the program within the three original states and the intensive development of the AMUL model in other states. Operation Flood III was launched in 1987 as part of the Government of India's Seventh Five Year Plan to extend the program into more areas and as of 1992 was still on going.

The replication of the AMUL model in different states entailed the coordinated efforts of the national and state governments, farmers, and donor agencies. The center for coordination and implementation of the project activities was the Dairy Development Corporations established in each state. The corporation's primary task was the organization of the village cooperative societies and milk producers' unions. It was responsible for recruiting the spearhead teams who were to form the nucleus staff of the producers' unions and the promotion, organization, and supervision of the operations of the DCSs. The Dairy Development Corporations also operated breeding farms to produce cross-breeds for sale to farmers (Karnataka), semen for distribution (Karnataka), and bulls for union bull farms (Madhya Pradesh and Rajasthan).

The National Dairy Development Board, the government agency overseeing the planning and execution of dairy development nationally, assisted these corporations by training the Dairy Development Corporation's and the union's staff. It was also in charge of supervising the dairy cooperatives during

---

[13] Information used in this case study was drawn from Martin Doornbos *et al.*, 1990, Dairy Aid and Development, New Delhi: Sage Publications and World Bank internal documents.

the first year. In addition, the Board assisted the Dairy Development Corporations in the design and construction of the union milk and feed plants, the preparation of marketing studies to determine plant product mixes, and other consulting services. Capital for establishing these corporations were supplied by the national government, the state governments (at least 20%), and the Union themselves.

Government Price Policy Reform

Although milk prices were not subject of price controls in the three states, pasteurized milk from state dairy plants were sold at prices significantly lower than the prevailing market rate. This policy of government subsidization of consumer milk prices was lifted upon commencement of the project to improve competition in the milk market.

Project Performance

Operation Flood was relatively successful in strengthening the dairy sector in India. Moreover, the cooperatives provided farmers the opportunity to gain greater access to production, marketing, and livestock services that previously were out of their reach. Shah and Bhargava (1982) found that as a result of the project, milk yields were significantly higher in villages that were part of the program, resulting in higher farm incomes. Its attractiveness to farmers is evidenced by the jump in the number of farmer participating families from 1.8 million in 1981 to 4.5 million in 1986. The number of dairy cooperative societies increased from 10,400 to 42,700 during the same period; while the volume of milk procured more than doubled from 2.6 million liters in 1981 to 7.9 million liters in 1986. The rapid rise in the rate of participation can be traced to the fact that during the term of implementation of the National Development Project, the financial rate of return (FRR) to landless families with cross-bred cows was 37 percent and was greater for farmers who could grow their own fodder. The FRR for the DCSs was 28 percent, and for producer unions 17 percent. Economic rates of return were not calculated, but were expected to be significantly higher than the opportunity cost of capital in India which was estimated at 12 percent. With respect to the initial state projects, the Rajasthan and the Karnataka projects registered economic rates of return of 28 and 22 percent respectively. Madhya Pradesh, however, displayed a negative economic rate of return. The upgrading of local dairy cattle in Madya Pradesh proceeded at a slower pace than projected, which severely reduced expected incremental milk production and contributed to operating deficits at the union and corporation/federation levels.

Project Constraints

The project, however, was not free of problems. There were bureaucratic delays, particularly at the state level where widespread AMUL cooperative development was often perceived as a threat to state functionaries and entrenched milk industry interests. State government collaboration was not always forthcoming and depending on individual state attitudes, the pace of implementation varied. A central plank of the AMUL cooperative organization is farmer ownership/control at the DCS, union, and federation level, and most importantly, freedom of the cooperative organizations to manage all aspects of milk procurement, processing, marketing, and pricing. This required transferring state ownership and control of the milk industry to farmer participants which the majority of states were reluctant or extremely slow to do.

Despite implementation difficulties, Operation Flood stands out amongst the many joint government-private sector-donor undertakings because of its sustainability. There is widespread and enthusiastic support amongst Indian villagers; the approach has had a solid grassroots base. Direct benefits accruing to participating DCS farmers include a reliable market for their milk and a higher family income; these benefits served as a strong incentive for farmers to become part of the program and for the national government to establish AMUL dairy cooperatives all over India. At the same time, a few

lessons can be learned from the Indian experience. The AMUL model depends for its efficient functioning on effective leadership and autonomous farmer control at all levels. Operation Flood showed that as long as the financing of the interdependent aspects of AMUL operations continue to be dependent on individual state budgeting procedures, coordination, efficiency, and financial viability are impaired.

Although the AMUL model has been proven to be sustainable in India, its effective replication across countries is not necessarily assured. As an illustrative example of the complexities involved in implementing standard development models across countries, a modified version of the AMUL model was implemented with World Bank assistance in Pakistan in 1977. The project primarily comprised the establishment and operations of Village Livestock Associations (VLAs) and was designed to improve the marketing of meat and milk by offering adequate prices with technical support and assured input supply to encourage the increased supply of beef and milk. The main components of the project, like the AMUL model, were the provision of an organized market for milk, the provision of technical services on animal husbandry and feed programs including animal health and artificial insemination services, the training of VLA staff, and the supply of start-up equipment for each new livestock association. The project performed very poorly and generally failed in its original objectives of improving livestock production and increasing farm incomes. Its poor performance was partly attributed to the inadequate commitment of the Punjab government, and was exacerbated by political rivalries among the agencies involved. Of the target of 500 VLAs, only 150 were formed, of which only 95 were actively operating. Overall, project performance was very inadequate.

LIVESTOCK SERVICES DELIVERY IN KENYA

INTRODUCTION

Private investments are made based on the expectation of immediate and/or future economic gains (e.g. the Brazilian case). Government policies shape the economic environment for private investments. They determine the incentives or disincentives for private entry into an industry; they define the boundary for opportunities for generating economic profit. The case of Kenya illustrates the profound impact of a government's policy of subsidization of livestock services on private investments. Although excess demand for the services exists, the economic disincentives due to government pricing policy have been so significant that the private sector is deterred from participating in the industry. This case study begins with a brief overview of the Kenyan livestock sector. A description of the channels for and the effectiveness of the delivery of livestock services follows.

THE LIVESTOCK SECTOR

Livestock represents a major national resource in Kenya; in 1989, the livestock population consisted of 18.4 million cattle (including 5.1 million dairy cattle), 13.5 million sheep and goats, and 24 million chickens (FAO-WHO-OIE, 1989). The output of the livestock sector amounted to $826 million or 37.5 percent of the value added in agriculture in 1988 (USDA, 1990). Most livestock in Kenya is owned by smallholders and pastoralists. A large portion of the livestock population is concentrated in the densely populated agricultural areas, the remainder is widely scattered over the sparsely populated rangelands.

THE LIVESTOCK SERVICES SECTOR[14]

The delivery of livestock services in Kenya during the mid-1980s was almost completely monopolized by the government and was under the aegis of the Department of Veterinary Services of the Ministry of Livestock Development (MLD). The operation of providing livestock services was functionally divided among three divisions and one support unit: the Field Services, the Veterinary Research, and the Veterinary Public Health Divisions, and the Project and Management Support Unit. The Field Services Division (FSD) was responsible for general disease control, vector (tick and tse-tse) control, clinical services, and artificial insemination activities. The Veterinary Research Division provided various support services to the FSD including the production of vaccines, laboratory services, and dip testing. The Veterinary Public Health Division handled the inspection and regulation of meat, milk, and other animal products. The Epidemiology and Economics Unit was responsible for performing epidemiological and economic analysis for disease control purposes. Lastly, livestock extension services were provided by the donor-supported National Extension Project, which wass based on the training and visit system of management.

Clinical and preventive services were provided by veterinary officers, livestock officers, animal health assistants, and junior animal health assistants of the FSD. The FSD operated veterinary clinical centers; the centers operated clinical runs which were routes covered periodically by the veterinary clinician to dispense treatments and drugs at fixed points by the road-side. Clinical care, provided to farmers at subsidized prices, were dispensed by the veterinary officers and by animal health assistants under their supervision. The prices of the drugs dispensed by the veterinarians were fixed by

---

[14] Information used in this case study was drawn from World Bank internal documents and Phylo Evangelou, 1984, Livestock Development in Kenya's Masailand, London: West View Press.

the government. These prices have remained unchanged for several years and in many instances were lower than the tender prices which were themselves substantially lower than retail prices. MLD budgetary problems affected the field service veterinarian's supply of veterinary drugs; shortages of some drugs occurred. Although prescriptions could be issued by the veterinary officers, the shortage of commercial pharmacies in the rural areas further constrained the ability of farmers to obtain the drugs prescribed.

Vaccinations for infectious diseases such as rinderpest, contagious bovine pleuropneumonia (CBPP), and food and mouth disease (FMD) were compulsory in some parts of the country. They were performed free, except in "scheduled" or large-scale farm areas where the government assumes that large-scale farmers could easily afford the costs involved. For example, for FMD control, a charge of Ksh 2 per head was levied in the scheduled areas. If an outbreak occurred, quarantines were imposed and free compulsory vaccination was provided in the area surrounding the nucleus of the outbreak. Outside the compulsory vaccination areas, vaccination is voluntary and a fee of Ksh 4 per vaccination was charged. Ksh 4 was a subsidized price; the actual costs of trivalent and quadrivalent FMD vaccines were Ksh 4.45 and Ksh 5.80 respectively (Table A8.1). The vaccination fee has caused resentment among farmers in the scheduled areas since most of the large farms in the scheduled areas have been divided into small holdings. Consequently, farmers regard the vaccination fee as unfair, because the original large-scale farm justification for the fee no longer existed. Resentment over the fee provoked farmer noncompliance with the inoculation program.

The impact of the Department of Veterinary Services' budgetary problems extended to the agency's clinical and preventive services geographic area of coverage. Transport vehicles are essential to the provision of veterinary care and preventive services. However, of the department's fleet of 1,116 vehicles in 1986, only 294 (26%) were in running condition. Vehicles were left unrepaired because they were too old or obsolete, government regulations and paperwork were time-consuming, or there was a lack of funds to purchase the parts and limited equipment to do the repairs. As a result, many veterinary officers were unable to go on their scheduled clinical routes. In some cases, farmers had to provide transportation or pay for the petrol to enable the veterinarian to visit their farms.

Dips for tick control in the mandatory areas were mostly operated by the government and dipping fees were subsidized. In areas outside the coverage of the tick control program, dips were usually privately or communally run. The government tick control program had been plagued with major problems which seriously hampered its effectiveness. Difficulties in program implementation included a shortage of acaricide, inadequate control of acaricide strength in the dip, water supply constraints, inadequate supervision of the dips, unwillingness of the farmers to dip Zebu cattle, and the general lack of operating funds. As a counter measure to the unreliability of government dips, farmers either set up private or communal dips or simply did not practice dipping at all. Farmers who raised grade cattle, however, recognized the economic importance of dipping. A World Bank study of a pilot project in Uasin Gishu showed that given a properly managed dip system, farmers who owned improved breeds were highly committed to dipping their cattle. Indeed, many large-scale grade cattle owners have found it economical to set up their own dipping or spraying facilities because of the necessity of insuring that their animals were adequately protected, rather than risk them by dipping in an under-strength or improperly managed government dip. Moreover, the adverse effect on milk production of walking animals to and from the government dip, the trauma of the dipping procedure, the risk of contracting contagious or infectious diseases as the result of herd mixing at dips, and the actual labor cost involved provided added incentives for managing a private dip. Farmers who owned Zebu stock, on the other hand, showed little interest in dipping their animals. The Zebu breed has a higher tolerance to ticks and

Table A8.1: Estimates of costs and selling prices of vaccines and trypanocidal drugs used by the Department of Veterinary Services, 1986.

VACCINE/DRUG	COST/DOSE Ksh	PRICE/DOSE Ksh
Rinderpest T/C	0.15	free
Contagious bovine pleuropnemonia	0.20	free
FMD quadrivalent	5.80	a
FMD trivalent	4.45	a
FMD bivalent	3.10	a
FMD monovalent	1.50	a
Rabies T/C (human)	250.00	free
Rabies HEP (cats)	230.00	10.00
Rabies LEP (dogs)	7.05[b]	2/10[c]
Brucella S 19	3.51	3.50
Enterotoxaemia	0.73	0.60
Anthrax	0.75	0.40
Leptospirosis	9.00	8.00
Haemorrhagic septicaemia	1.10	1.40
Horse sickness	65.20	20.00
Samrin	29.00	29.00
Berenil	6.40	6.75
Ethidium	2.75	3.00
Novidium	2.90	3.00
Quinapyramine sulphate	8.00	8.00
Quinapyramine pro-salt	9.00	9.00
Orf	0.45[b]	0.40
Newcastle disease	0.20[b]	free
Lumpy skin	0.20[b]	0.45
Rift Valley Fever	0.30[b]	0.30
Bluetongue	0.30[b]	0.40
Sheep and Goat Pox	0.20[b]	0.15
Fowl Typhoid	0.16[b]	0.15
Contagious caprine pleuropneumonia	0.69[b]	free

Notes: a - Free for routine vaccinations in small scale farming and pastoral compulsory vaccination areas; Ksh 2 per dose in scheduled (family large scale farming) compulsory vaccination ares. In non-compulsory vaccination areas Ksh 4 per dose on demand. Ring vaccination in the event of an outbreak is free in all instances. b - estimates. c - Ksh 2 per dose during campaigns and Ksh 10 at other times.
Source: World Bank data.

tick-borne diseases than the improved dairy and beef breeds. Consequently, Zebu owners did not find it necessary to incur the cost of dipping.

Rinderpest and CBPP vaccines were produced by the Kenya Agricultural Research Institute, while FMD vaccine was produced at the Wellcome Institute (a private institute). Both institutions had production capacities that exceeded local demand. The bottleneck in vaccine supply was not in its production, but in its distribution mechanism; there were insufficient cold chain equipment for storing and distributing the vaccines in the field. Four private companies (Wellcome, Bayer, Shell, and Ciba-Geigy) supplied the acaricide requirements of the Department of Veterinary Services on an annual tender basis. Veterinary drugs were available through normal retail outlets. The Pharmacy and Poison Ordinance detailed the drugs which can only be sold on prescription.

Many of the problems facing the Department of Veterinary Services stemmed from its large size and from its budgetary constraint. The government's open-ended policy of recruiting all the newly trained people produced by its training establishments (about 75 veterinary officers, 35 livestock officers, and 250 animal health assistants were trained every year in Kenya) placed increasing and unsustainable pressure on the departmental budget. Compounding the problem was the government's policy of subsidizing the livestock services it provided, thereby requiring continued support from the treasury. But the total budget of the Department continued to decline through time; it declined by 28% in constant prices from 1980/81 to 1985/86, with a sharp decline in transport operating expenditures (-37%) and capital expenditures (-88%). Thus, in the situation of shrinking budgetary allocations and expanding administrative structure, it was the quantity and quality of livestock services which suffered.

The budgetary shortfall, compounded by management problems, caused the deterioration of livestock services delivery. First, the vaccination programs, in particular rinderpest, CBPP and FMD, deteriorated due to the lack of transport and the breakdown of the cold chain. Second, the disease surveillance and investigation network of the Department was severely constrained by the lack of transport and the inability to replace old and obsolete laboratory equipment. Third, similar problems were encountered with vaccine production; breakdowns in equipment disrupted production. Fourth, the supplies of acaricides for the cattle dips which are intended to control ticks and tick-borne diseases have been inadequate. Consequently, poor dip management resulted in a decline in dipping rates as farmers lost confidence in government services, leading to increased livestock morbidity and mortality rates. Fifth, clinical services were hampered by a lack of transport, clinical equipment, and drugs. Rationing of services resulted and in many areas, these services almost ceased operation.

Private veterinary practices in Kenya were rare, because private practitioners could not compete with the subsidized clinical services provided by the Department of Veterinary Services. In general, only the large-scale commercial cattle, dairy, and the vertically-integrated poultry farms retained the services of private veterinarians. Deteriorating government services and increasing livestock populations created a large imbalance between the supply and demand for livestock services. Although the government disallowed all Department of Veterinary Services personnel from engaging in private clinical work, the demand for veterinary services had been so great that some government veterinarians, nonetheless, rendered services unofficially. Farmers, drawn by their need for the services, went to the extent of providing transport and food for the veterinarian and paid fees which approximated the "market rate."

LIVESTOCK SERVICES DELIVERY IN INDONESIA

INTRODUCTION

In countries with relatively small and undeveloped livestock sectors, the delivery of livestock services is typically dominated by the government. As more specialized and technologically advanced livestock industries develop, a demand for private-sector services is created. Barring government restrictions, privates sector participation increases as the industry's technological sophistication increases; in particular, private provision of clinical and preventive care begins to substitute for publicly provided services. The case of Indonesia is selected because it presents a typical example of the structure and pattern of livestock services delivery in a sector which is still in the initial stages of development. The government remains the dominant force in the sector, but private-sector participation is growing and flourishing. The following discussion begins with a brief overview of the livestock sector in Indonesia; the subsequent sections describe the delivery of livestock services.

THE LIVESTOCK SECTOR

The livestock sector of Indonesia is small, dispersed, and undeveloped relative to the other countries that have been studied; its contribution amounted to only $1.9 billion or 10 percent of the value-added in agriculture in 1988 (USDA, 1990). The livestock population consists mainly of cattle (10 million), goats (10.6 million) and chickens (444 million) (FAO-WHO-OIE, 1990). The cattle and buffaloes are kept primarily by smallholders as a source of draft power, manure for crop production, meat (essentially from old cows and young male animals), milk and milk products, and hides. Animals also commonly serve as a "living" savings account and are a source for ready cash (Tillman, 1981).

LIVESTOCK SERVICES DELIVERY[15]

The delivery of livestock services in Indonesia in the mid-1980s was largely the responsibility of the government. In the early 1980s, a more comprehensive livestock health delivery system was established which included field services, laboratories, quarantine facilities, vaccine production centers, and drug assay laboratories guided by a central policy making organization in Jakarta. But as a result of the increasing availability of veterinary graduates, private animal health services were beginning to have an impact on livestock production, particularly in more specialized areas such as commercial dairy and poultry production. This trend was expected to continue in view of the more attractive salaries offered by private enterprises.

The Public Sector

Two government agencies oversaw the delivery of livestock services in Indonesia, the Directorate General of Livestock Services (DGLS) and the Directorate of Animal Health (DAH). The DGLS operated field offices which provide clinical and preventive care to the livestock farmers. The DAH was responsible for vaccination programs and disease eradication campaigns, veterinary surveillance, quarantine services, food hygiene/inspection, and drug quality control.

The DGLS veterinarians and veterinary assistants supplied the drugs required by their clinical activities. Farmers paid for the cost of the drugs, the price of which was subsidized by the government.

---

[15] Information for this case study was drawn from Winrock International Institute for Agricultural Development (1986), "A Review of the Livestock Sector in the Republic of Indonesia," a report prepared for the Asian Development Bank and the Republic of Indonesia, Morrilton, Arkansas: Winrock International Institute for Agricultural Development.

During vaccination campaigns, the vaccines were provided free. Farmers did not have to pay for the services of the government veterinarians and veterinary assistants, but they usually offered gratuities such as free lunches.[16]

The field veterinary services were one of the weakest points in the government livestock health delivery system. Facilities and transport in the field were inadequate. Large quantities of vaccines were lost in the field due to lack of refrigeration and the veterinary assistants commonly had to walk, use public transport or borrow motorcycles to reach the farmers. The veterinary assistants provided most of the vaccinations and treatments in the villages. Although the veterinary assistants were expected to attend as least 6 months of training, many did not undergo any formal training, which consequently reduced their effectiveness in the field.

Veterinary Research and Diagnostic Laboratories

Veterinary research was largely undertaken by the Research Institute for Animal Diseases at Bogor. Supported by both Australian and British expatriate teams, research at the institute was directed at overcoming the basic diseases faced by Indonesian livestock producers. The Disease Investigation Centers were primarily responsible for disease surveillance, they also conducted some applied research. The center's staff mainly engaged in diagnostic work as well as the training of field veterinarians and veterinary assistants.

Veterinary Drugs and Biologicals

The Veterinary Biologics Center started producing vaccines and diagnostic antigens in 1979 and by 1986 manufactured a wide range of products. Most of its output were used by the government in its eradication programs (FMD), mass vaccination schemes (haemorrhagic septicaemia, anthrax, Newcastle disease) and diagnostic laboratories (antigens for brucellosis), but as of 1986, production satisfied only 20 percent of demand. Most commercial producers, for example, still used imported vaccines. The Veterinary Drug Assay Unit was established in the mid-1980s to act as the testing center for all veterinary drugs and vaccines before release into the Indonesian market.

The Private Sector

In 1989, 1,036 or approximately 33 percent of Indonesian veterinarians were working in the private animal health sector (FAO-WHO-OIE, 1990). Some were in small animal practice in the larger towns, but there were a few full-time practices serving the livestock industry. Where the private sector could not fill the demand for veterinary services, the deficit was commonly made up by government or university veterinarians acting as consultants to the larger commercial enterprises outside government working hours. In addition, drug distributors and animal feed manufacturers who used medicaments in their products were required to employ staff veterinarians. These agribusinesses provided livestock services to farmer clients and followed up complaints or problems concerned with their products.

Farmer Cooperatives

Farmer cooperatives which specialized in livestock production also employed veterinary staff as a service to members. In particular, the Association of Milk Cooperatives of Indonesia (GKSI), whose

---

[16]By early 1991, the government has declared its commitment to gradually eliminate the subsidies to the livestock services sector; in particular, the government intends to begin charging farmers for the services of its veterinary personnel and to charge for the full cost of the veterinary drugs (personal communication with Mr. Nelson Hutabarat, Agricultural Counselor of the Embassy of Indonesia, March 1991).

members included livestock/dairy cooperatives, village unit cooperatives, and village dairy cooperatives (locally known as Kooperative Unit Desa or KUD), provided technical services to their farmer members. The GKSI specifically provided livestock health and artificial insemination services and conducted extension activities covering animal nutrition and feeding. In 1987, the dairy cooperatives under GKSI employed over 20 veterinarians to service their farmer members.

While the private sector provided less job security, salaries were substantially higher than in government, particularly in drug companies. Thus it was expected that the private-sector animal health services will expand with the growth of the technically advanced livestock industries. However, the requirements of most smaller farmers will continue to be met by the government livestock service for the foreseeable future.

LIVESTOCK SERVICES DELIVERY IN THE PEOPLE'S REPUBLIC OF CHINA

INTRODUCTION

A nation's ideological structure is a crucial determinant of the degree of private participation in the delivery of livestock services; the level of private-sector involvement is an inverse function of the intensity of the socialist inclinations of governments. The case of the People's Republic of China is an illustrative example of livestock services delivery in a socialist economy. Although the public sector has a complete monopoly in its delivery, an increasingly important issue is the extent to which farmers are to cover the cost of these services. This case study begins with a brief overview of the livestock sector in the China; the second section describes the livestock healths services sector.

THE LIVESTOCK SECTOR[17]

The livestock sector in the People's Republic of China[18] is dominated by household production units for whom pig and chicken raising is a sideline pursued to take full advantage of surplus resources (labor and by-products). Its contribution to national income is only about 14 percent of the value-added in farm activities, and 11 percent of net incomes of farmers. Even though China possesses about 5 percent of the world's cattle and 12 percent of its sheep, ruminants are mostly raised either on a subsistence basis or as draft animals, and contribute little to total meat production. Of the latter (measured in carcass weight), pigs contribute about 88 percent, poultry 8 percent, and other livestock only about 4 percent.

THE LIVESTOCK SERVICES SECTOR

Given China's socialist economy, the delivery of livestock services was characteristically monopolized by the public sector. Livestock health programs at the central government level were administered by the Animal Husbandry Bureau (AHB) of the Ministry of Agriculture, Animal Husbandry, Industry, and Fisheries (MAAF). The AHB carried out the national programs concerned with disease prevention, vaccination, planning of veterinary services, and pharmaceutical management. It was divided into three divisions--the divisions of Preventive Medicine, Livestock Quarantine, and Pharmaceuticals. The Preventive Medicine Bureau was responsible for providing clinical care and disease prevention activities. The Livestock Quarantine Division was responsible for domestic quarantine concerns; the General Quarantine Station under the MAAF but separate from AHB, was responsible for inspection and quarantine of imported and exported live animals. The Pharmaceuticals Division set standards, issued licenses, and managed testing for locally produced or imported vaccines and pharmaceuticals. The AHB operated service stations at the township level; these township centers were supported by an additional 5,600 service institutions at and above the county level. Farmer-technicians working on a part-time basis were also employed in most of China's villages. Wide variations, however, existed between provinces and between counties within provinces in the delivery of the services.

---

[17] This case study was drawn from FAO (1990), "Livestock Services", Working Paper No.6 in China Agricultural Support Services Project, Rome: FAO and World Bank (1987), China The Livestock Sector, Washington, D.C.:World Bank.

[18] References to the People's Republic of China hereafter shall be abbreviated to China.

Veterinary Service at the Farm Level

The veterinary station, located at strategic points in municipalities, counties, townships, villages, and state farms, was the basic field unit from which livestock services were dispensed. Most incoming requests from farmers for assistance were made in person. Veterinarians usually made regular rounds of farms in their area so that livestock farmers were able to consult them frequently. Most farmers indicated that they requested veterinary assistance often, not only in cases of livestock sickness, but also to obtain advise on feeding and breeding. The problem that veterinarians commonly encountered wass the inability to make firm diagnoses because of the lack of laboratory aids.

The poultry health programs on large breeding and production farms and even on many of the smaller farms were better organized than any of the health programs for other livestock species. This was mainly due to the special character of poultry production (where housing, feeding, stock management, and health have been combined into an integrated production system) which allowed for the transfer of complete poultry production systems from other countries. The large farms employed resident veterinarians who were in charge of vaccinations, hatchery, and flock health, medication, and other such activities. In addition, many of the health measures developed on the breeding farms spilled over to benefit the smaller farms, where day old chicks were received along with instructions as to their proper care.

Livestock Extension

Extension services were provided through a network of Animal Husbandry and Veterinary Service Centers located at provincial, prefecture, county, and township levels. Livestock extension resources were frequently inadequate. Township and county offices spearheading the extension program generally lacked the resources and recurrent budget for effective communication of information to farmers. At the township level, staff sometimes lacked even the basic tools and drugs for animal husbandry and veterinary improvement programs. This situation was further aggravated by the Animal Health Bureau's historical philosophy of providing complete service to farmers, thus diluting available budget resources. The Animal Health Bureau was frequently involved in the provision of farmer services in the livestock feed, and product marketing and processing sectors that could equally be provided by township enterprises or specialized households. The Bureau's involvement in these sectors was primarily driven by the central government's new policy requiring budgetary self-sufficiency at all levels. Thus, the township level offices frequently engaged in revenue generating activities.

Vaccine Production

Vaccines of any type were not used for dairy cattle in China. Control of brucellosis relied exclusively on slaughtering or quarantine. Vaccines for pig diseases, all of Chinese origin, were prepared in vaccine laboratories under the control of the Animal Health Bureau. Veterinarians usually administered vaccines to pigs, but trained farmers may purchase the vaccine for use on their own farms. Most of the poultry vaccines used in China were manufactured in regional laboratories in Nanjing, Fuzhou, Beijing, and Tianjin. Antibiotics in feed premix or water soluble form were available from veterinary centers and feedmills, but were in limited supply; many were produced in Shanghai. Vaccines were provided free to the farmer, but veterinary drugs were sold at cost (plus an administrative charge). The farmer also paid a delivery/injection charge which varied according to province.

Cost Recovery

Wide variations in charges to farmers for the provision of livestock extension and veterinary services existed across provinces and counties. Provincial and lower level Animal Health Bureau administrators were largely unaware of cost recovery mechanisms outside their provinces. Many believed

that full cost recovery could not be achieved until the services were upgraded. But with the central government's new policy of reducing funding from the central treasury and making provinces and townships budgetarily self-sufficient, cost recovery has become a critical issue. For example, Leishue county in Jiangsu Province implemented effective cost recovery measures through charges on essential services. Eighty five percent of total expenses were recovered with the remaining 15 percent plus staff performance bonuses being provided by the province. The county did not invest in livestock services that could be alternatively sourced (e.g. slaughterhouses) and achieved high levels of farmer contact as evidenced by the vaccination coverage rates for pigs, buffalo, and poultry of 100, 90, 75 percent respectively and a 100 percent AI coverage of pigs with 80-90 percent conception to first insemination. Conversely, the income from household charges levied against Jilin province's approximately 3.6 million rural households was estimated to be less than Y18 million, about 50 percent of the provincial Animal Health Bureau budget. That livestock services in Jilin were relatively poor in comparison to Jiangsu and was in part due to fiscal constraints.

APPENDIX B
STATISTICAL TABLES

This section presents supplementary statistics on livestock health services in various countries in the world. Tables B1.1 to B1.3 provide data on livestock population and the number of veterinary personnel. Tables B2.1a to B2.4c show the calculations for the estimation of the breakeven VLUs per country and per square kilometer by country for Cameroon, Guinea, Kenya, and Uganda.

Table B1.1: Livestock and human population, 1989.[a/]

COUNTRY	CATTLE	DAIRY COWS	BUFFALOES	HORSES	MULES & ASSES	CAMELS	SHEEP	GOATS	PIGS	CHICKENS	OTHER POULTRY	HUMAN POPN	VLU[b/]
WORLD	1281473	222846	140028	60461	57925	19072	1175525	526440	846174	10574460	839471	5205	2430035
AFRICA	185794	28319	2650	4732	14103	14267	200711	169467	13097	645210	26994	628	290736
Algeria	1410	574		190	430	135	12500	3600	5	23100	102	24	4274
Angola	3100	295		1	5		270	980	485	6050		9	3826
Benin	932	118		6	1		890	994	680	24000		4	1822
Botswana	2350	295		25	151		250	1480	11	1300		1	2925
Burkina Faso	2850	463		70	403	5	3050	5350	496	21600		8	4859
Burundi	345	61					370	770	84	3900		5	601
Cameroon	4582	98		25	39		3170	3213	1299	16400		10	6164
Cape Verde	12	1			7		3	80	70	250			62
Central Afr. Rep	1495	46					130	1200	397	2700	8	2	1900
Chad	4115	412		195	245	516	2310	2310	13	3750		5	5769
Congo	70	2					102	245	50	1500		1	147
Côte d'Ivoire	991	158		1	1		1500	1500	450	16500		12	1840
Djibouti	72				8	58	415	501					226
Egypt	1950	1500	2650	10	1961	77	1320	1650	15	30000	7730	52	7844
Equatorial Guinea	5						35	8	5	220	30		14
Ethiopia	28900	2900		2600	5470	1070	24000	18000	20	57000		45	41685
Gabon	10	3					84	64	155	2150		1	127
Gambia	300	30		18	41		163	190	13	400			405
Ghana	1150	173		2	10		2200	2000	550	8000		14	2104
Kenya	13457	5100		2		800	6325	7500	100	24000		24	21031
Lesotho	530	81		120	128		1450	1040	73	1000		1	1031
Liberia	42	6					240	235	140	4000	240	2	208
Libya	240	50		48	62	190	5800	970		37000		4	1582
Madagascar	10250	59					800	1200	1420	21000	14650	11	11576
Malawi	1100	97			1		220	1000	220	8500		8	1515
Mali	4880	488		58	530	235	5650	5650	60	22000		9	7277
Mauritania	1260	274		17	150	810	4200	3300		3700		1	3215
Mauritius	33	10					7	95	10	2000	29	1	78
Morocco	3500	1601		200	1380	43	17500	5960	9	37600		24	8661
Mozambique	1370	395			20		120	380	165	21500	645	15	2129
Namibia	2060	170		50	74		6500	2550	49	510		1	3227
Niger	3600	534		298	512	420	3500	7570	37	17000		6	6255
Nigeria	12200	1220		250	700	18	13200	26000	1300	200000		109	20483
Reunion	19	11					3	43	98	3700			121
Rwanda	630	163					367	1100	100	1200	15	6	1002
Senegal	2673	267		208	210	8	3886	1200	490	11000		7	4021
Sierra Leone	330	50					330	180	50	5700	50	4	514
Somalia	5200	1100		1	49	6700	13800	20300	10	3220		7	16472
South Africa	11850	920		231	224		29850	5860	1470	38000	656	34	17690
Sudan	22600	3500		21	671	2900	19000	14000		30000		24	32946
Swaziland	660	154		2	14		37	325	20	800			876
Tanzania	14000	2850			173		5000	6650	186	31000	2800	26	18533

Table B1.1 cont'd: Livestock and human population, 1989.[a/]

COUNTRY	CATTLE	DAIRY COWS	BUFFALOES	HORSES	MULES & ASSES	CAMELS	SHEEP	GOATS	PIGS	CHICKENS	OTHER POULTRY	HUMAN POPN	VLU[b/]
AFRICA cont'd													
Togo	240	38		2	3		1050	1200	250	5500		3	686
Tunisia	614	260		56	301	185	5000	1120	4	17300		8	2025
Uganda	3912	1056			17		1780	2900	450		17		5670
Zaire	1450	8					890	3050	810	19500		34	2452
Zambia	2770												2770
Zimbabwe	2770	290			2		85	519	200	15000		8	3371
NORTH AMERICA													
Canada	12195	1421		338	4		728	27	10635	107800	7210	26	20330
United States	99180	10123		5203	52		10858	1750	55499	1550000	81800	248	157259
CENTRAL AMERICA													
Belize	50	4		5	4		4	1	26	850	25		81
Costa Rica	1735	310		114	12		6	11	223	5000		2	2271
El Salvador	1162	236		93	25		5	15	450	4750	5		1732
Guatemala	2023	450		112	46		660	76	800	15000		8	3176
Honduras	2601	333		170	91		7	27	600	8200		4	3450
Mexico	34999	6300		6170	6356		6000	10500	14080	226000	13400	86	58646
Nicaragua	1650	195		250	53		4	6	680	6500		3	2403
Panama	1502	110		171	5			7	240	6800	182	2	1891
SOUTH AMERICA	261069	28917	1150	13899	7182		113647	21875	55658	942214	19452	290	352674
Argentina	50782	2900		2900	255		29345	3200	4200	52000	7310	31	61207
Bolivia	5476	78		320	710		12300	2400	2127	14000	404	7	8747
Brazil	136814	18600	1150	5850	3320		20500	11000	33200	600000	10600	147	187005
Chile	3500	680		490	38		6600	600	1400	26000		12	6124
Colombia	24671	3400		1950	1250		2697	947	2600	40000		31	31735
Ecuador	4024	800		430	336		1883	300	4160	48000	186	10	7987
Paraguay	8074	108		330	45		449	146	2305	16915	558	4	9756
Peru	4044	693		660	710		13056	1734	2380	55000		21	8641
Surinam	75	8					6	7	21	5500	60		150
Uruguay	10548	580		470	5		25560	14	215	8700	330	3	14121
Venezuela	12856	1010		495	512		425	1450	2856	61206		19	16597
ASIA	391556	53818	135538	17086	27583	4535	325643	296342	420136	4233878	525727	3049	927644
Afghanistan	1600	780		400	1330	265	12500	2100		7000		15	5040
Bangladesh	23000	3575	2000	45			1150	10879		85000	33000	112	30980
Bhutan	424	111	7	16	27		30	34	64	200		1	604
Hongkong	1	1		1					350	5998	537	5	243
India	195500	29000	73700	955	1538	1400	53486	107000	10300	270000		836	324745
Indonesia	10050	255	3300	725			5500	10600	6700	444000	28500	177	23653
Japan	4682	1410		21			27	40	11866	330000	8	123	15342
Korea (Dem.)	1280	36		44	5		380	290	3145	20000		22	3180
Korea (Rep.)	2039	276		44			3	139	4852	58467	509	43	5367

Table B1.1 cont'd: Livestock and human population, 1989.[a/]

COUNTRY	CATTLE	DAIRY COWS	BUFFALOES	HORSES	MULES & ASSES	CAMELS	SHEEP	GOATS	PIGS	CHICKENS	OTHER POULTRY	HUMAN POPN	VLU[b/]
ASIA cont'd													
Laos	805	46	1050	43				95	1300	7000	372	3	2656
Malaysia	639	43	220	5			100	347	2350	58800	4300	16	2755
Mongolia	2541	560		2060		542	13451	4300	169	341		2	6536
Myanmar	10000	2400	2220	140	9		295	1100	3000.0	34000	6335	40	16737
Nepal	6343	689	2950				880	5210	515	10000		18	10949
Pakistan	17363	2847	14349	457	3174	972	28345	34194		164670	1350	118	45261
Philippines	1482	15	2800	300			30	2212	7809	65921	6600	60	9301
Singapore								2	321	4000	657	2	207
Sri Lanka	1800	540	1000	1			28	520	100	9000	33	17	3536
Thailand	5285	60	5443	18			145	100	4679	95000	15988	54	14271
Vietnam	3026	46	2907	133			24	411	11643	72400	23900	65	12874
MIDDLE EAST													
Bahrain	6	2				1	8	16		950			21
Iraq	1650	398	145	58	441	58	9500	1600		77000		18	4381
Israel	357	113		4	7	10	375	125	130	22590	8400	4	910
Jordan	29	18		3	22	15	1225	500		60000	10	3	847
Kuwait	29	17		4		8	320	43		30000		2	392
Lebanon	55	41		2	16		145	475	22	12000		2	298
Oman	136	43			24	83	220	770		1900		1	392
Qatar	8	2		1		22	128	78		1450			68
Saudi Arabia	250	130		3	116	405	7698	3700		70000		13	2684
Syria	756	310	1	43	204	5	13903	1053	1	12900	328	12	2824
Turkey	12000	5000	540	620	1410	3	34850	13100	10	58790	2974	54	23976
United Arab Emir.	48	17				100	250	575		6500		1	313
EUROPE	125569	45790	366	4253	1431		151264	15135	185925	1291343	114398	498	298227
Albania	705	248	2	42	74		1555	1106	201	5300	3		1433
Austria	2541	891		44			256	32	3874	13590	559	7	5561
Belgium	2967	935		23	1		190	8	5950	35000	311	10	7262
Denmark	2226	750		29			86		9105	14600	948	5	7707
Finland	1379	508		36			59	3	1327	5704		4	2632
France	21780	9237		269	37		12001	1103	12480	19000	33100	56	39241
Germany, D. R.	5710	1989		102			2634	19	12464	49430		16	14742
Germany, F. R.	14659	5040		363			1464	52	22589	72035	4521	61	32092
Greece	731	350	1	60	251		10376	5970	1226	31000	310	9	3798
Hungary	1690	580		76	5		2215	16	8327	56719	4885	10	7313
Ireland	5637	1387		53	22		4991	9	961	7686	1195	3	8131
Italy	8737	2973	105	250	136		11623	1214	9359	128300	23000	57	19484
Luxembourg													
Netherlands	4606	1900		64			1405	34	13820	100000	2571	14	14618
Norway	932	336		16			2248	92	750	4100		4	1926
Poland	10733	4800		1005			4409	10	18835	59820	6368	37	26557

Table B1.1 cont'd: Livestock and human population, 1989.[a/]

COUNTRY	CATTLE	DAIRY COWS	BUFFALOES	HORSES	MULES & ASSES	CAMELS	SHEEP	GOATS	PIGS	CHICKENS	OTHER POULTRY	HUMAN POPN	VLU[b/]
EUROPE cont'd													
Portugal	1359	414		26	250		5354	745	2326	18000	5400	10	3918
Romania	7170	2090	700	36		18800	1000	15400	142200	11500	23		101633
Spain	5050	1831		241	230		23797	3100	16100	55000	267	39	18409
Sweden	1662	562		58			396		2320	11000	290	8	3566
Switzerland	1850	786		49	2		360	70	1869	6400		6	3703
United Kingdom	11902	3142		184	5		29046	61	7626	127000	10802	57	23240
Yugoslavia	4759	2587	25	340	29		7564		7396	69473	5399	23	12759
OCEANIA	30858	3911		496	9		225577	2064	5393	70847	2491	26.0	61215
Australia	22434	1663		317	2		165000	684	2671	54000	2163	16	42722
New Zealand	7818	2195		98			60569	1222	411	8700	190	3	16536

[a/]Number of livestock in thousands, human population in millions.
[b/]A veterinary livestock unit (VLU) is equal to 1 cow, 1 camel, 2 horses, 2 pigs, 2 donkeys, 10 small ruminants, or 100 fowl.

Source: FAO-WHO-OIE (1989).

Table B1.2: Livestock, agricultural production, and GDP values, 1988.

COUNTRY	VALUE OF PRODUCTION Livestock $INT Mil.	Agriculture $INT Mil.	GDP US$ Mil.	LIVESTOCK/ AGRICULTURE (%)	LIVESTOCK/ GDP (%)
AFRICA					
Algeria	881	2123	51899.1	41.50	1.70
Angola	201	632	6925.9	31.80	2.90
Benin	115	554	1764.7	20.76	6.52
Botswana	107	121	2012.9	88.43	5.32
Burkina Faso	183	671	2874.0	27.27	6.37
Burundi	42	739	11642.6	5.68	0.36
Cameroon	224	1419	12666.6	15.79	1.77
Cape Verde			263.0		
Central African Rep	115	363	1118.4	31.68	10.28
Chad	216	554	1052.8	38.99	20.52
Congo	15	155	2219.6	9.68	0.68
Côte d'Ivoire	136	2644	10310.3	5.14	1.32
Djibouti			395.4		
Egypt	1920	7241	30978.4	26.52	6.20
Equatorial Guinea			141.2		
Ethiopia	1299	3243	5684.5	40.06	22.85
Gabon	9	86	3234.2	10.47	0.28
Gambia	15	99	211.8	15.15	7.08
Ghana	121	1321	5229.7	9.16	2.31
Kenya	826	2202	8418.5	37.51	9.81
Lesotho	66	95	426.7	69.47	15.47
Liberia	22	241		9.13	
Libya	306	616	21097.0	49.68	1.45
Madagascar	472	1765	2501.2	26.74	18.87
Malawi	98	831	1387.1	11.79	7.07
Mali	368	835	2055.4	44.07	17.90
Mauritania	158	188	976.3	84.04	16.18
Mauritius	24	182	2069.0	13.19	1.16
Morocco	992	2824		35.13	
Mozambique	160	796	1257.8	20.10	12.72
Namibia	245	300	1895.2	81.67	12.93
Niger	314	667	2330.7	47.08	13.47
Nigeria	1749	9780	29740.3	17.88	5.88
Reunion	19	78		24.36	
Rwanda	70	645	2327.6	10.85	3.01
Senegal	172	817	4979.7	21.05	3.45
Sierra Leone	35	300	1144.1	11.67	3.06
Somalia	514	709	1046.3	72.50	49.13
South Africa	3334	6776	88225.4	49.20	3.78
Sudan	1901	3261	8953.6	58.30	21.23
Swaziland	47	193	612.2	24.35	7.68
Tanzania	642	2837	3137.0	22.63	20.47
Togo	37	326	1363.1	11.35	2.71
Tunisia	412	1395	10051.6	29.53	4.10
Uganda	404	2840	4898.8	14.23	8.25
Zaire	143	2740	9705.7	5.22	1.47
Zambia	169	527	3618.0	32.07	4.67
Zimbabwe	260	1137	5891.5	22.87	4.41
NORTH AMERICA					
Canada	6541	17283	488749.0	37.85	1.34
United States	64341	137770	4847310.0	46.70	1.33

Table B1.2 cont'd: : Livestock, agricultural production, and GDP values, 1988.

COUNTRY	VALUE OF PRODUCTION Livestock $INT Mil.	Agriculture $INT Mil.	GDP US$ Mil.	LIVESTOCK/ AGRICULTURE (%)	LIVESTOCK/ GDP (%)
CENTRAL AMERICA					
Belize			288.9		
Costa Rica	347	907	4611.8	38.26	7.52
El Salvador	191	752	5473.2	25.40	3.49
Guatemala	331	1258	8056.2	26.31	4.11
Honduras	190	702	4456.5	27.07	4.26
Mexico	7755	16487	174159.0	47.04	4.45
Nicaragua	196	580		33.79	
Panama	220	494	4551.4	44.53	4.83
SOUTH AMERICA					
Argentina	8665	18221	93854.0	47.56	9.23
Bolivia	499	1071	4361.9	46.59	11.44
Brazil	13761	45652	350451.0	30.14	3.93
Chile	1059	2564	22081.5	41.30	4.80
Colombia	2989	6957	38873.7	42.96	7.69
Ecuador	1680	1909	10292.5	88.00	16.32
Paraguay	552	1960	3951.4	28.16	13.97
Peru	1009	2544	19070.7	39.66	5.29
Surinam	24	98	12353.0	24.49	0.19
Uruguay	1363	1729	7943.7	78.83	17.16
Venezuela	1799	3019	60226.4	59.59	2.99
ASIA					
Afghanistan	809	1944		41.62	
Bangladesh	1063	7027	18888.7	15.13	5.63
Bhutan	22	86	283.2	25.58	7.77
Hongkong	65	88	55291.5	73.86	0.12
India	14377	74349	270193.0	19.34	5.32
Indonesia	1896	19008	84249.9	9.97	2.25
Japan	9774	18052	2842770.0	54.14	0.34
Korea (Dem.)	569	3994		14.25	
Korea (Rep.)	1961	5864	171311.0	33.44	1.14
Laos	219	640	532.7	34.22	41.11
Malaysia	803	5407	34695.7	14.85	2.31
Mongolia	587	754		77.85	
Myanmar	727	5925		12.27	
Nepal	464	1492	3151.8	31.10	14.72
Pakistan	5738	13771	38472.8	41.67	14.91
Philippines	1377	6690	39142.3	20.58	3.52
Singapore	170	174	24530.6	97.70	0.69
Sri Lanka	161	1757	7127.3	9.16	2.26
Thailand	1887	11208	59597.1	16.84	3.17
Vietnam	1652	7351	6912.2	22.47	23.90
MIDDLE EAST					
Bahrain			3358.8		
Iraq	620	1788		34.68	
Israel	597	1337	45991.1	44.65	1.30
Jordan	182	341	5879.1	53.37	3.10
Kuwait			20019.4		
Lebanon	206	529		38.94	
Oman			7701.7		
Qatar			5717.0		
Saudi Arabia	853	1576	75292.6	54.12	1.13
Syria	914	2694	11340.1	33.93	8.06
Turkey	3648	16063	70886.9	22.71	5.15
United Arab Emirates			23285.8		

Table B1.2 cont'd: : Livestock, agricultural production, and GDP values, 1988.

COUNTRY	VALUE OF PRODUCTION Livestock $INT Mil.	Agriculture $INT Mil.	GDP US$ Mil.	LIVESTOCK/ AGRICULTURE (%)	LIVESTOCK/ GDP (%)
EUROPE					
Albania	272	626		43.45	
Austria	2307	3461	127195.0	66.66	1.81
Belgium	3073	4230	153829.0	72.65	1.92
Denmark	3500	5035	107560.0	69.51	3.25
Finland	1297	1723	105271.0	75.28	1.23
France	17952	34777	955596.0	51.62	1.88
Germany, D. R.	5842	9585		60.95	
Germany, F. R.	15321	22090	1201820.0	69.36	1.27
Greece	1478	5252	52490.5	28.14	2.82
Hungary	3525	7201	27959.1	48.95	12.61
Ireland	2852	3317	32485.8	85.98	8.78
Italy	8344	22325	831954.0	37.38	1.00
Luxembourg			6561.6		
Netherlands	7798	10008	228276.0	77.92	3.42
Norway	891	1139	89820.7	78.23	0.99
Poland	8629	19073	68823.9	45.24	12.54
Portugal	1070	2432	41882.8	44.00	2.55
Romania	4612	13151		35.07	
Spain	6227	17714	340469.0	35.15	1.83
Sweden	1686	2788	191803.0	60.47	0.88
Switzerland	1731	2259	183660.0	76.63	0.94
United Kingdom	10058	15773	828750.0	63.77	1.21
Yugoslavia	3890	8323	61765.2	46.74	6.30
OCEANIA					
Australia	9721	151181	246279.0	6.43	3.38
New Zealand			41221.7		

Note: Figures for Belgium include Luxembourg; Australian figures include New Zealand. The international dollar ($int) was developed by FAO and is based on a single world price for each commodity.

Source: Values of livestock and agricultural production were from USDA (1990). GDP values were from the World Bank.

Table B1.3: Number of veterinarians and animal health auxiliary personnel and veterinary livestock units (VLUs) per veterinarian and auxiliary personnel, 1989.

COUNTRY	NUMBER OF VETERINARIANS					NO. OF ANIMAL AUXILIARIES				RATIO OF		VLU PER	
	Govt	Labs, univ, train. inst.	Priv. Vets	Other Vets	Total	Health assist.	Field asst/ vaccinators	Food inspect.	Total	Govt/ Priv Vets	Aux./(Govt+ Priv vets)	Vet	Aux Pers
AFRICA													
Algeria	8	159	1	379	547	700	0	0	700	8.0	77.8	7813	6105
Angola	35	16	3	18	72	114	195	0	309	11.7	8.1	53139	12382
Benin	64	7	2	7	80	103	94	59	263	32.0	4.0	22774	6927
Botswana	18	10	1	1	30	459	1092	74	1625	18.0	85.5	97483	1800
Burkina Faso	50	10	3	18	81	127	298	0	425	16.7	8.0	59981	11432
Burundi	43	12	2	1	58	119	299	0	418	21.5	9.3	10362	1438
Cameroon	88	19	3	1	111	44	225	0	269	29.3	3.0	55530	22914
Cape Verde	6	0	0	2	8	7	12	18	37		6.2	7788	1684
Central Afr. Rep	3	4	0	8	15	237	21	0	258		86.0	126639	7363
Chad	49	15	0	0	64	326	55	167	548		11.2	90141	10527
Congo	6	11	6	49	72	128	165	20	313	1.0	26.1	2038	469
Côte d'Ivoire	80	13	6	11	110	372	584	80	1036	13.3	12.0	16727	1776
Djibouti	4	0	0	0	4	4	7	6	17		4.3	56400	13271
Egypt	12320	3300	1430	1170	18220	2530	4950	4730	12210	8.6	0.9	431	642
Equatorial Guinea	7	0	0	2	9	0	2	5	7		1.0	1589	2043
Ethiopia	311	35	0	8	354	641	934	136	1711		5.5	117754	24363
Gabon	0	3	6	1	10	35	0	0	35		5.8	12680	3623
Gambia	7	2	0	4	13	100	40	35	175		25.0	31177	2316
Ghana	107	9	3	11	130	321	471	185	977	35.7	8.9	16185	2154
Kenya	645	65	32	60	802	2362	268	338	2968	20.2	4.4	26223	7086
Lesotho	16	1	1	4	22	29	45	4	78	16.0	4.6	46841	13212
Liberia	5	4	1	1	11	20	15	12	47	5.0	7.8	18900	4423
Libya	253	42	6		301	172	400	0	572	42.2	2.2	5256	2766
Madagascar	81	9	5	10	105	548	448	0	996	16.2	11.6	110243	11622
Malawi	17	12	1	5	35	547	126	6	679	17.0	37.7	43271	2230
Mali	58	21	2	455	536	112	535	0	647	29.0	10.8	13576	11247
Mauritania	14	0	0	0	14	89	119	0	208		14.9	229607	15454
Mauritius	20	3	4	9	36	30		3	33	5.0	1.4	2180	2378
Morocco	260	88	89	70	507	1010	640	260	1910	2.9	5.5	17082	4534
Mozambique	62	37	0	0	99	175	209	0	384		6.2	21505	5544
Namibia	21	7	8	2	38	92	88	27	207	2.6	7.1	84911	15587
Niger	38	12	0	6	56	590	229	135	954		25.1	111688	6556
Nigeria	980	314	297	218	1809	2370	700	2126	5196	3.3	4.1	11323	3942
Reunion	2	1	14	4	21	1	17	10	28	0.1	1.8	5743	4307
Rwanda	30	8	2	1	41	244	302	3	549	15.0	17.2	24435	1825
Senegal	39	12	4	13	68	356	176	0	532	9.8	12.4	59126	7558
Sierra Leone	17	2	2	0	21	13	60	0	73	8.5	3.8	24452	7034
Somalia	273	105	0	0	378	433	1200	89	1722		6.3	43577	9566
South Africa	191	201	1021	94	1507	182	348	262	792	0.2	0.7	11739	22336
Sudan	830	128	0	0	958	435	328	131	894		1.1	34390	36852
Swaziland	13	3	2	2	20	52	204	8	264	6.5	17.6	43810	3319
Tanzania	150	142	10	2	304	807	1730	140	2677	15.0	16.7	60962	6923

Table B1.3 cont'd: Number of veterinarians and animal health auxiliary personnel and veterinary livestock units (VLUs) per veterinarian and auxiliary personnel, 1989.

COUNTRY	NUMBER OF VETERINARIANS					NO. OF ANIMAL AUXILIARIES				RATIO OF		VLU PER	
	Govt	Labs, univ, train.	Priv. inst.	Other Vets	Total	Health assist.	Field asst/ vaccinators	Food inspect.	Total	Govt/ Priv Vets	Aux./(Govt+ Priv vets)	Vet	Aux Pers
AFRICA cont'd													
Togo	28	9	5	19	61	53	48	3	104	5.6	3.2	11238	6591
Tunisia	232	70	34	114	450	0	194	200	394	6.8	1.5	4499	5138
Uganda	352	44	15	8	419	732	1350	12	2094	23.5	5.7	13531	2708
Zaire	369	140	145	242	896	750	635	200	1595	2.5	3.1	2737	1537
Zambia	30	30	1	35	96	89	395	0	484	30.0	15.6	28854	5723
Zimbabwe	67	30	51	6	154	445	298	67	810	1.3	6.9	21892	4162
NORTH AMERICA													
Canada	800	250	5000	100	6150	2900	500	1500	4900	0.2	0.8	3306	4149
United States	2486	7363	39500	4291	54000	19268	768	7750	27786	0.1	0.7	2912	5660
CENTRAL AMERICA													
Belize	5	1	1	3	10	6	0	3	9	5.0	1.5	8075	8972
Costa Rica	125	40	341	0	506	85	0	34	119	0.4	0.3	4489	19086
El Salvador	85	10	156	1	252	0	40	52	92	0.5	0.4	6871	18821
Guatemala	97	58	280	0	435	95	99	24	218	0.3	0.6	7300	14567
Honduras	77	20	46	5	148	68	47	56	171	1.7	1.4	23310	20175
Mexico	2000	2900	5250	150	10300	5500	3200	3500	12200	0.4	1.7	5694	4807
Nicaragua	40	18	50	0	108	60	0	30	90	0.8	1.0	22245	26694
Panama	186	7	208	24	425	203	0	45	248	0.9	0.6	4448	7623
SOUTH AMERICA													
Argentina	760	0	4935	0	5695	0	1143	0	1143	0.2	0.2	10748	53550
Bolivia	63	45	920	18	1046	17	10	5	32	0.1	0.0	8362	273329
Brazil	10213	1825	5695	7900	25633	4331	1468	3410	9209	1.8	0.6	7295	20307
Chile	372	230	1620	120	2342	86	0	0	86	0.2		2615	71209
Colombia	1959	485	3116	1181	6741	453	0	0	453	0.6	0.1	4708	70056
Ecuador	75	10	0	0	85		179	0	179		2.4	93967	44621
Paraguay	426	135	460	0	1021	95	1460	125	1680	0.9	1.9	9556	5807
Peru	600	241	1287	280	2408	384	0	0	384	0.5	0.2	3588	22503
Surinam	8	0	1	0	9	8	4	8	20	8.0	2.2	16711	7520
Uruguay	280	0	1500	0	1780	340	0	506	846	0.2	0.5	7933	16691
Venezuela	450	400	3200	0	4050	70	250	550	870	0.1	0.2	4098	19077
ASIA													
Afghanistan	132	57	14	0	203	320	24	25	369	9.4	2.5	24828	13659
Bangladesh	748	152	25	70	995		2250	2250		29.9	0.0	31136	
Bhutan	5	6	0	8	19	141	174	12	327		65.4	31784	1847
Hongkong	9	2	22	8	41	81	54	144	279	0.4	9.0	5923	870
India	25900	2550	575	875	29900	59000	2500	0	61500	45.0	2.3	10861	5280
Indonesia	625	837	1036	602	3100	1320	0	0	1320	0.6	0.8	7630	17919
Japan	8229	1386	14391	2935	26941					0.6	0.0	569	

Table B1.3 cont'd: Number of veterinarians and animal health auxiliary personnel and veterinary livestock units (VLUs) per veterinarian and auxiliary personnel, 1989.

COUNTRY	NUMBER OF VETERINARIANS					NO. OF ANIMAL AUXILIARIES				RATIO OF		VLU PER	
	Govt	Labs, univ, train. inst.	Priv. Vets	Other Vets	Total	Health assist.	Field asst/ vaccinators	Food inspect.	Total	Govt/ Priv Vets	Aux./(Govt+ Priv vets)	Vet	Aux Pers
ASIA cont'd													
Laos	21	16	0	5	42	314	1738	31	2383		113.5	63231	1114
Malaysia	124	90	116	268	598					1.1		4607	
Mongolia	879	129	0	100	1108	0	2529	279	2808		3.2	5899	2328
Myanmar	1048	184	858	0	2090	851	0	0	851	1.2	0.4	8008	19668
Nepal	161	6	6	0	173	1252	170		1422	26.8	8.5	63286	7699
Pakistan					2239				4898			20215	9241
Philippines	320	230	939	1276	2765	1574	0	112	1686	0.3	1.3	3364	5517
Singapore	17	7	30	11	65	60	37	51	148	0.6	3.1	3189	1400
Sri Lanka	212	20	17	15	264	335	550	0	885	12.5	3.9	13393	3995
Thailand	383	215	320	88	1006	1597	2018	765	4380	1.2	6.2	14186	3258
Vietnam	1990	285	25	50	2350	4100	8200	800	13100	79.6	6.5	5478	983
MIDDLE EAST													
Bahrain	12	1	4	15	32	16	3	0	19	3.0	1.2	653	1100
Iraq	1729	341	95	1725	3890	1055	987	340	2382	18.2	1.3	1126	1839
Israel	168	84	168	211	631	0	56	118	174	1.0	0.5	1443	5232
Jordan	136	5	3	33	177				45	45.3	0.3	4786	18824
Kuwait	96	0	40	2	138	120		45	165	2.4	1.2	2843	2378
Lebanon	16	5	25	16	62	10	20	6	36	0.6	0.9	4806	8278
Oman	36	11	4	30	81	52	60	8	120	9.0	3.0	4840	3267
Qatar	30	3	4	4	41	11	3	0	14	7.5	0.4	1649	4829
Saudi Arabia	166	0	0	0	166	267	0	0	267		1.6	16170	10054
Syria	525	200	1531	25	2281	937		70	1007	0.3	0.5	1238	2804
Turkey	1777	340	1422	160	3699	2611				1.2		6482	
United Arab Emir.	36	3	120	0	159	59	39	0	98	0.3	0.6	1965	3189
EUROPE													
Albania	40	117	0	1477	1634	658	200	31	889		22.2	877	1612
Austria	553	942	424	1919	3838					1.3		1449	
Belgium	202	173	3220	500	4095					0.1		1773	
Denmark	469	240	1118	679	2506	0	0	171	171	0.4	0.1	3075	45071
Finland	504	146	141	272	1063	0	0	74	74	3.6	0.1	2476	35564
France	540	455	6330	510	7835	464		2073	2537	0.1	0.4	5008	15468
Germany, D. R.	600	840	10	3440	4890	2000	185	1300	3485	60.0	5.7	3015	4230
Germany, F. R.	1094	1644	7066	6150	15954			10000	10000	0.2	1.2	2012	3209
Greece	1431	194	560	300	2485	160	230	0	390	2.6	0.2	1528	9739
Hungary	750	305	1255	1190	3500					0.6		2089	
Ireland	291	58	1333	34	1716					0.2		4738	
Italy	3733	267	6310	4563	14873					0.6		1310	
Luxembourg	11	4	71	3	89					0.2			
Netherlands	300	300	2004	1150	3754	0	0	1200	1200	0.1	0.5	3894	12181
Norway	261	198	558	541	1558					0.5		1236	

Table B1.3 cont'd: Number of veterinarians and animal health auxiliary personnel and veterinary livestock units (VLUs) per veterinarian and auxiliary personnel, 1989.

COUNTRY	NUMBER OF VETERINARIANS					NO. OF ANIMAL AUXILIARIES				RATIO OF		VLU PER	
	Govt	Labs, univ, train. inst.	Priv. Vets	Other Vets	Total	Health assist.	Field asst/ vaccinators	Food inspect.	Total	Govt/ Priv Vets	Aux./(Govt+ Priv vets)	Vet	Aux Pers
EUROPE cont'd													
Poland	7270	940	69	906	9185	3785	0	1874	5659	105.4	0.8	2891	4693
Portugal	1170	220	350	42	1782					3.3		2199	
Romania	3330	680	0	0	4010	6100	5100	1450	12650		3.8	5186	1675
Spain	4700	3500	1600	3500	13300					2.9		1384	
Sweden	369	230	188	1072	1859	0	0	220	220	2.0	0.4	1918	16207
Switzerland	120	350	820	360	1650	0	0	150	150	0.1	0.2	2244	24687
United Kingdom	614	833	7537	355	9339				3029	0.1	0.4	2489	7673
Yugoslavia	4540	766	0	0	5306	2347	1924	4271	8542		1.9	2405	1494
OCEANIA													
Australia	821	550	3656	200	5227	814	193	1901	2908	0.2	0.6	8173	14691
New Zealand	193	45	826	291	1355	179	0	988	1167	0.2	1.1	12204	14170

Country Notes: Algeria, Belgium, Brazil, Chile, Congo, Gabon, Korea DPR, Mozambique, Romania, Spain, Sudan-information not updated. Chile, Equatorial Guinea, Greece, Mexico, Poland - 1988 data. Ecuador - national animal health program staff only. United Kingdom - figures for veterinarians in private practice and in laboratories are approximate. Sweden - auxiliary personnel involved in food hygiene include 80 government veterinarians. Government veterinarians include both central government and local veterinarians. Field assistants also include vaccinators. Animal health assistants - with 2-3 years training, working under supervision of veterinarians. Involved in hygiene includes meat inspectors.

Source: FAO (1989). Values for the veterinary livestock units are from Table B1.1.

Table B2.1a: Fixed investments of a private veterinary practice in Cameroon, 1988.

FIXED INVESTMENTS	AQUISITION COST ($)	LIFESPAN	DEPN/ YEAR ($)
Vehicle	13793	4	3448
Vet. Equipment	2069	5	414

Source: World Bank data.

Table B2.1b: Costs and returns to private veterinary practice in Cameroon, 1988.

COSTS	Unit	AMOUNT ($)
Depreciation:		
Vehicle	per year	3448
Vet. Equipment	per year	414
Total		3862
Operating expenses		3276
Fuel and maintenance		
$0.20/km, 100 km/trip		
100 trips/year		2000
200 trips/year		4000
240 trips/year		4800
Cost of capital (13.5%)		
100 trips/year		1234
200 trips/year		1504
240 trips/year		1612
Total costs		
100 trips/year		10372
200 trips/year		12642
240 trips/year		13550
Additional Revenue:		
Drugs sales	26897	
25% sales mark-up		6724
50% sales mark-up		13448

Note: CFAF 290 = US$ 1; fuel maintenance costs assumed to be $0.20/km, 100 km/trip for illustrative purposes.
Source: World Bank data.

Table B2.1c: Breakeven VLUs by production system of a private veterinary practice in Cameroon, 1988.

PRODUCTION SYSTEM	FEE/ ANIMAL ($)	BREAKEVEN VLUs/YEAR Pure Vet Service	Vet Service +25% margin	Vet Service +50% margin
TRADITIONAL				
100 trips/year	2	5186	1824	NA
200 trips/year		6321	2959	NA
240 trips/year		6775	3413	51
INTERMEDIATE				
100 trips/year	12	864	304	NA
200 trips/year		1053	493	NA
240 trips/year		1129	569	8
HIGH INTENSITY				
100 trips/year	20	519	182	NA
200 trips/year		632	296	NA
240 trips/year		677	341	5

Note: Breakeven VLU = (depreciation costs + operating costs - drug sales margin)/fee per animal. NA - not applicable, drug sales exceed cost of operation.

Table B2.2a: Fixed investments of a private veterinary practice in Guinea, 1986.

FIXED INVESTMENTS	AQUISITION COST ($)	LIFESPAN	DEPN/ YEAR ($)
Vehicle	4514	4	1128
Vet. Equipment	833	5	167

Note: FG 360 = US$ 1.
Source: World Bank data.

Table B2.2b: Costs and returns to private veterinary practice in Guinea, 1986.

COSTS	Unit	AMOUNT ($)
Depreciation:		
Vehicle	per year	1128
Vet. Equipment	per year	167
Total		1295
Operating expenses	per year	1042
Fuel and maintenance		
$0.20/km, 100 km/trip		
100 trips/year		2000
200 trips/year		4000
240 trips/year		4800
Cost of capital (12%)		
100 trips/year		520
200 trips/year		760
240 trips/year		856
Total Costs		
100 trips/year		4857
200 trips/year		7097
240 trips/year		7993
Additional Revenue:		
Drugs sales	2597	
25% sales mark-up		649
50% sales mark-up		1299

Note: FG 360 = US$ 1; fuel and maintenance cost assumed to be $0.20/km, 100 km/trip for illustrative purposes.
Source: World Bank data.

Table B2.2c: Breakeven VLUs by production system of a private veterinary practice in Guinea, 1986.

PRODUCTION SYSTEM	FEE/ ANIMAL ($)	BREAKEVEN VLUs/YEAR		
		Pure Vet Service	Vet Service +25% margin	Vet Service +50% margin
TRADITIONAL				
100 trips/year	2	2429	2104	1779
200 trips/year		3549	3224	2899
240 trips/year		3997	3672	3347
INTERMEDIATE				
100 trips/year	12	405	351	297
200 trips/year		591	537	483
240 trips/year		666	612	558
HIGH INTENSITY				
100 trips/year	20	243	210	178
200 trips/year		355	322	290
240 trips/year		400	367	335

Note: Breakeven VLU = (depreciation costs + operating costs - drug sales margin)/fee per animal.

Table B2.3a: Fixed investments of a private veterinary practice in Kenya, 1988.

FIXED INVESTMENTS	AQUISITION COST ($)	LIFESPAN	DEPN/ YEAR ($)
Vehicle	18873	4	4718
Vet. Equipment	6761	5	1352
Office Furniture	282	10	28
Total	25915		6099

Note: Sh17.75 = US$1.
Source: Kenya Veterinary Association, 1988.

Table B.6b: Costs and returns to private veterinary practice in Kenya, 1988.

COSTS	Unit	AMOUNT ($)
FIXED COSTS:		
Depreciation:		
Vehicle	per year	4718
Vet. Equipment	per year	1352
Office Furniture	per year	28
Insurance	per year	676
Rent-clinic	per year	4056
Telephone, electricity and water	per year	2704
Total		13535
VARIABLE COSTS:		
Fuel & maintenance		
0.25/km;100 km/trip		
100 trips	per year	2535
200 trips	per year	5070
240 trips	per year	6085
Cost of capital (15%)		
100 trips	per year	2411
200 trips	per year	2791
240 trips	per year	2943
Total Costs		
100 trips	per year	18481
200 trips	per year	21396
240 trips	per year	22563
Drugs and expendable supplies inventory	per year	6247
25% margin on sales		1562
50% margin on sales		3123

Note: Sh17.75 = US$1.
Source: Kenya Veterinary Association, 1988.

Table B2.3c: Breakeven VLUs by production system for a private veterinary practice in Kenya, 1988.

PRODUCTION SYSTEM	FEE/ ANIMAL ($)	BREAKEVEN VLUs/YEAR Pure Vet Service	Vet Service +25% margin	Vet Service +50% margin
TRADITIONAL				
100 trips	2	9240	8460	7679
200 trips		10698	9917	9137
240 trips		11281	10500	9720
INTERMEDIATE				
100 trips	12	1540	1410	1280
200 trips		1783	1653	1523
240 trips		1880	1750	1620
HIGH INTENSITY				
100 trips	20	924	846	768
200 trips		1070	992	914
240 trips		1128	1050	972

Note: Breakeven VLU = (total costs - drug sales margin)/fee per animal.

Table B2.4a: Fixed investments of a private veterinary practice in Uganda, 1990.

FIXED INVESTMENTS	AQUISITION COST ($)	LIFESPAN	DEPN/ YEAR ($)
Motorcycle (185 cc)	1,800	4	450
Vet. Equipment			
Refrigerator	1,400	5	280
Monocular microscope	730	5	146
Microscope slides, racks, stains	150	2	75
MacMaster slide	45	2	23
Stethoscope	25	5	5
Automatic syringe	70	2	35
Surgical instruments (set)	420	5	84
Sterilizer tray with heater	80	2	40
Instrument tray	35	2	18
Calf puller	380	5	76
Embryotome & embryotome wire	220	3	73
Palm knife	90	3	30
Aurescope	170	5	34
Hoof cutter	25	3	8
Footrot shears plus blades	25	3	8
Mouth gag	35	3	12
Stomach tube	50	3	17
Bull-dog pliers	25	3	8
Burdozzo	210	3	70
Drenching gun	100	3	33
Autopsy set	250	5	50
Balance	250	3	83
Glassware	200	2	100
Gloves rack	10	5	2
Protective clothing	200	2	100
Containers and boxes	300	3	100
Cryogenic flask, 34 li.	850	2	425
Thermos flask, 2 li.	50	2	25
Ancillary equipment	235	2	118
Subtotal			2,078

Source: World Bank data.

Table B.7b: Costs and returns to private veterinary practice in Uganda, 1990.

ITEMS		COST/YEAR ($)
COSTS		
DEPRECIATION		
Vehicle		450
Vet. Equipment		2,078
Subtotal		2,528
OPERATING EXPENSES		
Supplies:		
Hypodermic syringe, nylon		30
Hypodermic needles, packs of 12		20
Nylon suture material, cassette		70
Nylon suture material, refills		30
Catgut sutures, cassette		250
Calving rope (nylon)		20
Disposable uterine catheters, 25s		20
Teat canulae, pack of 12s		10
Chemicals		200
Insurance		650
Rent-clinic		1,500
Utilities		400
Stationery and post.		200
Subs. & memberships		100
Subtotal		3,500
Fuel and maintenance		
$0.18/km, 40 km/trip		
100 trips/year		720
200 trips/year		1,440
240 trips/year		1,728
Cost of capital (38%)		
100 trips/year		2564
200 trips/year		2838
240 trips/year		2947
Total Costs		
100 trips/year		9,312
200 trips/year		10,306
240 trips/year		10,703
Additional Revenue		
Drug sales	10,698	
25% sales mark-up		2,675
50% sales mark-up		5,349

Source: World Bank data.

Table B2.4c: Breakeven VLUs by production system for a private veterinary practice in Uganda, 1990.

PRODUCTION SYSTEM	FEE/ ANIMAL ($)	BREAKEVEN VLUs/YEAR Pure Vet Service	Vet Service +25% margin	Vet Service +50% margin
TRADITIONAL				
100 trips/year	2	4,656	3,319	1,982
200 trips/year		5,153	3,816	2,478
240 trips/year		5,352	4,014	2,677
INTERMEDIATE				
100 trips/year	12	776	553	330
200 trips/year		859	636	413
240 trips/year		892	669	446
HIGH INTENSITY				
100 trips/year	20	466	332	198
200 trips/year		515	382	248
240 trips/year		535	401	268

Note: Breakeven VLU = (Depreciation costs + operating costs - drug sales margin)/fee per animal.

Distributors of World Bank Publications

ARGENTINA
Carlos Hirsch, SRL
Galeria Guemes
Florida 165, 4th Floor-Ofc. 453/465
1333 Buenos Aires

AUSTRALIA, PAPUA NEW GUINEA, FIJI, SOLOMON ISLANDS, VANUATU, AND WESTERN SAMOA
D.A. Books & Journals
648 Whitehorse Road
Mitcham 3132
Victoria

AUSTRIA
Gerold and Co.
Graben 31
A-1011 Wien

BAHRAIN
Bahrain Research and Consultancy Associates Ltd.
Esterad Building No. 42
Diplomatic Area
P.O. Box 2750
Manama Town 317

BANGLADESH
Micro Industries Development Assistance Society (MIDAS)
House 5, Road 16
Dhanmondi R/Area
Dhaka 1209

Branch offices:
156, Nur Ahmed Sarak
Chittagong 4000

76, K.D.A. Avenue
Kulna

BELGIUM
Jean De Lannoy
Av. du Roi 202
1060 Brussels

CANADA
Le Diffuseur
C.P. 85, 1501B rue Ampère
Boucherville, Québec
J4B 5E6

CHINA
China Financial & Economic Publishing House
8, Da Fo Si Dong Jie
Beijing

COLOMBIA
Infoenlace Ltda.
Apartado Aereo 34270
Bogota D.E.

COTE D'IVOIRE
Centre d'Edition et de Diffusion Africaines (CEDA)
04 B.P. 541
Abidjan 04 Plateau

CYPRUS
MEMRB Information Services
P.O. Box 2098
Nicosia

DENMARK
SamfundsLitteratur
Rosenoerns Allé 11
DK-1970 Frederiksberg C

DOMINICAN REPUBLIC
Editora Taller, C. por A.
Restauración e Isabel la Católica 309
Apartado Postal 2190
Santo Domingo

EGYPT, ARAB REPUBLIC OF
Al Ahram
Al Galaa Street
Cairo

The Middle East Observer
41, Sherif Street
Cairo

EL SALVADOR
Fusades
Avenida Manuel Enrique Araujo #3530
Edificio SISA, 1er. Piso
San Salvador

FINLAND
Akateeminen Kirjakauppa
P.O. Box 128
Helsinki 10
SF-00101

FRANCE
World Bank Publications
66, avenue d'Iéna
75116 Paris

GERMANY
UNO-Verlag
Poppelsdorfer Allee 55
D-5300 Bonn 1

GREECE
KEME
24, Ippodamou Street Platia Plastiras
Athens-11635

GUATEMALA
Librerias Piedra Santa
5a. Calle 7-55
Zona 1
Guatemala City

HONG KONG, MACAO
Asia 2000 Ltd.
48-48 Wyndham Street
Winning Centre
2nd Floor
Central Hong Kong

INDIA
Allied Publishers Private Ltd.
751 Mount Road
Madras - 600 002

Branch offices:
15 J.N. Heredia Marg
Ballard Estate
Bombay - 400 038

13/14 Asaf Ali Road
New Delhi - 110 002

17 Chittaranjan Avenue
Calcutta - 700 072

Jayadeva Hostel Building
5th Main Road Gandhinagar
Bangalore - 560 009

3-5-1129 Kachiguda Cross Road
Hyderabad - 500 027

Prarthana Flats, 2nd Floor
Near Thakore Baug, Navrangpura
Ahmedabad - 380 009

Patiala House
16-A Ashok Marg
Lucknow - 226 001

INDONESIA
Pt. Indira Limited
Jl. Sam Ratulangi 37
P.O. Box 181
Jakarta Pusat

ISRAEL
Yozmot Literature Ltd.
P.O. Box 56055
Tel Aviv 61560
Israel

ITALY
Licosa Commissionaria Sansoni SPA
Via Duca Di Calabria, 1/1
Casella Postale 552
50125 Florence

JAPAN
Eastern Book Service
37-3, Hongo 3-Chome, Bunkyo-ku 113
Tokyo

KENYA
Africa Book Service (E.A.) Ltd.
P.O. Box 45245
Nairobi

KOREA, REPUBLIC OF
Pan Korea Book Corporation
P.O. Box 101, Kwangwhamun
Seoul

KUWAIT
MEMRB Information Services
P.O. Box 5465

MALAYSIA
University of Malaya Cooperative Bookshop, Limited
P.O. Box 1127, Jalan Pantai Baru
Kuala Lumpur

MEXICO
INFOTEC
Apartado Postal 22-860
14060 Tlalpan, Mexico D.F.

MOROCCO
Société d'Etudes Marketing Marocaine
12 rue Mozart, Bd. d'Anfa
Casablanca

NETHERLANDS
De Lindeboom/InOr-Publikaties
P.O. Box 202
7480 AE Haaksbergen

NEW ZEALAND
Hills Library and Information Service
Private Bag
New Market
Auckland

NIGERIA
University Press Limited
Three Crowns Building Jericho
Private Mail Bag 5095
Ibadan

NORWAY
Narvesen Information Center
Book Department
P.O. Box 6125 Etterstad
N-0602 Oslo 6

OMAN
MEMRB Information Services
P.O. Box 1613, Seeb Airport
Muscat

PAKISTAN
Mirza Book Agency
65, Shahrah-e-Quaid-e-Azam
P.O. Box No. 729
Lahore 3

PERU
Editorial Desarrollo SA
Apartado 3824
Lima

PHILIPPINES
International Book Center
Fifth Floor, Filipinas Life Building
Ayala Avenue, Makati
Metro Manila

PORTUGAL
Livraria Portugal
Rua Do Carmo 70-74
1200 Lisbon

SAUDI ARABIA, QATAR
Jarir Book Store
P.O. Box 3196
Riyadh 11471

MEMRB Information Services
Branch offices:
Al Alsa Street
Al Dahna Center
First Floor
P.O. Box 7188
Riyadh

Haji Abdullah Alireza Building
King Khaled Street
P.O. Box 3969
Damman

33, Mohammed Hassan Awad Street
P.O. Box 5978
Jeddah

SINGAPORE, TAIWAN, MYANMAR, BRUNEI
Information Publications Private, Ltd.
02-06 1st Fl., Pei-Fu Industrial Bldg.
24 New Industrial Road
Singapore 1953

SOUTH AFRICA, BOTSWANA
For single titles:
Oxford University Press Southern Africa
P.O. Box 1141
Cape Town 8000

For subscription orders:
International Subscription Service
P.O. Box 41095
Craighall
Johannesburg 2024

SPAIN
Mundi-Prensa Libros, S.A.
Castello 37
28001 Madrid

Librería Internacional AEDOS
Consell de Cent, 391
08009 Barcelona

SRI LANKA AND THE MALDIVES
Lake House Bookshop
P.O. Box 244
100, Sir Chittampalam A. Gardiner Mawatha
Colombo 2

SWEDEN
For single titles:
Fritzes Fackboksforetaget
Regeringsgatan 12, Box 16356
S-103 27 Stockholm

For subscription orders:
Wennergren-Williams AB
Box 30004
S-104 25 Stockholm

SWITZERLAND
For single titles:
Librairie Payot
6, rue Grenus
Case postale 381
CH 1211 Geneva 11

For subscription orders:
Librairie Payot
Service des Abonnements
Case postale 3312
CH 1002 Lausanne

TANZANIA
Oxford University Press
P.O. Box 5299
Dar es Salaam

THAILAND
Central Department Store
306 Silom Road
Bangkok

TRINIDAD & TOBAGO, ANTIGUA BARBUDA, BARBADOS, DOMINICA, GRENADA, GUYANA, JAMAICA, MONTSERRAT, ST. KITTS & NEVIS, ST. LUCIA, ST. VINCENT & GRENADINES
Systematics Studies Unit
#9 Watts Street
Curepe
Trinidad, West Indies

UNITED ARAB EMIRATES
MEMRB Gulf Co.
P.O. Box 6097
Sharjah

UNITED KINGDOM
Microinfo Ltd.
P.O. Box 3
Alton, Hampshire GU34 2PG
England

VENEZUELA
Libreria del Este
Aptdo. 60.337
Caracas 1060-A

Recent World Bank Discussion Papers *(continued)*

No. 134 *Forest Economics and Policy Analysis: An Overview.* William F. Hyde and David H. Newman, with a contribution by Roger A. Sedjo

No. 135 *A Strategy for Fisheries Development.* Eduardo Loayza, in collaboration with Lucian M. Sprague

No. 136 *Strengthening Public Service Accountability: A Conceptual Framework.* Samuel Paul

No. 137 *Deferred Cost Recovery for Higher Education: Student Loan Programs in Developing Countries.* Douglas Albrecht and Adrian Ziderman

No. 138 *Coal Pricing in China: Issues and Reform Strategy.* Yves Albouy

No. 139 *Portfolio Performance of Selected Social Security Institutes in Latin America.* Carmelo Mesa-Lago

No. 140 *Social Security and Prospects for Equity in Latin America.* Carmelo Mesa-Lago

No. 141 *China's Foreign Trade and Comparative Advantage: Prospects, Problems, and Policy Implications.* Alexander J. Yeats

No. 142 *Restructuring Socialist Industry: Poland's Experience in 1990.* Homi J. Kharas

No. 143 *China: Industrial Policies for an Economy in Transition.* Inderjit Singh

No. 144 *Reforming Prices: The Experience of China, Hungary, and Poland.* Anand Rajaram

No. 145 *Developing Mongolia.* Shahid Yusuf and Shahid Javed Burki

No. 146 *Sino-Japanese Economic Relationships: Trade, Direct Investment, and Future Strategy.* Shuichi Ono

No. 147 *The Effects of Economic Policies on African Agriculture: From Past Harm to Future Hope.* William K. Jaeger

No. 148 *The Sectoral Foundations of China's Development.* Shahid Javed Burki and Shahid Yusuf, editors

No. 149 *The Consulting Profession in Developing Countries: A Strategy for Development.* Syed S. Kirmani and Warren C. Baum

No. 150 *Successful Rural Finance Institutions.* Jacob Yaron

No. 151 *Transport Development in Southern China.* Clell G. Harral, editor, and Peter Cook and Edward Holland, principal contributors

No. 152 *The Urban Environment and Population Relocation.* Michael M. Cernea

No. 153 *Funding Mechanisms for Higher Education: Financing for Stability, Efficiency, and Responsiveness.* Douglas Albrecht and Adrian Ziderman

No. 154 *Earnings, Occupational Choice, and Mobility in Segmented Labor Markets of India.* Shahidur R. Khandker

No. 155 *Managing External Debt in Developing Countries: Proceedings of a Joint Seminar, Jeddah, May 1990.* Thomas M. Klein, editor

No. 156 *Developing Agricultural Extension for Women Farmers.* Katrine A. Saito and Daphne Spurling

No. 157 *Awakening the Market: Viet Nam's Economic Transition.* D. M. Leipziger

No. 158 *Wage Policy during the Transition to a Market Economy: Poland 1990–91.* Fabrizio Coricelli and Ana Revenga, editors

No. 159 *International Trade and the Environment.* Patrick Low, editor

No. 160 *International Migration and International Trade.* Sharon Stanton Russell and Michael S. Teitelbaum

No. 161 *Civil Service Reform and the World Bank.* Barbara Nunberg and John Nellis

No. 162 *Rural Enterprise Development in China, 1986–90.* Anthony J. Ody

The World Bank

Headquarters
1818 H Street, N.W.
Washington, D.C. 20433, U.S.A.

Telephone: (202) 477-1234
Facsimile: (202) 477-6391
Telex: WUI 64145 WORLDBANK
RCA 248423 WORLDBK
Cable Address: INTBAFRAD
WASHINGTONDC

European Office
66, avenue d'Iéna
75116 Paris, France

Telephone: (1) 40.69.30.00
Facsimile: (1) 40.69.30.66
Telex: 640651

Tokyo Office
Kokusai Building
1-1 Marunouchi 3-chome
Chiyoda-ku, Tokyo 100, Japan

Telephone: (3) 3214-5001
Facsimile: (3) 3214-3657
Telex: 26838

ISBN 0-8213-2119-6