WILLINGNESS TO PAY FOR LIVESTOCK SERVICES: THE CASE OF TAMIL NADU

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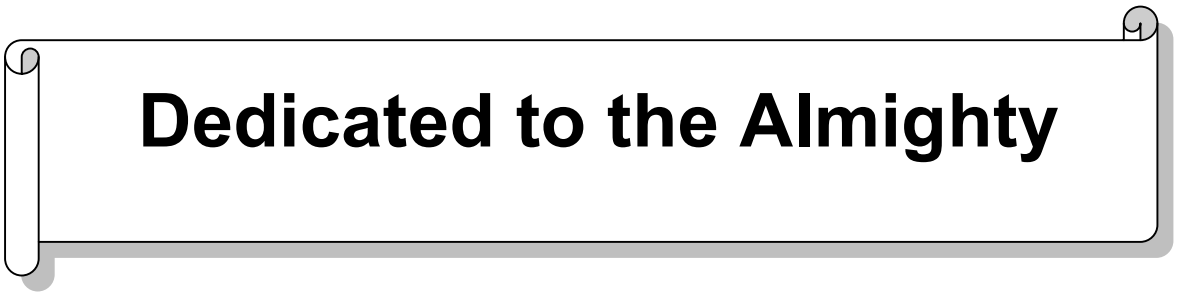
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CERTIFICATE

This is to certify that the thesis entitled, "**WILLINGNESS TO PAY FOR LIVESTOCK SERVICES: THE CASE OF TAMIL NADU",** submitted in part fulfillment of the requirements for the award of the degree of **DOCTOR OF PHILOSOPHY** in **Animal Husbandry Economics** to the Tamil Nadu Veterinary and Animal Sciences University, Chennai is a record of bonafide research work carried out by **G. KATHIRAVAN** under my supervision and guidance and that no part of this thesis has been submitted for the award of any other degree, diploma, fellowship or similar titles. However, as per TANUVAS regulations, a portion of the thesis has been sent for publication in a peer reviewed journal and a copy of the published reprint is enclosed.

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ABSTRACT

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A study was undertaken in Tamil Nadu to study the cost and uptake of livestock services, analyse the demand and willingness to pay (WTP) values for animal health care and bovine breeding services and to ascertain the constraints faced by farmers in availing services. The districts of the state were categorised as livestock developed (LD) and livestock underdeveloped (LUD). In all, 320 farmers were selected through multistage random sampling technique from four districts selected, two each from LD (Thanjavur and Sivagangai districts) and LUD (Coimbatore and Villupuram districts) categories. The data were collected through personal interview method and payment cards were used for contingent valuation.

Of the respondents, 98.99 per cent in LUD districts and 99.49 per cent in LD districts had easy access to public services, while 55.35 per cent and 35.62 per cent, respectively, had access to home services by veterinarians. Home services rendered by veterinarians was rated as the best (0.83), followed by private veterinary clinics (0.75), home services by para-veterinarians (0.74), public veterinary centres (0.64) and co-operative centres (0.48). The public veterinary centres were to be the major animal health care (51.55 per cent) and bovine breeding services (60.77 per cent) providers followed by home services by veterinarians. While all type of cases were being taken to private veterinary centres, private services were preferred primarily for acute and obstetrical cases. Farmers in LUD districts predominantly used privately provided AI than public AI. Although no charges were made for animal health care services rendered at public veterinary centres, the charges in terms of imputed labour cost for bringing the animal to the centre was incurred. Service fee accounted for more than 60 per cent of cost of treatment for home service by a veterinarian or a para-veterinarian. The variations in visit cost of animal health care services were significantly explained by service provider type, place of service, type of diseases, source of drugs, value of animal, follow-up need, household income and district versatility. Similarly, variations in insemination cost was significantly explained by source of semen, place of service, number of straws used, quantity of milk sold and VLUs.

Determinants of demand for livestock services were analysed through a two part double hurdle model (probit in the first stage and zero truncated poisson in the second stage). The hurdle model estimates showed that all types of cases, distance to public veterinary centre and value of animal had increased the use of private health care services, while the visit cost decreased the positive probability. Milk price, quantity of milk sold, success rate of insemination, number of crossbred cows, and values of animal inseminated had increased the probability of using private AI, while number of graded buffaloes alone favoured use of public AI.

The maximum likelihood interval regression models were used to estimate the value of WTP for annual health care for livestock and bovine breeding services. Overall mean WTP value for annual health care services in cows was Rs. 202.34 for in-centre services, while the same was Rs. 261.66 for home services. Similarly, the mean stated WTP values for in-centre services in buffaloes was Rs.135.78, Rs.130.12 in bullocks, Rs.56.30 in sheep and Rs.61.60 in goats. However, these values were higher for home services.

Importance of quality attributes of public centres' services were assessed. Contingent valuation was used to elicit the value of quality improvements of public veterinary centres. Tobit regression analysis was used to explore the relationship between each of the partial WTP values and the corresponding quality attribute's status quo level. Marginal effects of variations in the positive WTP values, and variations in the probability of stating a positive WTP values to respondents who declared that they were unwilling to pay were estimated. There existed absolute concordance between WTP results and the quality attributes' perceptions in terms of the probability to have a positive WTP value and the WTP themselves. The estimated values of WTP for improving geographical proximity, waiting time, attitude of staffs, drug availability, service provider-farmer relationship, chance of recovery and chance of conception through public veterinary centre services were Rs.7.72, Rs.7.72, Rs.5.20, Rs.6.58, Rs.3.91, Rs.5.84 and Rs.11.71, respectively.

Constraints in availing livestock services by farmers exhibited that long distance to the public veterinary centre and long waiting time before their cases were attended to by the services provider and inadequacy of drugs in the centre were the major limiting factors of public livestock services. High service charges, expensive drug/semen costs and delay in availing appointments of service provider were assessed to be the main problems of private livestock services.

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LIST OF ABBREVIATIONS AND TERMINOLOGIES

1. Abbreviations:

AI	-	Artificial Insemination
BAIF	-	Bharatiya Agro Industries Foundation
CGR	-	Compound Growth Rate
CV	-	Contingent Valuation
FAO	-	Food and Agriculture Organisation of the United Nations
GOI	-	Government of India
LD	-	Livestock Developed
LUD	-	Livestock Under Developed
PC	-	Payment Card
PVC	-	Public Veterinary Centre
SPFR	-	Service Provider Farmer Relationship
SR	-	Small Ruminants
VLU	-	Veterinary Livestock Units
WTP	-	Willingness To Pay

2. Terminologies:

Public Veterinary Centre	:	Government veterinary hospitals and dispensaries
Private Veterinary Clinic	:	Veterinary clinics owned by veterinarians
Home services by veterinarian	:	Door step services of either Government/Co-operative employed or unemployed veterinarians in their private capacity
Home services by para-veterinarian	:	Door step services of Government employed livestock inspectors and livestock assistants in their private capacity
Co-operative Veterinary Centre	:	Veterinary centres (milk collection centres) of Milk Co-operatives

CHAPTER I

INTRODUCTION

"The greatness of a nation and its moral progress can be judged by the way its animals are treated"

- Mahatma Gandhi

Livestock has been an integral part of the Indian rural economy since time immemorial. Intertwinkled with the religious, social and cultural ethos of the people, their importance transcends the study of economics. Besides complementing and supplementing crop agriculture, animal agriculture has often been providing succour and sense of security to farmers even during the failure of crop agriculture due to vagaries of monsoons. Livestock is an indispensable tool of income generation to millions of poor households across the country, besides being a major source of protein and supplementary nutrition, draught power, fertilizer, fuel and a store of wealth (Ravishankar and Birthal, 1999).

Livestock plays a crucial role in national economy, especially for the rural vulnerable landless and women folk, employing over 11 million of them in principal and 8 million in subsidiary status which is about 5 per cent of total working force in the country. The livestock sector contributes around 6.29 per cent to GDP with the value of output from livestock working out to Rs 1,64,509 crore at current prices during 2003-04. Contribution of livestock sub-sector to agricultural GDP has shown an impressive growth in the last two decades from just less than 15 per cent in the late 1970s to over 29.90 per cent in 2003-04, with the value of livestock output growing up by 6 per cent per annum during the period and the dairy and poultry industries contributing to the major share of this growth. The increasing demand for livestock products due to the sustained economic growth and rising income have made the demand for livestock products income elastic, with the income elasticity being estimated at around unity even in rural areas (GOI, 2006 and FAO, 2005).

The estimates of Government of India (2004-05) have shown that the country has 185.20 million cattle (15 per cent of world's cattle), of which 24.67 million cattle were crossbreds. While the total cattle population has decreased by 6.89 per cent [Compound Growth Rate (CGR): -1.18 per cent] during the period between 1997 and 2003, the crossbred population has increased by 12.60 per cent during the same period and notably the states of Tamil Nadu, Maharashtra, Kerala, Uttar Pradesh, Karnataka and Punjab together accounted

for about 60 per cent of the country's crossbred cattle population. In addition, the country had 97.90 million buffaloes (56 per cent of world's buffalo), which increased by 8.91 per cent during the period 1997–2003 with a CGR of 1.43 per cent. To add to the remarkable status the country enjoys in the world cattle and buffalo population, there are 185.90 million small ruminants in the country consisting of 61.50 million sheep (ranking third in world) and 124.40 million goats (ranking second in world). The small ruminant population also had shown an increasing trend with 6.96 per cent in sheep and 1.38 per cent in goat during 1997-2003 (CGR- Sheep: 1.13 per cent and Goat: 0.23 per cent).

However, the livestock production systems across the country are characterized by low input and low productivity, with the system of production by and large being 'extensive'. Majority of livestock owners are only marginal farmers with an average herd size of 3.7 cattle and buffaloes. In case of small ruminants, the production system is either nomadic (30 per cent) or sedentary (70 per cent). There is also an inverse relationship between land and livestock holdings, excluding landless category (Ravishankar and Birthal, 1999), indicating better equity of farmers with respect to livestock holding. That is, the distribution of livestock is more equitable than that of land, with the bottom 60 per cent of rural households owning 65 per cent of milch animals, leading to a much more equitable distribution of gains from livestock production (Ahuja *et al.,* 2000).

1.1 Setting

Livestock provides livelihood to over 65 per cent of the State's population and contribute 62 per cent of employment generated in Tamil Nadu. Livestock also contributes significantly in supplementing the income of small and marginal farmers and landless labourers and in generating gainful employment to a substantial number of rural population, many of whom are women who play a major role in the care and management of livestock in the State (Govt. of Tamil Nadu, 2004). Further, over 70 per cent of the farming community own milch animals, which remains the single major source of supplementary income for the farming community.

In Tamil Nadu, the total cattle population is 91.41 lakhs which accounts for 4.94 per cent of the total cattle population in the country and buffalo population is 16.50 lakhs representing 1.69 per cent of the total buffalo population of the nation. The cattle population, which was 105.72 lakhs in 1974, got reduced to 91.41 lakhs in 2002. Similarly, the buffalo population, which was 28.53 lakhs, declined to 16.50 lakhs during

the same period. However, the milk production in the State has increased tremendously over the past 20 years, implying an impressive improvement in productivity. From only 1.74 million tonnes of milk production in 1981, it has risen to 4.75 million tonnes in 2003, which in turn, resulted in an increase of per capita availability of milk to 217g per day, a quantity almost equivalent to the ICMR recommended level of 220g. In addition, the State has 55.93 lakhs of sheep and 81.77 lakhs of goat, accounting for 9.10 per cent and 6.58 per cent, respectively, of the nation's sheep and goat population.

Various veterinary institutions, manned by the government, cooperatives, NGOs, University and private personnel, spread over the State provide animal health care and breeding services and play a major role in increasing and sustaining the production potentials of livestock and poultry.

1.2 Problem focus

Significant market led opportunities have recently been opened up for the livestock sector as a result of globalization and economic liberalisation policies initiated by the Government of India in 1991. Livestock production is growing faster than any other agricultural sub-sector and by 2020, this sub-sector is predicted to produce more than half of the total agricultural output in value terms in the country. Growth in demand for livestock products is primarily expected to emanate due to human population growth, increasing urbanization and rising income, as the demand for livestock products is income elastic (Bhalla and Hazell, 1997).

These developments present enormous opportunities to boost rural income and accelerate the pace of poverty reduction through promoting livestock sub-sector. However, this requires a policy regime that facilitates sustainable growth in livestock productivity at the farm level as well as in the processing sector.

The production potential of livestock depends primarily on the quality of nutrition, genetic upgradation and upliftment of animal health status. However, these factors, unfortunately, continue to be poor in almost all the states of the country. While the productivity improvement is likely to result in a rapid increase in the demand for quality livestock services, the policies and institutions are yet to get geared up to meet these challenges. Constraints to livestock production and service needs of poor livestock keepers are to be studied to find the ways and means to deliver them at the least cost. The policy

priorities and directions for service delivery often get determined only by the beliefs of the planners and decision makers. While those trained in veterinary science argue that it is poor animal health which is the main constraint to livestock production, the nutritionists point to the poor availability of feed and fodder, and the breeders to poor genetics, there is a whole range of livestock services that are needed to enhance the capacity of poor households to exploit the full potential of increased livestock productivity (Ahuja and Redmond, 2001). These services include health and production services such as health care, disease prevention and control, pharmaceutical supplies, feed and fodder supply, breeding, research and extension, and other market oriented services such as credit, livestock insurance, delivery of market information, marketing and processing.

Effective and efficient delivery of animal health and production services is considered as vital for gainful livestock development and hence, efficient delivery of livestock services has become a subject of rising concern to many national and international organisations including FAO. Livestock services around the world are usually delivered through a system composed of government institutions and to a greater or lesser extent, organisations and individuals belonging to the private sector. However in many developing countries due to transforming structural reforms, direct involvement of public sector in the delivery of livestock services is apparently melting away and the projects focusing on strengthening of non-governmental organisations (NGOs), producer organisations, private veterinary practice and the use of para-veterinarians especially in basic animal health care programmes are being promoted (Kleeman, 1999).

In India, recognising the importance of livestock to the rural poor and their inability to avail the fully paid livestock services, the Governments in centre and the States have been extending these services at a huge subsidy with their vast veterinary institutional network built-up in the past five decades through many livestock sector promotion schemes to augment livestock production and productivity. In addition, there are co-operatives, NGOs and private entrepreneurs endeavouring these livestock services to a lesser extent. The key focus all through the past planning periods had been on improving the delivery of veterinary services by strengthening the capabilities and coverage of State Animal Husbandry Departments. Thus, the number of State run veterinary institutions grew from about 2000 in 1951 to over 52000 in 2003. However, all these investments aimed mostly at curative services or livestock development schemes including crossbreeding. The share of professionals responsible for disease investigation

and control was only 3.5 per cent, supplemented by limited disease prevention role of the animal health service in the field (Ahuja *et al.,* 2000).

Although public sector is believed to be the appropriate means of delivering livestock services, the government generally could not perform, with the efficiency with which it should have done, in practice. Some even now argue that it could be better to privatise these 'public services' (Leonard, 1993). The advocacy for privatization has, however, been tempered by the recognition that in many situations, livestock services require some form of public management and intervention. The availability and quality of these livestock services are therefore unlikely to improve, unless public sector performance is strengthened (Holden *et al.,* 1996). Serious doubts have also been expressed about the desirability and sustainability of public veterinary service provision in India. Even the steering group constituted by the Government of India observed that free veterinary and artificial insemination services have resulted in an infrastructure that is vast and expensive, which the State governments are finding extremely difficult to sustain (GOI, 1996). As Ahuja *et al.* (2000) noted the vicious cycle of limited cost recovery, contributing to budgetary constraints that, in turn, limit the availability and quality of public provision of livestock services, together undercut the tremendous potential of the Indian livestock sector. Growing fiscal pressures exacerbated by the huge subsidy and less adequate cost recovery for the services had left the governments to bring down their priorities and budget allotments towards improving the quality of public provision of livestock services. Policy initiatives aimed at increased cost recovery, which could alleviate these financial difficulties, however, are often deferred by the policy makers on the assumption that the farmers would not be willing to pay for these services.

1.3 Objectives

In the light of above scenario, this study was undertaken in southern peninsular State of India, Tamil Nadu, with the following specific objectives:

a) to study the cost and uptake of livestock services by farmers;
b) to analyse the factors influencing demand for livestock services;
c) to measure the willingness to pay for livestock services;
d) to identify the constraints in availing livestock services; and
e) to suggest appropriate policy implications to promote delivery and acceptance of livestock services.

1.4 Scope of the study

This study would give an idea on the primary livestock service providers, kinds of services available, levels of access, service use pattern and the price at which these services are available. Consequently, the planners and policy makers might gain a background knowledge that would facilitate them to formulate appropriate strategies for efficient delivery of livestock services. The results of the study will be useful for planners and policy makers to recognize and exploit the values of attributes in livestock services. The factors influencing the demand for livestock services that could be identified by this study would be extremely valuable for the policy makers in examining the potential impact of removing or reducing the price subsidies on these services. The estimated users' willingness to pay (WTP) for the total animal health care and contract breeding services would provide clues for designing a 'vet-claim' policy in line with 'medi-claim' policy for humans, besides presenting an idea on the cost recovery measures or deciding whether the government should provide these services at all. The estimates of willingness to pay for quality improvements in the public livestock services would facilitate the policy makers and planners to gain an insight into the important features of the delivery system that are to be upgraded. The analysis of the impediments in the livestock services would again aid the planners and administrators to frame suitable policies to provide better livestock services that would effectively benefit the farmers.

1.5 Limitations of the study

The study has been conducted in four districts of the State by collecting information from the sampled livestock farmers and hence could not be generalised. As most of the farmers did not maintain records on the usage of livestock services, they had to recall the required information from their memory and furnish. Crosschecks were done to minimize the errors due to recall bias and to ensure the reliability of the information provided by them. Since the study is confined to the demand side of livestock services alone, the supply side of it, which was not the scope of this study, should also be taken into consideration while formulating policies relating to delivery of livestock services. Moreover, the study is limited to curative health care services for cattle, buffaloes, sheep and goats and breeding services for domestic bovines alone and hence, adequate caution must be exercised while interpreting and generalising the results of this study.

1.6 Organisation of the study

Chapter I : Introduction - Problem focus, objectives, scope and limitations of the study are presented.

Chapter II : Review of Literature - Review of economic framework of livestock services and the relevant past literature is presented.

Chapter III : Design of the Study - A brief account of sampling design and methodology of the study is presented.

Chapter IV : Description of the Study Area - General agro-climatic and socio-economic conditions of the study area are described.

Chapter V : Results and Discussion - The results of the study are presented and discussed.

Chapter VI : Summary and Conclusions - Results are summarised, conclusions drawn and policy implications specified.

CHAPTER II

REVIEW OF LITERATURE

Studying through the past research work opens up new avenues for further research. A comprehensive review of literature is an integral part of any investigation, as it not only throws light on the past work, but also provides a basis for new findings. Although ample literature are available on willingness to pay and its contingent valuation in human health care and environment, literature specific to livestock services are rather scarce. However, the available literature that have direct or indirect bearing on the present study are presented under the following sub-heads:

2.1 Economic framework of livestock services

2.2 Delivery of livestock services

2.3 Prices of livestock services

2.4 Demand for livestock services

2.5 Willingness to pay for livestock services

2.6 Constraints in livestock services

2.7 Livestock services: The Indian case

2.1 Economic framework of livestock services

Economic theory has long been used to rationalize the role of public and private sector in the supply of different types of livestock services (Umali *et al.,* 1992 and Leonard, 1993). Pareto-efficiency of competitive equilibrium that assumed absence of externalities, symmetrically informed buyers and sellers, lack of increasing returns to production, dearth of individual's influence on the market and non-existence of transaction costs predisposed the early thinking on the delivery of livestock health services (Umali *et al.,* 1992 and FAO, 1998), which, in turn, drove the policy for delivery of veterinary services in many countries around the world in eighties and nineties. Umali *et al.* (1992) compared the economic principles against the actual patterns of delivery to see if there was any scope for transferring responsibility from the public sector to the private. They surveyed over 40 developing countries to determine the degree of public and private sector participation in the delivery of veterinary services. It was found that the States play an excessively dominant role in the delivery of animal health services in many countries and there existed opportunities for transferring some veterinary services from the public sector to the private sector.

The theory provided a basis for identifying the appropriate sector for an economically optimal provision of a given service. It aided to identify the opportunities for privatisation or provided a greater insight into the organisational features required to supply those services that would not otherwise be provided by the private sector (Holden *et al.*, 1996). Since the logic and rationale for assigning specific tasks and responsibilities have to be based on certain economic principles, a brief review of these doctrines is made in the sections that follow.

2.1.1 Public and private goods

Livestock services could be either a public good or a private good. A `public good' was said to be non-excludable and non-subtractable (Beynon *et al.*, 1998). Veterinary services displayed varying degrees of public and private good characteristics. Services such as disease surveillance, research without patent upholding and extension targeting a mass were considered a public good and therefore were best provided by public sector, while production and distribution of vaccines and drugs, treatment of individual animals and associated diagnostic support were considered private goods and theoretically were best supplied by the private good (Holden *et al.*, 1996).

Ahuja *et al.* (2000) stated that a pure public good provided benefits that were non-excludable and non-rival, while the benefits provided by a pure private good were fully excludable and rival. Among the livestock services, clinical diagnosis (or prescription) and breeding were examples of private goods, whereas services such as disease surveillance, quarantine and food hygiene/inspection were public goods. That is, most animal health (clinical treatment, non-compulsory vaccination, sale of veterinary pharmaceutical services) and all animal breeding services (selection and multiplication of improved breeding stock, semen production and AI) were private goods, and thus they could be efficiently delivered by private providers. The benefits from these services could be exclusively appropriated by the livestock farmers, while other farmers could not benefit from the services at the same time.

Umali *et al.* (1994) pointed out that purely private and purely public goods occupied opposite ends of the economic spectrum, whereas some animal health services lied between these limits, while a few produced externalities or spill-over effects. These occurred as Pigou (1946) explained, when an individual, rendered (or consumed) some

services for which payment was received (or made), coincidentally the other people were also rendered services from whom payment could not be exacted.

2.1.2 Externalities

An essential characteristic of an externality or the spill-over effect is that the costs associated with a negative externality or the benefits associated with a positive externality are not realized by the individual consuming or producing the service (Umali *et al.*, 1992). This spill-over effect might be negative, as in the case of excessive use of acaricides which lead to drug resistance or environmental contamination, or positive when a farmer vaccinating animals confer positive benefit to others by reducing the risk of disease to their livestock (Holden *et al.*, 1996). Further, an externality occurs when the action of one economic agent affects the consumption or production of other economic agents in a way that it is not reflected in the market (Ahuja and Redmond, 2001).

2.1.3 Market efficiency and information

Although the fundamental theory assumed symmetrical knowledge of both buyers and sellers, the hypothesis is apparently violated in the case of a number of livestock services, where the service provider had significantly more information than the user and there were incentives to exploit (Ahuja and Redmond, 2001). Asymmetry of information could lead to two types of market failures, viz., moral hazard and adverse selection. Moral hazard occurred when the service provider was able to provide a sub-standard service without the consumer being aware of the difference in quality, adverse selection occurred when actions were observed but type was unknown (Holden *et al.*, 1996). Umali *et al.* (1994) viewed that the problem of moral hazard was limited to functions such as food hygiene/ inspection and drug quality control. However, Ahuja and Redmond (2004) stated that the problem of information asymmetry was much more general owing to more number of principal-agent relationships that could be identified in livestock service delivery and it was the poor who were often at an information disadvantage.

2.1.4 Economies of scale

Economies of scale existed when the cost of providing a service fell as the scale of operation increased (Holden *et al.,* 1996). In such cases, presence of a large market was necessary for the private agents to invest in such fixed cost and provide the service. Some animal health services, such as veterinary research and extension, diagnostic services and the delivery of clinical services in remote areas, required huge fixed costs, which deterred

the private sector from delivering these services until they could achieve significant scale to make the delivery of these services profitable (Ahuja, 2004). The State, on the other hand, was usually able to achieve sufficient economies of scale to provide services at a price that consumers could afford.

2.1.5 Functional classification of livestock services

According to Leonard (1990), animal health services in broader terms included preventing and curing diseases. Preventive services included immunization of animals, eradication or control of carriers or vectors, such as ticks and flies, other disease control measures, such as veterinary surveillance, quarantine, slaughter of infected animals and control of import and export of live animals and inspection and control of animal products to prevent transmission of diseases to humans. However, Umali *et al.* (1994) applied the principles of 'rivalry' and 'excludability' to identify the most appropriate sources of delivery of veterinary services. Also, they emphatically stated that it was necessary to classify each service on the basis of its public and private character, while taking into account any externalities, moral hazard problems, or free rider problems that might accompany the production or consumption of the service to determine the appropriate channel for delivery. Based on these characteristics, they grouped livestock services into two, viz., health and production. Clinical intervention, preventive veterinary services and provision of veterinary inputs formed the health services, while animal breeding, livestock research and extension warped production services. Their classification further proceeded such that the clinical diagnosis and treatment, production and distribution of vaccines and other veterinary supplies as to be pure private goods and services such as veterinary surveillance, research and extension, on the other hand, to be public goods. Underlying these principles, FAO (1998) suggested the following responsibilities to public and private sectors for delivery of animal health services:

Public sector: Ensuring the health of the national herd including disease surveillance, compliance monitoring, quarantine, quality control of remedies and vaccines, planning for emergencies and reporting to international bodies and neighbouring countries; food safety supervision, import and export inspection and certification according to international standards; regulation, monitoring and support of other partners in animal health care system; accreditation of personnel; creation of an enabling environment for the private sector; and general formulation of livestock development policy.

Private sector: Clinical diagnosis and treatment; production and distribution of remedies and vaccines; artificial insemination; management of herd health and production programmes; marketing livestock and products; and similar services.

Shared responsibility: Disease diagnosis and reporting; compulsory testing; accreditation; tick and fly control; food hygiene and inspection; continuing education and training; diagnostic support; animal welfare; notifiable disease control; disease emergency response; zoonosis control; research and advice and extension.

According to Cinnamond (2004), animal health services were divided into six categories, viz., i) Curative or clinical services, for the treatment of sick animals through diagnosis and the use of drugs; ii) Preventive services and regulatory bans to stop occurrence of new disease cases in animals; iii) Pharmaceutical supply of livestock drugs; iv) Education/ extension, encompassing animal health and nutrition and (veterinary) public health education; v) Public health, which relates to zoonotic and food-borne disease control, hygiene, food and feed safety and the environment and vi) Meat inspection services at processing plants.

2.2 Delivery of livestock services

Although veterinarians were the primary providers of animal health services, many developing countries also relied upon the paraprofessionals to assist or complement veterinarians (De Haan and Nissen, 1985). Some developing countries had a short supply of veterinarians and even when there seemed to be enough of them, they were often unwilling to work in rural areas. Paraprofessionals provided care in areas where veterinary care would otherwise be unavailable. In areas where there were genuine problems in paying, the government had the additional responsibility of empowering the farmers to demand quality services. However, the public veterinary services were often accused of mostly benefiting wealthy farmers (Leonard, 1985). Whatsoever the case, in most developing countries, the public sector had been the major provider of veterinary services in the last four decades. It had always been felt that it was the responsibility of the state to provide these services regardless of their efficiency and quality, while justifying the governments' involvement on social rather than economic grounds (Jarvis, 1986).

The availability and quality of livestock services could play a key role in increasing the productivity of livestock sector. However, the presence of readily controlled diseases and the consequent poor performance of the livestock sector was

indicative of weak delivery systems that had failed to provide necessary advice and drugs to livestock producers (FAO, 1988). The States had typically assumed almost sole responsibility for the delivery of animal health services in developing countries. The inadequate supply of veterinary services had therefore commonly been attributed to poor public sector performance (De Haan and Bekure, 1991; Leonard, 1993).

Although most preventive veterinary services are identified more with public goods, Gros (1994) suggested sub-contracting of these services under the supervision of government-run official services for the delivery to be further effective. He also affirmed that apart from the 'intrinsic' economic nature of the services, environmental factors such as the nature of prevailing livestock system, herd size, value of the average animal, producer concentration in a given area and the receptiveness of high-level policy makers were to determine the extent of private delivery of livestock services.

Umali *et al.* (1994) viewed that all animal health services could not and should not all be privatised. Instead, a policy of selective privatisation should be pursued such that the services that were purely private goods should be shifted to the private hands followed by slow transfer of other services. In order to achieve this, they suggested that the government should lower trade barriers, remove price subsidies on publicly provided drugs, eliminate restriction on private practice, subcontract services to the private sector, promote insurance plans, create a suitable environment for the development of smallholder producer organizations, and provide targeted, subsidized delivery in areas where animal health services are necessary but unprofitable for private providers.

Gros (1994) considered that any policy aimed at privatizing the entire spectrum of services, without regard to their nature, was likely to result in significant market failure. Hence, an optimal balance between the private and public sectors was necessary to achieve fruitful results. Kartamulia *et al.* (1995) observed that the private sector delivery of veterinary services was gaining increased recognition as an alternative to State provision, where some governments were promoting it so as to reduce the financial burden on the State, and ostensibly improve the efficiency of service delivery. Their argument was that because of the economic nature of veterinary services, farmers who enjoyed the direct benefits of services such as artificial insemination and drug delivery should be made to pay for such services.

According to FAO (1997), for privatisation to take place, the following services needed to be brought under the responsibility of the private sector : clinical diagnosis and treatment,

production and distribution of remedies and vaccines, artificial insemination, management of herd health and production programmes, marketing of livestock and products, etc.

Most of the developed nations had a high proportion of private veterinary practitioners, with the figures ranging from 50 per cent in Germany to 85 per cent in Belgium (Mlangwa and Kisauzi, 1994). Carney (1998) observed that it had long been the case that veterinary services were mainly provided on a private, consumer-pay basis. Further, Wise and Adams (1999) also noted that over 80 per cent of the veterinarians in the United States were in private practice and earned reputation on par with human physicians.

However, contrary to the practice in the industrialised world, the delivery of these services was still largely dominated by the State in many developing countries in Asia and Africa, whereas private delivery of animal health services was confined to the intensive producers and for animal breeding services to a few established large scale farms or vertically integrated livestock cooperatives, who carried out their own selection and insemination programs, for example, National Dairy Development Board in India (Ahuja *et al.,* 2000).

The results of privatisation in sub-Saharan Africa were so far encouraging, particularly with respect to cost recovery and drug distribution (De Haan and Bekure, 1991). Privatisation had made a significant progress there, either by careful planning (as in Morocco) or by default. The availability of drugs and their use in animals were significantly higher in countries that had privatised veterinary services and drug supplies (in Cameroon, Central African Republic, Cote d'Ivoire, Ghana, Mali, Senegal and Kenya) compared to those retaining government monopolies (Daniels and Skerman, 1993 and Holden, 1999). Also, tse-tse fly control in Zimbabwe and Botswana and delivery of vaccination in Morocco had shown a significant improvement after privatisation. The cost of provision of these services had also been reported to be significantly lower (Holden, 1999).

Developing nations in Africa had attempted to privatise veterinary services with mixed results (Umali *et al.*, 1994; Angniman, 1996; Carney, 1998). In most African countries, privatisation of veterinary services had the main objectives of enhancing the productivity and efficiency of the livestock sector and benefiting animal agriculture, the producer, the State and the veterinarians (Mpelumbe, 1994). However, in the absence of proper implementation, privatisation had resulted in private practitioners concentrating mainly in urban and periurban areas, with rural areas being left unattended to (Thome *et al.*, 1995). Further, Holden and Chema (1996) also observed that there was relatively little

evidence to suggest that privatisation had improved the delivery of veterinary services in developing countries.

To most sub-saharan governments, the relationship between private veterinary services and the efficiency in the delivery system seemed less difficult or less obvious, because of uncertainty surrounding demand, particularly in pastoral areas. Whether or not private sector involvement improved the efficiency of delivery depends on the demand response from livestock producers. The response, in turn, depended on producers' attitude towards the services delivered by private individuals. This was so because, over time, livestock producers had been blemished by State provision of free veterinary services. Since livestock producers then had to pay for private veterinary services, differences in attitude towards this were expected because livestock producers face different socio-economic circumstances (Tambi *et al.* 1999).

In Asia, experiences with the Animal Husbandry Development Network (AHDN) in Indonesia indicated that the provision of private service delivery was promising (Kartamulia *et al.*, 1995). For privatisation of veterinary services in Indonesia, projects were being implemented under the DELIVERI programme, supported by the governments of Indonesia and the United Kingdom, which had the goals of client focused approaches to the planning and delivery of livestock services to small scale and resource poor farmers and judging the viability of the private system. DELIVERI had identified Western Indonesia as more suitable for privatisation of veterinary services, whereas the opportunities in Eastern Indonesia seemed to be poor. Private veterinary services were emerging in response to market demand in intensive livestock areas in Western Indonesia. Even in Eastern Indonesia, the AUSAID-EIVSP project had introduced a cost recovery system in some districts. The Indonesian Veterinary Association had proposed that the government should promote privatisation encompassing a range of private services, including private veterinarians, veterinary technicians and paravets, as well as improved access to animal health services and information for farmers (DELIVERI, 2001).

Trujillo (1996) reported that in Mexico, government policies had caused a radical transformation in the labour market for veterinary graduates and resulted in an important trend towards private initiative, displacing the public sector into second place. The proportion of veterinarians in Mexico working in the public sector had fallen from 85 per cent in the 1970s to 30 per cent in 1995. In Latin America too, countries like Argentina already had an existing private veterinary services sector, being evident from the reports

of Nader (1996) that, until 1995, out of 19638 veterinarians graduated, only 6 per cent (1187) were employed in the public sector and the majority were in private practice. Among Asian nations, China and Thailand were rapidly progressing towards privatisation of veterinary services, while Russia and Easter European countries had already started implementing privatised delivery of these services. Thus, the whole world appeared to be moving progressively towards private delivery of animal health and breeding services (Sen and Chander, 2003).

2.2.1 Delivery of livestock services by Third sector

Whilst proponents of privatisation had accepted that not all animal health services might be taken over by the private sector, efforts had continued to reform those services to be 'private goods', and to delegate their provision to organisations other than the State. The focus had also shifted away from defining the private sector as comprising solely market-dependent operators. A growing understanding had emerged of the current activities and potential roles of producers' associations, cooperatives and other NGOs, collectively known as the 'third sector', which were able to provide 'public good' animal health services (Ashley *et al.,* 1996).

James *et al.* (1999), while assessing the impact and effectiveness of Community Livestock Workers (CLWs) operating in Ghana, found that half of the CLWs studied to be adequately effective in terms of technical competence, cover and range of activities, community support and motivation levels, besides providing the services without bias in terms of production scale or the gender, cultural or physical location of producers. The CLWs were drawing modest but adequate income and non-financial benefits from their activities, which were reflected in high levels of motivation.

In Nepal too, Tulachan and Neupane (2000) recommended that NGOs as well as private enterprises should be more actively encouraged to establish veterinary dispensaries in different districts to cater to the needs of resource-poor and small holder livestock farmers.

Animal health services delivery in pastoral areas of Kenya had been a major challenge to all providers in the light of policy shift towards privatisation. Implementing the animal health privatisation policy in pastoral areas required a radical change from the conventional approach prescribed for high/ medium potential areas of the country. The challenge was greater, considering the conditions in pastoral areas such as insecurity, poor infrastructure, low cash economy, high cost of service delivery, vastness of the areas, and lack of veterinary personnel. Due to inadequate animal health services in arid and semi-arid lands, various service delivery

initiatives, including community-based animal health service delivery systems, had emerged as an alternative option. Initially, it was designed to offer basic animal health care service to the community by community-selected animal health workers on a voluntary basis. However, its time now to re-package these service delivery initiatives within the privatisation framework to make them sustainable and economically viable (Okwiri *et al.*, 2001).

Ramadas and Ghotge (2002) stated that traditional healers had historically played a critical role in animal health care in many Indian villages. Yet over years, they had gradually been sidelined by mainstream veterinary services system and their knowledge and skill often condemned for being 'quackery' or 'witchcraft'. Hence, Anthra, an NGO in Andhra Pradesh and Maharashtra, developed a community health care system with Animal Health Workers selected from the local community. This, in turn, improved the availability of local health care services, documented high success rate of ethno-veterinary medicines to treat disease conditions, produced low-cost medicines with community participation, empowered women and improved bio-diversity. Similarly, Rajarethinam (2002) reported on the success of Pudukkottai Livestock Development Project in Tamil Nadu, which trained the village based 'Link Worker Couples' on basic animal husbandry services.

The efforts of NGOs like BAIF in India, Prosikha in Bangladesh and Intermediate Technology in India and Kenya, conspicuously showed their superior skills in reaching the poorest of the poor. When the governments of the respective countries introduced full cost recovery, reports were encouraging as far as the poor people were concerned (Sen and Chander, 2003). However, contrasting evidence was also not rare, as reported by Leonard (1985) in Argentina and Brazil that the private supply of veterinary services had been biased towards large and medium scale farmers.

Mugunieri *et al.* (2003) found that the community-based animal health workers (CBAHWs) played an important role in animal health service delivery in the marginal areas of Kenya despite the constrains in legal and policy frameworks. They stressed the need for strengthening the CBAHW programmes in marginal areas, which had not attracted private veterinary practice due to its aridity and poor infrastructure for not only improving animal health service delivery, but also for reducing poverty in marginal areas.

Southern Sudan, for example, had been providing treatments and vaccinations on a cost recovery basis (Leyland, 1996). Similarly, based on their field research in Africa, Hooton and Moran (2003) concluded that there was great potential for full cost recovery from community based animal health systems and that farmers, including poor, were

willing to pay market price for the services provided by community health workers. On the other hand, questions of sustainability had been raised in the case of the Integrated Livestock Development Project in Koraput district of Orissa, which focused on community organisation and avoided charging for services (Pradhan *et al.,* 2002).

As concerns were widespread those conventional models of private service delivery might not be suited to marginalised and resource poor areas, a number of alternative models had emerged to address these issues of service delivery in poor areas. Ahuja (2004) suggested the models that included community based animal health workers (AHWs), para-professionals, membership organization and self help groups and also suggested networking of private veterinarians and para-professionals as an approach to drastically lower transaction costs and improve availability of animal health services in remote marginal areas. He advocated the cost recovery through direct charges to make the service system viable, since it provided right incentives for the agents to deliver services the farmers wanted, made them accountable to the farmers and built on a genuine quality control mechanism, besides alleviating budgetary burden of the States.

2.2.2 Financing livestock services

Cheneau (1985) stated that inadequate financing had been the bane of many veterinary services all over the developing world. He also opined that the small proportion of the budgets in relation to the place of the livestock sector in the economy and their imbalance often impaired the normal functioning of animal husbandry services, so that they could only partly fulfil the task which they normally performed.

FAO (1990) declared that inadequate operating budgets coupled with lack of field personnel and transport generally resulted in initial reduction of local field services with the consequent non-provision of services aiming at controlling diseases or increasing animal productivity or stemming the spread of zoonotic diseases. A sequel to the inability to deliver such essential services was the lack of contact with the people, depriving animal health services of public support when budget allocations were being made. Further, Winrock International (1992) found that the inability to deliver adequate animal health services as a result of inadequate financing caused (i) inadequate disease surveillance, vaccine production and disease control measures, (ii) paucity of farm level curative and preventive services and (iii) weakening of public and extension services.

Turkson and Brownie (1999) assessed the adequacy of financing and resource allocation for veterinary services in Ghana, using the measures such as veterinary budget as proportions of the national budget and GDP, proportions of the veterinary budget allocated to salaries, ratios of

salaries to non-staff expenditure and of non-expenditure to veterinary livestock units and technical staff. These measures, generally declined over the period, confirmed the paucity of financing for veterinary services.

The deterioration in the fiscal condition of many African states forced to shift the delivery of veterinary services to the private sector, while a number of countries in South Asia continued with the State provision of these services. Recognising the importance of livestock in the livelihood of poor farmers among the developing nations and the assumption that the market would exclude poor livestock keepers due to poor paying capacity, the governments in many countries chose to build heavily subsidised systems for delivering even those services that could be most efficiently provided through the market (Ahuja and Redmond, 2001).

2.3 Prices of livestock services

Leonard (1993) pointed out that, when privatisation was introduced in Kenya, the cost of services did not necessarily rise but the number of visits made by the veterinarian definitely did, implying an increase in productivity. Also, in countries where the government services were subsidised, much of the subsidies did not reach the end users in India Ahuja *et al.* (2000). Also, Umrani (2001) observed that in Pakistan the users in private were often compelled to pay prices that were substantially higher than the prices prescribed by the government.

Ahuja (1999) stated that the AI services provided by BAIF in Gujarat State were completely free, while the government charged Rs. 5 and the charges of co-operative unions varied between Rs. 5 and 35. The farmers paid Rs. 5 for the AI done by trained inseminators at the primary co-operative societies and more if a veterinarian of the cooperative union did the insemination. Health services provided at government dispensaries were free until 1996 when a nominal fee (between Rs. 2 and Rs. 5) per visit at the centre was introduced. The prescribed fee for emergency home visits during office hours was same but the farmer was to bear the transportation cost. However, the prescribed fee structure was not differentiated by the type of service. Co-operative unions provided services for a fee, which varied significantly across districts. The fee for private practitioners tended to be differentiated according to the type of service. Total direct cost per animal worked out to be within the range of Rs. 35 and Rs. 50. For BAIF, which was providing AI and vaccination services at home, the cost was highest. In case of co-operatives, the share of operating cost was low, because, the vehicles were maintained centrally and the units were not required to bear the maintenance cost.

On an average, the farmers paid about Rs.25 per insemination to the cooperative or a government unit. However, the expenses incurred for veterinary visits were much higher, a visit by a private veterinarian costing around Rs.110. Comparable figures for co-operative and government doctors were about Rs. 55 and Rs. 100, respectively. For home visits, the government doctors charged several times more than what was prescribed. Private practice by government doctors is quite widespread (Ahuja, 1999)

Koma (2000) evaluated the structure of demand for animal health services in Uganda and noted that the effects of income and wealth on the demand for animal health services were weak. Similarly, Ahuja *et al.* (2000) reported from India that the magnitude of this effect was small and price elasticity was low and did not vary across income groups.

As the farmers in Zimbabwe had limited access to veterinary services, the government of Zimbabwe introduced Veterinary Livestock Technicians (VLTs) in 1980 to provide basic veterinary services through Animal Health Centres operating in each commune. These veterinary services were provided free of cost, although dipping fees and pharmaceutical charges were introduced. Despite free services, their use among farmers varied considerably. Whilst some farmers were not aware that veterinary services are available and they were to use them, other farmers regularly called the VLTs and even formed 'Veterinary clubs' under the guidance of VLTs (Pamela *et al.*, 2003).

2.4 Demand for livestock services

McInerney *et al.* (1992) found a few economic principles to guide decisions with regard to the optimal allocation of resources in animal health management: a) relationship between prices of output and veterinary input; b) relationship between veterinary inputs and their substitutes; and c) opportunity cost of devoting available resources to disease control activities. However, Chilonda and Huylenbroeck (2001) indicated that small-scale farmers make decisions in animal health management as a result of the interaction of several variables, which were grouped into categories such as characteristics specific to small-scale farmers and farms, economic factors, institutional setting and biophysical factors.

Hady and Lloyd (1992) provided evidence that on dairy farms, herd size affected input requirements including veterinary services. Educated and experienced farmers tended to have recognized the importance of having a healthy herd, which in turn increased the demand for animal health services.

Tambi *et al.* (1999) studied the socio-economic factors that influenced the likelihood demand for private veterinary services in the high potential agricultural areas of Kenya. Based on the probit and WLS estimates, factors such as herd size, number of breeding cattle in the herd, education/ training, farm income and market interest were found to have favoured likelihood for private veterinary services.

Ahuja *et al.* (2000) estimated demand for veterinary and artificial insemination services in Gujarat, Rajasthan and Kerala states and found that price was not an important determinant of the decision to use these services.

Woods (2000) observed that the actual distance of the farm from the Animal Health Centre and its proximity to roads and bus services could influence how difficult it was for the farmers to reach the Village Livestock Technicians and request services. Correspondingly, Chilonda and Huylenbroeck (2001) had also affirmed that the distance to the veterinary agents as a decisive factor determined the degree to which small-scale farmers relied on veterinary services.

Pamela *et al.* (2003) used factor and path analyses to identify the causal paths or relationships between variables affecting the demand and use of the various services by subsistence farmers in Zimbabwe in 1996. The important factors that positively affected whether they had sought veterinary assistance included familiarity of the farmer with the VLT, proximity to the VLT's base and training received by the farmers.

2.5 Willingness To Pay for livestock services

In Kenya, Leonard (1985) found that farmers were willing to pay for services that were reliable and effective and the poor gained greater access to the services when cost recovery was introduced. When veterinary services became commercial in 1980s, with staff charging for their curative visits, the work output increased significantly and inequality in distribution was reduced by at least one-half. In African countries, livestock owners were prepared to pay for veterinary interventions and drugs, but, to enable them to do so, economic measures should be taken by the government to improve their purchasing power (Cheneau, 1985; and Odeyemi, 1994).

George and Nair (1990) in Kerala found that there was no systematic variation in the use of breeding services based on the size of landholding.

Sulaiman and Sadamate (2000) revealed that a good number of farmers (about 50 per cent) in India were willing to pay for quality agricultural extension services at their

farms. Comparable evidences were available across the region for livestock services also. Based on a contingent valuation survey in three states of India, Ahuja *et al.* (2000) concluded that there was a significant willingness to pay for animal health services by all income groups, where they had also quoted cases of successful private delivery of livestock health and breeding services even in some very poor areas of India. Further, Rajasree and Subramanian (2003) maintained that the farmers agreed to pay for the services like AI, round the clock health care service, on-farm consultancy services, mobile veterinary services and for treatment of cases such as dystocia, fractures, rumenotomy, vaccination against contagious diseases and pregnancy diagnosis. All the three had concluded that privatisation was inevitable to provide agricultural extension and veterinary services to the farmers efficiently and effectively.

Umrani (2001) reported that most income groups, including the poor, were willing to pay for veterinary services in Pakistan. In the context of human health in Africa, Leonard (2001) noted that the failure of private markets could not be attributed to a lack of demand, as NGOs charged significant fees and their success was widespread in Africa.

2.5.1 Contingent valuation methods

Contingent Valuation (CV) survey has made remarkable progress, since its first application in the early 1960's by Davis (1963), to play an increasing role in environmental decision-making. Estimates of willingness to pay (WTP) for non-market goods and services using a survey-based approach dominate the literature on environmental valuation and help to guide public policy decisions concerning transport, health and natural heritage (Macmillan and Lienhoop, 2003).

CV survey studies simulate a market for a non-priced good with an objective to elicit, the maximum amount a non-market good is worth to the respondent by using either continuous or discrete CV formats. These two approaches and their possible biases along with ample comparative studies and WTP estimation procedures are presented below.

2.5.1.1 Continuous contingent valuation format

The two main approaches to elicit WTP values by using a continuous CV format are open-ended questions with or without iterative bidding and the payment card formats. In open-ended questions, respondents were simply asked to name their value for a non-marketed good or service (Johannesson *et al.,* 1992). The original form of CV constituted

an open ended question, in which respondents were asked to state their willingness to pay (or accept compensation) for a specified environmental improvement (or decrement) or a specified quality change (CIE, 2001).

a) Iterative bidding

The traditional willingness-to-pay application begins with an interviewer suggesting an initial (starting) bid. If the respondent is willing to pay the initial bid, the interviewer revises the bid upward until a negative response is obtained. A negative response to the initial bid results in the interviewer revising the bid downward until an acceptable amount is found. Depending on the design of the contingent market, the final bid is a measure of Hicksian compensating or equivalent surplus of Hicksian compensating (Randall *et al.,* 1974; Boyle and Bishop, 1988).

Several offshoots of the traditional bidding format have been used in recent years. For example, Schulze *et al.,* (1983) allowed respondents to choose the starting bid. Cummings *et al.* (1995) cited studies where payment cards were used to establish initial bids and bidding was conducted from this starting point.

Statistical analysis of the data generated by this technique is relatively straightforward. Alternatively, an attempt can be made to 'explain' the variation in values across individuals by regressing the 'bids' against a range of independent explanatory variables such as socio-economic characteristics and respondent attitudes. Ordinary Least Squares regression is usually employed for this task (Dwyer Leslie, 1991).

The argument in favour of this technique is that the bidding process helps the respondents to evaluate their preferences. An inherent weakness, however, is that the initial bid can influence respondents' final bids (Boyle *et al.,* 1985). Further, this task is criticized as being too difficult for respondents and leading to a large number of non-responses or protest zero responses (Johannesson *et al.*, 1991). The open-ended CV by iterative bidding method is rarely used now, because it has been found to be vulnerable to a range of biases, besides facing special problems where the good in question is not purchased directly by the public. The principal problem in the context of public or environmental goods, which are not privately purchased is that the respondents find open-ended questions relatively complex to answer, since they are not accustomed to paying for non-market goods and services (Hanemann, 1994).

b) Payment card

In order to alleviate the problems posed by 'bidding format', some kind of aid has been used to make it easier for the respondent to answer the valuation question. One such aid is the payment card format that tries to increase the response rate by confronting the respondent with an ordered sequence of bids. Payment card technique was developed by Mitchell and Carson (1981) so as to avoid the starting point problem that can arise in traditional bidding applications. Payment cards portrayed a range of money values beginning at zero and increasing at fixed intervals. Each payment card presents estimates (anchors) of what people in a specific income category paid for selected public services in the preceding year. The application of anchored payment cards involves describing the item to be valued and the hypothetical market for trading the item, as well as obtaining information on the respondents' income. The interviewer, then, shows the respondent a payment card corresponding to his or her income category, explains the information on the card, and asks the respondent to state a value for the item in question considering his or her household's annual income and the information provided on the card. This response is final and no bidding is involved.

Other researchers have used modified versions of the Mitchell-Carson's payment cards. Randall *et al.* (1981) compared estimates derived with two types of bidding formats, an open-ended question and a checklist approach. One type of payment card presented public expenditure anchors and the other displayed household expenditure anchors. The anchored payment cards generated fewer protest bids than did the other questioning formats, and the authors concluded that household-expenditure-payment cards generated a significantly different solid core (of) bids. However, these cards consistently generated the highest estimates of value, indicating that the form of the anchors might influence respondents' stated values.

Although Mitchell and Carson (1981) concluded that the anchors on the payment cards did not have any effect on respondent's final bid, the results of one test could not be taken as definitive (Randall *et al.,* 1981). Thus, even though payment cards were developed to avoid a starting point problem, questions remain as to whether the range of money values and the information portrayed on these cards influence responses to CV questions (Boyle and Bishop, 1988).

As concerns were raised on the use of payment cards in CV studies might be subjected to range and centering biases, Rowe *et al.* (1996) tested for biases with four versions of the payment card that had different ranges and center values. Their outcome

did not find range and centering biases, except when the payment card truncated, or did not present, and the upper end of the value distribution that respondents desired to select. Nevertheless, the payment card format is vulnerable to biases associated with the price ranges used, since the bids that the respondent had to choose from could affect his/ her valuation (Dario *et al.,* 2001).

Frew *et al.* (2004) assessed the willingness-to-pay for screening for colo-rectal cancer, using open-ended bidding game and payment scale formats. The bidding game format produced considerably higher estimates of WTP, whilst the significant differences between agreed valuations obtained using different initial bids supported the existence of starting-point bias in the bidding game. Given the significant difference in valuations generated by different formats, it followed that the economic case for preferring any one technology over others would depend considerably upon whichever format happened to have been used to generate the valuations.

However, Mataria *et al.* (2004) demonstrated the good feasibility of CV, using payment card approach, in a decomposed valuation scenario to avoid high cognitive burden on the respondents and thus increase the precision of results, while evaluating the stated willingness to pay for quality improvements in public health care system of Palestine.

2.5.1.2 Discrete contingent valuation format

The main approach to elicit WTP values by using a discrete CV format was closed-ended questions. In this, respondents were asked whether or not they would pay a single price out of a range of predetermined prices. This approach was similar to market transactions, where people were accustomed to deciding whether or not to buy a good at a specific price. Therefore, it was a very popular elicitation technique for contingent valuation surveys. By varying the price in different sub-samples, the proportion of respondents who were willing to pay the price can be calculated and by multiplying this proportion with the number of respondents, a demand curve for the good can be estimated (Dario *et al.,* 2001).

a) Dichotomous choice approach

This technique was first used by Bishop and Heberlein (1979). Subsequently, other studies have used similar analyses to estimate values for environmental amenities (Loehman and De, 1982). Hanemann (1984) further developed the conceptual and theoretical arguments for using this technique to estimate values and estimated the probability of observing a 'yes' response with simple logit or probit models.

In a dichotomous choice application, the item being valued and the hypothetical market for trading this item were described to respondents, as is done for other CV techniques. Respondents, then, are asked to state whether they accept or reject a single take-it-or-leave-it offer for the item being valued, but not asked to state a specific dollar value (Sellar *et al.,* 1985).

The simple and common single-bounded dichotomous choice estimation approach proposed by Cameron (1988) has the advantage of directly modeling the distribution of WTP using interval-censoring techniques. The argument in favour of this approach is its simplicity. Rather than having to deal with complicated bidding formats or understand the intricacies of anchored payment cards, survey respondents have to provide only a 'yes' or 'no' response to a single value/ money offer. Most respondents would never attempt to place a monetary value on environmental amenities and may find it difficult to provide specific money values, as is required when answering iterative bidding and payment card questions. However, respondents may respond with relative accuracy to a fixed offer, although a range of values remained where a respondent is unsure and had difficulty in deciding (Boyle and Bishop, 1988).

The sophisticated, double-bounded dichotomous choice framework is lauded for its statistical efficiency. Hanemann (1991) and Lusk and Hudson (2004) have shown double-bounded approach to yield more efficient estimates of mean WTP than single-bounded approach, primarily because the approach incorporates more information about an individual's WTP than a single dichotomous choice question.

Despite these advantages, double-bounded dichotomous choice method has shown to have several disadvantages: responses to the first and second dichotomous choice questions may not be perfectly correlated, leading to the confusion as to which WTP is most relevant (Cameron and Quiggin, 1994); the double-bounded approach may suffer from starting point biases, that responses to the second question depends on the prices offered in the first (Shogren and Herriges, 1996); and the method may not be incentive incompatible in a hypothetical context (Carson *et al.,* 1999).

Ready *et al.* (1996) found that the dichotomous choice elicitation method consistently generated much larger estimates of WTP than did a continuous method in a split sample CV study of WTP for food safety improvements. Although little or none of these differences were due to bias introduced by the statistical techniques used with the dichotomous choice data, most or all of the differences were due to differences in respondent behaviour.

Smith and Mansfield (1998) provided the results of a field test of CV estimates within a willingness to accept framework. Using dichotomous choice questions in telephone-mail-telephone interviews, they compared respondents' responses to real and hypothetical offers for the opportunity to spend time in a second set of interviews on an undisclosed topic. Five hundred and forty people were randomly split between the real and hypothetical treatments and the findings indicated no significant differences between people's choices with real and hypothetical offers. Choice models were not significantly different between real and hypothetical offers.

Blamey *et al.* (1999) proposed a new elicitation format, dissonance-minimizing format, with the objective of reducing the occurrence of 'yea-saying', i.e. respondents expressing their support for a program regardless of price. An empirical comparison of the dissonance-minimizing format with the conventional dichotomous choice and the ambivalence reducing polychotomous choice formats proved the results of dissonance-minimizing format to be better. However, a trichotomous choice question format

proposed by Loomis *et al.* (1999) reduced the number of 'yes' responses and produced a statistically significant decrease in willingness to pay for an open-space program.

Haab (1999) stated that simple dichotomous choice (or referendum) CV surveys have become the predominant choice for valuing non-market goods and services, although a number of researchers have recently recommended that dichotomous choice CV studies with a follow-up question to all no responses to determine whether the no response is a result of unwillingness to pay, or non-participation. In this context, he reported that simple identification of indifferent individuals would not suffice, if the goal of the study is to investigate the impact of covariates on either mean willingness to pay or the probability of non-participation. A simulation study showed that existing econometric models designed to account for non-participation were extremely sensitive to misspecification bias and accurate identification of the probability of non-participation was hampered by potential misspecification of the distribution of willingness to pay.

Calia and Strazzera (2000) analysed the bias of the Maximum Likelihood estimates produced by single or double bounded dichotomous choice models and the gain in efficiency associated to the double bound model, in different experimental settings. They found no significant differences in point estimates given by the two models, even for small sample size. However, greater efficiency of the double bound was confirmed, although differences tend to reduce by increasing the sample size. Hence, the use of the single rather than the double bounded model is suggested, provided that a reliable pretest is conducted and the sample size is large.

One disadvantage with both single and double-bounded approaches is that they only elicit discrete choices. That is, one only observes whether an individual will pay more or less than a particular price level. Thus, parametric assumptions must be made about the distribution of WTP in a sample. A more informationally efficient approach may involve eliciting each individual's exact WTP. Yet another disadvantage of both approaches is that they only consider WTP for a single good and estimation of cross-price effects between new and competing products requires a modification of conventional survey design (Lusk and Hudson, 2004).

In nutshel, studies implied that this method would lead to WTP values that exceed those derived in experimental or real-life markets. One possible explanation for the overestimation of WTP values using the dichotomous choice method is the presence of yea-saying.

b) Choice experiments

Hanley *et al.* (1998) outlined the 'choice experiment' approach, which has its roots in Lancaster's characteristics theory of value, in random utility theory and in experimental design, to environmental valuation. These choice pairs were designed to allow efficient statistical estimation of the underlying utility function, and to minimise required sample size. According to them, choice experiments have important advantages over other environmental valuation methods, such as CV and travel cost models, although many design issues remain unresolved. They illustrated the use of choice experiments with reference to a study in U.K. on public preferences for alternative forest landscapes, as this study allowed them to perform a convergent validity test on the choice experiment estimates of willingness to pay.

Adamowicz *et al.* (1998) examined an extension or variant of CV, the choice experiment, which employed a series of questions with more than two alternatives that were designed to elicit responses that allowed the estimation of preferences over attributes of an environmental state. They also combined the information from choice experiments and CV to test for differences in preferences and error variances arising from two methods, where they showed that choice experiments to have considerable merit in measuring passive use values.

Morrison *et al.* (1999) reported that the choice models were robust, having high explanatory power and variables that were statistically significant and consistent with expectations, which in turn, supported the hypothesis that choice modeling could be used to estimate non-use values for both environmental and social consequences of resource use changes.

i) Conjoint modelling

Conjoint analysis is a decomposition technique used to measure a respondent's preference given his/ her evaluation of various combinations of attributes and levels that define a particular product or a service (Green and Srinivasan, 1978). During the early 1980s, an estimated 400 conjoint analyses applications were carried out per year and the majority (59 per cent) of these studies pertained to consumers and industrial goods (18 per cent), finance (9 per cent) and other services (9 per cent). The principal applications of these studies were new product/concept evaluation, repositioning, competitive analysis, pricing and market segmentation (Wittink and Cattin, 1989).

The conjoint approach makes use of consumer choice theory, where a respondent's preference can be measured in terms of utilities for individual attributes of the products or services (Ozayan, 1997). An advantage of conjoint analysis relative to other multivariate analysis is the way it decomposes the overall preference of a respondent to determine the value of each attribute (Hair *et al.,* 1998).

Sambidi (2003) employed conjoint approach to decompose the broiler company executive's total state preference (i.e., expected profitability) for a particular location (i.e., a particular bundle of location attributes) into part worth evaluations for each attribute level in the site location decision.

ii) Conjoint rating and ranking

Conjoint rating was another method that can be used to elicit WTP for novel goods or services. Conjoint rating has been frequently used in marketing, transportation and environmental valuation literature. In a conjoint rating framework, consumers were typically confronted with a choice between alternative products where the products were defined by several attributes, such as price and quality. The consumer is typically asked to choose which product they would purchase, given several product descriptions (Adamowicz *et al.,* 1998 and Louviere *et al.,* 2000).

The advantage of the conjoint rating framework is that hypothetical responses to conjoint rating questions have been found to be similar to revealed preferences. Lusk and Schroeder (2002) found that hypothetical conjoint rating responses were statistically different from non-hypothetical responses, but differences were generally small. Even if conjoint rating is prone to hypothetical bias, this technique can readily be used to construct simulated retail settings, which have the advantage of increased realism for participants. Further, cross-price elasticities between novel and existing products, a task more difficult with other techniques such as dichotomous choice questions, can easily be estimated through conjoint rating (Lusk and Hudson, 2004).

Conjoint ranking is similar to the rating method described above, except that respondents were presented with three or more alternatives in one question and asked to rank the alternatives from most to least preferred. Conjoint ranking is no longer widely used because of theoretical difficulties in analysing the data (Louviere and Timmermans, 1990). Furthermore, the technique shares the weakness of conjoint rating in that respondents are not required to commit to selecting one alternative.

iii) Paired comparison

In a paired comparison, respondents are presented with two alternatives at a time and asked to rate their preference for the alternatives on a five or ten-point scale. A series of these questions are administered to each respondent. A study by Johnston and Desvousges (1997) used a paired comparison technique to estimate public preferences and values for various electricity generation scenarios. The impacts of alternative scenarios were described in terms of health, environmental and employment attributes. The application required respondents to make tradeoffs between these impacts and the cost of different forms of power generation, which was specified in terms of changes in the price that respondents would have to pay for electricity. This is the most frequently used version of conjoint analysis and commercial software packages are available for producing an experimental design and analysing the data. As with the other conjoint techniques, the paired comparison method is not underpinned by a full economic model of consumer choice and the statistical analysis of rating data using OLS is inappropriate. However, recent advances made in statistical analysis overcome these difficulties (Roe *et al.,* 1996 and Johnston and Desvousges, 1997).

c) Experimental auctions

Experimental auctions are a popular method of non-market valuation because of the evidence that consumers respond differently in hypothetical and real environments. Experimental auctions are generally conducted in one of two ways: first, consumers can be provided with an endowed good and then asked to bid to exchange their endowed good for a novel good (Fox, 1995); secondly, consumers can bid directly on several competing goods and a random drawing can be used to determine which good is binding so that one can focus on single-unit demand (List and Shogren, 1998).

Although experimental actions have advantages like straightforward modeling of determinants of WTP due to its continuous nature of the dependent variable (Lusk and Hudson, 2004), the method has several drawbacks which include: a) bidder values may become affiliated and hence degrades the incentive compatibility (Milgrom and Webber, 1982); b) bids may be truncated or censored by outside alternatives (substitutes) not available in the experiment (Harrison *et al.,* 2002); and c) a large frequency of zero-bidding resulting because of participant disinterest (Lusk and Hudson, 2004).

2.5.1.3 Biases in contingent valuation studies

The inspiration in a CV survey is to get the respondents to make hypothetical choices in the same way they would if faced with an actual decision situation. However, systematic errors can occur in the design as well as in the execution of a CV survey. Therefore, the possibility of biases in CV studies is large. These biases either overestimate or underestimate WTP. Mitchell and Carson (1981) have given a good overview of potential biases and of the ways in which they can and should be taken into account in a CV study.

Whitehead *et al.* (1994) tested specification bias in CV by determining the expected effects of omitting relative price variables on WTP and including measures of own-price and cross-price in an empirical CV function. They found that omission of an own-price variable downwardly biased the income coefficient, while omission of a cross-price variable resulted in an upwardly biased income and own-price coefficients. These results showed that omission of relative prices from WTP equations might lead to biased econometric results.

Ryan and Miguel (2000) developed a simple test of consistency in WTP experiments which was based on the theoretical basis of the technique: if commodity A was preferred to B, then individuals should be willing to pay more for A than B. The test was applied to elicit women's preferences for two alternative treatments for menorrhagia: conservative treatment versus hysterectomy. Thirty percent of respondents failed in the consistency test. Cost-based responses were found to partly explain inconsistent responses, which highlighted the potential problems when using WTP experiments within a cost-benefit analysis framework.

a) Yea-saying

Respondents seem to have the tendency to answer with ‘yes’ when responding to discrete CV questions in order to express their motivations instead of giving their true preferences (Kanninen, 1995; and Blamey *et al.*, 1999). Elicitation techniques with only a ‘yes/ no’ response alternative, i.e. the dichotomous choice format, may provoke yea-saying, since respondents are not allowed to express their support for the program regardless of price. Yea-saying may explain why WTP values elicited using a dichotomous choice format exceed those using other elicitation formats by far.

b) Protest answers

Some respondents may answer with 'no' or refuse to answer at all, because they oppose the payment vehicle, i.e. the use of a levy, but not the program itself (Blamey *et al.*, 1999). As in the case of yea-saying, elicitation techniques with only a 'yes/ no' response alternative seem to provoke protest answers. Depending on how these protest answers are treated, substantial differences in estimated WTP can occur. Most studies remove all protest answers from the sample, which produces much higher estimates of WTP (Ready *et al.*, 1996). Therefore, by capturing respondents who support the program but oppose the payment vehicle and giving them follow-up questions concerning their WTP for the program, protest answers might be avoided. Another possible source for protest answers could be respondents' ambivalence over trade-offs between money and changes in levels of a good (Ready *et al.*, 1995). If respondents are ambivalent they might answer with 'no' even if they care for the good. Especially the dichotomous choice format gives respondents no opportunity to express ambivalence and might provoke a higher amount of non-responses and protest answers. Therefore, by allowing respondents to make less of a commitment, i.e. by giving more than two possible responses, protest answers may be avoided.

c) Question ordering bias

If multiple CV questions are asked, the order in which the questions are presented may matter. Boyle *et al.* (1993) suggested that question ordering might be important when information bias is present and respondents are unfamiliar with the commodity being valued. By changing the order of the questions for a sub-sample, it can be tested for question ordering bias.

d) Payment vehicle bias

It is believed that respondents may not take their answers seriously because the questions are of hypothetical character. In addition, respondents may have incentives to behave strategically, which can produce both higher and lower valuations than the true one. If respondents believe that they have to pay less than the amount they state, they have incentives to overbid and vice versa. However, studies show that strategic behaviour seems to be a small problem in CV survey (Dario *et al.,* 2001). On the other hand, binary CV questions seem to give respondents incentives to state a true valuation (Johannesson, 1996).

e) Embedding effect

An embedding effect is said to occur when the estimated mean willingness to pay for an attribute is lower when it is valued as part of a more inclusive set of attributes, rather than on its own (Bennett *et al.,* 1998). At the extreme, the summation of values for individual attributes, when evaluated separately is sometimes observed to exceed an individual's total income. The embedding effect is not a bias. Rather, the value of all goods (market and non-market) is dependent on the context in which they are framed. Thus, the wider the array of substitute goods available to a consumer, the lower the value placed on any individual good (CIE, 2001).

Bennett and Larson (1996) described a survey that explored the application of CV to animal welfare issues by eliciting people's WTP to support specific farm animal welfare legislation. The findings suggested that CV might be applied to such animal welfare issues but that studies needed to formally address the associated problems of embeddedness, purchase of moral satisfaction and failure of respondents to adequately consider substitute and complementary goods and their potential effect of overstating WTP.

f) Warm glow effect

The warm glow effect is a problem related to the embedding effect. Studies showed that stated WTP often do not vary with the size of the program. Respondents seem not to express their valuation for a good, but some kind of general approval. Therefore, WTP for the programs 'diagnosis' and 'research' should differ (Kahneman and Knetsch, 1992 and Dario *et al.,* 2001).

g) Information bias

The information respondents have regarding the hypothetical commodity is crucial for a CV survey. Since the commodity being valued is normally a non-marketed good, respondents may not be very familiar with it. If estimated WTP is insensitive to familiarity with the commodity being valued, then it should not depend whether informed or uninformed respondents value the commodity. However, studies showed that responses to risk-income choices differ, whereas responses to risk-risk tradeoffs may be more stable, suggesting that persons who are unfamiliar with a disease cannot give valid and reliable answers to WTP questions (Viscusi *et al.*, 1991, Krupnick and Cropper, 1992, Dario *et al.,* 2001).

Ajzen *et al.* (1996) concluded that the nature of the information provided in CV survey can profoundly affect WTP estimates, and that subtle contextual cues can

seriously bias these estimates under conditions of low personal relevance. That is, the information about a public or private good can function as a persuasive communication, WTP was found to increase with the quality of arguments used to describe the good, especially under conditions of high personal relevance. Under low personal relevance, WTP for a public (but not a private) good is higher when an altruistic, as opposed to an individualistic, orientation is activated.

2.5.1.4 Statistical methods in contingent valuation studies

Ozuna *et al.* (1993) stated that the binary choice models, which were frequently used in the analysis of referendum CV data resulted in inconsistent parameter estimates because of omitted regressors, heteroskedasticity, and distribution asymmetry in these models, that in turn required misspecification tests be undertaken. They presented conditional moment tests for these problems and applied to data from two referendum CV studies, and the results showed that some models had misspecification problems and that these problems affected the estimation of welfare measures.

CV survey involved asking the respondent a sequence of nested questions. Asking and analyzing a nested sequence of questions was an efficient approach to data gathering and preference revelation. However, the resultant sequentially censored data set could not be efficiently analysed with the standard regression models like the tobit or nested logit models for which the nested tobit model was proposed as an efficient and consistent method of estimating regressions using sequentially censored data (Howe *et al.*, 1994). The empirical application of the model also suggested greater efficiency in comparison to the Heckman two-stage procedure.

Jordan and Elnagheeb (1994a) conducted Monte Carlo experiments to compare regression parameter and WTP estimates using the CV method's referendum and payment-card questioning formats. Strategic bias was controlled by making responses consistent with the true WTP. Two WTP models were constructed with linear and log-linear explanatory variables. Based on the efficiency and mean-squared-error criteria, the payment-card model was found superior to the referendum model. However, neither model outdid the other when the unbiasedness criterion was used. The performance of either model depended on the choice and distribution of the bids and payment-card categories.

Willingness-to-pay responses from dichotomous choice CV studies were often modelled using logistic regression, from which estimates of mean or median WTP were

calculated. As many factors influenced an individual's WTP, some of which might be unobserved, the regression model might have inadequate explanatory power, and parameter estimates might be biased and their significance overestimated (Langford, 1994).

Henson (1996) employed CV to estimate WTP for reductions in the risk of food poisoning, where the analysis accounted for the range of adverse health effects resulting from non-fatal cases of food poisoning as well as the risk of loss of life. A number of hypotheses regarding the value consumers attached to improvements in food safety was explored based on the results from a CV survey. Regression analysis was used to assess the factors influencing expressed WTP for safer food, including demographic factors, personal experience of food poisoning and beliefs and attitudes about food borne risk.

Roe *et al.* (1996) used several approaches to derive estimates of Hicksian compensating variation from conjoint ratings data. The different estimation approaches produced mixed results with respect to consistency with utility theory, statistical significance of key variables, magnitude of welfare estimates, and confidence bounds on welfare estimates. These findings indicated that conjoint analyses were not a panacea for the problems being debated regarding CV and travel cost methodologies, and conjoint questions appeared to share many of the advantages and disadvantages associated with dichotomous choice, CV questions.

Mansfield (1998) proposed a method to determine the influence of respondent characteristics on bias, as distinct from their influence on the preference parameters. He used a specific functional form for individual preferences to derive closed form analytical expressions for WTP and WTA that allowed systematic deviations in individual responses to be explicitly modelled by providing a structural interpretation of the error term, and obtained promising results for both open ended and dichotomous choice data using three contingent value data sets.

Langford *et al.* (1998) used versatile statistical techniques to achieve improved parameter estimates from models of dichotomous choice CV data. Random effects associated with bid amounts presented to respondents were modelled alongside the variance of individual responses, to give a nested model, which reflected the structure of the delta being analyzed. Quasi-likelihood methods for estimating parameters in such hierarchical models were discussed, and a simulation method for assessing goodness of fit was

demonstrated. However, estimated parameters might still be biased and hence, a parametric bootstrap technique was presented and compared to a delta method approximation.

A contingent valuation method (CVM) survey to determine foreign and resident WTP for return visits to two different Costa Rican national parks was administered in 1995. WTP values were estimated for future entrance fees associated with proposed improvements to infrastructure and services in the Poas Volcano and the Manuel Antonio parks. Resulting logistic CVM models were statistically robust and mean WTP for entrance fees differed among the parks and were considerably higher than current fees. Results indicated that even in a developing country setting, the CVM is a useful tool to help determine park entrance fees in spite of the following methodological limitations which are recommended for further study: the need to include potential park visitors in survey samples; the lack of detailed information framing and contingent scenarios for park related WTP questions; and the threat of cultural strategic biases when surveying residents of a developing country (Shultz *et al.* 1998).

In order to estimate sample WTP to preserve a 5.5 acre parcel of undeveloped land in Boulder, Colorado, Breffle *et al.* (1998) developed an interval model as a function of distance, income and other characteristics. The model accommodated individuals who might be made better off by development and addressed the accumulation of WTP responses at zero. Weighted sample WTP estimates were aggregated to obtain the neighbourhood's WTP, which in turn, demonstrated that CV is a flexible policy tool even for land managers and community groups wanting to estimate WTP to preserve undeveloped urban land.

As innovations in the estimation of referendum type CV models had led to WTP measures inconsistent with consumer preferences and unbounded from above or below, Haab and McConnell (1998) proposed a set of criteria which guarantee a bounded measure of WTP and developed a new model based on the beta distribution. The criteria rejected the traditional random utility model with unrestricted error terms in favor of the random WTP model with bounds on WTP.

Creel (1998) stated from Monte Carlo evidences that simple, misspecified referendum CV models sometimes lead to good estimates of mean WTP. He also quoted that the empirical studies had found the estimates of mean WTP derived from simple parametric models often differed little from those derived from nonparametric methods.

Besides, he indicated that very simple models, like simple logit referendum CV models, would estimate mean WTP consistently if the survey bids were drawn randomly from a uniform distribution.

Chen and Cosslett (1998) used simulated maximum likelihood to estimate a random parameter multinomial probit model of destination choice for recreational fishing trips, formulated to accommodate varying tastes and varying perceptions of environmental quality across individuals. The restricted likelihood ratio test strongly rejected the independent probit model, which was similar to the independent logit model in both the parameter and benefit estimates.

Fox *et al.* (1998) designed and implemented a method, CVM X, to calibrate hypothetical survey values using experimental auction markets. They tested the procedure using consumer WTP for irradiated/non-irradiated meat and the results showed that calibration factors for those who favour the irradiation process (0.67-0.69) were less severe than for those with an initial dislike of the process (0.55-0.59), suggesting that calibration might be commodity specific.

Appropriate elicitation of environmental attitudes for inclusion in non-market valuation models may improve the descriptive and predictive ability of these models, especially in the case of CV studies eliciting willingness to pay values. Luzar and Cosse (1998) identified an appropriate conceptual model of the attitude behavior relationship that was conceptually consistent with the process of CV. Using primary data collected from a survey of rural residents, WTP to accept changes in individual and state level water quality was estimated with and without attitudinal explanatory factors. In both models, attitudinal variables were significant explanatory factors, enhancing the explanatory and predictive power of the estimations.

Riddel and Loomis (1998) presented a technique that could be used to jointly estimate WTP for multiple scenarios proposed within a survey when the double bounded questioning format was used. Monte Carlo simulations were employed to show that estimates derived from the joint model provide lower parameter variances as well as tighter confidence intervals surrounding WTP. The model was used to estimate WTP values for data collected in telephone interviews of California residents concerning WTP for fire reduction programs in Oregon and California. Variance properties of these estimates were shown to be similar to those estimated using simulated data.

Blamey (1998) presented a theoretical model of symbolic and attitude-expressive CV responses, drawing on relevant contributions in psychology and political science. He argued that the highly symbolic and emotional nature of many environmental issues often activated the need for individuals to express their attitudes and values, which when coupled with a perceived non-decisiveness of individual questionnaire responses, could result in value-expressive considerations dominating some CV responses at the expense of the desired outcome-appraisal economic tradeoffs.

WTP for a health care program can be estimated in CV studies by a nonparametric approach. As the nonparametric approach is free from distributional assumptions, it is a strength compared with parametric regression-based approaches. However, while using a nonparametric approach it was not clear how to obtain confidence statements for WTP estimates, for example, when testing hypotheses regarding differences in mean WTP for different subsamples. Employing bootstrap techniques, as proposed by Tambour and Zethraeus (1998), allows statistical testing and confidence interval estimation. The method was applied to data from a CV study where the WTP for hormone replacement therapy was investigated and the mean WTP was estimated for the full sample and separately for women with mild and severe menopausal symptoms.

Kline and Wichelns (1998) used factor analysis and a discrete choice model to describe differences in public preferences that resulted from different attitudes regarding the goals of programs designed to preserve farmland and open space. Results described policy implications that were not apparent when using models that address socio-economic characteristics alone.

Donaldson *et al.* (1998) argued that, whether an open-ended question or a payment scale approach was adopted, the way in which WTP was recorded means that limited dependent variable models were more appropriate than standard regression analysis. It was suggested that two-part specification performs better than OLS or a standard Tobit model for the data from an open ended question on WTP with a large proportion of zeros, while grouped data regression was suggested as appropriate, if the payment scale method was adopted.

Logistic regression analysis of data from dichotomous choice CV studies often modelled the willingness-to-pay curve poorly and hence, Buckland *et al.* (1999)

developed solutions as to how to model responses as a function of several covariates, and how to model the case in which a proportion of respondents unwilling to pay anything.

A significant number of respondents to CV surveys stated either a zero bid, or refused to state a bid at all, for reasons associated with the process of valuation. These protest responses were routinely removed from CV samples because it was assumed that they were not indicative of respondents' 'true' values, which in turn, led to the emergence of a definitional controversy. One view is that the definition of protest responses and the rules for censoring them are dependent on whether the practitioner conceives of the CV survey as a market or as a referendum. However, what was not acknowledged is the possibility that protest responses and their meanings may vary according to the type of good being valued, the elicitation format, and the interaction between these elements and external factors. Moreover, when willingness to pay was viewed as a behavioural intention, it becomes important to determine what the responses actually mean (Jorgensen *et al.*, 1999).

Reiser and Shechter (1999) suggested using spike models, which explicitly allow and incorporate zero responses, to estimate individuals' willingness to pay for non-market environmental assets via preferences elicited by either open-ended or dichotomous choice questions.

Werner (1999) constructed a mixture distribution model by modifying the standard parametric survival model such that respondents in the lowest willingness-to- pay category might have either zero willingness to pay or a small positive willingness to pay. In comparison to the standard model, the mixture model led to a dramatic reduction in estimates of mean willingness to pay and the covariates such as income were found to be more significant in determining the positive portion of the distribution of willingness to pay.

Data on willingness to pay collected from CV surveys were usually censored at zero and in such cases, OLS estimation of the WTP equation produced inconsistent parameter estimates. The maximum likelihood estimation of the Tobit model, which was widely used in this case, was not robust to heteroscedasticity and non-normal error structure. Hence, Yoo *et al.* (2000) proposed a least absolute deviation estimator for the censored data structure, as the technique had also been found useful in the case of small amounts of data.

2.5.1.5 Comparison of valuation across methods

A number of studies have compared WTP estimates across elicitation methods. A short review of these works is presented below for gaining into the relative magnitude of WTP across methods and to ascertain how results might differ if an alternative elicitation technique was employed.

Mackenzie (1993) compared the informational efficiencies of contingent rating, contingent ranking, and two contingent paired-comparison methods as alternatives to the referendum CV method. The contingent rating method was hypothesized to be the most efficient because ratings convey information on preference intensities and could uniquely represent respondent indifference or ambivalence. Survey data on hunters' ratings of alternative hypothetical hunting trips were used to estimate four alternative indirect utility models from which marginal willingness-to-pay measures for individual trip attributes were derived. Model comparison, willingness-to-pay estimates, and their confidence intervals confirmed the relative efficiency of the contingent rating approach.

Kealy and Turner (1993) developed a test to find whether open-ended and close-ended CV mechanisms led to significantly different results. The test was based on joint estimation of willingness-to-pay responses to open- and closed-ended questions asked of the same sample of individuals. While individuals responded differently in a public good example, no differences in willingness-to-pay were found in a private good example. Possible explanations included different incentives for strategic behaviour and respondents' lack of familiarity with the open-ended question type.

Jordan and Elnagheeb (1994b) compared WTP estimates from an actual survey using a checklist question regarding WTP for groundwater quality improvements to WTP estimates that would had been obtained, had a single-bounded referendum (SBR) or a double-bounded referendum (DBR) question been asked. Results indicated differences among estimates from three types of question formats and a loss of statistical efficiency of parameter and WTP estimates while moving from the checklist and DBR formats to the SBR format. WTP estimates from the SBR question were more sensitive to sample size and model specification than the others.

Holmes and Kramer (1995) developed diagnostic tools to test the convergent validity of two common CV elicitation procedures, using the data from independent samples receiving dichotomous choice and payment card questions. They compared actual with counterfactual responses using deterministic and Monte Carlo methods and

found that WTP distributions and mean values varied by the value elicitation method. They, also, developed a paired-comparison test for procedure variance which indicated that yea-saying and starting point bias influenced dichotomous choice responses.

Boyle *et al.* (1996) compared independent applications of open ended and dichotomous choice formats using tests of means, estimating joint likelihood functions and nonparametric tests of distributions. The null hypothesis of no difference in the open ended and dichotomous choice estimates of central tendency could not be rejected for two out of three data sets, while estimated standard deviations were significantly different for all three data sets. In addition, actual dichotomous choice means and standard deviations exceeded those from comparable synthetic dichotomous choice data sets, suggesting either open ended questions underestimated values or dichotomous choice bid structures might lead to systematic overestimates. Similar results were obtained by Ready *et al.* (1996) in a split sample CV study of WTP for food safety improvements. Although little or none of these differences was due to bias introduced by the statistical techniques used with the discrete choice data, most or all of the difference was due to differences in respondent behaviour.

In order to verify whether the open ended format yielded lower estimates of WTP than did the close ended, or discrete choice, format, Brown *et al.* (1996) estimated WTP for a public environmental good under four conditions: actual payment in response to open ended and closed ended requests, and hypothetical payment in response to open ended and closed ended requests. The experimental results showed that the response format mattered far more for hypothetical than for actual payments and concluded that the discrete choice format yielded larger estimates of hypothetical WTP.

Boyle *et al.* (1998) investigated the effect of bid structures on welfare estimates using two pretest distributions (from open ended and dichotomous choice questions) and three bid structures (two bid, five bid, and multibid designs). Both Monte Carlo simulations and responses from a field experiment were used. Their results supported the growing evidence that 'yea saying' occurs and the problem becomes worse when bids are clustered at discrete bid levels in the upper tail of the distribution.

Whitehead *et al.* (1998) conducted construct validity tests for dichotomous choice and polychotomous choice CV questions, where they found that discrete choice and polychotomous choice estimates of willingness to pay were theoretically valid,

convergent valid and similar in terms of statistical precision. They also added that polychotomous choice respondents were less sensitive to information than dichotomous choice respondents and hence concluded sequential PC valuation questions could be used in studies where obtaining information about the certainty or intensity of respondent preferences would be useful.

Bohara *et al.* (1998) studied the potential of cost influenced responses in open ended and dichotomous choice formats on cross split sample information treatments to provide a total cost of the project treatment, a group size treatment, a combined treatment, and the baseline control group. They showed that the dichotomous choice values were not affected by cost and/or group size information while the open ended values were (negatively) affected, using a CV survey for a particular environmental good (the "field"), and in an induced value experimental laboratory setting with real payoffs and a context free, publicly provided good (the "lab").

According to Halvorsen and Salensminde (1998), most comparative studies established that the discrete choice CV method yields higher WTP estimates than the open-ended format. They found that WTP estimates from discrete choice data were very sensitive to assumptions made about the random utility, more specifically, violation of the homoscedasticity assumption might lead to the biased WTP estimates, if the error terms were correlated with the cost.

Blumenschein *et al.* (1998) carried out an experiment to compare the dichotomous choice CV method with real purchase decisions for a consumer good and to experiment the hypothetical bias (overestimates WTP) in dichotomous choice CV. They confirmed previous findings that hypothetical ‘yes’ responses overestimate real purchase decisions but they could not reject the null hypothesis that definitely sure ‘yes’ responses correspond to real purchase decisions.

Quiggin (1998) addressed on the issue of whether WTP for the benefits generated by a public good should be elicited on an individual or on a household basis. Differences between individual and household WTP might arise when members of the household were mutually altruistic. It was shown that, for general specifications of altruism, household WTP was less than the sum of household members' individual WTP.

Welsh and Poe (1998) developed a multiple bounded discrete choice elicitation technique that allowed respondents to express their level of voting certainty for a wide

range of referendum thresholds, where they compared values obtained from a multiple bounded model with values derived from three standard CV elicitation formats, viz., dichotomous choice, payment card, and open-ended. The multiple bounded discrete choice format covered the range of values associated with the other three predominantly used elicitation methods and alternative parameterisations of the multiple bounded discrete choice model correspond to these standard elicitation techniques.

Green *et al.* (1998) examined anchoring in single referendum questions in CV survey on WTP for public goods, and on objective estimation. Strong anchoring effects were found that led to systematically higher estimated mean responses from Yes/No referendum responses than from open-ended responses. This response pattern was similar for CV questions and for objective estimation questions. They concluded that psychometric anchoring effects, rather than incentive effects, were the likely cause of results commonly found in CV studies, and that the currently popular single referendum elicitation format was highly vulnerable to anchoring.

Johannesson *et al.* (1998) reported the results of an experiment comparing the dichotomous choice CV approach with real purchase decisions for a consumer good. In addition to this, they also tested the hypothesis that a more conservative interpretation of the dichotomous choice approach, where only absolutely sure ‘yes’ responses were counted as ‘yes’ responses, correctly predicted real purchase decisions. The results showed that the hypothetical ‘yes’ responses overestimated the ‘real yes’ responses and that the hypothetical absolutely sure ‘yes’ responses underestimate the ‘real yes’ responses.

O'Conor *et al.* (1999), while comparing different CV question formats with each other and with observed behaviour for a non-monetary estimation task, found that the single and double-bound dichotomous choice questions resulting in an estimated mean about twice as high as the actual value and the open-ended mean. The dichotomous choice question overestimation seemed to be due to an anchoring effect leading to "yea-saying" behaviour. However, the difference between dichotomous choice and open-ended questions was consistent with the pattern observed in CVs studies of the willingness to pay, which indicated that dichotomous choice questions seemed to be associated with a general overestimation problem that was present even for simple non-monetary estimation tasks.

Reaves *et al.* (1999) used a three-way treatment design to compare CV response formats (viz., open-ended, payment card, and double- bounded dichotomous choice), where the differences in survey response rates, item non-response rates, and protest bids were also examined. Convergent validity was found on comparing mean WTP values, while differences across formats were also identified in item non-response rates and proportion of protest bids. Overall, the payment card format exhibited desirable properties relative to the other two formats.

Haab (1999) stated that dichotomous choice (or referendum) CV surveys had become the predominate choice for valuing non-market goods and services. Although a number of researchers had recently recommended that dichotomous choice CV studies with a follow-up question to all no responses to determine whether the no response was a result of unwillingness to pay, or non-participation. However, Haab (1999) said that simple identification of indifferent individuals would not suffice, if the goal of the study was to investigate the impact of covariates on either mean willingness to pay or the probability of non-participation. A simulation study showed that existing econometric models designed to account for non-participation were extremely sensitive to misspecification bias and accurate identification of the probability of non-participation was hampered by potential misspecification of the distribution of willingness to pay.

2.6 Constraints in livestock services

Balasubramaniam and Johnknight (1982) reported that long distance to veterinary hospital and limited hours of availability of artificial insemination in the hospital were the limiting factors for the adoption and the use of artificial insemination for breeding their bovines.

Kunzru *et al.* (1989) reported that the constraints perceived by the farmers on the adoption of artificial insemination of cattle and buffaloes as old semen of crossbred bulls used (61 per cent), possible low conception rate (71 per cent), distance of village from artificial insemination centre (42 per cent), ignorance about artificial insemination (39 per cent), lack of time for bringing animals to the artificial insemination centre (33 per cent), artificial insemination carried out late after the cow was on heat (28 per cent).

Shantanukumar and Rao (1999) observed that the reasons for the poor extent of utilization of veterinary services by the dairy farmers could be (i) that the department has to cover large number of villages (ii) that the stockman visits the villages either during

vaccination campaign or when invited by the cattle owners for deworming and treatment of animals and (iii) that the facilities provided by the state husbandry department were inadequate and irregular.

Turkson and Brownie (1999) surveyed on veterinarians in Ghana to elicit their responses on issues concerning privatisation and indicated that a significant proportion (61 per cent) of government veterinarians, who formed 94 per cent of the respondents, were unwilling to go into private practice, due to the reasons that private practice was too risky, that farmers were unwilling or unable to pay for services, that capital to start such practices was lacking and that the societal value for animals was low. Also, low livestock densities and the absence of commercial livestock farming were perceived as deterrents to the sustainability of private practice.

Chilonda and Huylenbroeck (2001) related the organization of veterinary services to both availability and quality of veterinary personnel and the ability to perform correct diagnosis and treatment. Lack of infrastructure such as roads to markets, sources of veterinary products and services and communication could limit the choice of animal health inputs of small-scale farmers. Furthermore, the absence of credit for livestock production might influence animal health management decisions, as those small-scale farmers with no credit funding might opt to use fewer animal health inputs or none at all.

2.7 Livestock services: the Indian case

India has a very large network of public veterinary services. The adequacy of availability of good quality health and breeding services, however, remained a major problem in India. Mortality in cattle and small ruminants continued to be high and artificial insemination programs designed to upgrade the bovine stock covered only about 10 million cattle and buffaloes, or about 10 percent of the total breedable population (World Bank, 1996).

During the period of fiscal recession in the early 90's, the State governments were finding it extremely difficult to sustain these services (GOI, 1996). As a result of decreasing employment opportunities in the public veterinary sector, more and more veterinarians were venturing into the field of private practice.

Singh *et al.* (1998), on reviewing the animal health services in India, stated that the number of livestock units per veterinary institution had declined from 9451 in 1984-85 to 7325 in 1992-93, whereas the number of veterinary hospitals, polyclinics and

dispensaries increased by 26 per cent and the number of veterinary aid centres increased by 23 per cent during the same period. Similarly, there had been a substantial increase in the manpower engaged in animal health services, as a result the number of livestock units per veterinarian declined from 23935 in 1971 to 9359 in 1993. Although majority of veterinarians were engaged in government sector, the number of private practitioners had increased manifold recently, that is, there was a large increase (200 per cent) in the number of private veterinarians between 1985 and 1993.

The major providers of livestock services in India were State animal husbandry departments, Co-operative unions, NGOs and private veterinarians. While the animal husbandry departments provided both clinical and AI services through veterinary dispensaries, AI and sub-centres, polyclinics and first aid centres, the co-operative unions utilised the network of primary milk co-operative societies at the village level to ensure that the farmers received the services either at the doorstep or at the cooperative society at the village (Ahuja, 1999).

Prabaharan (2000) concluded that in order to sustain this large infrastructure and manpower, the veterinary services sector in India consumed 60–80 per cent of the budget allocated to livestock support services and advocated that the mandate of the Government of India with regard to livestock services should be modified so that the current clinical veterinary and artificial breeding services were moved to private hands and government departments devote their energy to disease prevention and control. According to him, privatisation of veterinary services would also facilitate withdrawal of subsidies, which could then be utilised to develop the infrastructure for further promotion of the livestock sector in India.

Ahuja *et al.*(2000) studied on the pattern of use, demand and willingness to pay for veterinary services in Rajasthan, Kerala and Gujarat states in India and revealed that most livestock keepers were willing to pay for animal health and breeding services and that there was enough scope for private sector participation and for cost recovery. In this study, WTP for veterinary services was estimated using a CV technique using dichotomous choice method (Ahuja *et al.*, 2000).

Certain State governments in India had already started encouraging and promoting private practitioners, for example, Uttar Pradesh, Rajasthan, Gujarat and Kerala. These States had also introduced a cost recovery approach for providing animal health care and

breeding services by the public sector. The private veterinary practitioners, although largely concentrated in urban areas and mostly attending to pets, were increasingly reaching out to semi-urban and rural areas. The clients of the private veterinary practitioners were found to be highly satisfied with quality of services provided by them (Sen, 2001).

Disinvestment in several public sectors had begun in India and the veterinary services sector run by the government was one among those being scrutinized. A rough estimate of the annual losses on account of epidemic and endemic diseases, parasites and other pests was INR 70 billion (approximately USD 1.5 billion) and serious concerns were being raised over the efficacy and efficiency of the government-run veterinary services (Sen and Chander, 2003). Nevertheless, while acknowledging the virtues of privatisation, they, also, agreed that privatisation alone was no panacea and the public sector had important roles to play in provision of livestock services. They favoured for a blend of public and private services to achieve a healthy and productive livestock sector in the country.

CHAPTER III

METHODOLOGY OF THE STUDY

This chapter briefly sketches the rationale behind choice of the study area, the sampling framework, and the statistical and econometric techniques used for analysing the data collected.

3.1 Choice of the study area

The State of Tamil Nadu was chosen to be the universe of the study area. Following Selvakumar *et al.* (2002), the districts of Tamil Nadu state was classified under two categories, viz., 'livestock-developed' (LD) and 'livestock-underdeveloped' (LUD), based on initial baseline developed using the value of livestock output, total rural population and common property resources available for livestock husbandry. Randomly selected, Coimbatore and Villupuram districts represented LD category, while Thanjavur and Sivagangai districts represented LUD category in the study (Figure 3.1).

3.2 Sampling design

A multistage sampling procedure was adopted to select the respondents of the study. In the first stage, as stated above, four districts, two each from LD (Coimbatore and Villupuram districts) and LUD (Thanjavur and Sivagangai districts) areas were selected randomly. In the second stage, 16 blocks, four from each of the four selected districts, were chosen at random and in the third stage, two public veterinary centres from each chosen block were selected using simple random sampling technique (Figure 3.2). In the fourth stage, 10 farmers were randomly selected amongst those seeking services in each chosen public veterinary centre on the day of interview, thus constituting a total sample size of 320 for the study.

3.3 Period of study

The reference year for the study was 2003-04 and the data collection was undertaken during the period of March - October, 2005.

3.4 Method of enquiry and collection of data

From the livestock farmers so selected, relevant data were collected to achieve the objectives of the study. For this purpose, structured and pilot tested interview schedules were prepared. The interview schedule had six sections. In section one, the objectives and implications of them were outlined, with an introductory information about the study. In section two,

personnel, demographic and socio-economic details of the farmers including livestock wealth, milk price, quantity of milk sold, meat price, number of small ruminants sold annually, etc., were portrayed. Section three aimed at assessing the access to, uptake of and various costs of animal health care and breeding services incurred by farmers and their general perceptions on quality of livestock services. In section four, respondents were asked to characterise the *status quo* level of seven attributes of public livestock services and assess a transition from the *status quo* to the preferred state.

The seven attributes of public livestock services listed were, i) geographical proximity, ii) waiting time, iii) attitude of staff, iv) 'service provider-farmer' relationship, v) drug availability, vi) chance of recovery and vii) chance of conception. A general question about whether the farmer would be willing to pay any extra user fee to receive a better quality service was enquired, followed by presenting a payment card, having anchors of Rs.5, starting from Rs.5 to Rs.500, if their answer to the above question was positive.

Section five offered the farmers with a hypothetical question to assess their maximum WTP for total annual animal health care and bovine breeding services per conception. In order to perform this, a separate payment card depicting charges ranging from Rs.25 to Rs.1500, with an equal interval of Rs.25. Section six of the interview schedule presented a list of constraints in availing livestock services from different service providers, and the farmers were asked to rank them.

3.5 Methods of analyses

3.5.1 Descriptive analysis

Cost components of and uptake of animal health care and bovine breeding services by farmers from various types of service providers were tabulated and analysed using conventional average and percentage analyses.

3.5.2 Price variations in livestock services (Multiple regression analysis)

Separate linear regression models were fitted to analyse the factors predisposing variations in the average 'visit cost' of animal health services and the mean cost of an insemination.

$$Y_j = \alpha + \sum_{i=1}^{n} \beta_i X_i + \mu$$

Where, Y_j = average visit cost or average insemination cost (Rs.); j=1,2

n = 15 for average visit cost of health care and 13 average insemination cost;

α = constant;

X_i = explanatory variables;

β_i = coefficient of parameters; and

μ = error term

The explanatory variables (X_is) used in the regression models are presented in Tables 3.1 and 3.2.

Table 3.1
DESCRIPTION OF VARIABLES USED IN REGRESSION ANALYSIS OF AVERAGE VISIT COST

Explanatory variables	Levels	Specification	X_i
Type of service provider [a]	Veterinarian; Para-veterinarian; Traditional healer	1 – if veterinarian; 0 - otherwise	X_1
		1 – if para-veterinarian; 0 - otherwise	X_2
Place of service [b]	Home, Centre	1 – if at home; 0 - otherwise	X_3
Category of disease/ disorder [c]	Acute medical cases (AM); Acute surgical cases (AS); Chronic surgical cases (CS); Obstetrical cases (OBS); Gynecological cases (GYN); Chronic medical cases (CM)	1 – if AM; 0 - otherwise	X_4
		1 – if AS; 0 - otherwise	X_5
		1 – if CS; 0 - otherwise	X_6
		1 – if OBS; 0 - otherwise	X_7
		1 – if GYN; 0 - otherwise	X_8
Source of drug [d]	Private; service provider	1 – if private; 0 - otherwise	X_9
Follow-up [e]	Single visit; multiple visits	1 – if multiple visits; 0 – otherwise	X_{10}
Value of animal affected	Continuous	In Rs.'000	X_{11}
Annual household income	Continuous	In Rs.'000	X_{12}
Livelihood share of animal husbandry	Continuous	As proportion of income from livestock to total income	X_{13}
Distance from nearest public veterinary centre	Continuous	Travel time in minutes	X_{14}
District versatility [f]	LD; LUD	1 – if LD; 0 – otherwise	X_{15}

[a] reference category: Traditional healing; [b] reference category: Centre; [c] reference category: Chronic medical cases; [d] reference category: Service provider; [e] reference category: Single visit; [f] reference category: LUD

Table 3.2
DESCRIPTION OF VARIABLES USED IN REGRESSION ANALYSIS OF AVERAGE INSEMINATION COST

Explanatory variables	Levels	Specification	X_i
Source of semen [a]	Government supplied; privately purchased; natural service (NS)	1 – if private; 0 – otherwise	X_1
		1 – if NS; 0 – otherwise	X_2
Place of service [b]	Home; centre	1 – home; 0 – otherwise	X_3
Species [c]	Cow; buffalo	1 – if cow; 0 – otherwise	X_4
Repeated insemination [d]	Single; multiple (follow-up)	1 – if follow-up; 0 – otherwise	X_5
Milk price	Continuous	Rs. per litre	X_6
Quantity of milk sold	Continuous	Litres per day	X_7
Veterinary livestock units	Continuous	In units	X_8
Mean household education	0 – illiterate; 1– primary; 2 – secondary; 3 – collegiate	Mean of family adults' education	X_9
Annual household income	Continuous	In Rs.'000	X_{10}
Livelihood share of animal husbandry	Continuous	As proportion of income from livestock to total income	X_{11}
Distance from nearest public veterinary centre	Continuous	Travel time in minutes	X_{12}
District versatility [e]	LD; LUD	1 – if LD; 0 – otherwise	X_{13}

[a] reference category: Govt. supplied; [b] reference category: Centre; [c] reference category: Buffalo
[d] reference category: Single insemination; [e] reference category: Livestock underdeveloped

3.5.3 Demand for animal health care and bovine breeding services (Double hurdle-Poisson regression analysis)

The econometric models concerned with discrete counts of veterinary visits and inseminations were found to be appropriate to analyse the factors influencing demand for animal health care and bovine breeding services. The Poisson hurdle model is more appropriate than Ordinary Least Square (OLS) models as it takes into account the discrete nature of the dependent variable and also that there may be two underlying processes that lead to either zeros or positive outcomes (Heineck, 2004). The idea underlying the hurdle formulations is that a binomial probability model governs the binary outcome of whether a count variate has a zero or a positive realization. If the realization is positive, the "hurdle is crossed", and the conditional distribution of the positives is governed by a truncated-at zero count data model (Mullahy, 1986). This would also enable to assess whether the service of a specific provider was obtained either by chance or choice.

Therefore, starting with the binomial process on whether the dependent variable takes on the probability mass function is

$$\Pr(Y=y)=\begin{cases}\pi, & y=0\\ 1-\pi, & y=1,2,3,...\end{cases}$$

The probability mass function of the zero-truncated Poisson process is

$$\Pr(Y=y\,|\,Y\neq 0)=\begin{cases}\dfrac{\lambda^{y}}{(e^{\lambda}-1)y!} & y=1,2,3,....\\ 0 & otherwise\end{cases}$$

Therefore, the unconditional probability mass function for Y is

$$\Pr(Y=y)=\begin{cases}\pi, & y=0\\ (1-\pi)\dfrac{\lambda^{y}}{(e^{\lambda}-1)y!} & y=1,2,3,...\end{cases}$$

Assuming that the observations are independent and identically distributed, the log likelihood for the i[th] observation is

$$\ln L(\pi_i,\lambda_i,y_i)=\begin{cases}\ln\pi_i, & y=0\\ \ln\left\{(1-\pi_i)\dfrac{\lambda_i^{y_i}}{(e^{\lambda_i}-1)y_i!}\right\} & y=1,2,3,...\end{cases}$$

Using the complementary log-log link to model π_i and the log link model λ_i, so that $\pi_i=e^{-e^{x_i\beta_1}}$ and $\lambda_i=e^{x_i\beta_2}$, the log likelihood would be

$$\ln L=\ln\left\{\prod_{i\in\Omega_0}(e^{-e^{x_i\beta_1}})\prod_{i\in\Omega_1}(1-e^{-e^{x_i\beta_1}})\prod_{i\in\Omega_1}\frac{e^{y_i x_i\beta_2}}{(e^{e^{x_i\beta_2}}-1)y_i!}\right\}$$

$$=\ln\left\{\sum_{i\in\Omega_0}-e^{x_i\beta_1}+\sum_{i\in\Omega_1}\ln\,(1-e^{-e^{x_i\beta_1}})\right\}+\left\{\sum_{i\in\Omega_1}y_i x_i\beta_2-\sum_{i\in\Omega_1}\ln\,(e^{e^{x_i\beta_2}}-1)-\sum_{i\in\Omega_1}\ln\,(y_i!)\right\}$$

$$=\ln\{L_1(\beta_1)\}+\ln\,\{L_2(\beta_2)\}$$

where $\Omega_0=\{i\,|\,y_i=0\},\Omega_1=\{i\,|\,y_i\neq 0\}$ and $\Omega_0\cup\Omega_1=\{1,2,....,N\}$.

That is, the log likelihood is the sum of the log likelihood from the binomial probability model, $\ln L_1(\beta_1)$, and the log likelihood of the truncated-at-zero count model, $\ln L_2(\beta_2)$.

Therefore without losing information, the hurdle-model can be maximized by maximizing the two components separately. Here, the hurdle models for animal health care and bovine breeding services were estimated by employing a Probit model and a truncated-at-zero Poisson model. To ease interpretation (Long, 1997), marginal effects were calculated following the Probit and the truncated count data models. The variables used in the models are described in Tables 3.3 and 3.4.

Table 3.3

DESCRIPTION OF VARIABLES USED IN DEMAND ANALYSIS FOR ANIMAL HEALTH CARE SERVICES

Dependant variable: No. of visits to (or by) the service provider in the last one year

Explanatory variables	Description
Age of head of the family	Years in numbers
Mean household education	Mean of family adults' education (0 – illiterate; 1 – primary; 2 – secondary; 3 – collegiate)
Annual household income	In Rs. '000
Livelihood share of animal husbandry	As proportion of income from livestock to total income
Milk price	Rs. per litre
Quantity of milk sold	Litre per day
Visit cost	Rs. per visit (includes average cost of transport, service and drug)
Category of disease/ disorder [a]	1 – if AM; 0 - otherwise
	1 – if AS; 0 - otherwise
	1 – if CS; 0 - otherwise
	1 – if OBS; 0 - otherwise
	1 – if GYN; 0 - otherwise
Value of animal affected	In Rs. '000
Possession of crossbred/graded buffalo [b]	1 – if possessing; 0 - otherwise
Veterinary livestock unit	Units
Waiting time	Measured in minutes
Quality of services	Cumulative score of quality attributes
Distance from nearest public veterinary centre	Travel time in minutes
District versatility [c]	1 – if LD; 0 – otherwise

[a] reference category: Chronic medical cases; [b] reference category: Not possesing crossbred/graded buffalo ; [c] reference category: LUD

Table 3.4
DESCRIPTION OF VARIABLES USED IN DEMAND ANALYSIS FOR BOVINE BREEDING SERVICES

Dependant variable: No. of inseminations done in the last one year

Explanatory variables	Description
Mean household education	Mean of family adults' education (0 – illiterate; 1 – primary; 2 – secondary; 3 – collegiate)
Annual household income	In Rs. '000
Milk price	Rs. per litre
Quantity of milk sold	Litres per day
Average insemination cost	Rs. per insemination (includes average cost of transport, service and semen)
Species of animal [a]	1 – if cow; 0 - otherwise
Value of animal inseminated	In Rs. '000
Success of insemination [b]	1 – if conceived; 0 - otherwise
Crossbred cows	Numbers owned
Graded buffaloes	Numbers owned
Veterinary livestock unit	Units
Distance from nearest public veterinary centre	Travel time in minutes
District versatility [c]	1 – if LD; 0 - otherwise

[a] reference category: Cow; [b] reference category: Not conceived ; [c] reference category: LUD

3.5.4 Modelling of WTP values for annual animal health care and bovine breeding services (Interval Regression)

Contingent Valuation (CV) approach was used to study the farmers' true WTP for two types of annual health care and breeding services: (a) providing annual health care or bovine breeding services at government veterinary centres (in-centre), (b) extending annual health care or bovine breeding services at farmers' door steps (at farm gate). The farmers were posed with two scenerios for eliciting their WTP as narrated below:

Scene 1: There is an offer to provide annual health care for your animals (or make your animal conceived) *by providing services at the government veterinary centre*. This offer will include all expenses on medicines, service fee, etc. (or semen straw, medicine, pregnancy diagnosis, service fee, etc. in case of breeding services). What is the maximum amount of money you would be willing to pay for this offer?

Scene 2: There is an offer to provide annual health care for your animals (or make your animal conceived) *by providing services at your farm gate*. This offer will

include all expenses on medicines, service fee, etc. (or semen straw, medicine, pregnancy diagnosis, service fee, etc. in case of breeding services). What is the maximum amount of money you would be willing to pay for this offer?

A payment card depicting charges ranging from Rs.25 to Rs.1500, with an equal interval of Rs.25 were shown to them to encircle the amount that they were willing to pay for the offers described above.The payment card WTP data pertain to *total annual animal health care* and *contract bovine breeding services* were analysed as interval data on the assumption that the respondent's true maximum WTP is atleast as high as the amount chosen on the payment card, but less than the next highest amount listed on the card. As interpreted by Morey *et al.* (1997), this analysis presumed that a farmer would not choose any amount that exceeds his true maximum WTP, and therefore circles the highest amount mentioned on the card that is less than or equal to his maximum WTP.

The WTP values estimated in this study were for hypothetically providing total annual animal health care for bovines, caprines and ovines, and for making a cow/buffalo conceived by extending the breeding services either at the veterinary centre or at farmer's doorstep. The WTP was assumed to be a function of a respondent's attributes and a random component that caused the WTP value to vary across respondents, even if they possessed same attributes. Hence Cameron and Huppert (1989) suggested that there could be some bias and that its sign would be indeterminate in OLS, while the Maximum Likelihood Interval technique could be unambiguously more reliable if used on interval midpoints. Kolmogorov-Smirnov test also confirmed the normal distribution in random component assumed in the payment card estimation model study. Therefore, the interval model maximizes the likelihood of an individual's WTP that lies between the amount chosen on the payment card, WTP_M, and the next larger amount, WTP_L. The probability that WTP_i lies between WTP_{Mi} and WTP_{Li} is given by Morey *et al.* (1997) as below:

$$= \Phi\left(\frac{WTP_{L_i} - E(WTP_i)}{\sigma_i}\right) - \Phi\left(\frac{WTP_{M_i} - E(WTP_i)}{\sigma_i}\right)$$

$$Prob\left(WTP_{M_i} \le WTP_i \le WTP_{L_i}\right) = Prob\left(WTP_i < WTP_{L_i}\right) - Prob\left(WTP_i > WTP_{M_i}\right)$$

where Φ is the standard normal cumulative density function. Then the expectation of the individual's WTP, $E(WTP_i)$, is:

$$(WTP_i) = E(WTP_i) + \xi_i$$
$$= \alpha + \sum \beta_i X_i + e_i$$

The description of variables used in the interval regression model fitted to analyse the factors predisposing the stated WTP values for annual health care services to cows, buffaloes, bullocks, sheep and goat, and bovine breeding services are narrated in Table 3.5.

3.5.4.1 Estimation of interval model of WTP

STATA 9.0 SE was used to estimate the values of the parameters that maximized the log of the likelihood function:

$$LogL = \sum \log\left\{\Phi\left(\frac{WTP_{L_i} - E(WTP_i)}{\sigma_i}\right) - \Phi\left(\frac{WTP_{M_i} - E(WTP_i)}{\sigma_i}\right)\right\}$$

3.5.5 Modelling WTP values for stated quality improvements (Tobit regression analysis)

Tobit model was used to analyse the association between willingness to pay values for the stated quality improvements in the public livestock services and the respondents' demographic and socio-economic characteristics in the study area as described by Tobin, 1958. This model was preferred over the OLS estimator which fails to account for qualitative differences between the limit observations (those with zero WTP) and the non-limit observations (those with WTP > 0), leading to erroneous estimation of marginal effects (Donaldson *et al.,* 1998 and Mataria *et al.,* 2004).

Cameron and Huppert (1989) suggested using interval regression for analyzing payment card interval WTP data. However, Tobit model was used here following Whitehead *et al.* (1995) and Johnson *et al.* (1998), since the data contained a high ratio of zero values and relatively narrow intervals, because the payment card used in this study portrayed a thinner interval between anchors to find the WTP value for quality improvements.

Seven tobit regression analyses were carried out, each concerning a partial WTP value (dependent variable) and a list of explantory variables, including corresponding quality attribute's *status quo* level, and respondents' demographic and socioeconomic characteristics. Exaplanatory variables used in the models are listed in Table 3.6.

The Tobit model identifies the characteristics of respondents that could determine WTP for the quality improvements. Following Greene (2000) and Cho *et al.* (2005), the Tobit model can be generally expressed as below:

$$WTP_i = X_i\beta + u_i \quad X_i\beta + u_i > 0$$
$$WTP_i = 0 \quad X_i\beta + u_i \leq 0$$

where for the i^{th} household, X_i is the vector of explanatory variables, u_i is the random disturbance term, and β is the parameter vector common to all households. Assuming that the random error is independent and normally distributed across respondents, the expected WTP for an observation drawn at random is:

$$E(WTP) = \Phi(X\beta/\sigma)\, X\beta + \sigma\,\phi(X\beta/\sigma)$$

where Φ represents the normal distribution function, ϕ represents the normal density function, and σ represents the standard deviation. Furthermore, the expected value of WTP for observations above zero, called E(WTP*), is simply $X\beta$ plus the expected value of the truncated normal error terms (Cho *et al.*, 2005). Then, the expected WTP can be expressed as:

$$E(WTP) = \Phi(X\beta/\sigma)\, E(WTP^*)$$

Unlike linear models, the marginal effect or partial derivative for a given explanatory variable is nonlinear and thus is not equal to β_i. The decomposition of this marginal effect that is obtained by considering the effect of a change in the i^{th} variable of X on WTP (McDonald and Moffitt, 1980):

$$\partial E(WTP)/\partial X_i = \Phi(X\beta/\sigma)\ (\partial E(WTP^*)/\partial X_i) + E(WTP^*)\partial\Phi(X\beta/\sigma)/\partial X_i$$

The marginal effects of (i) variations in the positive WTP values, and (ii) variations in the probability of stating a positive WTP values for respondents who declared that they were not willing to pay were estimated.

3.5.6 Analysis of constraints (Garret's ranking technique)

Garret's ranking technique was adopted to analyse the problems faced by farmers in study area while availing animal health care and bovine breeding services from different types of service providers. The respondents were asked to rank the given factors that were limiting their service reception. The order of merit thus given by the respondents were converted into ranks by using the following formula:

$$\text{Per cent position} = \frac{100(R_{ij} - 00.5)}{N_j}$$

Where

R_{ij} –Rank given for i^{th} factor by j^{th} individual

N_j – Number of factors ranked by j^{th} individual

The per cent position of each rank thus obtained was converted into scores by referring to table given by Garret and Woodworth (1969). Then for each factor, the scores of individual respondents were added together and divided by the total number of respondents for whom scores were added. These mean scores for all the factors were arranged in descending order, ranks were given and the most limiting factors were identified.

Table 3.6
SPECIFICATION OF EXPLANATORY VARIABLES FOR THE TOBIT REGRESSION MODELS

Quality parameters stated to be improved	Levels of attributes	Scoring/measurement scale
Geographical proximity to public veterinary centre	Very far, far, average, close, very close	1 – very far; 0 - otherwise
		1 – far; 0 – otherwise
		1 – average distance; 0 – otherwise
Waiting time before meeting the service provider	Very long, long, average, not long, not long at all	1 – very long; 0 - otherwise
		1 – long; 0 - otherwise
		1 –average; 0 - otherwise
Attitude of the public veterinary centre's staff	Good, fair, bad, very bad	1 – very bad; 0 – otherwise
		1 – bad; 0 – otherwise
Receiving adequate information on the sickness and treatment of animals	Service provider (SP) spent sufficient time and explained: the health status/heat stage, how to use the medicaments, what to do to prevent/ not to complicate; information was clear and sufficient	The service provider-farmer relationship: Multi-item Likert scaling - average of five items' scores multiplied by 20, range [20,100]
Being able to find the prescribed treatment/AI	All, some of them, None	1 – none of them; 0 – otherwise
		1 – some of them; 0 – otherwise
Chance of recovery after visiting the centre	SP at centre is competent, recovered after treatment at centre, not recovered and sought for re-examination by others, others SPs are competent	Multi-item Likert scaling - average of five items' scores multiplied by 20, range [20,100]
Chance of conception after inseminating at the centre	Animal becomes pregnant after inseminating at this centre, calves born are superior at centre, not conceived and went to private, private insemination calves are superior, prefer natural service	Multi-item Likert scaling - average of seven items' scores multiplied by 20, range [20,140] converted into percentage (100% = 140 score)
Sex of respondent	Male; female	1 – male; 0 – otherwise
Age of respondent	Continuous	In years
Educational level of respondent	Illiterate; primary; secondary; collegiate	0 – illiterate; 1 – primary; 2 – secondary; 3 - collegiate
Annual household income	Continuous	In Rs. '000
Livelihood share of livestock	Continuous	Proportion of income from livestock to total income
Milk price	Continuous	Rs. per litre
Quantity of milk sold	Continuous	Litres per day
Possession of crossbred/graded buffaloes	Possessing; not-possessing	1 – if possessing; 0 - otherwise
Veterinary livestock unit	Continuous	Units
Purpose of visit to public veterinary centre	Treatment; AI	1 – if treatment; 0 – otherwise
No. of previous visits made during the last year	Continuous	Counts
Distance from the public veterinary centre	Continuous	Travel time in minutes

Note: Geographical proximity = "Close" and "Very close" are combined and included in the constant
Waiting time = "Not long" and "Not long at all" are included in the constant
Attitude = "Good" and "Fair" are combined and included in the constant
Drug availability = "All" is included in the constant.

Table 3.5
DESCRIPTION OF VARIABLES USED IN INTERVAL REGRESSIONS

Explanatory variables	Description	Interval Regression Models (X_i)				
		Health services				Bovine breeding services
		Cow	Buffalo	Bullock	Sheep/ Goat	
Sex of respondent [a]	1 – if male; 0 - otherwise	X_1	X_1	X_1	X_1	X_1
Age of respondent	Years in numbers	X_2	X_2	X_2	X_2	X_2
Mean household education	Mean of family adults' education*	X_3	X_3	X_3	X_3	X_3
Annual household income	In Rs. '000	X_4	X_4	X_4	X_4	X_4
Livelihood share of livestock	As proportion of income from livestock to total income	X_5	X_5	X_5	X_5	X_5
Possession of crossbred/ graded buffaloes [b]	1 – if possessing; 0 - otherwise	X_6	X_6	-	-	X_6
No. of cows and buffaloes	Numbers owned	X_7	X_7	-	-	X_7
No. of sheep/goat	Numbers owned	-	-	-	X_6	-
Veterinary livestock unit	Units	-	-	X_6	X_7	-
Milk price	Rs. per litre	X_8	X_8	-	-	X_8
Quantity of milk sold	Litre per day	X_9	X_9	-	-	X_9
Bullock rented [c]	1 – if rented; 0 - otherwise	-	-	X_7	-	-
Mutton/Chevon price	Rs. per Kg.	-	-	-	X_8	
Distance from nearest public veterinary centre	Travel time in minutes	X_{10}	X_{10}	X_8	X_9	X_{10}
District versatility [d]	1 – if LD; 0 – otherwise	X_{11}	X_{11}	X_9	X_{10}	X_{11}

[a] reference category: female; [b] reference category: Not possessing crossbred/graded buffalo ; [c] reference category: own use; [d] reference category: LUD; *Educational level: 0 – illiterate; 1 – primary; 2 – secondary; 3 – collegiate

CHAPTER IV

DESCRIPTION OF THE STUDY AREA

The performance of a livestock farming system is influenced by an array of agro-climatic factors like location, rainfall, soil type, land use pattern, etc. Hence, the livestock related production activities should be interpreted taking into account the intrinsic quality of its surrounding factors and infrastructure facilities like veterinary institutions. With this fact in view, a brief note on the characteristic features of the study area relevant to livestock system is presented in this chapter.

4.1 Location

Tamil Nadu state was considered for the study. In which the four districts viz., Coimbatore, Villupuram, Thanjavur and Sivagangai chosen for the study. The descriptions of their locations are discussed in this section. Coimbatore district lies in the Western agro-climatic zone of Tamil Nadu bordering the Western Ghats, situated between 10°10' and 11°30' of northern latitude and 76°40' and 77°30' of the eastern longitude. The district has a geographical area of 7469 Sq.Km., surrounded by the Nilgiris district in its western and south-western sides, Erode district on the north and Dindigul district on the east. It shares part of its boundary with the state of Kerala.

The other livestock developed district Villupuram is located between 11°38'25" north and 12°20'44" south: 78°15'00" west and 79°42'55" east with an area of 7217 Sq.Km. This district forms a part of north-eastern agro-climatic zone of Tamil Nadu. Thiruvannamalai and Kanchipuram districts surround this district on the east, while Cuddalore district on the east and south, Salem and Dharmapuri districts on the west and Thiruvannamalai and Kanchipuram districts on the north.

One of the sampled livestock underdeveloped districts, Thanjavur district is located in the Cauvery Delta agro-climatic zone of Tamil Nadu with an area of 3397 Sq.Km and is positioned between 9°50' and 11°25' of the northern latitude and 78°45'and 70°25' of the eastern longitude. The district is bounded on the north by the Coloroon river, which separates it from Perambalur and Tiruchirappalli districts and on the east, it is bounded by Thiruvarur and

Nagapattinam districts and on the south by the Palk Strait and Pudukottai district and on the west by Pudukkottai and Thiruchirappalli districts.

The yet another livestock underdeveloped district chosen for this study, Sivagangai district is placed between 9°43' and 10°2' of the northern latitude and 77°47' and 78°49' of the eastern longitude with an area of 4086 Sq.Km. It is bounded in the north and east by Pudukottai district and parts of Tiruchirapalli district, east and south by Ramanathapuram district, and in the south by parts of Virudhunagar and Madurai districts.

4.2 Topography

The landscape of Coimbatore district is packed with naturally diverse ecosystems such as hills, plains, forests, evergreen fields, drought prone areas, river bodies, tanks, etc. Whereas, a greater part of Villupuram district is covered by the metamorphic rocks belonging to genesis family. There are also three great groups of sedimentary rocks belonging to different geological periods. The Kalrayan hills in the north represents a continuous range of hills covered with some thorny forests and vegetation.

In Thanjavur district, deltaic region covers the whole northern and eastern portions of the district, where the Cauvery river with its wide network of branches irrigates more than half of the district. The non-deltaic or upland coats the rest of the southern and western areas, which is dry and devoid of hill, slopes gradually seawards. However, the nature of terrain in Sivagangai district is characterised by undulating topography with residual hills and the six rivers flowing through it, viz. Vaigai, Bambar, Kottagudi, Thennar, Uppargundar and Sarugani, irrigate this district.

4.3 Administrative revenue divisions

The Coimbatore district has been divided into three revenue divisions, nine taluks, 19 blocks and 482 revenue villages. Villupuram district consists of four revenue divisions, eight administrative taluks, 22 blocks and 1490 revenue villages.

The Thanjavur district has three revenue divisions, eight taluks, 14 developmental blocks and 904 revenue villages, while Sivagangai district is divided into two revenue divisions, six taluks, 12 blocks and 522 revenue villages.

4.4 Climate and rainfall

The season wise break up of average actual and normal rainfall in the year 2003-2004 for the study districts are furnished in Table 4.1.

Table 4.1 RAINFALL IN THE STUDY AREA (2003-04)

(in mm)

Districts	South West Monsoon (June 2003 to September 2003)		North East Monsoon (October 2003 to December 2003)		Winter Season (January 2004 and February 2004)		Summer Season (March 2004 to May 2004)		Annual Total (June 2003 to May 2004)	
	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal
Coimbatore	90.1	192.9	305.4	327.0	16.7	26.1	202.0	148.4	614.2	694.4
Villupuram	636.0	433.0	530.8	484.8	22.5	34.5	491.3	77.1	1680.6	1029.4
Thanjavur	364.3	342.0	463.4	545.7	4.0	50.7	311.6	114.6	1143.3	1053.0
Sivagangai	395.0	289.6	256.3	415.5	0.0	35.8	199.1	135.1	850.4	876.0
State Average	**336.5**	**331.5**	**403.1**	**464.6**	**11.6**	**37.4**	**283.4**	**128.4**	**1034.6**	**961.8**

Source: Department of Economics and Statistics, Chennai-600 006.

The Villupuram district received the highest rainfall (1680.6 mm) in the year 2003-04, followed by Thanjavur (1143.3 mm), Sivagangai (850.4 mm) and Coimbatore (614.2 mm). It could be observed that Villupuram district received 636.0 mm rain during south west monsoon, followed by 530.8 mm during north east monsoon, 491.3 mm during summer and 22.5 mm during winter. Thanjavur district benefited much by north east monsoon (463.4 mm) followed by south west monsoon (364.3 mm), whereas Sivagangai received more rain during south west monsoon (395.0 mm) followed by north east mansoon (256.3 mm). Notably, all the districts in the area had received more than normal rain fall during summer. The average annual rainfall was more than state average (1034.6 mm) in Villupuram and Thanjavur districts, while Sivagangai and Coimbatore received less rain fall comparatively. However, the distance of normal to actual (low) rainfall was more in Coimbatore district.

4.5 Soil classification

Table 4.2 portrays the soil types in the study area. In all the districts, red loam soil was found to be predominant, while black soil was found in Villupuram and Sivagangai districts alone. The sandy coastal alluvium was found in Villupuram and Thanjavur districts and red sandy soil was found only in Coimbatore district.

Table 4.2 SOIL CLASSIFICATION IN THE STUDY AREA

District	Soil types
Coimbatore	Red Loam, Red Sandy Soil
Villupuram	Red Loam, Black Soil and Sandy Coastal alluvium
Thanjavur	Red Loam, Sandy Coastal alluvium
Sivagangai	Red Loam, Black Soil

Source: Department of Economics and Statistics, Chennai-600 006.

4.6 Demography

The demography in the study areas relating to the year 2003-04 is depicted in Table 4.3. It is evident that the proportion of male and female populations within each district and between districts did not vary much.

Table 4.3 DEMOGRAPHY IN THE STUDY AREA (2003-04)

District	Population			Population		Literate	Cultivators	Agricultural Labourers
	Male	Female	Total	Rural	Urban			
Coimbatore	1580341 (50.89)	1524875 (49.11)	**3105216 (100.00)**	1677677 (54.03)	1427539 (45.97)	1929429 (62.14)	231522 (7.46)	341280 (10.99)
Villupuram	1485677 (50.21)	1467186 (49.59)	**2958863 (100.00)**	2551085 (86.22)	407778 (13.78)	1625765 (54.95)	415031 (14.03)	465219 (15.72)
Thanjavur	1029037 (49.49)	1050071 (50.51)	**2079108 (100.00)**	1492349 (71.78)	586699 (28.22)	1371159 (65.95)	124494 (5.99)	309201 (14.87)
Sivagangai	569487 (49.33)	587020 (50.84)	**1154507 (100.00)**	828423 (71.76)	326354 (28.27)	710206 (61.52)	157762 (13.65)	78196 (6.77)

Figures in parentheses indicate per cent to total population in respective district

Source: Department of Economics and Statistics, Chennai-600 006.

Villupuram district had the highest rural population of 86.22 per cent, followed by Thanjavur, Sivagangai and Coimbatore districts. However, Coimbatore district had the highest urban population of 45.97 per cent, followed by Sivagangai, Thanjavur and Villupuram districts. With regard to the proportion of literates to the total population, Thanjavur had higher literates (65.95 per cent), followed by Sivagangai (61.52), Coimbatore (62.14) and Villupuram (54.95)

districts. The highest population of cultivators was found in Villupuram district (14.03 per cent) as compared to 13.65 per cent in Sivagangai, 7.46 per cent in Coimbatore and 5.99 per cent in Thanjavur districts. Similarly, Villupuram district had a higher population of agricultural labourers (15.72 per cent), as against Thanjavur (14.81), Coimbatore (10.99) and Sivagangai (6.77) districts.

4.7 Land holding

The size wise representation of land holdings in the study area is presented in Table 4.4. Notably, all the four districts had high per cent (more than 75 per cent) of marginal farmers, except Coimbatore district, which had only 42.99 per cent of marginal farmers, for the reason that this district had a higher proportion of large farmers (29.46 per cent). It needs special emphasis that all the other three districts had a low proportion of small and large farmers indicating the fact that these districts were dominated by marginal farmers.

Table 4.4 LAND HOLDING IN THE STUDY AREA (2003-04)

(Numbers)

District	Marginal farmers	Small farmers	Large farmers	Total no. of farmers
Coimbatore	98713 (42.99)	63257 (27.55)	67655 (29.46)	229625 (100.00)
Villupuram	402738 (76.54)	79452 (15.10)	44021 (8.36)	526211 (100.00)
Thanjavur	205186 (77.67)	35944 (13.61)	23038 (8.72)	264168 (100.00)
Sivagangai	229339 (81.17)	35397 (12.53)	17806 (6.30)	282542 (100.00)

Marginal farmers: owning less than 2.5 acre.

Small farmers : owning 2.5 to 5.0 acre.

Large farmers : owning more than 5.0 acre.

Figures in parentheses indicate per cent to total no. of farmers

Source: Department of Economics and Statistics, Chennai-600 006.

4.8 Land use pattern

Table 4.5 illustrates the land use pattern in the study area during 2003-04. The net area sown in Coimbatore district accounted for 45.41 per cent of the total area as against 36 per cent of the state. Similarly, the forest cover in Coimbatore district (16.89 per cent) is more in relation to other districts in the study area. However, Villupuram district had the highest percentage of permanent pastures

and grazing land (0.59 per cent), barren and uncultivable land (8.10 per cent) and current fallows (15.54 per cent) among all the four districts. Among the study districts, Thanjavur district had more of net area sown and cultivable wasteland (46.42 and 4.59 per cent, respectively), which was also greater than the state average of 36.00 and 2.92 per cent, respectively. The other fallow lands and lands put to non-agricultural use were more in Sivagangai district, with 28.25 per cent and 27.86 per cent, respectively.

4.9 Irrigation

Source wise details of net area irrigated in the study districts are shown in Table.4.6. Evidently, ordinary wells are the major source of irrigation in Coimbatore and Villupuram districts, with 86.49 and 60.48 per cent, respectively, followed by tube wells (4.79 and 24.22 per cent, respectively). However, Thanjavur district benefited much from canals (60.46 per cent), followed by tube wells (37.82 per cent) and ordinary wells (1.59 per cent). On the contrary, Sivagangai district gained more through tanks (79.74 per cent), followed by ordinary wells (17.69 per cent) and tube wells (2.57 per cent).

Table 4.6 SOURCE-WISE NET AREA IRRIGATED IN THE STUDY AREA (2003-04)

(Hectares)

District	Source					Total net area irrigated
	Canals	Tanks	Tube wells	Ordinary wells	Other sources	
Coimbatore	11534 (7.54)	368 (0.24)	7326 (4.79)	132304 (86.49)	1431 (0.94)	152963 (100.00)
Villupuram	3276 (2.59)	15945 (12.62)	30605 (24.22)	76424 (60.48)	110 (0.09)	126360 (100.00)
Thanjavur	76761 (60.46)	168 (0.13)	48011 (37.82)	2023 (1.59)	0	126963 (100.00)
Sivagangai	0	58310 (79.74)	1876 (2.57)	12938 (17.69)	0	73124 (100.00)
STATE	449458 (20.93)	384960 (17.92)	304136 (14.16)	994491 (46.31)	14628 (0.68)	2147673 (100.00)

Figures in the parentheses represent the per cent to respective district total
Source: Department of Economics and Statistics, Chennai-600 006.

4.10 Livestock population

The details of livestock and poultry population in the study area are presented in Table 4.7. Villupuram district has the highest livestock population of

(6.46 per cent to that of the state), followed by Coimbatore (3.73 per cent), Thanjavur (3.65 per cent) and Sivagangai (3.06 per cent) districts.

The exotic and crossbred bovine population outnumbered (88.96 per cent) the indigenous cattle (11.04 per cent) in Coimbatore district. The situation is reverse in the district in the case of buffaloes, where the non-descript population is 52.26 per cent compared to Murrah and graded (47.74 per cent) buffaloes. The small ruminants, goat and sheep comprised 30.75 and 22.20 per cent, respectively, of the total district livestock population. Besides, Coimbatore is endowed with nearly half of the total state poultry population.

The total cattle population was at high in Villupuram district, where 9.02 per cent of state's cattle population is housed. Similarly, this district also possessed the largest number of indigenous, exotic and crossbred cattle population. In addition, the total (2.95 per cent) and non-descript buffalo (3.03 per cent) population was also high in Villupuram district, with respect to that of the state and among the four districts in the study area. These population features enabled the district to become the milk-shed area of the state. Besides flocking 5.76 per cent of the state's goat population, Villupuram district was on the same platform with Sivagangai district housing the highest percentage of sheep population (4.07 per cent) in the study area.

The livestock population of Thanjavur district comprised 37.22 per cent of goat, 4.61 per cent of sheep, 30.96 per cent of exotic and crossbred cattle, 22.68 per cent of indigenous cattle and 3.78 per cent of buffaloes. Notably in the Sivagangai district, nearly three-fourth (74.68 per cent) of the total cattle population was of indigenous type. A similar picture was seen concerning the buffalo population too, where the non-descript animals were 89.19 per cent to the total buffalo population in that district.

4.11 Veterinary institutions

The Animal Husbandry Department, Government of Tamil Nadu has taken up various development measures to promote animal health care by treating diseases, adopting disease prevention measures and creating awareness

among the people on the adoption of scientific practices in livestock rearing. In view of the above objectives, several veterinary institutions have been established all over the state. Various veterinary institutions located in the study area are presented in Table 4.8.

The facilities such as polyclinic, canine rabies control unit and mobile laboratory are present only in Coimbatore district among the four districts in the study area. There are two Clinician centers in Thanjavur, while Coimbatore and Villupuram districts have one each. Sivagangai district lacks either of these facilities. Of the total of 139 veterinary hospitals in the state, the numbers present in the study area are as follows: Coimbatore (15), Villupuram (7), Thanjavur (6) and Sivagangai (2). The number of veterinary dispensaries, mobile dispensaries and sub centers located in the four districts are: 47, 19 and 117 in Coimbatore; 49, 22 and 100 in Villupuram; 48, 14 and 70 in Thanjavur and 24, 11 and 90 in Sivagangai, respectively. For disease investigation purpose, one animal disease investigation unit is available in all the districts of the study area. There are two livestock farms in Thanjavur district and one each in Villupuram and Sivagangai districts. A frozen semen production station is located at Thanjavur district. Cattle breeding and Fodder Development units are present in all the three districts in the study area except Villupuram.

Table 4.8 VETERINARY INSTITUTIONS AND SUB CENTRES IN THE STUDY AREA (2003-04)

(Numbers)

Veterinary institutions	Districts				State
	Coimbatore	Villupuram	Thanjavur	Sivagangai	
Poly Clinics	1	-	-	-	6
Clinician Centres	1	1	2	-	22
Hospitals	15	7	6	2	139
Dispensaries	47	49	48	24	922
Mobile Dispensaries	19	22	14	11	382
Mobile Units	2	4	3	-	55
Livestock Sub Centres	117	100	70	90	2043
Canine Rabies Control Units	1	-	-	-	5
Animal Disease Intelligence Unit	1	1	1	1	15
Poultry Disease Diagnostic Laboratory	-	-	-	-	2
Mobile Laboratory	1	-	-	-	4
Rinderpest Squad	1	-	1	-	16
Rinderpest Vigilance Unit	1	-	-	-	8
Rinderpest Checkpost	1	-	-	-	8
Poultry Extension Centres	-	1	2	2	26
Frozen Semen Production Station	-	-	1	-	4
Cattle Breeding and Fodder Development	1	-	1	1	20
Livestock Farms	-	1	2	1	11

Source: Department of Veterinary Services, Chennai 600 006.

The animal health and breeding services are also offered by the network of District Co-operative Milk Producers' Unions established in Coimbatore and Villupuram districts, while no such institutions are operating in Thanjavur and Sivagangai districts.

Table 4.5 LAND USE PATTERN IN THE STUDY AREA (2003-04)

(Hectares)

District	Forest	Non-Agricultural use land	Barren and Uncultivable land	Permanent pastures and grazing land	Misc. trees, crops and groves	Cultivable waste	Current fallows	Other fallows	Net area sown	Total area
Coimbatore	112270 (16.89)	88989 (13.39)	9922 (1.49)	1065 (0.16)	2520 (0.38)	2874 (0.43)	49715 (7.48)	95506 (14.37)	301684 (45.41)	664645 (100.00)
Villupuram	72644 (10.31)	135339 (19.21)	57096 (8.10)	4178 (0.59)	6589 (0.94)	10497 (1.49)	109426 (15.54)	33570 (4.76)	275244 (39.06)	704483.01 (100.00)
Thanjavur	3426 (1.01)	78981 (23.32)	2201 (0.65)	1766 (0.52)	6494 (1.92)	15538 (4.59)	22086 (6.52)	50957 (15.05)	157215 (46.42)	338664 (100.00)
Sivagangai	21895 (5.22)	116937 (27.86)	5614 (1.34)	1381 (0.33)	7630 (1.82)	17742 (4.23)	20074 (4.78)	118536 (28.25)	109811 (26.17)	419620 (100.00)
State	2122041 (16.29)	2113353 (16.22)	509378 (3.91)	113474 (0.87)	282980 (2.17)	379439 (2.92)	953963 (7.32)	1862861 (14.30)	4689156 (36.00)	13026645 (100.00)

Figures in parentheses indicate per cent to total area

Source: Department of Economics and Statistics, Chennai-600 006.

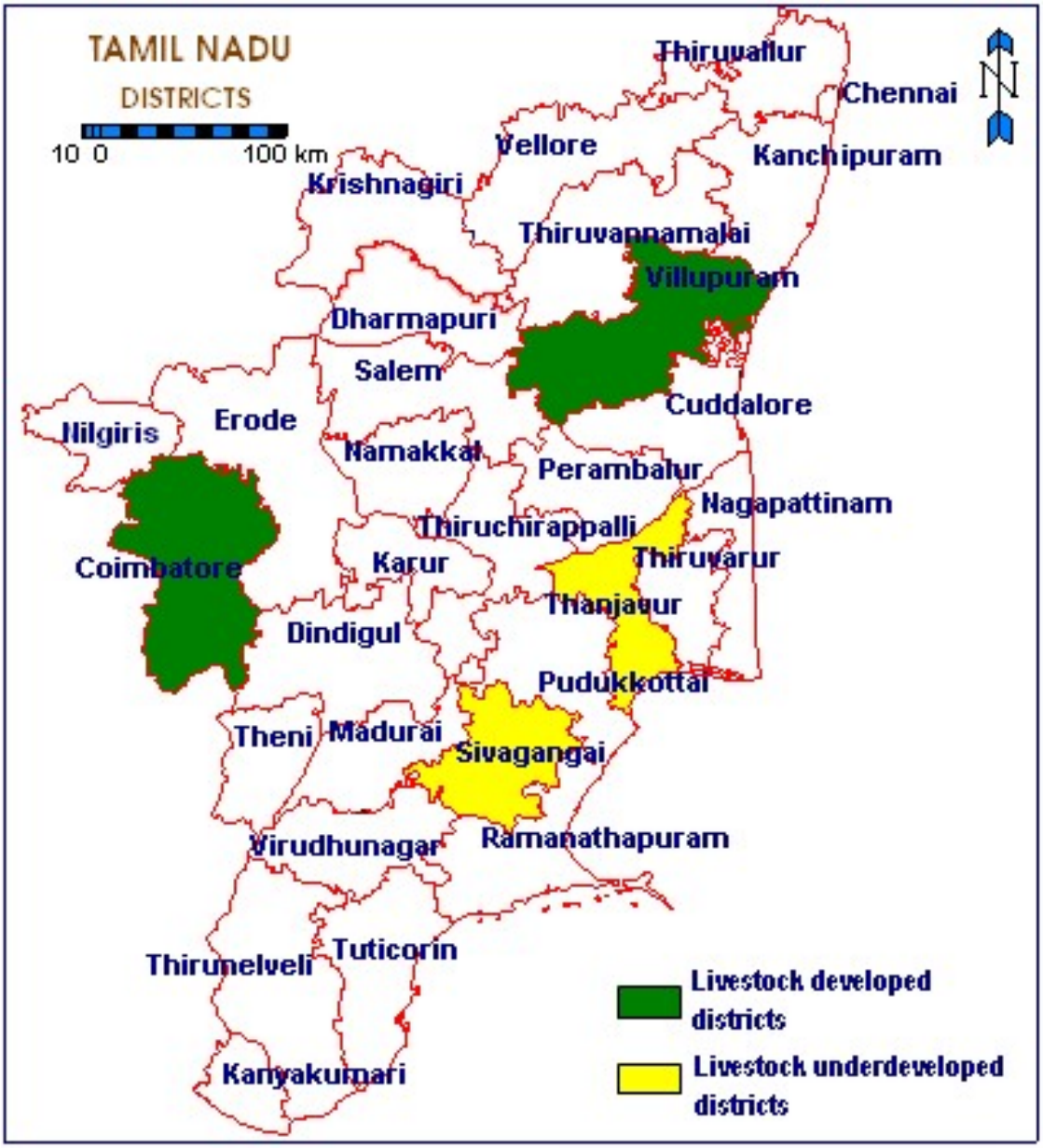
Table 4.7 LIVESTOCK AND POULTRY POPULATION IN THE STUDY AREA (2002)

Districts	Exotic and Crossbred	Indigenous and ND	Total cattle	Murrah and Graded	ND Buffaloes	Total Bufflaoes	Sheep	Goat	Other Livestock	Gross livestock population*	Poultry
Coimbatore	322532 (6.28)[a] (88.96)[b] (34.62)[c]	40038 (1.00)[a] (11.04)[b] (4.30)[c]	362570 (3.97)[a] (100.00)[b] (38.91)[c]	19531 (3.62)[a] (47.74)[b] (2.10)[c]	21381 (1.91)[a] (52.26)[b] (2.29)[c]	40912 (2.47)[a] (100.00)[b] (4.39)[c]	206835 (3.70)[a] (22.20)[c]	286499 (3.50)[a] (30.75)[c]	34948 (7.97)[a] (3.75)[c]	931764 (3.73)[a] (100.00)[c]	42028686 (48.54)[a]
Villupuram	336032 (6.54)[a] (40.77)[b] (20.80)[c]	488104 (12.20)[a] (59.23)[b] (30.21)[c]	824136 (9.02)[a] (100.00)[b] (51.01)[c]	15098 (2.80)[a] (30.81)[b] (0.93)[c]	33905 (3.03)[a] (69.19)[b] (2.10)[c]	49003 (2.95)[a] (100.00)[b] (3.03)[c]	227455 (4.07)[a] (14.08)[c]	471428 (5.76)[a] (29.18)[c]	43599 (9.94)[a] (2.70)[c]	1615621 (6.46)[a] (100.00)[c]	772090 (0.89)[a]
Thanjavur	282641 (5.50)[a] (57.72)[b] (30.96)[c]	207052 (5.17)[a] (42.28)[b] (22.68)[c]	489693 (5.36)[a] (100.00)[b] (53.64)[c]	13792 (2.56)[a] (40.00)[b] (1.51)[c]	20684 (1.85)[a] (60.00)[b] (2.27)[c]	34476 (2.08)[a] (100.00)[b] (3.78)[c]	42123 (0.75)[a] (4.61)[c]	339807 (4.16)[a] (37.22)[c]	6754 (1.54)[a] (0.74)[c]	912853 (3.65)[a] (100.00)[c]	634546 (0.73)[a]
Sivagangai	70580 (1.37)[a] (25.16)[b] (9.22)[c]	209992 (5.25)[a] (74.84)[b] (27.43)[c]	280572 (3.07)[a] (100.00)[b] (36.64)[c]	1641 (0.30)[a] (10.81)[b] (0.21)[c]	13542 (1.21)[a] (89.19)[b] (1.77)[c]	15183 (0.92)[a] (100.00)[b] (1.98)[c]	227672 (4.07)[a] (29.74)[c]	234746 (2.87)[a] (30.66)[c]	7478 (1.71)[a] (0.98)[c]	765651 (3.06)[a] (100.00)[c]	720831 (0.83)[a]
State	5139944 (100.00)[a] (56.23)[b] (20.55)[c]	4001099 (100.00)[a] (43.77)[b] (16.00)[c]	9141043 (100.00)[a] (100.00)[b] (36.55)[c]	538968 (100.00)[a] (32.50)[b] (2.16)[c]	1119447 (100.00)[a] (67.50)[b] (4.48)[c]	1658415 (100.00)[a] (100.00)[b] (6.63)[c]	5593485 (100.00)[a] (22.37)[c]	8177420 (100.00)[a] (32.70)[c]	438544 (100.00)[a] (1.75)[c]	25008907 (100.00)[a] (100.00)[c]	86591273 (100.00)[a]

a – Per cent to respective state population; b – Per cent to respective species population in the district
c – Per cent to gross livestock population of respective district; * Canine not included
Source: Department of Veterinary Services, Chennai 600 006.

Figure 3.1

MAP SHOWING THE STUDY AREA



CHAPTER V

RESULTS AND DISCUSSION

The results of the study to analyse the demand and willingness to pay values for animal health care and bovine breeding services in selected districts of Tamil Nadu are presented and discussed in this chapter under the following headings:

5.1 Characteristics of sample farmers and farms

5.2 Livestock services in the study area

5.3 Uptake of livestock services

5.4 Cost of livestock services

5.5 Time costs of livestock services

5.6 Determinants of demand for livestock services

5.7 Factors influencing the WTP values for livestock services

5.8 WTP values for quality improvements in public veterinary centres

5.9 Constraints in livestock services

5.1 Characteristics of sample farmers and farms

5.1.1 Average land ownership among sample farmers

Average land ownership among sample farmers across the districts chosen is presented in Table 5.1, along with the number of farmers falling under specific category. As could be seen from the table, landless farmers owning livestock did not have representation in the random sample selected. Overall, the sample had more numbers of marginal farmers (145), followed by small (91) and large (84) farmers. The average landholding among large farmers was worked out to be 8.01 acres, while the small farmers possessed 3.98 acres and marginal farmers had 1.31 acres.

Among district categories, LUD districts possessed a large number of marginal farmers (66), followed by small (56) and large (38) farmers. However,

LD districts were endowed with a huge number of marginal farmers (79), followed by large (46) and small (35) farmers.

The average land ownership among large farmers in LUD district was 8.02 acres, whereas the average ownerships among small and marginal farmers were 3.95 and 1.38 acres, respectively. Average land ownership among farmers of LD districts did not vary much from LUD districts, as the large farmers in LD districts found to possess 8.00 acres, small farmers with 4.04 acres and the marginal farmers with 1.25 acres.

Among farmer categories, large farmers were more in Villupuram district (27), followed by Sivagangai (23), Coimbatore (19) and Thanjavur (15) districts. Whereas, a large number of small farmers were found in Sivagangai district (36), followed by Villupuram (21), Thanjavur (20) and Coimbatore (14) districts. With regard to marginal farmers, they out numbered in Coimbatore (47), Thanjavur (45), Villupuram (32) and Sivagangai (21) districts.

5.1.2 Animal ownership in the study area

5.1.2.1 Average animal ownership among sample farmers

Average ownership of different types of animals across sample districts is presented in Table 5.2. Average numbers of cattle owned in the study area was 4.11, which composed of 0.27 indigenous cows, 1.32 cross bred cows, 0.99 bullocks and 1.53 young cattle. It is significant to notice that the crossbred wealth among cattle was crowded, because in addition to crossbred cows, most of young animals were crossbreds.

The results exhibited that the State in general and the study areas in particular, were moving towards more of crossbred population. However, in case of buffaloes, non-descript buffalo holding (0.32) bulged over graded (0.18) and young buffaloes (0.26). Of the average 2.38 small ruminants held in the study area, 0.93 was due to sheep and the remaining (1.45) to goats, which indicate that goat population out numbered among study sample.

5.1.2.1.1 Animal ownership in LUD districts

Farmers of LUD districts possessed a high number of young cattle (1.52), followed by bullocks (1.04), crossbred (0.98) and indigenous cows (0.36) across cattle category. Among buffaloes, ownership of non-descript buffaloes were more (0.34), followed by young (0.26) and graded (0.11) buffaloes. Of the average number of 1.76 small ruminants possessed, 1.33 was of goat and 0.44 of sheep.

5.1.2.1.2 Animal ownership in LD districts

As displayed in Table 5.2, farmers in LD districts were found to own an average of 4.32 cattle, 0.81 buffalo and 3.01 small ruminants, thus accounting to 4.52 VLU. Unlike LUD, in LD districts, the crossbred cows owned were more (1.66), followed by young cattle (1.54), bullocks (0.94) and indigenous cows (0.18). The ownership structure gives an idea for the reason as to why these districts are livestock developed and how they became milk shed area of the State. Even among buffaloes, the ownership quantity difference between non-descript (0.30) and graded (0.24) buffaloes were less compared to LUD districts, where more of non-descript buffaloes were found. Similarly, the average number of sheep and goats owned were nearer to each other, being at 1.44 and 1.57, respectively.

5.1.2.2 Average livestock wealth among landholding categorise

The average livestock holding of different categories of farmers was estimated and the results are presented in Table 5.3. The overall averages for all the districts were calculated and the picture revealed that in case of cattle, the maximum average was among the large farmers category for all kinds of cattle. When compared with other livestock species, the overall total average for cattle was estimated to be 1.03 and was highest in large farmers category (1.24). In case of buffalo, the overall total average was 0.25 and was highest in small farmers category (0.31). However in sheep, the overall total average was 0.94 and average was highest among large farmers (1.66), while in goats the overall total average was 1.45 and was highest in marginal farmers category (1.88). The overall average ownership of small ruminants across sample farmers was worked out to be 1.19.

5.1.2.2.1 Animal ownership among land holding categories of LUD districts

In LUD districts, the number of indigenous cows owned by the farmers was small and was found to be 0.25 per marginal farmer, 0.29 per small farmer and 0.50 per large farmer with the average being 0.36. But owning of crossbred cows showed a different picture where almost all the marginal farmers owned one crossbred cow (0.91) and large farmers more than one (1.14), which indicated the importance of crossbred cows as the income earning occupation. Similarly, large farmers owned more of bullocks (1.41) and young cattle (1.82) among farmers category. The total cattle ownership picture revealed that the large farmers owned more of cattle (1.22), followed by small farmers (0.96) and marginal farmers (0.69). The ownership of buffalo illustrated different pattern with different kinds of buffaloes viz., non-descript, graded, young buffalo being more in small farmer category with the average of 0.58, 0.18 and 0.29, respectively. The number of buffaloes was highest in small farmers' category (0.35) and followed by marginal farmers and large farmers (0.20), with an overall average of 0.23. However, among small ruminants, larger farmers had more of sheep (0.64) and marginal farmers possessed more of goat (1.73). The overall livestock ownership pattern revealed that the large farmers possessed more of cattle, while small farmers possessed more of buffaloes and marginal farmers owned a large number of small ruminants. The livestock population distribution among sample farmers indicated the importance of different species of livestock to various categories of farmers.

5.1.2.2.2 Animal ownership among land holding categories of LD districts

In case of LD districts, the average wealth of indigenous cows was higher among small farmers (0.22), while the large farmers possessed more of crossbred cows with an average of 1.97. The total cattle average in the LD districts was 1.08 and was found to be higher among large farmers (1.26) and lower among marginal farmers (0.66). In case of buffaloes, the total average was higher among marginal farmers (0.41) and lower with large farmers (0.20). The reason could be due to the difficulties associated with rearing of buffaloes, the large farmers might have opted for other livestock species. In case of small ruminants, while

the average number of sheep was higher among large farmers (2.50), the average number of goats was found more with marginal farmers (2.11). The overall average number of small ruminants reared by sample farmers was 1.50.

On comparison with LUD districts, in case of LD districts, the overall average ownership was lower in case of indigenous cows and higher for crossbred cows, which could be because of improved infrastructural and marketing facilities. Similar picture was also noticed in case of buffaloes, where the overall average ownership for non-descript buffaloes was lower in LD districts. However, the grand average of graded buffaloes in LD districts (0.24) was more than that of LUD districts (0.11). Correspondingly, the average of small ruminants in LD districts (1.50) was almost double than that of LUD districts (0.88).

5.1.3 *Status quo* level of economic factors in the study area

Status quo level of a few economic factors, pertaining with study area, used for further calculation and analysis are presented in Table 5.4. The overall milk price in the study area was Rs.8.09 per litre and no significant difference was found between LUD and LD districts. However, the daily average of milk sold was significantly higher in LD districts (12.43 litres) than that of LUD districts (8.32 litres) with the overall average being at 10.39 litres per day in the study area.

Average annual household income in the study area was Rs.65080, where no significant difference could be recorded between farmers of LUD and LD districts. Despite this, livelihood share of livestock, which was calculated as the proportion of income from livestock to the total income, was significantly differing among district categories. The share was 0.39 in LD districts as against 0.33 in LUD districts with the overall share in the study area being at 0.36. The results stand testimony for the categorisation of districts (LUD and LD) done in this study.

5.2 Livestock services in the study area

5.2.1 Access to livestock services

A number of socio-economic and cultural factors influence the ability of farmers to benefit from the services and these could result in differential access to services within the same geographical area (Ahuja *et al.,* 2000).

Access to animal health and bovine breeding services was examined by directly asking the respondents whether they would be able to obtain these services as and when they needed them. The results portrayed in Table 5.5 indicated that 98.99 per cent of the farmers in LUD districts and 99.49 per cent in LD districts informed that they would be able to obtain public veterinary centres services as and when needed. Of the farmers in different districts, the farmers in Coimbatore districts had the highest (100.00 per cent) access, followed by Sivagangai (99.23 per cent), Villupuram (98.98 per cent) and Thanjavur (98.75 per cent) districts.

With regard to the access to veterinarians rendering home services, the farmers in LD districts had better access (55.35 per cent) than those in LUD districts (35.62 per cent). Similarly, access to home services offered by para-veterinarian was also significantly higher in LD districts (57.98 per cent) vis-à-vis LUD districts (41.13 per cent). On the contrary, access to private veterinary clinic was comparatively higher in LUD districts (41.89 per cent) than in LD districts (19.06 per cent). Even among LD districts, farmers in Coimbatore district had a very minimal access (3.75 per cent) to private veterinary clinics. The higher access to private veterinary clinic in LUD districts could be attributed to the preference attitude of farmers towards private bovine breeding services. Similarly, the farmers in Thanjavur district alone were found to have access to private services for breeding their bovines. However, access to natural breeding was more in LD districts (76.88 per cent), especially in Villupuram district (81.25 per cent), than in LUD districts (69.50 per cent).

5.2.2 General perceptions of sample farmers on the livestock services

General perceptions of the sample farmers on the quality of livestock services they received from different types of service providers are presented in Table 5.6. The picture reveals that the farmers had troubles in availing services

from pharmacy shop, private veterinary clinics, and home services by the veterinarians and even by para-veterinarians in the study area. The farmers informed that they had waited for a long time to receive the services both from public veterinary centres (0.93) and private veterinary clinics (0.83), while it was not so in case of ethnic/traditional healers and pharmacy shop. Further, the farmers were able to receive services during emergency from veterinarians extending home services (0.98), from ethnic/traditional healers (1.00) and from para-veterinarians (1.00), while it was difficult to get the service from co-operative and public veterinary centres. The farmers considered the service providers of public veterinary centres, private veterinary clinics, co-operative veterinary centres and veterinarians extending home services were adequately trained and they treated the farmers kindly, taking adequate care of livestock which was not so in case of traditional practitioners. The infrastructural facilities available with public veterinary centres, private veterinary clinics and co-operative veterinary centres were considered to be moderate. The farmers expressed that working hours at public veterinary centres and co-operative veterinary centres were inconvenient with their score being only 0.30 and 0.25, respectively. However, working hours of private veterinary clinics, and veterinarians and para-veterinarians serving at door step were considered to be convenient. Inconvenience in the working hours of public veterinary centres could be probably not due to official hours stipulated, but due to low promptness of service provider there. The farmers considered services of pharmacy shop and home services by veterinarian and para-veterinarian as expensive, while the services of public veterinary centres and co-operative veterinary centres were affordable. The overall satisfaction level with the service provider was highest for home services by veterinarian, followed by public veterinary centres and was lowest for pharmacy dispensed 'over the counter' medication. The average perception for the quality of livestock service revealed that the farmers considered the home services rendered by veterinarians as the best one (0.83) followed by private veterinary clinic (0.75), home services by para-veterinarian (0.74), public veterinary centre (0.64) and co-operative veterinary centre (0.48).

The overall picture revealed that the quality of livestock services offered by ethnic practitioners was not effective.

5.3 Uptake of livestock services

5.3.1 Uptake of animal health care services

5.3.1.1 Uptake of animal health care services in LUD districts

The uptake of animal health care services from different service providers by the farmers in LUD is presented in Table 5.7. Of the 339 cases enumerated in LUD districts, 180 cases (53.10 per cent) were attended to at public veterinary centres, while 104 cases (30.68 per cent) were presented to home services by veterinarians and 28 cases (8.26 per cent) were attended to by para-veterinarians at the farm gate. The cases presented to traditional healers and private veterinary clinics were only meagre, with 15 (4.42 per cent) and three (0.88 per cent) cases, respectively. Farmers themselves have treated their animals in nine occasions (2.65 per cent) by purchasing drugs directly from pharmacy without the advice of any qualified service provider.

Chronic medical cases, counting to 60, dominated the show of all types of cases brought to public veterinary centres for treatment, followed by acute medical (46), gynaecological (28), acute surgical (26) and chronic surgical (20) cases. Notably, none of the obstetrical cases were brought to public veterinary centres for treatment in LUD districts. Of the 104 cases attended to by veterinarians through home visits, 50 were acute medical cases and the remaining were obstetrical (34), acute surgical (10), chronic surgical (7), chronic medical (2) and gynaecological (1) cases. It is interesting to note that all of the obstetrical cases of large ruminants were attended to by home visits of either veterinarian or para-veterinarian. Although para-veterinarians were attending to cases by home visits, the number of cases presented to them was only less (8.26 per cent of total cases). Of the 28 cases attended to by para-veterinarians, 16 were obstetrical cases, 7 acute medical cases and 5 acute surgical cases. This shows that the farmers preferred to call para-veterinarians only during emergency, so as to render first aid services. The number of cases brought to private veterinary clinics

operating in the area was only three and that too for gynaecological treatment. The assistance of traditional healers was sought by the farmers to aid in obstetrical cases and to treat chronic medical cases. Although the number of pharmacy dispensed medication was found high (9), it was only for treating chronic ailments.

The average number of visits taken to treat a chronic surgical case in public veterinary centre was more, being at 2.85, followed for gynaecological cases (2.71), acute medical cases (2.50), acute surgical cases (2.50) and chronic medical cases (1.23). However, veterinarians have made two home visits on an average to treat both chronic surgical and medical cases, while taking only 1.90 visits to treat an acute medical case. The obstetrical cases warranted an average of 1.26 visits for the home visiting veterinarians and acute surgical cases required visit of veterinarians for 2.50 times. However, para-veterinarians took 2.60 visits, on an average, to treat a surgical case, while 1.75 visits to cure an obstetrical case which indicates their poor technical competence vis-à-vis veterinarians attending to either at public veterinary centres or at home. Although traditional healing appeared to take minimal number of visits to treat a case, the intensity of illness that could be treated by the ethnic healer still remains a question, besides they were not preferred for all types of cases, except for chronic medical and obstetrical cases.

5.3.1.2 Uptake of animal health care services in LD districts

The uptake and the use pattern of animal health services by the farmers in LD districts are presented in Table 5.8. Similar to LUD districts, in LD districts also, the public veterinary centres were the major service provider followed by home services by veterinarians, home services by para-veterinarians, traditional healers, pharmacy and private veterinary clinics. Of the 402 cases recorded in these districts, 202 cases (50.25 per cent) were treated at public veterinary centres, while 132 cases (32.84 per cent) were attended to by veterinarians and 45 cases (11.19 per cent) by para-veterinarians through home services. Number of cases attended by ethnic/traditional healers was only 17 (4.23 per cent), while the

pharmacy dispensed medication was for five cases (1.24 per cent). The results indicated that the role of private veterinary clinics was very meagre in both large and small ruminant health care, although they played a vital role in pet care. It could be understood from the table that all types/categories of cases were taken for treatment in public veterinary centres and veterinarians rendering home services. The use pattern of animal services implied that the veterinarians were preferred over para-veterinarians for treating ailments of farm animals.

Of the 202 cases attended to at public veterinary centres, acute medical cases were more (77), followed by gynaecological cases (62), chronic medical cases (45), acute surgical cases (10), chronic surgical cases (6) and obstetrical cases (2). Although chronic medical and gynaecological cases did not require an emergency visit, they needed follow-up for days together and hence, they outnumbered in public veterinary centres. Overall, the number of cattle taken to medication at public veterinary centres was more compared to buffaloes and small ruminants.

Acute medical cases constituted 79 out of total 132 cases attended to by veterinarians through home visits. The obstetrical cases which warranted an in-house attention were generally attended to by veterinarians. It appeared that the farmers in the LD districts did not prefer their chronic types of cases to get attended to by private service providers, as it levied them more in terms of service fee and drug charges.

The services of para-veterinarians were mostly sought to attend acute medical and obstetrical cases, as they warrant an immediate medical attention. Similar to LUD districts, in LD also, the services of traditional healers were looked for treating chronic medical and obstetrical cases alone, that too, in a restricted number, 15 and 2, respectively. The average number of visits taken to treat a case at public veterinary centres was 2.09, while the home serving veterinarians took 1.69 and para-veterinarians taking 1.29 visits. The lesser the number of visits by para-veterinarians does not necessarily mean the efficiency,

as the average number of visits required depends mainly on the severity of disease condition.

5.3.1.3 Overall uptake of animal health care services in the study area

Overall use pattern of animal health services by the farmers in the study area is presented in Table 5.9. Of the 741 cases enumerated during the study, 382 cases (51.55 per cent) were attended to at public veterinary centres, while 236 cases (31.85 per cent) by veterinarians and 73 cases (9.85 per cent) by para-veterinarians through home services. Among the remaining cases, 32 (4.32 per cent) were attended to by traditional healers, 14 (1.89 per cent) cases through 'over the counter' dispensed medication and four (0.54 per cent) by private veterinary clinics. The results implied that the public veterinary centres were the major service providers for all types of cases followed by veterinarians attending to at the farm gate, which means that the key factor, qualified and competent veterinarian, has played a key role in deciding the service provider to ensure better health of livestock wealth. However, the free service offered at public veterinary centres could never be ignored while inferring on the preference attitude of farmers on choosing the service provider.

As could be seen from the table, the treatments were skewed towards cattle among all categories of service providers. Of the 382 cases reported to the public veterinary centres in the study area, the number of acute medical cases were more (123) followed by chronic medical (105), gynaecological (90), acute surgical (36), chronic surgical (26) and obstetrical (2) cases. The less number of obstetrical cases taken to these centres was due to the nature of the disease or disorder condition so as to ensure restricted movement of animals. Considering the cases attended to by veterinarians through home services, acute medical cases followed by obstetrical cases predominantly attracted the role of veterinarians, although a limited number of other categories of cases were also attended to. Para-veterinarians seemed to have been called for treating obstetrical cases, especially for dystocia and retained placenta mostly, followed by acute medical cases and acute surgical cases to a certain extent.

Although overall picture (Figure 5.1) indicated that the public veterinary centres were the single major animal health care providers in the study area, their role appeared to have been lesser than expected vis-à-vis the huge investment made by the government in terms of infrastructure and man power. The findings of this study were similar to the observations of De Haan and Nissen (1985), where they noted that veterinarians were the main livestock service providers, and the para-professionals complemented veterinarians in developing countries. Further, as Ramadas and Ghotge (2002) stated, the role of traditional healers in animal health care services was found to be low.

5.3.2 Uptake of bovine breeding services by the sample farmers

The use pattern of bovine breeding services by the farmers in the study area is displayed in Table 5.10.

5.3.2.1 Uptake of bovine breeding services in LUD districts

Of 385 inseminations/breeding services recorded in LUD districts, 176 were carried out at public veterinary centres, 116 by veterinarian through home services, 44 each through private veterinary clinics and natural breeding and only 5 by para-veterinarians attending to at farms. In all, 333 cattle and 52 buffaloes were found to have got bred.

The use pattern of bovine breeding facilities in LUD districts display an interesting feature that only less than half number of AIs were performed at public veterinary centres, while privately procured germplasm for insemination was getting popularised, because the private veterinary clinics and home serving veterinarians were using frozen semen procured from outside sources such as Central Frozen Semen Production and Training Institute, Bangalore. However, natural breeding is also still in vogue, and as ascertained from farmers, they preferred natural breeding for the repeat breeding cows and buffaloes. Concerning the services/number of inseminations per conception, public veterinary centres required an average of 2.59 inseminations, while home serving veterinarians was taking only 1.71 services, private veterinary clinics required

1.91 inseminations and 2.20 times of natural breeding per conception. Although para-veterinarians appeared to take lesser number of inseminations per conception, no conclusion could be drawn as their number in the sample is less.

5.3.2.2 Uptake of bovine breeding services in LD districts

Unlike LUD districts, in LD districts most of inseminations were carried out at public veterinary centres. Of 446 inseminations studied, 329 were carried out in public veterinary centres, while 87 through natural breeding and a meagre eight and 12 through private veterinary clinics and home service of veterinarians, respectively. It becomes imperative to note that the farmers in LD districts preferred AI at public centre. It could be attributed to the disinclination of veterinarians in the area to carry the AI containers for inseminating at farmers doorstep.

The number of inseminations or breeding services required per conception in LD districts indicated that the public veterinary centres outperformed other service providers in the area. In public veterinary centres, the number of services needed per conception was only 1.99 as against 2.00 for home serving veterinarians, 2.25 for private veterinary clinics and 2.64 for natural breeding. The better conception rate in public veterinary centres might be due to the presence of well informed farmers who brought their animals at the right time for insemination.

5.3.2.3 Overall uptake of bovine breeding services in the study area

Overall, 831 inseminations/bovine breeding services were carried out in the study area. Of this, 505 were from public veterinary centres, 131 by natural breeding, 128 by the veterinarians through home service, 62 through private veterinary clinics and a meagre five by para-veterinarians through home service. It could be inferred from the results that the public veterinary centres were the major bovine breeding service provider in the study area (Figure 5.2). However, natural breeding still remained to be an important mode of breeding. This, in turn, reflects the ignorance of farmers and or lack of effective extension services

in those areas. The common reason attributed by the farmers for choosing natural breeding was repeat breeding if AI is resorted to.

On an average, 2.11 inseminations were required per conception. More specifically, cows required 2.15 services, while buffalo required 1.88 inseminations. The results in case of buffaloes could not be generalized, as the total number of AI observed in buffaloes was only limited. It was found that home services produced better results on conception of animals compared to in-centre services. The possible reason could be that the animals which were inseminated at home were not stressed out, as against the animals brought to the centre which were exposed to physical stress due to transport.

5.4 Cost of livestock services

5.4.1 Cost of animal health care services

5.4.1.1 Average cost of animal health care services

5.4.1.1.1 Average cost of animal health care services in LUD districts

The average cost of treating different types of cases by various service providers in LUD districts is presented in Table 5.11. The average cost includes average cost on service, labour and drugs. Although the drugs are free for the cases brought to public veterinary centres, the farmers were expected to incur cost in the form of imputed labour charges for bringing the animals to the centre, besides a few drugs prescribed to be purchased outside.

The average total cost of treating a chronic surgical case in cattle attended to at public veterinary centres was as high as Rs.48.09, followed by treating an acute medical case (Rs.37.97), gynaecological case (Rs.35.76), acute surgical case (Rs.27.71) and chronic medical case (Rs.22.84). The high cost in the treatment of chronic surgical cases, acute medical cases and gynaecological cases could be attributed to the prescriptions made to procure outside, besides the labour cost incurred to take the sick animals to the centre. However, these costs were low in case of buffaloes which could be due to the high resistance of buffaloes to

diseases/disorders and speedy recovery from ailments, that warranted only a few number of visits.

The acute medical cases of cattle treated by home visiting veterinarians levied the farmers for Rs.239.10, followed by acute surgical cases (Rs.232.23), chronic medical cases (Rs.212.50), obstetrical cases (Rs.175.51) and chronic surgical cases (Rs.143.34). The major proportion of treatment cost was service fee and the remaining to cost of drugs purchased. This would possibly be the reason why most of the chronic cases which required follow-up treatments for days together were taken to public veterinary centres for treatment. However, the cases that were acute in nature warranted immediate and meticulous medical attention and were preferred to have been treated by emergency home visits. As the service fee charged by home visiting para-veterinarians was found to be less compared to the veterinarians attending to cases at home, the average cost of treatment on engaging para-veterinarians was low. The treatment of an acute surgical case by a para-veterinarian amounted to Rs.174.00 as against Rs.232.33 by a veterinarian. Similarly, acute medical cases treated by a para-veterinarian costed Rs.115.00 compared to Rs.239.10 by a veterinarian. The low cost always did not mean the best service, as the quality of outcome varied between service providers (as evident from Table 5.6). Besides, even among cases, the disease conditions that were treated by veterinarians appeared to have been complicated or life threatening.

The average total cost of treatment of a chronic medical case through traditional healing was low because, the treatment ingredients were mostly home made or freely available. However, the average cost incurred (Rs.23.34) was almost equivalent to the cost incurred at public veterinary centres where a rationale therapy was administered. The costs of pharmacy dispensed medication (Rs.19.00 in cattle; Rs.12.50 in small ruminants) comprised only the cost of drugs and were mostly dewormers and rumentonics as ascertained from farmers.

5.4.1.1.2 Average cost of animal health services in LD districts

As could be seen from Table 5.12, the average cost of treating a chronic medical case in cattle at public veterinary centres was Rs.17.79 and for a small ruminant, it was Rs.8.08. Although public veterinary centres did not charge any service fee, costs were incurred in the form of labour cost for driving animals to the centre, and a few prescriptions made for outside purchase amounted to the average total cost mentioned in the table. Acute surgical cases brought to public veterinary centres required Rs.80 per case, possibly because of the prescriptions made for private purchase of surgical items and medicines. However, in case of gynaecological cases which required follow-up treatments for days together, labour cost was the only cost due to labour on the part of farmer.

Acute medical cases treated by private veterinarians through home visit costed the farmers an average amount of Rs.294.17. The major share here was the service fee (Rs.170.31) incurred with the remaining going to drugs. It is worth to note that the private veterinarians in LD districts were found to have been charging more compared to private veterinarians in LUD districts. Similarly, in case of acute surgical cases, the average service fee was Rs.166.67 and costs on drugs were Rs.125.00 which together amounted to Rs.291.67. The obstetrical cases in cattle which mainly required technical labourer rather than costly medicaments levied the farmers Rs.212.42, had it been attended to by veterinarians through home service. However, if the same was attended to by a para-veterinarian, it costed Rs.132.69 alone. The difference was mainly due to the service fee charged by the service providers concerned.

5.4.1.1.3 Average cost of animal health services in the study area

Cost of treating an ailing animal in the study area is presented in Table 5.13. The results of the study indicated that the cost of treatment in cattle was more compared to other species of animals with the similar disease condition. The mean cost of treatment of a chronic disease in cattle brought to public veterinary centres was Rs.20.83, in which the labour cost alone accounted to Rs.17.35, with the remaining amount for the drugs purchased outside. However, the mean costs of

treating a chronic medical condition in buffalo and small ruminant brought to public veterinary centres were only Rs.13.34 and Rs.10.80, respectively. Cost of treating an acute surgical case in cattle at public veterinary centres was Rs.43.08 and treating chronic surgical case was Rs.41.85, while acute medical cases costed Rs.35.69 and gynaecological cases Rs.31.68. The major component of the average cost in all these cases was the labour cost to bring the sick animal to the centre.

Acute medical cases of cattle attended to by the veterinarians through home service tolled the farmers a cost of Rs.272.83, whereas the acute surgical cases drained a sum of Rs.256.00. The major component of mean cost in the cases treated by the veterinarians through home services was the service fee followed by the drug cost. The high cost of Rs.333.33 for treating a gynaecological case by hiring the services at the doorstep conveys the reason as to why the home serving veterinarians were not invited for treating such cases. Moreover, these cases are not of emergency type that would necessitate immediate medical attention.

Availing home services of a para-veterinarian for treating an obstetrical case in buffaloes costed as high as Rs.232.14 as compared to Rs.134.50 in case of cattle. The difference in cost could be attributed to the complicated nature of the disease/disorder that occurs in buffaloes than in cows. The cost of treatment of acute surgical cases in cattle using home service by a para-veterinarian was Rs.174.00 as against Rs.256.00 for the cases attended to by a veterinarian. Equally, acute medical cases in cattle attended through the home service of a para veterinarian costed to Rs.125.00, in contrast to Rs.272.83 for the cases attended to by a veterinarian. This low cost does not necessarily mean "the best treatment at the least cost", because the severity of the disease condition and the value of the animal affected, besides the quality of service would influence the cost of service. Service fee accounted for a major share of the mean cost of treatment in cases attended to by either a veterinarian or a para-veterinarian through home service.

The average cost of treating a chronic medical case by using the services of traditional healers was Rs.20.58 in cattle, Rs.12.50 in buffaloes and Rs.10.83 in small ruminants. The average cost of attending to obstetrical cases in small

ruminants by a traditional healer was Rs.11.67. The reduced cost on availing services of traditional healers was primarily due to the fact that the ingredients used for treatment were only either home made or available freely.

The cost of services on the acute medical cases attended to by private veterinary clinics could not be detailed as the number of case recorded was only one. The pharmacy dispensed medication for treating the chronic medical cases in cattle accounted to Rs.21.25, while the same was Rs.14.16 in case of small ruminants. As ascertained from the farmers in the study area, these drug costs were due to the deworming drugs and a few rumentonics purchased.

5.4.1.2 Visit cost of animal health care services

5.4.1.2.1 Visit cost of animal health care services in LUD districts

The mean visit cost for availing the services of different service providers on treating various categories in LUD districts is presented in Table 5.14. The mean visit cost for the chronic medical cases in small ruminants taken to public veterinary centres was as high as Rs.21.67, followed by Rs.17.93 for cattle and Rs.13.34 for buffaloes. The visit cost for small ruminants was high because the animals were commonly taken to the centres in vehicles engaged, besides the private purchase of a few drugs prescribed. The visit cost for treating a chronic surgical case in cattle at public veterinary centres was as high as Rs.16.84, followed by acute medical (Rs.14.91), gynaecological (Rs.13.28) and acute surgical (Rs.11.27) cases. The results indicated that the chronic nature of the disease that required follow up treatments accounted for more visit cost in terms of imputed labour cost for bringing the animals to the centre.

The visit cost of a veterinarian rendering home services was high at Rs.141.38 for attending to obstetrical case of a cattle, followed by acute medical (Rs.125.84) and obstetrical (Rs.122.85) cases in buffaloes and chronic medical (Rs.106.25), acute surgical (Rs.95.00) and chronic surgical (Rs.71.67) cases in cattle. The average visit fee (for service alone) for a veterinarian visiting and rendering home service ranged from Rs.45.84 in chronic surgical case to Rs.94.45 in obstetrical case of cattle. Although charges of Rs.200.00 in gynaecological cases of

cattle and Rs.175.00 for acute surgical cases in buffaloes were recorded, the results could not be discussed in detail as the number of observations was low.

The visit cost for treating the cases with para-veterinarians attending to at homes were ranging from Rs.66.93 for an acute surgical case to Rs.100.32 for an obstetrical case of cattle. The service cost (charged by para veterinarian) per visit ranged from Rs.41.67 to attend to an acute medical case of buffalo to Rs.65.62 to manoeuvre an obstetrical case of cattle. Although the visit costs were comparatively low for treating all types of cases through engaging para veterinarians than veterinarians treating at farm, satisfaction in terms of quality was assessed to be high for veterinarians (Table 5.6).

5.4.1.2.2 Visit cost of animal health care services in LD districts

The average visit cost for farmers utilising animal health care services in the LD districts were similar to those in LUD districts, except the difference in the magnitude of the cost. The average visit cost for treating chronic medical cases in cattle at public veterinary centre was Rs.14.75, while the same in case of small ruminants was Rs.8.08. However, the visit cost of treating an acute surgical case in cattle was Rs.27.58 (Table 5.15). The higher amount in this case was due to the prescriptions made for private purchase. Overall, the cost of labour which was incurred for driving the animals to the public veterinary centres accounted for a major share of visit cost.

The visit cost on hiring a veterinarian for home service was high for obstetrical cases in cattle (Rs.189.45), followed by acute medical cases in cattle (Rs.159.17), obstetrical cases in buffaloes (Rs.148.43), acute surgical cases in cattle (Rs.145.84), chronic surgical cases in cattle (Rs.122.50) and gynaecological cases in cattle (Rs.108.34). It is essential to note that the visit cost of veterinarians for home service was more in LD districts, compared to LUD districts. Further, the service fee to the veterinarians accounted for a major share of visit cost.

Obstetrical cases in cattle attended to by para-veterinarians through home service attracted a high visit cost (Rs.107.82), followed by acute medical cases in cattle (Rs.102.50) and buffaloes (Rs.95.00) and obstetrical case of small ruminants

(Rs.90.00). The results indicated that not only veterinarians in LD districts charged more, but also the para-veterinarians than those in LUD districts. The prime share of visit cost was the escalating service fee payable to service provider.

As the traditional healers were found to use either home made preparations or herbs freely available, the cost of treatment was low. However, the efficacy of the traditional medicine could not be studied as the healers were found to use combination of allopathic and ethnic medicines in many cases.

Similar to the farmers in LUD districts, in LD districts also, the visit cost of pharmacy dispensed medication was Rs.25.00 in cattle and Rs.17.50 in small ruminants. It needs special mention that the farmers did not have any follow-up consultation/treatment with the pharmacies. That is, irrespective of the fact that whether the animal has recovered or not, the farmers had not turned back to the pharmacy for the second time to make 'over the counter' purchase. When the animals did not recover, they were then found to avail the services of qualified professionals.

5.4.1.2.3 Overall visit cost of animal health services in the study area

The overall visit costs incurred by farmers availing animal health care services from different types of service providers are presented in Table 5.16.

Of the cases taken for ensuring health care services at public veterinary centres, chronic medical cases in cattle required high visit cost (Rs.16.69), followed by acute surgical (Rs.16.65), chronic surgical (Rs.15.69), acute medical (Rs.15.67) and obstetrical cases (Rs.12.50) in cattle. With regard to buffaloes, the visit cost for treating gynaecological cases was Rs.12.50, while the chronic medical cases required Rs.13.34. In all, the major share of visit cost for the cases attended to at public veterinary centre was due to labour cost alone as no service fee had been charged.

The visit cost on engaging a veterinarian for home service ranged from Rs.84.37 for attending to chronic surgical case to Rs.165.75 for manoeuvring an obstetrical case in cattle. The major share of visit cost was to the service fee charged

by the service provider. The average service fee per visit ranged from Rs.53.13 for a chronic surgical case to Rs.115.75 for attending to an obstetrical case in cattle. Availing services of home serving para-veterinarians costed comparatively lesser to the farmer per visit, not considering the quality of service. The visit cost, including drug and fee, amounted from Rs.66.93 for attending to an acute surgical case to Rs.104.85 for attending to an obstetrical case in cattle. Here too, the service fee of para-veterinarians accounted for the major portion of visit cost.

It could be observed from the table that the visit cost of ethnic or traditional healers was more than that of visiting the public veterinary centres. Nevertheless, the strain to the farmer was less, as the case was attended to at home. The sample farmers were found to use private veterinary clinics, for treating the gynaecological problems of cattle at large. The cost of visiting a private veterinary clinic was Rs.90.00 to treat a gynaecological case, in which Rs.46.67 was towards service fee and Rs.38.34 was for drugs. As the size of the respondents availing the animal health care services from private veterinary clinics for other types of cases was less in number, the result is not discussed in detail.

5.4.1.2.4 Factors influencing visit cost of animal health care services

In order to examine whether the differences in visit cost incurred by farmers were based on service provider type, place of service, type of illness, source of drug, need for follow up, value of animal affected, annual household income, livelihood share of livestock, distance from the nearest public veterinary centre and district versatility, a multiple regression analysis was effected. Table 5.17 presents the results of multiple regression explaining the variation in visit cost of service provider rendering animal health care services. Multiple regression models were fitted separately for the two district categories (LD and LUD), besides Model 1 and Model 2, where Model 1 was for entire study area without incorporating district groups (district versatility) and Model 2 by incorporating district groups as an independent variable.

a) LUD districts

Of the variables used to explain the variation in the visit cost of animal health care services in LUD districts, service providers' categories (viz., veterinarian and para-veterinarian), place of service, source of drug for treatment, annual household income and livelihood share of livestock were found to be significantly affecting the visit cost of animal health care services. The model showed a good fit with the adjusted R^2 of 0.706, i.e., 70.60 per cent of variations in the dependent variable was explained by the variables incorporated in the model. The results of the model fitted for LUD districts indicated that availing the services of veterinarians as against using traditional method of healing would additionally cost Rs.103.44 to the farmer, whereas using para-veterinarians would cost an additional amount of Rs.71.18 alone. That is, the services of a veterinarian were costlier than a para-veterinarian (for about Rs.32.00). Correspondingly, when the service is availed at farm gate (home), it would cost an extra amount of Rs.102.69 as compared to the services delivered at the centre. Although charging additional amount could be justified for the charges incurred on transport and additional work/over time beyond duty hours, the magnitude had no justification in the farmer's perception. When the drug was provided by the service provider himself during visit/treatment, the visit cost of treatment got reduced by Rs.9.80, while purchasing drugs outside would cost them higher. This could be attributed to the fact that the charges on medicines were mostly included in the service provider fee itself, and even when the service provider charged it separately, it costed less to the farmers as the service providers purchased these medicines at a lesser rate than the retail price or used the medicines available public veterinary centres' depot. However, when these medicines were prescribed for purchase from private medical store, the cost escalated as the farmers did not get any concession in price.

As the annual household income increased by Rs.1000, the visit cost also increased by Re.0.04, which could be due to the fact that when the service providers sought for fee, they also considered the farmers' wealth status and for the poor, they charged comparatively less. However, when the livelihood share of livestock increased, the visit cost also increased by Rs.17.98. That is, on the

proportion of income from livestock to total income increased by one unit, the farmers were forced to pay more and paid additionally Rs.17.98.

b) LD districts

The multiple regression model constructed to explain the visit cost of animal health care services in LD districts was fitted well with an adjusted R^2 of 0.801. Of the variables incorporated, service provider types (viz., veterinarian and para-veterinarian), place of service, types of diseases (especially, acute medical and surgical and obstetrical cases), source of drugs, value of animal affected, follow-up nature of case and annual household income were all found to be significantly influencing the visit cost variations for animal health care services in LD districts. The increase in the visit cost when the farmer used the services of a veterinarian in lieu of an ethnic healer was high at Rs.131.72 in LD districts, compared to Rs.103.44 in LUD districts. Similarly, availing the services of a para-veterinarian also augmented the cost by Rs.83.53. However, the difference between the cost in availing a veterinarian and a para-veterinarian was less in LD districts (around Rs.28.00) compared to LUD districts (around Rs.32.00). Availing the services at the farm gate would increase the cost by Rs.120.14, as against the service being availed at the centre. In contrast to the model fitted for LUD districts, in the model fitted for LD districts, the types of cases seemed to be significantly affecting the visit cost. Visit cost for acute medical cases was more than that for chronic medical cases (reference category) by Rs.16.32, while the cost for acute surgical and obstetrical cases exceeded chronic medical cases by Rs.21.73 and Rs.27.94, respectively. With regard to the source of drugs, instead of service provider providing drug, when the farmers were prescribed to purchase the drugs privately, the visit cost got escalated by Rs.30.89. When a particular case required follow-up treatment in LD districts, the average visit cost came down by Rs.26.39. However, the value of animal affected was found to be significantly affecting visit cost in LD districts alone, with an increment of Rs.1.07 for every Rs.1000 increase in the animal value. Annual household income also had a significant positive effect on the visit cost. The visit cost increased by Re.0.14 for every additional increase of Rs.1000 in annual household income.

c) Overall (study area)

The multiple regression models, model-1 and model-2, built-in using all the sample respondents in the study area, were fitted well with the adjusted R^2s of 0.741 and 0.745, respectively. In model-1, where no district category was specified, the visit cost of animal health services got significantly influenced by the service provider type, place of service, type of diseases/disorders, source of drugs for treatment, follow-up nature of case, value of animal affected, annual household income and livelihood share of livestock. Overall, the use of services of a veterinarian over an ethnic healer increased the visit cost for farmer by Rs.122.29, while the use of services of a para-veterinarian was found to increase the cost by Rs.78.42. The place of service, when it was farmer's home, would cost him an additional amount of Rs.115.02. Of the diseases/disorders types, only acute medical and obstetrical cases were found to significantly be influencing the visit cost. If the case departed from chronic medical to acute medical type, it would add to the visit cost by Rs.9.83 and if the same was to be an obstetrical case, it would cost the farmer an additional amount of Rs.20.18. When the farmer was prescribed to get the medicines from private medical stores, the visit cost would have an addition of Rs.15.39, than when the drugs were provided by the service provider himself. Compared to the cases requiring single visit, the follow-up cases costed the farmers an amount getting reduced by Rs.16.85. The value of animal had a positive incremental effect on the visit cost by Rs.1.02 for every additional value of Rs.1000. Similarly, annual income of household increased the visit cost by Re.0.04 for every incremental addition of Rs.1000. When the livelihood share of livestock of farmers, that is, the proportion of income from animal husbandry to total income increased by an unit, it would increase the visit cost by Rs.15.47.

The multiple regression fitted in model-2, where the district specific characters (LUD/LD districts) included exhibited similar results as shown in model-1, except that the variable, livelihood share of livestock did not turn to be significant and the newly included variable, district versatility interestingly turned out to be significant and positive. The explanatory variables that were found to be significant in model-1 were also significant in model-2, but with a

little differences in their magnitude. The significant positive value of district variable in model-2 indicated that the farmers in LD districts would be paying Rs.9.94 more than what the farmers in LUD districts had paid.

5.4.2 Cost of bovine breeding services

5.4.2.1 Average cost of bovine breeding services

Average cost incurred by the farmers in the study area for breeding their bovines using the services of various service providers is portrayed in Table 5.18.

5.4.2.1.1 Average cost of bovine breeding services in LUD districts

It could be understood from the table that the cost charged for AI in public veterinary centres was only Rs.15 for both cows and buffaloes. However, the average total cost which included imputed labour charges for taking the animals to the centre varied among the species. The average total cost seemed to be higher (Rs.30.19) in buffaloes compared to cows (Rs.28.07), which could be due to the fact that driving buffaloes required longer travel time to reach the centre and to be back.

On availing the services of a veterinarian at farm gate for bovine breeding, the average total cost got escalated to Rs.58.32 for cows and Rs.48.33 for buffaloes. As there was no appreciable level of labour involved on farmers' part, the variation in the cost was attributable only to the cost of semen. The service providers were found to have different categories/grades and breeds of semen straws for cows, while only one kind for buffalo.

Although the average total cost of insemination for the services rendered at home by para-veterinarians was found to be Rs.50.00 for cows, further discussions could not be done due to their poor representation in the sample. However, it was observed that the average insemination cost charged in private veterinary clinics was Rs.34.74 for cows and Rs.35.00 for buffaloes, while the average total cost of insemination accrued to the farmers including labour cost was Rs.39.61 and Rs.40.00, respectively. It is worth to note that the location of

private veterinary clinics was very much accessible to the farmers than public veterinary centres, and hence, the cost on labour was relatively less.

The average total cost of bovine breeding by natural breeding was worked out to be Rs.29.83 for cows and Rs.38.21 for cows. The cost, in case of cows was low, because of the low quality/low blood level of exotic germplasm of bulls that were used for breeding, while the high cost in buffaloes could be attributed to the graded buffalo bulls being used. The cases, where the animals were bred free of cost by natural service, during grazing, were not uncommon in the study area.

5.4.2.1.2 Average cost of bovine breeding services in LD districts

Average total cost of an insemination at farmers' end for inseminating their cows in public veterinary centre was Rs.26.99, while for buffaloes it was Rs.28.05. The less cost as compared to LUD districts was due to reduction in travel time to the centre and as the public veterinary centres were clustered around human habitations. As stated earlier, the labour charge for driving buffaloes was more, which in turn, increased the average total cost for inseminating buffaloes.

With regard to the average cost of inseminations by veterinarians extending home services, the cost was Rs.52.50 for cows and Rs.35.00 for buffaloes. It needs special mention that the average cost here was comparatively lower than LUD districts. That is, the preference of farmers towards privatised artificial insemination in LD districts was limited, unlike LUD districts.

Average total cost incurred per insemination at private veterinary clinics did not differ significantly from that of LUD districts. However, the cost of natural breeding was more in LD districts, as the cost was Rs.41.15 in cows and Rs.44.26 in buffaloes.

5.4.2.1.3 Overall average cost of bovine breeding services in the study area

As indicated earlier, the charge collected at public veterinary centres per insemination was uniform at Rs.15.00. However, the average total cost, including labour cost for transport accrued to the farmers varied from Rs.27.58 in cows to

Rs.29.17 in buffaloes. The variation in the cost was due to labour cost involved to take the animals to the centre. Obviously, the labour cost for buffaloes was higher than that of cows for the reasons already stated.

Overall average cost of insemination by engaging a veterinarian at farm gate was Rs.57.83 for cows and Rs.45.00 for buffaloes. Low cost in the case of buffaloes could be attributed to the limited variation in the cost of semen straw used, while the higher cost for cows was due to the range of semen straws that the service provider had in stock. As ascertained from farmers, the private service providers had semen straws for cattle ranging from Rs.30.00 to Rs.75.00, based on the quality of germplasm.

Farm gate insemination services by para-veterinarians were not as popular as animal health care services provided by them. Similarly, breeding through private veterinary clinics was also not very much preferred by the farmers in LD districts. The average total cost of insemination incurred by the farmers receiving services from private veterinary clinics was Rs.39.81 for cows and Rs.40.00 for buffaloes. On an average, the labour cost accounted to only about Rs.5 for taking the animal to private veterinary clinic, which meant that these clinics were well located at places where animal populations were dense.

The average total cost of natural breeding in cows was Rs.37.42 and in buffalo, it was Rs.42.20 in the study area. It is worth to note that the labour cost involved in this case was little, because the natural breeding services available adjacent to farm gate alone were preferred by the farmers, irrespective of the quality of bulls being used for serving. In contrast to the findings of Ahuja (1999) in Gujarat, the cost of bovine breeding services in the study area was relatively lesser for all categories of service providers.

5.4.2.1.4 Factors influencing average cost of bovine breeding services

As it was done for animal health care services, the factors influencing the average cost of an insemination service were analysed separately for each district categories, LUD and LD, besides having two multiple regression analyses carried out for overall study area with and without district specific characters (Model-1 and Model-2). All the four regression models viz., LUD, LD, model-1 and model-2, had good fits with the adjusted R^2s of 0.640, 0.559, 0.619 and 0.619, respectively (Table 5.19).

The explanatory variable, source of semen had a consistently positive and statistically significant influence on the average cost of bovine breeding services in all the four models fitted. The results showed that if the farmer shifted his preference from public veterinary centres to privately purchased AI straws, he would incur an additional cost of Rs.16.90 in LUD districts, Rs.10.69 in LD districts, Rs.15.04 in model-1 and Rs.15.18 in model-2. That is, the farmers in LUD districts had to pay, preferred to pay and were paying more than what was being paid in LD districts. The results indicated that the farmers in LUD districts preferred the privately supplied AI straws. In contrast to this, the farmers of LD districts were found to have paid an incremental amount of Rs.8.56 for natural service over public veterinary centres' AI, while the LUD districts' farmers were found paying only Rs.5.52 additionally. Interestingly, the farmers in LD districts were biased towards either AI from public veterinary centres or natural breeding. The overall models, model-1 and model-2, fitted indicated that the natural breeding would result in an additional cost of around Rs.7.60 over public veterinary centres' AI.

Place of bovine breeding service was identified to be a significant factor that positively influenced the cost of breeding services in all the four models fitted. When the place of service was shifted from centre to farm or home, the cost would increase by Rs.14.36, Rs.14.02, Rs.15.01 and Rs.15.11 in LUD and LD districts that could be observed from model-1 and model-2, respectively. The increase in the cost for home service was justifiable in terms of transport cost

involved to service provider and reduced labour cost to the farmers. On the contrary, the multiple inseminations/repeated inseminations factor had been consistently negative and statistically significant in all the four models fitted. The farmers of LUD districts were expected to pay only Rs.10.85 for repeated inseminations, significantly less than what they paid for single insemination, while the farmers of LD districts would be paying Rs.9.31 less for repeated inseminations than what they paid for single insemination.

Quantum of milk sold had been found to be significantly affecting the cost of bovine breeding services positively in all the four models fitted. For every additional litre of milk sold daily, the average cost of an insemination increased by Re.0.37 and 0.26 in LUD and LD districts, respectively. The overall models indicated that every additional unit of milk sold would increase the cost by around Re.0.30. That is, as the daily cash-flow increased, the farmers were willing to pay more. However, the possession of veterinary livestock units (VLU) had consistent negative effect in all the four models and statistically significant effect in the models fitted for LD districts, model-1 and model-2, which indicated that as the number of animals (represented in terms of VLU) increased, the farmers were not willing to pay additionally as maintaining more number of animals would burden them. Besides, the private service providers reduced the cost for those who own more number of animals in order to keep up their clientele base.

Of the explanatory variables incorporated into the models, species of animal inseminated, milk price, annual household income, livelihood share of livestock, mean household education, distance from nearest public veterinary centres and district versatility (incorporated in model-2) were not significantly influencing the average cost of an insemination in bovines.

5.5 Time costs of livestock services

5.5.1 Average time costs of animal health care services

Travel, waiting and service time are among the primary non-price factors that affect service quality (Ahuja *et al.,* 2000). Table 5.20 displays the average time costs associated with animal health care services in the study area. Although

average travel time was highest for visiting the public veterinary centre in both LUD (23.05 min.) and LD (21.32 min.) districts, the magnitude was much higher in LUD districts. This could be explained by the fact that the LD districts had a dense network of veterinary institutions over LUD districts. Travel time for visiting private veterinary clinics in LUD districts was 14.00 minutes, while the same was 20.05 minutes in case of LD districts, which could be due to the fact that the number of cases attended to at private veterinary clinics in LUD districts was more than that of LD districts. Besides, the private clinics in LD districts were located in the townships alone, concentrating mainly on pet animals.

The waiting time in Table 5.20 refers to the time lag between the first contact with the service provider and the receipt of service. Waiting time with regard to veterinarians providing home services in LUD districts was highest (23.01 min.), followed by public veterinary centre services at LUD districts (22.35 min.), home services by para-veterinarians (22.01 min.) and public veterinary centre services at LD districts (20.10 min.). The least waiting time was for pharmacy dispensed medication in both categories of districts. Longer waiting time in case of home services could be attributed to the travel time needed for the service providers to reach the farmers' home, after the call.

Interpretation of service time is relatively more difficult since it depends on a number of factors such as complexity of disease, ability of service provider to diagnose and provide treatment quickly, attention paid by service provider, including the time taken to explain the level of sickness to the farmers, provide advice on after care, etc., (Ahuja *et al.,* 2000). Thus, while high service time could be due to the complexity of the case, with the service provider paying a great deal of attention in treating the animal, it could also be a reflection of the ability of service provider to provide quick diagnosis and treatment. Notably, the average service time was highest for both home services by veterinarians and para-veterinarians in both LUD and LD districts. Further, there was an appreciable time difference between the public veterinary centre services and private home visits in both LUD and LD districts. The average service time for

public veterinary centre service was 12.11 minutes in LUD districts and 14.50 minutes in LD districts.

5.5.2 Average time costs of bovine breeding services

Average travel, waiting and service time for bovine breeding services are presented in Table 5.21. Once again, the travel time was highest for availing services from public veterinary centres in LUD districts (40.30 min.), followed by LD districts (37.53 min.). The travel time to reach private veterinary clinics in LD districts was 10.38 minutes, while the same in LUD districts was 10.11 minutes. In contrary to Ahuja *et al.* (2000)'s view, an important point to be noted here is that both travel and waiting time were much higher in case of breeding services compared to curative services, which could be due to the fact that the farmers preferred artificial insemination over its close substitute, the natural service. However, the service time was relatively less in case of insemination services vis-à-vis curative services both in LUD and LD districts.

5.6 Determinants of demand for livestock services

5.6.1 Determinants of demand for animal health care services in the study area

The econometric models of demand for animal health care services used here are those concerned with discrete counts of visits to either public veterinary centres or private livestock service providers. A double process approach, which envisaged to distinguish the contact process (to access to specific provider or not?) from utilisation (given that the first answer was YES, how much was consumed? That is, whether the contact was by chance or by choice). Although this double process approach had been found to be used extensively to analyse human health care demand (for example, Noronha and Andrade, 2002; Fabbri and Monfardini, 2002), this approach was adopted to analyse the factors influencing demand for animal health care and bovine breeding services in this pioneering study. The demand for public and private animal health care services was measured by counts of utilisation, i.e. number of public and private visits consumed by the farmers in the sample.

The results of the maximum likelihood estimation of the two parts of the hurdle model (probit at the first stage and zero truncated poisson at the second stage) are presented in Tables 5.22 and 5.23. It appeared that the first stage model (probit) exhibited a better fit than the second stage model (zero truncated poisson).

Notably, the probit stage indicated that the age of the head of the family had a significant negative probability for choosing private services. That means, as age advances the probability for availing animal health care services from private livestock service provider declines. However, higher milk price corresponded to higher chances of contacting public veterinary centres with the probit coefficient being 0.1112. Likewise, as visit cost increased, the coefficient for choosing public veterinary centres decreased significantly (-0.0733), while that of private service increased (0.0657). It becomes imperative to recall that the visit cost in public veterinary centres was mostly due to the labour cost involved for bringing the animals to the centre. Again, it was due to the distance from centre and hence, the results could be justified. As indicated by marginal effects of probit coefficients that the farmers are more likely to choose public veterinary centre for treating acute medical (0.0912) and gynaecological (0.2815) cases compared to the significant negative prospects for private services. Further, initial contact likelihoods for all types of diseases/disorders, except obstetrical cases were significantly negative for private services. The significant negative coefficient of obstetrical cases for public services indicated that the respondents did not favour the use of public veterinary centres for these cases. As expected, the likelihood for availing the services of public system would become low as the distance to the centre from home increased. On the contrary, when the distance to nearest public veterinary centre increased, the farmers are more likely to choose private animal health care services. Higher the value of animal affected corresponded to higher probability of contacting a private service provider. Similarly larger livelihood share of livestock and annual household income were found to reduce the probability of contacting public service provider. Better quality of service was found to increase the demand for both public and private services,

especially for private provider even at a higher rate. Importantly, the significant district versatility variable indicated the less probable contact of farmers in LD districts with public delivery system for availing animal health care services. The results of the study are in accordance with the findings of Tambi *et al.* (1999) obtained from the high potential agricultural areas of Kenya.

In the second stage, where positive counts alone were considered in the zero truncated poisson regression, the probabilities of many regressors had been changed. This could be due to the reason that the farmers would initially choose some sort of treatment for their animals, irrespective of inherent factors with the delivery system. However, for frequent visits to be made, farmers considered many factors including the ones that are relevant to animal diseases.

The regressor, average visit cost turned to be negatively significant ($p \leq 0.05$) for private services, which showed that the demand would be narrowed down as the average visit cost of private services increased. That is, initially the cost was not considered as an inhibiting factor for a single visit, but when it became multiple visits, the cost started affecting negatively the demand for private animal health care services. Surprisingly, the marginal effects for choosing private services were more for different types of cases, such as acute medical (1.9613), acute surgical (6.3625), chronic surgical (7.5659), obstetrical (1.6694) and gynaecological (6.0218) cases as compared to chronic medical cases, which could be due to the satisfaction the farmers attained in their previous experience. The distance exhibited a significant and negative probability for choosing public services. That is, as the distance to the nearest public veterinary centre increased, the likelihood for choosing private livestock services was more compared to the negative effect exerted on public delivery system. In the same way, as the value of animal affected increased, the demand for private services was significantly ($p \leq 0.01$) more vis-à-vis negative attitude exhibited towards public delivery system. More importantly, when the quality of services improved, the farmers tended to prefer public delivery system than private services for obvious reasons. The quality index constructed from Table 5.6 was

used as a proxy for quality of services. Therefore, efforts to improve these quality attributes in public delivery system would help to promote confidence among farmers.

5.6.2 Determinants of demand for bovine breeding services

The demand for public and private bovine breeding services was measured by counts of insemination services availed by the farmers. The results of the maximum likelihood estimation of the two parts of the hurdle model (probit at the first stage and zero truncated poisson at the second stage) are presented in Tables 5.24 and 5.25. As seen in the models for animal health care services, the first stage of these models were also found to be fitted well compared to the second stage (zero truncated poisson).

The probit model in the first stage indicated that milk price had a significant ($p \leq 0.01$) effect on deciding the private insemination services. This means that as the milk price increased, the demand for private artificial inseminations also increased. Likewise, the quantity of daily milk sales also played a significant role in choosing the source of insemination. Specifically, an increase in the quantum of daily milk sales would significantly reduce the likelihood of availing insemination at public veterinary centres (-0.0583), thus boosting the chance of availing private insemination (0.1522). Although average cost of insemination tended to boost the chance for private insemination, it significantly reduced the chance of public services. The reason could be that the farmers ought to think that the semen straws used in private were to be of higher quality, and so they were ready to accept even higher cost. However for the negative probit coefficient towards public delivery system, the obvious reason was the labour charges incurred for taking the animals to the centre. Success of insemination [measured in terms of a proxy; pregnant (1) and non-pregnant (0)] was found to have a higher likelihood towards privately performed breeding services. As found in animal health care services, distance to the public veterinary centre had significantly improved the demand for private bovine breeding services (0.0184), while veterinary livestock units owned had

significantly reduced the chance of preferring private services. Similarly, number of crossbred cows owned had been found significantly improving the chance of availing public services. That is, the farmers tended to prefer public delivery system over private, as the number of crossbred cows was more in the herd. Likewise, as the number of graded buffaloes to the herd increased, it significantly ($p \leq 0.01$) lessened the chance of availing private insemination services. In general, the buffaloes were mostly inseminated at public veterinary centres, as they could not be restrained in other places for AI. It is imperative to note that the demand for AI at public veterinary centre was found to be more among the farmers in LD districts, while the farmers in LUD districts tended to prefer private AI.

The second stage, zero truncated poisson regression model, indicated that the milk price had a significant and positive influence on the use of private AI. As milk price increased, the marginal probability (0.0133) of using private insemination services also increased. Quantity of milk sold also exerted a similar effect on availing private insemination services. However, the average cost of insemination had a significant negative effect towards public services (-0.0167) than towards private insemination (-0.0002). The results did not agree with the findings of Ahuja *et al.* (2000), who found that the price was not an important determinant of demand for bovine breeding in Gujarat, Rajasthan and Kerala. On the contrary, the regressor, success of insemination had a significantly higher probability towards private services than public insemination services. Differing from probit results, as the number of crossbred cows owned increased with the farmers, they tended to favour private artificial insemination. The results showed that the frequency of visits would be more, if more number of crossbreds were owned. The discussion with farmers also revealed that those who owned more number of crossbred cows established a good proximity with private service provider and proceeded for multiple visits. However, the reverse was true in case of more number of graded buffaloes owned. This could be due to the fact that the buffaloes could not be restrained easily outside, where no drives (trevis) were available. The analysis also indicated that the VLUs had a significant and negative effect on the use of public insemination services. This could be due to

the fact that when the VLU owned increased, the farmers could not bring their bovines for public centres, as they had to manage other animals also.

Although value of animals inseminated was found to be significant for both public and private insemination services, the probability for choosing private insemination was more and increased with the values of animals inseminated. Notably, the district versatility factor did not have any significant effect on frequency of visits made both for public and private insemination services.

5.7 Factors influencing the WTP values for livestock services

5.7.1 Factors influencing the WTP values for annual animal health care services

WTP values for extending annual animal health care services were elicited using payment card depicting values starting from Rs.25.00 to Rs.1500. The payment card was having equal interval of Rs.25.00 between anchors. Data collected through payment card were analysed using interval regression, as suggested by Cameron and Huppert (1989).

Interval regression models were fitted separately for each category of animals for extending annual health care facilities both in-centre and at home, as described in chapter on the design of study. Besides, models were also fitted for extending both in-centre and farm gate bovine breeding services. Explanatory variables used in the interval regression models are described in Table 3.5. Results of interval regressions that studied the relationship between the explanatory variables and the stated true maximum WTP values are detailed in the section that follows.

5.7.1.1 Modelling WTP values for annual health care services in cows

a) In-centre services

The model fitted to explain the WTP values elicited for rendering in-centre annual health care services was well fitted, with the log likelihood being estimated to be -488.1513 (Table 5.26). Of the factors included in the model, five explanatory variables viz., household education, annual household income, possession of

crossbred (dummy), quantity of daily milk sold and district category were found to be significantly predisposing the stated WTP values, for in-centre annual health care services in cows. However, other explanatory variables included in the model, sex of the respondent, age of the respondent, livelihood share of livestock, number of cows and buffaloes owned, milk price and distance from the nearest public veterinary centre did not significantly affect the stated WTP values.

The results of model indicated that as mean household education increased by one level, the true maximum WTP also increased by Rs.14.16, which could be attributed to the fact that the education of family members would increase the awareness on the health of animals. Similarly, significant positive coefficient of annual household income exhibited that a thousand rupees increase in annual income would positively increase the WTP values by Re.0.28. Farmers possessing crossbred cows in their herd were willing to pay Rs.33.35 more than those who had no crossbred cows, which could be due to the fact that the crossbred animals were more prone for ailments than desi animals. Likewise, every additional litre increase in the quantity of daily milk sold would increase the stated WTP value by Rs.7.74. This could be due to the reason that the farmers who sold more quantum of milk had more cash to disperse. More importantly, farmers in LD districts were willing to pay an additional amount of Rs.23.32 as compared to the farmers in LUD districts.

b) Farm gate services

In addition to variables that were found to be significantly influencing WTP values for in-centre services, the explanatory variable, distance from nearest public veterinary centre had also significantly predisposed the value of true maximum WTP for farm gate annual health care services in cows (Table 5.26).

The results of the model explained that an increase in the level of mean household adults' education would enhance the stated true maximum WTP by Rs.14.06 for home driven annual health care services in cows. Similarly, for every thousand rupees increase in annual household income, there would be an

increase of Re.0.26 in the stated true maximum WTP value. Farmers who owned crossbred cows were willing to pay Rs.37.01 more than who did not own, which shows the importance that the farmers attached to the crossbred cows. As average quantity of daily milk sold increased by a litre, the stated WTP value increased by Rs.7.12, which could be due to the reasons stated earlier. Distance from the nearest public veterinary (measured in terms of travel time to reach the centre) had a highly significant ($p \leq 0.01$) and positive influence on the true WTP value. WTP value would increase by Rs.1.29 for every additional minute travelled, to avail annual health care services extended at farm gate. The regression results also exhibited that the farmers of LD districts had a higher inclination than LUD districts' farmers towards contract annual health care services extended at home.

5.7.1.1.1 Mean WTP values for annual health care services in cows

The mean WTP values calculated using the interval regression model fitted are presented in Table 5.27. Overall mean WTP value for annual health care services extended was Rs.202.34 for in-centre services, while the same was Rs.261.66 for home services. The mean stated WTP values for both in-centre and at home services in LD districts were more (Rs.232.62 and Rs.293.15, respectively) as compared to LUD districts (Rs.172.50 and Rs.230.65, respectively). The higher amount in the LD districts could be attributed to the increased crossbred cattle wealth along with improved milk marketing facilities available in this area.

5.7.1.2 Modelling WTP values for annual health care services in buffaloes

a) In-centre services

The interval regression model fitted to explain the variation in the stated true maximum WTP values for health care services to buffaloes extended at the centres exhibited a good fit with the log likelihood being -56.86 (Table 5.28). Of the factors fitted to explain the WTP values for in-centre services, sex of respondent, possession of graded buffalo (dummy), quantity of daily milk sold, distance from nearest public veterinary centre and district versatility were found

to be significant. The results indicated that the male respondent preferred to pay Rs.13.91 more over the female counterpart for annual health care to buffaloes. The farmers who possessed graded buffaloes had an inclination to pay Rs.19.21 more as compared to those not possessing, which could be attributed to the reason that they are high yielders. Similarly, a litre increase in the quantity of daily milk sold was found to increase the stated WTP value by Rs.4.88. The reason could be that the increased milk sales had left the farmer with more cash on-hand. Interestingly, the farmer, whose locality was away from the public veterinary centre, was willing to pay less than those who were placed nearer to the centre. That is, an every additional minute travel time required to reach the centre would decrease the stated true WTP amount by Re.0.50. Obviously, as this offer was proposed for in-centre services, the distance would be an inhibiting factor to state a higher WTP value. Further, the farmers of LD districts were willing to pay Rs.22.49 more than what the farmers in LUD districts offered, which could be attributed to the improved livestock related activities in the area.

It was found that the explanatory variables included in the fitted model, age of respondent, mean household education, annual household income, livelihood share of livestock, number of cows and buffaloes owned and milk price had not exerted any significant effect on the stated WTP values for annual health care services in buffaloes.

b) Farm gate services

The results of interval regression analysis indicated that the sex of respondent, quantity of daily milk sold, distance from nearest public veterinary centre and district versatility had significantly predisposed the stated true maximum WTP values for annual health care services in buffaloes proposed to be rendered at farm gate (home). However, the breed dummy factor which was significant in the model fitted for in-centre services turned out to be insignificant for home services.

As could be seen from Table 5.28, the sex of the respondent, with its significantly positive coefficient, represented that the males were willing to pay

Rs.11.85 more than females. Increased awareness of males on the cost of treatments could be attributed to the above result. The results of analysis also expressed that a litre increase in the quantity of daily milk sold would boost the stated WTP value by Rs.5.23, which could be due to the fact that more quantity of milk sold would leave the farmers with sufficient liquid cash. In contrast to the in-centre services, the distance to the nearest public veterinary centre had a significant and positive influence on the stated WTP value for farm gate services. That is, a minute increase in the travel time required to reach the public veterinary centres would add Re.0.39 in the stated WTP value. Compared to the farmers in LUD districts, farmers of LD districts were willing to pay Rs.26.91 more for availing annual health care services at farm gate for their buffaloes.

5.7.1.2.1 Mean WTP values for annual health care services in buffaloes

Table 5.29 presents the mean WTP values predicted from the interval regression model fitted. Overall mean WTP value for annual health care services in buffaloes was Rs.135.78 for in-centre services and Rs.186.20 for farm gate services. The mean stated WTP values for both in-centre and at home services in LD districts were higher (Rs.165.99 and Rs.221.12, respectively) as compared to LUD districts (Rs.106.57 and Rs.152.45, respectively). The higher the amount in the LD districts could be attributed to the improved milk marketing facilities available in this area, which left the farmers with more hard cash.

The results indicated that the mean willingness to pay for availing annual health care services in cows was more than that in buffaloes (Figure 5.3). The possible reason could be that the buffaloes are hardy, which faced minimal threat from diseases, as compared to cows.

5.7.1.3 Modelling WTP values for annual health care services in bullocks

a) In-centre services

The model fitted to explain the WTP values elicited for rendering in-centre annual health care services for bullocks was found fitted well, with the log likelihood being -193.28 (Table 5.30). Of the factors included in the model, five explanatory variables viz., age of the respondent, annual household income,

bullock rented (dummy), distance from nearest public veterinary centre and district versatility were found significantly predisposing the stated WTP values for in-centre annual health care services in bullocks. However, other explanatory variables included in the model such as sex of the respondent, mean household education, livelihood share of livestock and veterinary livestock units owned did not significantly affect the stated WTP values.

The results of regression analysis indicated that the age of respondent had a significant and negative influence on the stated WTP value. As age advanced by one year, the stated WTP value for in-centre annual health care services in bullocks would get decreased by Re.0.44. Annual household income exhibited a significantly positive influence on the stated WTP value, as a thousand rupees increase in annual income would increase the WTP value by Re.0.12. Notably, when the bullocks were rented, the stated WTP value for enabling annual health care services increased by Rs.64.17. Because, the daily income accrued from rented bullocks would be more as compared to those not rented or used for self. The respondent, whose locality was away from the public veterinary centre, was willing to pay less than those who were placed nearer to the centre. That is, an every additional minute travel time required to reach the centre would decrease the stated true WTP amount by Re.0.81. However, the farmers of LD districts were willing to pay Rs.17.72 more than what the farmers in LUD districts offered.

b) Farm gate services

In addition to the variables that were found significantly influencing WTP values for in-centre services, the explanatory variable, veterinary livestock units had also predisposed the value of true maximum WTP for farm gate annual health care services in bullocks (Table 5.30).

Interval regression analysis of WTP for farm gate services exhibited similar results as that of in-centre services analysis. The age of respondent had a significant and negative influence on the stated WTP value. As age advances by one year, the stated WTP value for farm gate annual health care services in bullocks would get decreased by Re.0.46. Annual household income exhibited a

significantly positive influence on the stated WTP value, as a thousand rupees increase in annual income would increase the WTP value by Re.0.16. Similarly, when the bullocks were rented, the stated WTP value for enabling annual health care services increased by Rs.63.06. Because, the daily income derived from rented bullocks were more as compared to those not rented or used for self. However, unlike in-centre services model, in the farm gate services interval regression model, the farmer who was placed in far-off places from the public veterinary centre was willing to pay more than those who were placed nearer to the centre. That is, an every additional minute travel time required to reach the centre would increase the stated true WTP amount by Re.0.46 for home service. Similarly, the farmers of LD districts were willing to pay Rs.17.42 more than what the farmers in LUD districts offered.

5.7.1.3.1 Mean WTP values for annual health care services in bullocks

The mean WTP values estimated through the interval regression models fitted are presented in Table 5.31. Overall mean WTP value for annual health care services extended was Rs.130.12 for in-centre services and Rs.172.77 for home services. The mean stated WTP values for both in-centre and at home services in LD districts were larger (Rs.132.36 and Rs.175.37, respectively) than that of in LUD districts (Rs.128.18 and Rs.170.50, respectively). The higher amount in the LD districts could be attributed to the increased livestock related activities in these areas and high cost of animal health care services already in vogue.

5.7.1.4 Modelling WTP values for annual health care services in sheep

a) In-centre services

The interval regression model fitted to explain the variation in the stated true maximum WTP values for annual health care services to sheep extended at the centre generated a log likelihood of -18.6385 (Table 5.32). Of the factors fitted to explain the WTP values for in-centre services, age of the respondent, livelihood share of livestock, number of sheep, veterinary livestock units owned and distance from the nearest public veterinary centre were found to be significantly influencing the stated WTP value. The results indicated that the age of

respondent had a significant and negative effect on the stated WTP value, as the age advanced by one year, the stated WTP value was found to be decrease by Rs.1.06. Livelihood share of livestock which was calculated as the proportion of income from the livestock to total annual income had a significant positive influence on the stated true maximum WTP value for extending in-centre annual health care services for sheep. The results showed that as the proportion of income from the livestock increased by one unit the willingness to pay value increased by Rs.38.82. This in turn exhibited the importance attached to the livestock, especially to the sheep, by the farmers owning sheep. The analysis also indicated that the stated WTP value would increase by Re.0.65 for every addition of a sheep to the flock owned by the farmer. However, an increase in the veterinary livestock units owned by the farmer would significantly reduce the stated WTP value by Rs.4.76. The above results clearly explained the importance of sheep to the farmers owning sheep alone. Because, large ruminants contribute more to a livestock unit than small ruminants, where one livestock unit means five sheep/goat or one cattle/buffalo. Notably, even when the farmer's locality was away from the public veterinary centre, the WTP value was found to increase for such offer. That is, an every additional minute travel time required to reach the centre would also increase the stated true WTP amount by Re.0.48. This was possible because, on most of the occasions, the sheep were brought to the centre by vehicles which, in turn, took only a minimal time to reach the centre.

It was observed that the explanatory variables, sex of the respondent, mean household education, annual household income, mutton price in local area and district versatility had not exerted any significant effect on the stated WTP values for annual health care services in sheep.

b) Farm gate services

The results of interval regression analysis indicated that the age of respondent, livelihood share of livestock, veterinary livestock units owned and distance from the nearest public veterinary centre had significantly predisposed the stated true maximum WTP values for farm gate annual health care services in

sheep. However, the number of sheep owned, which was significant and positive in the in-centre services model turned to be insignificant in the farm gate services model.

Similar to the in-centre services model, the results of farm gate services model indicated that age of the respondent had a significant and negative effect on the stated WTP value, where one year advancement in the age of respondent was found to decrease the stated WTP value by Re.0.95. Moreover, the livelihood share of livestock which was calculated as the proportion of income from the livestock to total annual income had a significant positive influence on the stated true maximum WTP value for extending even for farm gate annual health care services for sheep. The results showed that as the proportion of income from the livestock increased by one unit, the WTP value increased by Rs.39.63. This, in turn, exhibited the importance attached to the livestock especially to the sheep by the farmers owning sheep. However, an increase in the veterinary livestock units owned by the farmer would significantly reduce the stated WTP value by Rs.5.30. Further, when the farmer's locality was away from the public veterinary centre, the WTP value was also found to increase significantly. That is, an every additional minute travel time required to reach the centre would also increase the stated true WTP amount by Rs.1.13.

5.7.1.4.1 Mean WTP values for annual health care services in sheep

The mean WTP values worked out through the interval regression models fitted are displayed in Table 5.33. Overall mean WTP value for annual health care services was Rs.56.34 for in-centre services and Rs.87.49 for home services. Surprisingly, the mean stated WTP values for both in-centre and at home services in LUD districts were larger (Rs.60.99 and Rs.89.31, respectively) as compared to LD districts (Rs.52.73 and Rs.86.07, respectively). The higher the amount in the LUD districts could be attributed to the underprivileged livestock farmers of this area.

5.7.1.5 Modelling WTP values for annual health care services in goat

a) In-centre services

The interval regression model fitted to explain the variation in the stated true maximum WTP values for annual health care services to goats to be extended at the centre exhibited a good fit with log likelihood being -106.16 (Table 5.34). Of the factors fitted to explain the WTP values for in-centre services, age of the respondent, veterinary livestock units owned, distance from the nearest public veterinary centre and district versatility were found to be significant. The results indicated that as age of the respondent advances by a year, the stated WTP value would decrease by Re.0.48 for extending in-centre annual health care to goat. In contrast to the models fitted for sheep, the model fitted for goats exhibited a significant positive association of veterinary livestock units with the stated WTP value. As the veterinary livestock units owned by farmers increased by a unit, the WTP value would increase by Rs.3.40. This could be due to the reason that the farmers own goat along with large ruminants. Further, the farmers, whose locality was away from the public veterinary centre, were willing to pay less than those who were placed nearer to the centre. That is, an every additional minute travel time required to reach the centre would decrease the stated true WTP amount by Re.0.61. Obviously, as this offer proposed in-centre services, the distance would be an inhibiting factor to state a higher WTP value. However, the farmers of LD districts were willing to pay Rs.13.94 more than the farmers in LUD districts.

The analysis revealed that the explanatory variables included in the fitted model, viz., sex of the respondent, mean household education, annual household income, livelihood share of livestock, number of goats and chevon price in local area had not exerted any significant effect on the stated WTP values for annual health care services in goats.

b) Farm gate services

The results of interval regression analysis pointed out that the number of goats and veterinary livestock units owned, distance from nearest public veterinary centres and district versatility had significantly determined the stated true maximum WTP values for farm gate annual health care services in goats.

The age of respondent which was found to be significant in the in-centre services model had become insignificant in this model. However, the factor, number of goats owned had turned to be significant, influencing the stated WTP values for farm gate services.

The results of regression analysis exhibited that an addition of a goat to the flock would significantly reduce the stated WTP value by Rs.1.77. However, as the veterinary livestock units owned by farmers increased by an unit, the stated WTP value would get boosted by Rs.2.84. The results clearly exhibit that the poor, who depend mainly on goats, would be willing to pay less compared to others. Unlike in-centre services, the distance to the nearest public veterinary centre had a significant and positive influence on the stated WTP value for farm gate services. That is, a minute increase in the travel time required to reach the public veterinary centre would add Re.0.50 in the stated WTP value. Compared to the farmers in LUD districts, farmers of LD districts were willing to pay Rs.13.80 more for getting annual health care services at farm gate for their goats.

5.7.1.5.1 Mean WTP values for annual health care services in goats

Table 5.35 displays the mean WTP values predicted from the interval regression model fitted. Overall mean WTP value for annual health care services in goat was Rs.61.61 for in-centre services and Rs.95.27 for farm gate services. The mean stated WTP values for both in-centre and at home services in LD districts (Rs.67.68 and Rs.100.01, respectively) were higher as compared to LUD districts (Rs.51.53 and Rs.87.42, respectively). The higher amount in the LD districts could be attributed to the increased livestock oriented activities in these areas.

5.7.2 Modelling the WTP values for bovine breeding services per conception

5.7.2.1 Determinants of WTP values for the public veterinary centre services

Factors influencing the WTP values per conception through the services proposed at public veterinary centre and those at farm gate were analysed using interval regression analysis. Table 5.36 presents the influence of the factors

included in the model on the true maximum WTP values of farmers for getting their cow/buffalo conceived through in-centre services. Of the factors incorporated in the model for cow, mean household education, annual household income, livelihood share of livestock, breed dummy, quantity of daily milk sold and district versatility were found to significantly influence the WTP values. The results indicated that as the level of household education improved, the WTP value increased at the rate of Rs.7.72. This result implies the fact that education makes the people to understand current market trends and importance of livestock. Further, every thousand rupees increase in the annual household income would increase the stated WTP value by Rs.0.10. Notably, the livelihood share of livestock, which was worked out as the proportion of income from livestock to the total income, had a significant negative influence on the stated WTP value. That is, every unit addition to proportion would reduce the stated WTP value by Rs.19.69, which might be due to the fact that dependency on livestock for livelihood was significantly high among poor, who could not afford to pay more. Crossbred cows added Rs.15.77 over desi or non-descript cows to the WTP. The higher WTP value in case of crossbred cows might be due to the economic importance attached towards these animals, as losses arising due to conception failures are nothing less than huge and the possible increased daily milk production ensuring them to pay more for animal breeding services. It is imperative to note that the quantity of daily milk sold had a significant positive influence on the WTP and it enhanced Rs.4.39 per litre increase. The farmers in LD district had inclined to pay Rs.11.02 unlike the farmers in LUD district, for every conception of their cow, which could be due to their prosperity in terms of breedable stock and other material wealth. Besides, the higher charges levied for private veterinary services in LD district could have made them to opt for high WTP values.

Willingness to pay values for breeding buffaloes, at public veterinary centres were significantly determined by mean household education, breed dummy, quantity of daily milk sold, distance from the nearest public veterinary centre and district versatility. Unlike cows, distance to the nearest public

veterinary centre had a significant role in determining WTP values in buffaloes. The results exhibited that every minute increase in travel time to the public veterinary centre was found to bring down the WTP by Re.0.62, a sequel to the strenuous efforts required to take the animals to the centres.

5.7.2.2 Determinants of WTP values for the farm gate services

The results of the interval regression analysis fitted to evaluate the factors determining the stated WTP values per conception of cow/buffalo by the services provided at farm gate are furnished in Table 5.36. The willingness to pay values in cow were found to significantly predispose by mean household education, annual household income, breed dummy, quantity of daily milk sold, distance from the nearest public veterinary centre and district versatility. However, in case of buffaloes, all these factors, except annual household income had a significant influence on the stated WTP values.

As the mean household education upgraded by a level, the stated WTP values in cow increased by Rs.6.08, while in buffalo it was Rs.16.01. However, an every thousand rupees increase in annual household income would increase the stated WTP value to go up by Rs.0.12 only in case of cows. The economic significance of the crossbreds and graded buffaloes in terms of production and the huge loss that might arise due to conception failures in these high productive stocks led the respondents owning crossbred cows to pay Rs.14.03 and Rs.33.99 in buffaloes more in relation to those possessing only desi or non-descript animals. A litre increase in the quantity of daily milk sold could boost the WTP values in cow and buffalo to the tune of Rs.4.41 and Rs 2.62, respectively as a result of affluent and regular flow of cash in hand. As the distance for the nearest public veterinary centre increased, the farmers were inclined to pay Rs.0.67 in case of cows and Rs.0.59 in case of buffaloes for every additional minute required to travel. The farmers in the LD district would prefer to pay more to the tune of Rs 11.04 for cows and Rs.42.41 for buffaloes per successful conception, than LUD district. Well established milk marketing network and upgraded breedable stock

in the LD district favoured them to pay more than the farmers in LUD district could.

5.7.2.3 Mean WTP values for bovine breeding services

In all, 270 farmers owning cows and 56 owning buffaloes were studied. Surprisingly, all of them were willing to enter into such an agreement to get their animals conceived.

Table 5.37 summarises the average maximum WTP elicited by the farmers in both LD and LUD districts for achieving conception in their bovines. The sample farmers in the study area were willing to pay a maximum of Rs.112.80 and Rs.136.14 for effecting pregnancy in their cows and buffaloes, respectively, by availing in-centre services, while they were ready to offer Rs.159.28 and Rs.186.04 for the breeding services to be delivered at farm gate. In this context, it is appropriate to note the findings of Thirunavukkarasu (2003) where he assessed the average number of Artificial Insemination (AI) services required for making a cow and buffalo conceived as 2.90 and 3.92, respectively in Tamil Nadu. This indicates that the government is charging Rs.43.50 and Rs.58.80 for achieving conception in a cow and buffalo, respectively, after extending a huge subsidy at current rates (i.e. Rs.15 per AI) for the in-centre services.

The mean true maximum WTP value was found to be more for buffaloes than cows, postulated both in-centre and home services (Table 5.37). The true WTP for making a buffalo pregnant by extending services at farm gate was as high as Rs.214.82 in LD district. These high values for buffaloes could be attributed to the difficulties faced by the farmers while driving this species to the veterinary centres and the obvious poor breeding efficiency of buffaloes, which in turn warrants more number of AIs per conception as compared to cows (Thirunavukkarasu, 2003).

There were perceivable differences in the WTP values elicited per conception of farm animals between LD and LUD districts. This could be probably due to the well developed milk marketing infrastructure that encouraged the farmers to rear good quality stock available in developed

districts. A marked difference of around Rs.30 and Rs.33 in the WTP per conception of a cow between the in-centre and farm gate services could be observed at LD and LUD districts, respectively, with the differences in case of buffalo breeding being around Rs.37 and Rs.62. The higher WTP values for home services could be due to labour scarcity for farm works and relatively higher wage rates.

The results of the study indicated that the people were willing to pay more for getting their animals conceived at the earliest and this amount was more than what the government charges now as insemination charges. The WTP values of the farmers in LD district were high compared to LUD district. Similarly, buffaloes attracted a high WTP value over cows, and among cows, crossbreds increased the WTP values than non-descript or desi cows did.

The analysis on the stated WTP values for animal health care and bovine breeding services indicated that the farmers were very much willing to pay for livestock services as ascertained by Ahuja *et al.* (2000), Rajasree and Subramanian (2003) and Ahuja *et al.* (2003).

5.8 Assessment of WTP values for quality improvements in public veterinary centres

5.8.1 Ratings of quality attributes of public veterinary centres

The farmers in the study area were asked to rank the seven important attributes of public livestock services presented and their responses were analysed through Garrett's ranking technique. The results of ranking procedure, as presented in Table 5.38 indicated that the geographical proximity of public veterinary centres was an important attribute which fetched an overall score of 66.94 to get developed both in LUD and LD districts. Chance of conception after inseminating at the centre was the next major attribute, followed by chance of recovery after visiting the centre, being able to find the prescribed treatments, waiting time before meeting the service provider, attitude of staffs in the public veterinary centres and receiving adequate information on the sickness and treatment of animals.

It is imperative to note that the farmers in different areas, namely LUD and LD, did not, differ in their views on the grades of importance of public veterinary centres' attributes. The results implied that the number of veterinary institutions delivering livestock services should get augmented, besides ensuring their presence amidst rural habitations.

The second rank attributed to the chance of conception of bovines after inseminating at public veterinary centre explained degree of the problem that farmers faced and importance of the factor to them. Therefore, efforts could be taken up to augment conception in bovines by ensuring good quality insemination, besides imparting extension programmes to update the farmers' knowledge on bovine breeding.

The chance of quick recovery depends on adequate diagnostic infrastructure, in addition to updated technical efficiency available with the service provider. Hence the farmers in the study area ranked this as a third major attribute to get their service centre improved by equipping with necessary infrastructures and by imparting latest technical know-how to the service provider. In order to compliment the fourth major attribute, receiving prescribed treatments, the centres should be stocked with adequate and relevant medicaments, taking in to account the agro-climatic and endemic animal health factors. The fifth ranked waiting time attribute envisaged that the organisation of public veterinary centres function may be modified in such a way that more man power can render quick services. Regarding other attributes, the attitude of staff in the public veterinary centre, if improved, the delivery of information what the farmers seek, would become possible.

5.8.2 Characterisation of *status quo* levels and identification of preferred states

a) Geographical proximity

Almost all the farmers, who visited public veterinary centres either for receiving animal health services or breeding their bovines reached the centre on foot, except a few who brought their small ruminants and calves carried through

by cycle or bullock cart. It took, 34.41 (±1.22) minutes, on average, for them to reach the centre. As the Table 5.39 shows, this was perceived as 'very far' and 'far' by more than half of the sample (very far: 13.44 per cent; far: 47.81 per cent). On the other hand, respondents declared a mean preferred travel time, the one that they estimate as 'very close' was 13.60 (±1.10) minutes. Enquiries also exhibited that 97.67 per cent of the respondents, who declared the distance as 'very far' were willing for improving the geographical proximity attribute. Similarly, of the farmers who declared the distance as 'far', 'average' and 'close' or 'very close', 89.54 per cent, 63.64 per cent and 19.15 per cent, respectively were willing to pay for reducing the distance. The results, in turn, exhibit the intensity of the problem, the farmer faces in the study area.

b) Waiting time

On an average, farmers waited 32.16 (±0.59) minutes prior to the veterinary consultation or bovine breeding at public veterinary centres. This was perceived as very long by 2.19 per cent of respondents and long by 40.00 per cent. Farmers declared that a waiting time of 19.50 (±2.6) minutes shall be perceived as not long at all, which is to be considered as a preferred state. To the question whether farmers would be willing to pay any amount for reducing the waiting time in public veterinary centre, all the farmers, who complained waiting time as 'very long' were willing to pay, while 92.19 per cent of farmers those declared waiting time as 'long', 80.77 per cent of the farmers who expressed the waiting time as 'average' were willing to pay some amount. As ascertained from the farmers, it was understood that the waiting time, on occasions, even exceeded to a few hours because of uncertainty over service providers' visit and hence, they positively responded for payment.

c) Attitude of public veterinary centre's staff

Of the 320 farmers interviewed, 65 (20.31 per cent) farmers complained that the attitude of centre's staff as very bad, while 74 (23.13 per cent) farmers reported that the attitude of staff as bad. However, more than half of the respondents (56.56 per cent) declared that they were received and treated in a

good manner in the centre. The farmers in the study area, who stated the public veterinary centre staffs' attitude as 'very bad' were all willing to pay for rectifying this disgust attitude, while 98.65 per cent of farmers who as declared 'bad' and 5.52 per cent of those uttered as 'good' were prepared to contribute for benefiting from the improved attitude of staff.

d) Drug/AI availability

All the prescribed or required drugs (or semen straw) for treatment (or insemination) were reported to be available for 65.93 per cent of respondents, while some of the drugs alone were available for 24.13 per cent of users and 10.94 per cent of farmers did not find any prescribed drug in public veterinary centres. 24.64 per cent of farmers, who secured all the drugs from public veterinary centres, were willing to pay for ensuring similar availability of all drugs in public veterinary centres at all times. Whereas, 89.19 per cent of those who found only some drugs and 94.28 per cent of farmers who did not find any drug were willing to contribute for the said purpose.

e) Service provider – farmer relationship (SPFR)

The farmers' answers to the different Likert scaling questions led to the per cent estimation of a mean SPFR score of 76.43 (±0.43), which indicated that most of the farmers had a good relationship with the service provider, stayed sufficient time in the centre and had got the required information on the health/heat status of their animals. In order to establish a smooth relationship with the service provider in public veterinary centres and to get all required information on the health status and treatment of animals, 39.06 per cent of respondents were ready to pay some amount.

f) Chance of recovery

The mean score percentage of chance of recovery attribute worked out from the responses of farmers to the different Likert scaling questions was 72.63 (±0.45). The results indicated that there exists scope to improve the chance of recovery attribute in the centres by establishing adequate clinical infrastructure

and infusing recent technical know-hows to the service providers. In this context, it is worth to note that 53.75 per cent of sample farmers were willing to pay some amount to ensure speedy recovery of their ailing animals.

g) Chance of conception

The respondents' views to the different Likert scaling questions constructed gave the per cent estimation of a mean chance of conception score of 48.28 (±0.44). The results apparently exhibited that the chance of conception after inseminating at the centres was not up to the expectations, which had forced the farmers to seek alternate avenues such as private insemination, home services by veterinarians and para-veterinarians and natural breeding for breeding their bovines. More importantly, 79.69 per cent of respondents were very much willing to pay for improving the chance of conception by some means. The results revealed the intensity of problems faced by the farmers owning breedable bovines.

5.8.3 Factors influencing WTP for quality improvements in public veterinary centres

Seven Tobit regression analyses, each followed by Ramsey's (1969) RESET test, were carried out to explore the relationship between each of the partial WTP values and the corresponding quality attribute's *status quo* level, adjusting for farmers' socio-demographic and economic characteristics, besides variables concerning the location of the public veterinary centre. The list of explanatory variables and their specifications are presented in Table 3.6.

Results of the seven Tobit regressions along with the marginal effects of the independent variables on the stated WTP values are presented in the section that follows.

5.8.3.1 Geographical proximity

The farmers in LUD districts were willing to pay a mean sum of Rs.6.16 to have a close proximity of the public veterinary centre, while LD districts' farmers were ready to pay Rs.9.25. Overall, the respondents in the study area were willing to pay Rs.7.72 for improving the geographical proximity attribute of the public veterinary centre (Table 5.40).

The probability that the respondents visiting from a 'very far' place to the public veterinary centre be willing to pay in order to have a 'very close' centre was 0.2531 greater than that of a respondent living 'very close' or 'close' to the centre. More over, those living 'very far' from a centre were willing to pay an extra Rs.13.01 at every coming visit to have a very close centre (Table 5.41). Farmers who perceived the distance separating them from the centre as 'far' had a higher probability of 0.4729 than that of farmers perceiving the distance as 'very close' or 'close' to be willing to pay to have a 'very close' centre; and they were willing to pay Rs.8.19 more at every visit for this purpose. The probability that a respondent's WTP value to have a 'very close' public veterinary centre be greater than zero, given that the farmer's perception of the distance to the centre was 'average', was 0.2162 higher than that of a farmer perceiving the distance as 'very close' or 'close'. More over those living at an average distance from the centre were willing to pay Rs.5.59 for every visit to the centre. The results indicated an absolute concordance between WTP results and distance perception in terms of the WTP values stated. Further, the farmers in LD districts had a higher probability of 0.0819 than LUD districts' farmers to state a positive WTP value to have a very close public veterinary centre, and were willing to pay an extra Rs.1.33 for this purpose, all things being equal. Results suggested that the respondents with higher quantity of daily milk sold, had a higher probability of 0.0093 to state a positive WTP value to have a very close public veterinary centre, and were willing to pay an extra Re.0.15 on every visit for this purpose. Similarly, farmers possessing crossbred cattle and/or graded buffalo had a greater probability of 0.1473 to state a positive WTP value to have a very close public veterinary centre, and were willing to pay an extra Rs.1.94 for this rationale. Farmers those visited the centre for availing animal health services exhibited a higher probability of 0.1344 than those visited for insemination to state a positive WTP value in order to have a very close public veterinary centre, and were willing to pay an extra Rs.1.93 on every visit. The above results explicitly revealed the importance that the farmers were attached on this attribute, which

in turn, suggest to open up new public veterinary centres at places where animal population is dense.

5.8.3.2 Waiting time

As could be seen from the Table 5.42, farmers of LD districts were willing to pay more (Rs.8.45) than the farmers of LUD districts (Rs.6.98) in order to reduce the waiting time before the case was being attended to by the service provider in the public veterinary centre. On an average, the respondents in the study area were willing to pay Rs.7.72 for minimising waiting time in public veterinary centres.

The probabilities that respondents who waited 'very long' and 'long' time before being their cases attended to by the service provider be willing to pay to benefit from a waiting time perceived as not long at all, were 0.0894 and 0.2142, respectively, higher than that of a respondent who waited 'not long' or 'not long at all' (Table 5.43). Those waiting very long and long were willing to pay a comparable extra user fee of Rs.15.76 and Rs.6.46, respectively, on every visit so as to get benefited from a waiting time perceived as 'not long at all'. As shown in the geographical proximity attribute, the respondents with a higher quantity of milk sold had a higher probability of 0.005 to state a positive WTP value to have a waiting time as 'not long at all'. The results indicated that the increase in the veterinary livestock units owned would have a negative marginal probability for stating a positive WTP value to improve waiting time attribute. If the purpose of visit to public veterinary centre was availing animal health services, the farmers had a higher marginal probability of 0.0744 to state a positive WTP value to benefit from minimised waiting time, and were willing to pay an extra Rs.1.68 compared to those visited for availing bovine breeding services in the centre. The other factors relevant to district versatility and demography were not significantly influencing the results of the model fitted. It was observed that the waiting time attribute got worsened, on occasions, because of uncertainty over timing of visit of service provider, which could be solved by improving man power and also through enforcing strict adherence towards service timings.

5.8.3.3 Attitude of public veterinary centre's staff

In order to benefit from a better attitude exhibited by the staff of public veterinary centres, the farmers in LUD districts were willing to pay a mean sum of Rs.6.00, while LD districts' farmers were ready to pay only Rs.4.41 for this purpose. Overall, the respondents in the study area were willing to pay Rs.5.20 for improving the attitude of public veterinary centres' staff (Table 5.44).

Results of the Tobit regression analysis suggested that the farmers who found the attitude of the personnel of the public veterinary centre as 'very bad' and 'bad' had higher probabilities of 0.7015 ($p \leq 0.01$) and 0.7344 ($p \leq 0.01$), respectively, to state a positive WTP value to be treated in a 'good' manner, in comparison with those who already found that they were treated 'good' in the centre (Table 5.45). Further, farmers who had been treated in a 'very bad' and 'bad' manner were willing to pay an extra user fee of Rs.11.77 and Rs.11.52, respectively in order to benefit from a good attitude of the centre's staff. It is imperative to note that the females had a higher probability (0.1742) than males to state a positive WTP value, so as to benefit from a better attitude of staff. Similarly, as age of the respondent increased, the marginal probability of stating a positive WTP for attitude improvement would increase by 0.0097 ($p \leq 0.01$) and they were willing to pay an extra user fee of Re.0.05 ($p \leq 0.01$). As expected, improvements in the educational level of respondents increased the probability of stating a positive value by 0.1401 ($p \leq 0.01$) and also increased their WTP amount by Re.0.76 ($p \leq 0.01$). The regular visitor to public veterinary centre, which was measured in terms of number of visits to the centre in the last one year, had a probability of 0.0405 to state a positive WTP value and was willing to pay an additional user fee of Re.0.22 on every visit so as to gain from the better attitude of staff.

5.8.3.4 Drug/AI availability

As could be seen from the Table 5.46, the farmers in the study area were willing to pay an average of Rs.6.58 as extra user fee on every visit so as to get all the medicines and breeding facilities in the public veterinary centre at all times.

This WTP amount was significantly varied between LUD and LD districts as Rs.4.81 and Rs.8.32, respectively.

Tobit analysis results presented in Table 5.47 indicated that the farmers who were unable to get any prescribed drug/AI had higher probability of 0.5967 ($p \leq 0.01$) to state a positive WTP to gain from getting all the medicines at the centre itself, and were also willing to pay an user fee of Rs.12.72 compared to those who found 'all' medicines at the centre. Similarly, the visitors of the centres who found only some of the drugs prescribed were having a marginal probability of 0.05634 ($p \leq 0.01$) to state a positive WTP. They were also ready to pay an extra user fee of Rs.7.77 for getting all the drugs always at the centre. The farmers in LD districts exhibited a higher probability of 0.1750 ($p \leq 0.01$) for departing towards a positive WTP to get all the prescribed drugs at the centre itself and were willing to pay an user fee of Rs.1.57 for this endeavour. Interestingly, all the milk related factors incorporated in the model viz., milk price, quantity of daily milk sold and possession of crossbred cow and/or graded buffalo had exhibited higher probabilities of 0.0985 ($p \leq 0.01$), 0.0137 ($p \leq 0.05$) and 0.2013 ($p \leq 0.05$), respectively, to state a positive WTP value for getting the prescribed drugs always at public veterinary centre. A rupee increase in milk price per litre would increase the WTP amount by Re.0.87, while a litre increase in the quantity daily milk sold would increase the WTP amount by Re.0.12 to get all the drugs in the centre itself. Similarly, farmers owning crossbred cows and/or graded buffaloes inclined to pay an user fee of Rs.1.69 compared to those not owning, to find all the prescribed drugs at the centre itself.

5.8.3.5 Service provider–farmer relationship (SPFR)

In order to gain from the better SPFR established, the farmers in LUD and LD districts were willing to pay a mean sum of Rs.3.93 and Rs.3.88, respectively, without any significant difference between them. Overall, the respondents in the study area were willing to pay Rs.3.91 for improving the relationship with the service providers of public veterinary centre (Table 5.48).

A highly significant and negative coefficient of SPFR score was an expected result (Table 5.49). This means that, the probability that a farmer declaring a positive WTP value would decrease as SPFR score increased (an increase in SPFR score indicated that the farmer was much more satisfied from his relation with the service provider). The stated WTP values for improvements over this attribute behaved similarly; that is, as the SPFR score increased, farmers WTP values decreased ($p \leq 0.01$). A percentage increase in the score implied a reduction of 0.0165 and Re.0.15 in the probability to state a positive WTP value and in the stated WTP value themselves, respectively. As the educational level of respondent increased, the marginal probability of stating a positive WTP value increased by 0.1040 and their willingness to pay also increased by Re.0.92 for developing a better relationship with the service provider in the centre. The distance from the public veterinary centre, which is measured in terms of travel time (minutes), had a significant positive probability (0.0038) to state a positive WTP value. The results also indicated that the farmers' WTP value would increase by Re.0.03 for every additional minute that he was expected to travel to reach the public veterinary centre. That is, the farmers visited from distant places were inclined to receive maximum information from service provider on the health status of his animals, as he could not frequently visit the centre. If the purpose of visit to public veterinary centre was availing animal health care, the marginal probability of a farmer extending a positive WTP would increase by 0.1797 ($p \leq 0.01$) compared to those visiting for artificial insemination of their bovines. The farmer who brought his animal for treatment in the centre would also be willing to pay an extra user fee of Rs.1.56 than those who brought for artificial insemination.

5.8.3.6 Chance of recovery

As could be seen from Table 5.50, the farmers in the study area were willing to pay an average of Rs.5.84 as user fee on every visit so as to improve the chance of recovery of their animals' ailments after getting treated at public veterinary centre. This WTP amount did not vary significantly between LUD and LD districts as the amounts being at Rs.5.28 and Rs.6.40, respectively.

The results of Tobit regression analysis specified a highly significant and negative coefficient for the chance of recovery scores included in the model (Table 5.51). This means that a probability of a farmer declaring a positive WTP value decreased as his chance of recovery score increased (an increase in the chance of recovery score indicated that the respondent perceived higher probability of his animal recovering after visiting the centre). The stated WTP values for improvements over this attribute behaved in the same way; that is, as the percentage of chance of recovery scores increased, respondents WTP value decreased significantly ($p \leq 0.01$). A percentage increase in the chance of recovery score implied a reduction of 0.0192 and Re.0.18 in the probability to state a positive WTP value and in the stated WTP values themselves, respectively. The explanatory variables, district versatility and possession of crossbred cows/graded buffaloes had been found to have higher probabilities of 0.1852 and 0.1584, respectively, to state a positive WTP value in order to improve the chance of recovery of ailing animals after visiting public veterinary centre. Further, the farmers in LD districts were willing to pay Rs.1.81 as user fee more than the farmers in LUD districts, for this purpose. Similarly, those owning crossbred cows and/or graded buffaloes were willing to pay an extra amount of Rs.1.41 compared to those not owning. Among types of cases, acute medical (0.3759), acute surgical (0.3252), chronic surgical (0.3267) and obstetrical cases (0.3317) were attracted significantly ($p \leq 0.01$) for higher probabilities of stating positive WTP values as compared to chronic medical cases. In addition, these cases also predisposed for an additional WTP amount of Rs.5.67, Rs.5.32, Rs.5.84 and Rs.6.44, respectively. However, gynaecological cases did not show any significance over chronic medical cases. The probable reason for the farmers expressing more WTP value for the above diseases could be due to the fact, that the services of private service providers would hike the cost of treatment manifolds.

5.8.3.7 Chance of conception

In order to increase the chance of conception of bovines after inseminating at public veterinary centres, the farmers in LUD and LD districts were willing to

pay a mean sum of Rs.12.58 and Rs.10.93, respectively, without any significant difference between them (Table 5.52). Overall, the respondents in the study area were willing to pay Rs.11.71 for improving the chance of conception of animals inseminated at public veterinary centres (Figure 5.4).

As expected, the coefficient of chance of conception score was significant ($p \leq 0.01$) and negative (Table 5.53). The marginal probability of stating a positive WTP value, -0.0044, significantly decreased with an increase in the percentage score of chance of conception. Similarly, the value of WTP amount also decreased significantly at Re.0.25 for every per cent increase in the chance of conception score. This means that the respondents with high score were satisfied with the performance of the public veterinary centre and they declined to pay any extra amount. It is imperative to note that the farmers of LUD districts had a higher probability of 0.0422 compared to LD districts, to state a positive WTP value to have satisfied level of chance of conception in their bovines, and were also willing to pay an extra Rs.2.41 on every visit for this purpose. As exhibited in the availability of drug/AI attribute, all the milk related factors integrated in the model viz., milk price, quantity of daily milk sold and possession of crossbred cows and/or graded buffaloes had exhibited higher probabilities of 0.0346 ($p \leq 0.01$), 0.0043 ($p \leq 0.05$) and 0.2662 ($p \leq 0.01$), respectively, to state a positive WTP value for improving the chance of conception of bovines inseminated at public veterinary centres. A rupee increase in milk price per litre would increase the WTP amount by Rs.1.95, while a litre increase in the quantity daily milk sold would increase the WTP amount by Re.0.24 to improve the conception rate in bovines. Similarly, farmers owning crossbred cows and/or graded buffaloes inclined to pay an extra user fee of Rs.6.14 compared to those not owning, to boost the conception rate in their bovines inseminated at public veterinary centres.

5.9 Constraints in livestock services

The farmers in the study area were asked to rank the constraints that they faced on availing animal health care and bovine breeding services, both from public veterinary centres and from private livestock service providers.

5.9.1 Constraints in public livestock services

As could be seen from Table 5.54, the Garrett's score calculated for both animal health care and bovine breeding services, although varying little, had resulted in similar ranks for the constraints listed. Among the constraints faced by the farmers in the study area, long distance to the public veterinary centre was ranked first with a mean score of 69.71, which challenged the farmers from availing timely livestock services.

The next major limiting factor was the long waiting time before their case could be attended to by the service provider at public veterinary centres. The reason could be attributed to the irregular visit timings of service providers, besides a large number cases gathering in a few centres being attended to by a single service provider. That is, when one individual was to attend a number of cases presented to him at one single centre, it would take relatively a longer time to attend to the last cases. This, in turn, warranted ensuring adequate timing and sufficient man power in public veterinary centres.

Inadequacy of drugs in public veterinary centres was the third major constraint as ranked by the farmers. Although public veterinary centres were found to have been pumped with a variety of drugs and semen straws, adequacy of specific drugs needed for the most prevalent diseases specific to the areas were found lacking.

Poor quality inputs provided in the public veterinary centres was ranked as the fourth major constraint, followed by inconvenient working hours, poor quality services, labour scarcity to take the animals to the centre, inadequacy of skilled staff and poor attitude towards farmers were listed as constraints in availing public livestock services. However, the high cost listed in the interview

schedule was not at all ranked by any of the farmers in the study area. This means that the fees collected at the public veterinary centres were not perceived to be higher by farmers for availing services. On the ranks of constraints, comparable observations were also made even earlier by Balasubramaniam and Johnknight (1982), while assessing the bottlenecks of artificial insemination.

5.9.2 Constraints in private livestock services

The results of Garrett's ranking analysis presented in Table 5.55 indicated that ranks of both private animal health and breeding services were almost similar, with a little difference in scores alone. The high service charges levied by private service providers was the major hurdle, both in animal health and bovine breeding services, faced by the farmers in the study area. The Garrett's scores of animal health and bovine breeding services were 76.29 and 74.98 for this problem, respectively. Although charging high cost could be justified, to a certain extent, for the charges incurred on transport and additional work/over time beyond duty hours, the magnitude of the cost had no justification in the farmer's perception. These findings are in accordance with the observations made by Rajasree (2000).

Expensive drugs and semen straw cost was indicated as the second major problem faced by the farmers both in private animal health and bovine breeding services. As the private service providers prescribed medicines from private medical shops, the cost could have been naturally high. In case of private insemination, the service providers used semen straws purchased from outside the state at a high cost without subsidy and hence it would have become less possible for them to charge a less cost.

The third major constraint ranked by farmers was the delay in availing the appointment of service providers. The possible reason for this could be that many of the service providers extending private services including home services were found working with the government department, which made them to offer private services only beyond the stipulated working hours at the public veterinary centres. Therefore, many of the service providers who extended private services could attend to cases only beyond working hours.

Non-availability of service personnel was the next important constraint for the farmers, followed by long waiting time, long travel time, lack of trained veterinarians, inconvenient working hours and inadequate infrastructure. These were the inhibiting factors that the farmers came across in availing the private animal health and bovine breeding services.

Attitude of the private service providers was not quoted as poor by any farmers in the study area as a limiting factor in private livestock services. Obviously, those who rendered private services did follow cultural ethics and had good manners to keep their clientele network intact and wide spread for maximising their returns.

CHAPTER VI

SUMMARY AND CONCLUSIONS

6.1 Summary

Livestock has been an integral part of the Indian rural economy and an indispensable tool of income and employment generation to millions of poor households across the country, besides being a major source of protein and supplementary nutrition, draught power, fertilizer, fuel and a store of wealth. Recent globalization and economic liberalisation policies present enormous opportunities for our country to boost rural incomes and accelerate the pace of poverty alleviation through promoting livestock services. To exploit the production potentials of livestock, the quality of livestock services delivered by public sector needs to be improved much. Policy initiatives aimed at increased cost recovery, which could support the sustainability of public sector, however, all along been deferred by the policy makers on the assumption that the farmers would not be willing to pay for these services.

In the light of above scenario, this study was undertaken in Tamil Nadu, to assess the cost and uptake of livestock services by farmers, to analyse the factors influencing demand for livestock services, to measure the willingness to pay for livestock services, to identify the constraints in availing livestock services and to suggest appropriate policy implications to promote delivery and acceptance of livestock services.

The districts of Tamil Nadu state were classified into two categories, viz., 'livestock-developed' (LD) and 'livestock-underdeveloped' (LUD), based on initial baseline developed. Randomly selected, Coimbatore and Villupuram districts represented LD category, while Thanjavur and Sivagangai districts represented LUD category. A multistage sampling procedure was adopted to select 320 respondents seeking services from 32 chosen public veterinary centres (10 from each). From the respondents, relevant data were collected through structured and pilot tested interview schedule. In order to ascertain the value of WTP for quality improvements in public veterinary centres and to assess farmers' maximum WTP for total annual animal health care and bovine breeding services per conception, separate payment cards were used.

The chosen sample had more numbers of marginal farmers (145), followed by small (91) and large (84) farmers. The average landholding among large

farmers was 8.01 acres, while the small farmers possessed 3.98 acres and marginal farmers had 1.31 acres.

Average number of cattle owned per household was 4.11, which composed of 0.27 indigenous cows, 1.32 crossbred cows, 0.99 bullocks and 1.53 young cattle. However, non-descript buffalo holding (0.32) bulged over graded (0.18) and young buffaloes (0.26). Of the average 2.38 small ruminants possessed, 0.93 was sheep and the remaining (1.45) was goats. In LD districts, the overall average ownership was higher for crossbred cows (1.66) and lower in case of indigenous cows (0.18), and the grand average of graded buffaloes (0.24) was more than that of non-descript buffaloes (0.11), which could be because of improved infrastructural and marketing facilities. The average number of small ruminants in LD districts (1.50) was almost double than that of LUD districts (0.88).

The overall milk price in the study area was Rs.8.09 per litre and no significant difference was found between LUD and LD districts. However, the daily average of milk sold was significantly higher in LD districts (12.43 litres) than that of LUD districts (8.32 litres) with the overall average being at 10.39 litres. Average annual household income was Rs.65080, with no significant difference between farmers of LUD and that of LD districts. Despite this, livelihood share of livestock, which was calculated as the proportion of income from livestock to the total income, was significantly differing among district categories.

Easy access to public veterinary centres was reported by 98.99 per cent of the farmers in LUD districts and 99.49 per cent in LD districts. The farmers in LD districts had better access to home services of veterinarians (55.35 per cent) and para-veterinarians (57.98 per cent) than those in LUD districts (35.62 per cent and 41.13 per cent, respectively). The quality perception of farmers on livestock services revealed that the home services rendered by veterinarians as the best one (0.83), followed by private veterinary clinics (0.75), home services by para-veterinarians (0.74), public veterinary centres (0.64) and co-operative veterinary centres (0.48).

Overall use pattern of animal health care services indicated that the public veterinary centres were the major service providers for all types of cases, followed by veterinarians attending at the farm gate. Moreover, the services are skewed towards cattle among all categories of service providers. Of the cases reported to the public veterinary centres, number of acute medical cases was more, followed by chronic medical, gynaecological, acute surgical, chronic surgical and obstetrical cases. Acute medical cases followed by obstetrical cases predominantly attended to by veterinarians through home services, while para-veterinarians were attending to obstetrical cases.

The public veterinary centres were the major bovine breeding service provider, doing 2.17 inseminations, on an average, per conception. However, the next major service provider, home servicing veterinarian, required 1.74 inseminations per conception.

The results of the study indicated that the cost of treatment of cattle was more compared to other species of animals with the similar disease condition. The mean cost of treatment of a chronic medical case in cattle at a public veterinary centre was Rs.20.83, in which the labour cost alone accounted to Rs.17.35, with the remaining amount for the drugs purchased outside. However, the mean costs of treating a chronic medical condition in buffalo and small ruminant at public veterinary centres were only Rs.13.34 and Rs.10.80, respectively. Cost of treating an acute surgical case in cattle at a public veterinary centre was Rs.43.08 and treating a chronic surgical case was Rs.41.85, while an acute medical case costed Rs.35.69 and a gynaecological case Rs.31.68. The major component of cost in all cases was the labour cost incurred to bring sick animal to the centre.

Acute medical cases of cattle attended to by the veterinarians through home service tolled the farmers a cost of Rs.272.83, whereas the acute surgical cases drained a sum of Rs.256.00. The major component of mean cost in the cases treated by the veterinarians through home services was the service fee followed by the drug cost. The high cost of Rs.333.33 for treating a gynaecological case by hiring

the services at the doorstep conveys the reason as to why the home serving veterinarians were not invited for such cases.

Availing home services of para-veterinarians for treating an obstetrical case in buffaloes costed as high as Rs.232.14 as compared to Rs.134.50 in case of cattle. The cost of treatment of acute surgical cases in cattle using home service by a para-veterinarian was Rs.174.00 as against Rs.256.00 for the cases attended to by a veterinarian. The acute medical cases in cattle attended through the home service of a para veterinarian costed to Rs.125.00, in contrast to Rs.272.83 for the cases attended to by a veterinarian.

Of the cases taken for ensuring health care services at public veterinary centres, chronic medical cases in cattle required high visit cost (Rs.16.69), followed by acute surgical (Rs.16.65), chronic surgical (Rs.15.69), acute medical (Rs.15.67) and obstetrical cases (Rs.12.50) in cattle. With regard to buffaloes, the visit cost for treating gynaecological cases was Rs.12.50, while the chronic medical cases required Rs.13.34. The major share of visit cost for the cases attended to at a public veterinary centre was due to labour cost alone as no service fee was charged. The visit cost on engaging a veterinarian for home service ranged from Rs.84.37 for attending chronic surgical case to Rs.165.75 for manoeuvring an obstetrical case in cattle. The major share of visit cost was the service fee charged.

Multiple linear regression analyses were carried out to examine whether the differences in visit cost incurred by farmers were influenced by different factors/attributes. The visit cost of animal health services was influenced by the service provider type, place of service, type of diseases/disorders, source of drugs for treatment, follow-up nature of case, value of animal affected, annual household income, livelihood share of livestock and district versatility.

The charge collected at public veterinary centres per insemination was uniform at Rs.15.00. However, the average total cost, including labour cost for transport accrued to the farmers varied from Rs.27.58 in cows to Rs.29.17 in buffaloes. Overall average cost of insemination by engaging a veterinarian at farm

gate was Rs.57.83 for cows and Rs.45.00 for buffaloes. The average total cost of insemination incurred by the farmers receiving services from private veterinary clinics was Rs.39.81 for cows and Rs.40.00 for buffaloes.

Factors influencing the average cost of insemination services were analysed separately for each district categories, LUD and LD, besides two multiple linear regression analyses carried out for overall study area with and without district specific characters. The explanatory variables, source of semen, directly purchased AI straws and natural breeding, place of service, number of semen straws used, quantum of milk sold and VLUs owned were all influencing the cost of AI. Interestingly, the farmers in LD districts used either AI services from public veterinary centres or natural breeding, while the farmers in LUD districts preferred private AI.

Travel, waiting and service time were among the primary non-price factors that affected service quality. Average travel time was highest for visiting the public veterinary centre in both LUD (23.05 min.) and LD (21.32 min.) districts. Waiting time with regard to veterinarians providing home services in LUD districts was highest (23.01 min.), followed by public veterinary centre services at LUD districts (22.35 min.), home services by para-veterinarians (22.01 min.) and public veterinary centre services at LD districts (20.10 min.). Both travel and waiting time were much higher in case of breeding services compared to curative services, which could be due to the fact that the farmers preferred AI over its close substitute, the natural service. However, the service time was relatively less in case of insemination services vis-à-vis curative services both in LUD and LD districts.

A two part double Hurdle-Zero Truncated Poisson regression model (Probit at the first stage and zero truncated Poisson at the second stage) was used to analyse the factors influencing demand for animal health care and breeding services.

Notably, the probit stage indicated that the age of the head of the family advanced, he/she declined to go for private services. However, higher milk price

corresponded to higher chances of contacting public veterinary centres. As visit cost increased, the coefficient for choosing public veterinary centres decreased significantly, while that of private service increased. It also appeared that the farmers were more likely to choose public veterinary centre for treating acute medical and gynaecological cases compared to the significant negative chances for private services. Further, initial contact likelihoods for all types of diseases/disorders, except obstetrical cases were significantly negative for private services. The significant negative coefficient of obstetrical cases for public services indicated that the respondents did not favour the use of public veterinary centres for these cases. The likelihood of availing services of public system would become low as the distance of the centre from home increased, leading the farmers to choose private animal health care services. Higher value of animal affected also led to higher probability of contacting a private service provider. Similarly larger livelihood share of livestock and annual household income were found to reduce the probability of contacting public service provider. Better quality of service was found to increase the demand for both public and private services, especially for private provider even at a higher rate. Importantly, the significant district versatility variable indicated the less probable contact of farmers in LD districts for availing public animal health care services.

In the second stage, where positive counts alone were considered in the zero truncated poisson regression, the probabilities of many regressors had changed. This could be due to the reason that the farmers would initially choose some sort of treatment for their animals, irrespective of inherent factors with the delivery system. However, for frequent visits to be made, farmers considered many factors including the ones that are relevant to animal diseases. The regressor, average visit cost, turned to be negatively significant for private services, showing that the demand would be low as the average visit cost of private services increased. Surprisingly, the marginal effects for choosing private services were more for different types of cases, such as acute medical (1.9613), acute surgical (6.3625), chronic surgical (7.5659), obstetrical (1.6694) and gynaecological (6.0218) cases as compared to chronic medical cases. The distance

exhibited a significant and negative probability for choosing public services. As the value of animal affected increased, the demand for private services was significantly more vis-à-vis negative attitude exhibited towards public delivery system. More importantly, when the quality of services improved, the farmers tended to prefer public delivery than private services.

The demand for public and private bovine breeding services was measured by counts of insemination services availed by the farmers. The probit model in the first stage indicated that milk price had a significant effect on deciding the private AI services. Likewise, an increase in the quantum of daily milk sales would reduce the likelihood of availing insemination at public veterinary centres (-0.0583), thus boosting the chance of availing private AI (0.1522). Although average cost of insemination tended to boost the chance for private AI, it significantly reduced the chance of public services. Success of insemination [measured in terms of a proxy; pregnant (1) and non-pregnant (0)] was found to have a higher likelihood towards privately performed breeding services. As found in animal health care services, distance to public veterinary centre had significantly improved the demand for private bovine breeding services (0.0184), while VLUs owned had reduced the chance of preferring private services. Similarly, number of crossbred cows and graded buffaloes owned significantly improved the chance of availing public services. It is imperative to note that the demand for AI at public veterinary centre was found to be more among the farmers in LD districts, while the farmers in LUD districts tended to prefer private AI.

The second stage, zero truncated poisson regression model, indicated that the milk price and quantity of milk sold had a significant and positive influence on the use of private AI. However, the average cost of insemination had a significant negative effect towards public services (-0.0167) than towards private AI (-0.0002). Differing from probit results, as the number of crossbred cows owned increased with the farmers, they tended to favour private artificial insemination. However, the reverse was true in case of graded buffaloes owned.

The analysis also indicated that the VLUs had a significant and negative effect on the use of public AI services. Although value of animals inseminated was significant for both public and private AI services, the probability of choosing private AI was more and increased with the values of animals inseminated.

Interval regression analysis of the stated WTP values for in-centre annual health care services in cows were significantly predisposed by level of mean household education, annual household income, possession of crossbred (dummy), quantity of daily milk sold and district versatility. In addition to variables that were found to be influencing WTP values for in-centre services, the variable, distance from nearest public veterinary centre also significantly predisposed the value of true maximum WTP for farm gate annual health care services in cows. Overall mean WTP value for annual health care services was Rs.202.34 for in-centre services, while the same was Rs.261.66 for home services. The mean stated WTP values for both in-centre and home services in LD districts were more (Rs.232.62 and Rs.293.15, respectively) as compared to LUD districts (Rs.172.50 and Rs.230.65, respectively).

The significant factors influencing the WTP values for in-centre services of buffaloes were the sex of respondent, possession of graded buffalo (dummy), quantity of daily milk sold, distance from public veterinary centre and district versatility. However, breed dummy factor which was significant in the model fitted for in-centre services turned out to be insignificant for home services. Overall mean WTP value for annual health care services in buffaloes was Rs.135.78 for in-centre services and Rs.186.20 for farm gate services. The mean stated WTP values for both in-centre and home services in LD districts were higher (Rs.165.99 and Rs.221.12, respectively), as compared to LUD districts (Rs.106.57 and Rs.152.45, respectively). The results indicated that the mean willingness to pay for availing annual health care services in cows was more than that in buffaloes.

Of the factors included in the model fitted for annual health care services for bullocks, age of the respondent, annual household income, bullock rented (dummy), distance from public veterinary centre and district versatility were

predisposing the stated WTP values for in-centre annual health care services in bullocks. In addition to the variables that were influencing WTP values for in-centre services, VLUs had also predisposed the value of true maximum WTP for farm gate annual health care services in bullocks. Overall mean WTP value for annual health care services was Rs.130.12 for in-centre services and Rs.172.77 for home services. The mean stated WTP values for both in-centre and home services in LD districts were larger (Rs.132.36 and Rs.175.37, respectively) than that of in LUD districts (Rs.128.18 and Rs.170.50, respectively).

The true maximum WTP values for in-centre annual health care services to sheep were significantly explained by the factors such as age of the respondent, livelihood share of livestock, number of sheep, VLUs owned and distance from the public veterinary centre. The number of sheep owned, which was significant and positive in in-centre services model turned insignificant in the farm gate services model. Overall mean WTP value for annual health care services was Rs.56.30 for in-centre services and Rs.87.47 for home services. Surprisingly, the mean stated WTP values for both in-centre and home services in LUD districts were larger (Rs.60.89 and Rs.89.25, respectively) as compared to LD districts (Rs.52.73 and Rs.86.09, respectively).

Of the factors fitted to explain the WTP values for in-centre annual health care services to goats, age of the respondent, VLUs owned, distance from the public veterinary centre and district versatility were significant. However, number of goats owned had turned to be negatively significant, influencing the stated WTP values for farm gate services. Overall mean WTP value for annual health care services in goat was Rs.61.60 for in-centre services and Rs.95.28 for farm gate services. The mean stated WTP values for both in-centre and home services in LD districts (Rs.67.67 and Rs.100.00, respectively) were higher as compared to LUD districts (Rs.51.53 and Rs.87.42, respectively).

The in-centre services interval regression model for analysing the factors influencing the WTP values per conception in cow showed that mean household education, annual household income, livelihood share of livestock, breed

dummy, quantity of daily milk sold and district versatility were influencing the WTP values. Similarly, WTP values for breeding buffaloes, at public veterinary centres were determined by mean household education, breed dummy, quantity of daily milk sold, distance from the public veterinary centre and district versatility.

The stated WTP values per conception of cows by the services provided at farm gate were predisposed by mean household education, annual household income, breed dummy, quantity of daily milk sold, distance from the public veterinary centre and district versatility. However, in case of buffaloes, all these factors, except annual household income had a significant influence on the stated WTP values. The sample farmers in the study area were willing to pay a maximum of Rs.112.80 and Rs.136.14 for effecting pregnancy in their cows and buffaloes, respectively, by availing in-centre services, while they were ready to offer Rs.159.28 and Rs.186.04 for the breeding services delivered at farm gate. The mean true maximum WTP value was found to be more for buffaloes than cows, postulated both in-centre and home service. The true WTP for making a buffalo pregnant by extending services at farm gate was as high as Rs.214.82 in LD districts. There were perceivable differences in the WTP values elicited per conception of farm animals between LD and LUD districts. A marked difference of around Rs.30 and Rs.33 in the WTP per conception of a cow between the in-centre and farm gate services could be observed at LD and LUD districts, respectively, with the differences in case of buffalo breeding were around Rs.37 and Rs.62. The results of the study indicated that the people were willing to pay more for getting their animals conceived at the earliest and this amount was more than what the government charges now as AI charges. The WTP values of the farmers for this in LD district were high compared to LUD district. Similarly, buffaloes attracted a high WTP value over cows, and among cows, crossbreds increased the WTP values than non-descript or desi cows did.

The farmers in the study area were asked to rank the seven important attributes of public livestock services presented and their responses analysed

through Garrett's ranking technique indicated that the geographical proximity of public veterinary centres was the most important, followed by chance of conception, chance of recovery, being able to find prescribed treatments, waiting time before meeting the service provider, attitude of staffs in the centres and receiving adequate information on the sickness and treatment of animals.

Almost all the farmers, who visited public veterinary centres either for receiving animal health services or breeding their bovines, took the animals to the centre on foot**.** It took, 34.41 minutes, on average, for them to reach the centre. This was perceived as 'very far' and 'far' by more than half of the sample (very far: 13.44 per cent; far: 47.81 per cent). On the other hand, respondents declared a mean preferred travel time, the one that they estimated as 'very close' was 13.60 minutes. On an average, farmers waited 32.16 minutes prior to the veterinary consultation or bovine breeding at public veterinary centres. This was perceived as very long by 2.19 per cent of respondents and long by 40.00 per cent. Farmers declared that a waiting time of 19.50 minutes shall be perceived as not long at all, which is to be considered as a preferred state. Of the 320 farmers interviewed, 65 (20.31 per cent) farmers complained that the attitude of centre's staff as very bad, while 74 (23.13 per cent) farmers reported that the attitude of staff as bad. However, more than half of the respondents (56.56 per cent) declared that they were received and treated kindly at the centre. All the prescribed or required drugs (or semen straw) for treatment (or insemination) were reported available for 65.93 per cent of respondents, while some of the drugs alone were available for 24.13 per cent of users and 10.94 per cent of farmers could not find any prescribed drug. The farmers' answers to the different Likert scaling questions led to the per cent estimation of a mean SPFR score of 76.43, which indicated that most of the farmers had a good relationship with the service provider, stayed sufficient time in the centre and got the required information on the health/heat status of their animals. The mean score percentage of chance of recovery attribute worked out from the responses of farmers to the different Likert scaling questions was 72.63. The results indicated that there existed scope to improve the chance of recovery in the centres by establishing adequate clinical infrastructure

and infusing recent technical know-hows to the service providers. The per cent estimation of a mean chance of conception score was 48.28. More importantly, 79.69 per cent of respondents were willing to pay for improving the chance of conception rate. The results revealed the intensity of problems faced by the farmers owning breedable bovines.

Seven Tobit regression analyses were carried out to explore the relationship between each of the partial WTP values and the corresponding quality attribute's *status quo* level, adjusting for farmers' socio-demographic and economic characteristics, besides variables concerning the location of the public veterinary centre. The marginal effects of (i) variations in the positive WTP values, and (ii) variations in the probability of stating a positive WTP values for respondents who declared that they were not willing to pay were also estimated.

Overall, the respondents in the study area were willing to pay Rs.7.72 for improving the geographical proximity attribute of the public veterinary centre, while they were ready to pay Rs.7.72 for minimising waiting time in public veterinary centres. In order to benefit from a better attitude exhibited by the staff of public veterinary centres, the farmers were willing to pay Rs.5.20 and were willing to pay an average of Rs.6.58 as extra user fee on every visit so as to get all the medicines and breeding facilities in the public veterinary centre at all times. Similarly, the respondents in the study area were willing to pay Rs.3.91 for improving the relationship with the service providers of public veterinary centre and Rs.5.84 as user fee on every visit so as to improve the chance of recovery of their animals' ailments after getting treated at public veterinary centre. However, the farmers were willing to pay a mean sum of Rs.11.71 for improving the chance of conception of animals inseminated at public veterinary centres. An absolute concordance on the levels of attributes and the variations in the stated positive WTP values for quality improvements was noticed. Tobit regression analyses on the improvements of all above attributes indicated that the farmers who were at disadvantaged levels of each attribute were willing to pay more compared to those at an advantaged level.

The Garrett's score had shown in similar ranks for the constraints listed for both animal health care and bovine breeding services. Among the constraints faced by the farmers on availing services from public veterinary centres, long distance of the public veterinary centre was ranked first, followed by long waiting time before their case being attended to inadequacy of drugs, poor quality inputs, inconvenient working hours, poor quality services, labour scarcity to take the animals to the centre, inadequacy of skilled staff and poor attitude were listed as constraints.

Regarding private livestock services, the high service charges levied, followed by expensive drugs and semen straw cost, delay in availing appointment, non-availability of service personnel, long waiting time, long travel time, lack of trained veterinarians, inconvenient working hours and inadequate infrastructure. However, poor attitude of the service providers listed in the interview schedule was not quoted by any farmers in the study area as a limiting factor in availing private services.

6.2 Conclusions

Although the public veterinary centres continue to be the single major animal health care and bovine breeding service providers, the efficiency and the effectiveness with which they deliver the services appear to have been lesser than expected, as the result of need for huge financial resources required on the part of the government to create and sustain necessary clinical and breeding infrastructure and the enormous drain on government to support manpower. Demand for public services is likely to dwindle unless the quality of public veterinary services is improved. Home services produced better results compared to in-centre services, in terms of number of visits required for treating a case and the number of AIs per conception in bovines. The farmers are willing to pay for contract annual total health care of animals and bovine breeding services, besides being ready to pay more if improvement in the quality of public veterinary services is assured to them.

POLICY IMPLICATIONS

In the light of the findings of the study and the conclusions drawn from the results, the following policy options are drawn for promoting delivery and acceptance of animal health care and breeding services, so as to ensure better animal care and to assure better productivity of livestock and ultimately uplift the livestock farmers in particular and the rural poor in general:

1. The study suggests that, as most of the livestock keepers are willing to pay for high-quality animal health care and bovine breeding services, there is a need to improve the quality of public livestock services, in terms of geographical proximity, waiting time, attitude of staff, information dissemination, drug availability, chance of recovery from ailments and chance of conception after AI.
2. The farmers are willing to pay for the reduced travel distance, which would in turn reduce transportation stress and also cost. Therefore, the number of veterinary institutions delivering livestock services should be increased, besides ensuring their presence amidst rural habitations, so that the services can be charged nominally.
3. Public veterinary centres should be improved by equipping with necessary infrastructure and imparting latest technical know-how to the service providers, so that early recovery from illness can be ensured for which partial cost recovery measures from the users can be imposed as the farmers are willing to pay.
4. In order to make sure that all the prescribed treatments are available at public veterinary centres, the centres should be stocked with adequate and relevant medicaments, taking into account the agro-climate and endemic diseases existing in different areas.
5. Efforts should be taken up to improve the chance of conception in bovines inseminated at public veterinary centres by ensuring better quality management in AI, besides imparting an extension programme to update the farmers' knowledge on bovine breeding. Results of the study also indicated

that a marginal increase in the AI charges could be attempted to, when the services per conception could be minimised.

6. A model 'vet-claim' policy in line with the 'medi-claim' policy for humans may be evolved to extend 'annual animal health care' and 'contract breeding services' for which the farmers are willing to pay.
7. The government should also enable networking of veterinarians and para-veterinarians by clearly defining their roles, so as to expand the access to livestock services to all sections of farming community. Further, a regulatory framework for ensuring quality private livestock services should be devised.
8. The role of government and private livestock service providers should be balanced by restructuring the animal health care and bovine breeding networks and enabling each of the service institutions to develop into financially viable entities, which would require partial cost-recovery for the drugs used during the delivery of services at the centre and a full cost-recovery for the drugs and transport on delivering services at home.
9. A round the clock in-centre and mobile livestock services facilities could be created in livestock developed districts and their financial sustainability could be ensured on recovering full cost, at least in terms of transport and drugs, involved in rendering these services. These types of facilities would improve the access to quality livestock services for farmers and reduce exploitation by unethical practitioners.
10. Animal health care and bovine breeding services are of private good in nature and can be efficiently delivered by private livestock service providers. On the other hand, considering fiscal deficit and the difficulties the government experiences in providing free services, the government can pay attention towards market failures and provide public good services only for disease surveillance and disease eradication, preventive vaccination, regulation, legislation and quality control and the other sector support functions.

11. In order to ensure subsidised livestock services to the poor livestock keepers, and farmers in marginal areas where access to private livestock services are limited, the government should find out appropriate means of delivering these services. Partnership with private organizations and NGOs may also be thought of in this regard.

REFERENCES

Adamowicz, W., P. Boxall, M. William s and J. Louviere, 1998. Stated preference approaches for measuring passive use values: Choice experiments and contingent valuation. *American Journal of Agricultural Economics,* 80(1): 64-75.

Ahuja, V., 1999. Animal health and breeding services in Gujarat: A profile of service providers. *Paper prepared for phase-I of the study on Impact of commercialization on poor: Case of livestock services in India*, sponsored by The World Bank, Washington, DC and the Swiss Agency for Development and Co-operation. pp.1-40.

Ahuja, V., P.S. George, S. Ray, K.E. McConnell, M.P.G. Kurup, V. Gandhi, D. Umali and C. De Haan, 2000. Agricultural services and the poor: Case of livestock health and breeding services in India, IIM, Ahmedabad; The World Bank, Washington, DC and Swiss Agency for Development and Cooperation, Bern. pp. 1-148.

Ahuja, V. and E. Redmond, 2001. Economic and policy issues in livestock service delivery to the poor: Background paper for the FAO project memorandum. Pro-poor livestock policy initiative: Fostering the policy dialogue in support of equitable, safe and clean livestock farming. pp. 1-32.

Ahuja, V., K.E. McConnell, D. Umali and C. De Haan, 2003. Are the poor willing to pay for livestock services? Evidence from rural India. *Indian Journal of Agricultural Economics, 58* (1): 84-99.

Ahuja, V., 2004. The economic rationale of public and private sector roles in the provision of animal health services. *Scientific and Technical Review*, OIE*.,* 23(1): 33-45.

Ahuja, V. and E. Redmond, 2004. Livestock services and the poor. *Tropical Animal Health and Production,* 36(3): 247-268.

Ajzen, I., T.C. Brown and L.H. Rosenthal, 1996. Information bias in contingent valuation: Effects of personal relevance, quality of information and motivational orientation. *Journal of Environmental Economics and Management*, 30(1): 43-57.

Angniman, P.A., 1996. Privatization of veterinary services within the context of structural adjustment in Mali, Cameroon and Chad. FAO, Rome.

Ashley, S.D., S.J. Holden and P.B.S. Bazeley, 1996. The changing role of veterinary services: A report of a survey of chief veterinary officers' opinions. *Livestock in Development: A report to the Office International des Epizooties.* pp. 1-19.

Balasubramaniam, R. and A. Johnknight, 1982. Bottlenecks in modern dairying. *Indian Journal of Extension Education,* 18: 102-104.

Bennett, R. and D. Larson, 1996. Contingent valuation of the perceived benefits of farm animal welfare legislation: An exploratory survey. *Journal of Agricultural Economics,* 47(2): 224-235.

Bennet, J., M. Morrison and R. Blamy, 1998. Testing the validity of responses to contingent valuation questioning. *The Australian Journal of Agricultural and Resource Economics,* 42: 131-148.

Beynon, J., S. Akroyd, A. Duncan and S. Jones, 1998. Financing the future: Options for agricultural research and extension in sub-Saharan Africa. Oxford Policy Management, Oxford.

Bhalla, G.S. and P. Hazell, 1997. Food grains demand in India to 2020: A preliminary exercise. *Economic and Political Weekly,* 32(52): A150-A154.

Bishop, R.C. and T.A. Heberlein, 1979. Measuring values of extra market goods: Are indirect measures biased? *American Journal of Agricultural Economics,* 61:926-930.

Blamey, R.K., 1998. Decisiveness, attitude expression and symbolic responses in contingent valuation surveys. *Journal of Economic Behavior and Organization,* 34(4): 577-601.

Blamey, R.K., J.W. Bennett and M.D. Morrison, 1999. Yea-saying in contingent valuation surveys. *Land Economics,* 75(1): 126-141.

Blumenschein, K., M. Johannesson, G.C. Blomquist, B. Liljas and R.M. O'Conor, 1998. Experimental results on expressed certainty and hypothetical bias in contingent valuation. *Southern Economic Journal,* 65(1): 169-177.

Bohara, A.K., M. McKee, R.P. Berrens, H.J. Smith, C.L. Silva and D.S. Brookshire, 1998. Effects of total cost and group size information on willingness to pay responses: Open ended vs. dichotomous choice. *Journal of Environmental Economics and Management,* 35(2): 142-163.

Boyle, K.J., R.C. Bishop and M.P. Welsh, 1985. Starting point bias in contingent valuation bidding games. *Land Economics,* 61: 188-194.

Boyle, K.J., M.P. Welsh and R.C. Bishop, 1993. The role of question order and respondent experience in contingent valuation studies. *Journal of Environmental Economics and Management,* 25: S80-S99.

Boyle, K.J., F.R. Johnson, D.W. McCollum, W.H. Desvousges, R.W. Dunford and S.P. Hudson, 1996. Valuing public goods: Discrete versus continuous contingent valuation responses. *Land Economics,* 72(3): 381-396.

Boyle, K.J. and R.C. Bishop, 1988. Welfare measurement using contingent valuation: A comparison of techniques. *American Journal of Agricultural Economics,* 70: 372-381.

Boyle, K.J., H.F. MacDonald, H. Cheng and D.W. McCollum, 1998. Bid design and yea-saying in single bounded, dichotomous choice questions. *Land Economics,* 74(1): 49-64.

Breffle, W.S., E.R. Morey and T.S. Lodder, 1998. Using contingent valuation to estimate a neighbourhood's willingness to pay to preserve undeveloped urban land. *Urban Studies,* 35(4): 715-727.

Brown, T.C., P.A. Champ, R.C. Bishop and D.W. McCollum, 1996. Which response format reveals the truth about donations to a public good? *Land Economics,* 72(2): 152-166.

Buckland, S., D. MacMillan, E. Duff and N. Hanley, 1999. Estimating mean willingness to pay from dichotomous choice contingent valuation studies. *Journal of the Royal Statistical Society Series D-The Statistician,* 48: 109-124.

Calia, P. and E. Strazzera, 2000. Bias and efficiency of single versus double bound models for contingent valuation studies: A Monte Carlo analysis. *Applied Economics,* 32(10): 1329-1336.

Cameron, T.A., 1988. A new paradigm for valuing market goods using referendum data: Maximum likelihood estimation by censored logistic regression. *Journal of Environmental Economics and Management,* 13: 255-268.

Cameron, T.A. and D.D. Huppert, 1989. OLS versus ML estimation of non-market resource values with payment card interval data. *Journal of Environmental Economics and Management,* 17: 230–246.

Cameron, T.A and J. Quiggin, 1994. Estimation using contingent valuation data from a dichotomous choice with follow-up' questionnaire. *Journal of Environmental Economics and Management,* 27: 218-234.

Carney, D., 1998. Implementing the sustainable rural livelihoods approach. *In* Carney, D (Ed.). Sustainable rural livelihoods: What contribution can we make?. London, UK: DFID. pp. 1-218.

Carson, R.T., R. Groves and M. Machina, 1999. Incentive and informational properties of preference questions. Plenary address, European Association of Environmental and Resource Economics, Oslo, Norway.

Chen, H.Z. and S.R. Cosslett, 1998. Environmental quality preference and benefit estimation in multinomial probit models: A simulation approach. *American Journal of Agricultural Economics,* 80(3): 512-520.

Cheneau, Y., 1985. The organization of veterinary services in Africa. *Revue Scientifique et Techniqu :Office International des Epizooties,* 5 : 107–114.

Chilonda, P. and G. V. Huylenbroeck, 2001. A conceptual frame work for the economic analysis of factors influencing decision-making of small-scale farmers in animal health management. *Review of Scientific technology, Office International des Epizooties,* 20(3): 687-700.

Cho, S.H., D.H. Newman and J.M. Bowker, 2005. Measuring rural homeowners' willingness to pay for land conservation easements. *Forest Policy and Economics,* 7: 757-770.

CIE, 2001. Centre for international economics. Review of willingness-to-pay methodologies. *Prepared for Independent Pricing and Regulatory Tribunal of NSW. Centre for International Economic.* Canberra and Sydney. pp. 1-48.

Cinnamond, A.R., 2004. Animal health policy and practice: Scaling-up community based animal health systems, lessons from human health. Pro-poor livestock policy initiative. PPLPI Working paper No.22. pp.1-39.

Creel, M., 1998. A note on consistent estimation of mean WTP using a misspecified logit contingent valuation model. *Journal of Environmental Economics and Management,* 35(3): 277-284.

Cummings, R.G., G.W. Harrison and E.E. Rutstrom, 1995. Homegrown values and hypothetical surveys: Is the dichotomous choice approach incentive-compatible? *American Economic Review,* 85: 260-266.

Daniels, P and D. Skerman, 1993. Funding research and development – A producer pays approach. *In* Daniels, L., S. Holden, E. Lewin and S. Dadi (Eds), 1993. Livestock services for smallholders. Proceedings of a seminar, Yogyakarta, Indonesia, 10-15 November, 1992.

Dario, B., S. Nocera and H. Telser, 2001. The Contingent valuation method in health care: An economic evaluation of Alzheimer's disease. Discussion paper, January 2001. Department of Economics. Institute of Economics, University of Bern Gesellschaftsstr. Bern, Switzerland. pp.1-113.

Davis, R.K., 1963. Recreation planning as an economic problem. *Natural Resources Journal,* 3: 239-249.

De Haan, C. and S. Bekure, 1991. Animal health services in sub-Saharan Africa: Initial experiences with alternative approaches. World Bank Technical Paper 134, The World Bank, Washington, DC.

De Haan, C. and N.J. Nissen, 1985. Animal Health Services in sub-Saharan Africa: Alternative approaches. World Bank Technical Paper 44. The World Bank, Washington, DC.

DELIVERI, 2001. Private veterinary services, http://www.deliveri.org/deliveri/pilotapp/pvsintro.htm

Donaldson. C., A.M. Jones, T.J. Mapp and J.A. Olson, 1998. Limited dependent variables in willingness to pay studies: Applications in health care. *Applied Economics,* 30(5): 667-677.

Dwyer Leslie Pvt. limited, 1991. Drinking water quality. Economic evaluation, cost benefits study. http://www.deh.gov.au/about/publications/economics/subsidies/subsref.html

Fabbri, D. and C. Monfardini, 2002. Public Vs. private health care services demand in Italy. Working paper, Department of economics, Bologna, Italy. pp. 1-21.

FAO, 1988. Regional decentralisation for agricultural development planning in the Near East and North Africa. FAO Economic and Social Development Paper No.73, FAO, Rome.

FAO, 1990. Strengthening animal health services in developing countries, FAO Expert Consultation, FAO, Rome.

FAO, 1997. Profile of veterinary services in New Zealand (1995). FAO electronic conference on principles for rational delivery of public and private veterinary services.

FAO, 1998. Principles for rational delivery public and private veterinary services with reference to Africa.

FAO, 2005. Livestock information, sector analysis and policy research, AGAL livestock sector brief – India. pp. 1-21.

Fox, J.A., 1995. Determinants of consumer acceptability of bovine somatotropin. *Review of Agricultural Economics*, 17: 51-62.

Fox, J.A., J.F. Shogren, D.J. Hayes and J.B. Kliebenstei, 1998. Calibrating contingent values with experimental auction markets. *American Journal of Agricultural Economics,* 80: 455-465.

Frew, J.E., L.J. Wolstenholme and K.D. Whynes, 2004. Comparing willingness-to-pay: Bidding game format versus open-ended and payment scale formats. *Health policy,* 68: 289-298.

Garret, H.E. and R.S. Woodworth, 1969. Statistics in psychology and education. Bombay Vkils, Feffer and Simons Pvt. Ltd., pp. 329.

George, P.S. and K.N. Nair, 1990. Livestock economy of Kerala, Centre for Development studies, Trivandrum.

GOI, 1996. National livestock policy perspective: Report of the steering group. Ministry of Agriculture, New Delhi.

Government of Tamil Nadu, 2004. Policy note 2004-2005. Animal Husbandry Department demand no.6. Status of Animal Husbandry in the State.

GOI, 2006. Annual report 2005-06, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Government of India. pp. 1-87.

Green, P.E. and V. Srinivasan, 1978. Conjoint analysis in consumer research issues and outlook. *Journal of Consumer Research,* 5: 103-123.

Green, D., K. Jacowitz, D. Kahneman and D. McFadden, 1998. Referendum contingent valuation, anchoring and willingness to pay for public goods. *Resource and Energy Economics,* 20(2): 85-116.

Greene, W.H., 2000. Econometric Analysis, 4th Ed. Prentice Hall, New Jersey.

Gros, J.G., 1994. Of cattle, farmers, veterinarians and the world bank: The political economy of veterinary services privatization in Cameroon**.** *Public Administration and Development*, 14: 37-51.

Haab, T.C. and K.E. McConnell, 1998. Referendum models and economic values: Theoretical, intuitive and practical bounds on willingness to pay. *Land Economics,* 74(2): 216-229.

Haab, T.C., 1999. Nonparticipation or misspecification? The impacts of nonparticipation on dichotomous choice contingent valuation. *Environmental and Resource Economics,* 14(4): 443-461.

Hady, P.J. and J.W. Lloyd, 1992. Economic issues for the dairy practioner, Part II. Impact of dairy farm size on veterinary services. The Compendium, Food Animal, 14(12): 1641-1654.

Hair, J.F., R.E. Anderson, R.L. Tatham and W.C. Black, 1998. Conjoint analysis**.** Multivariate data analysis, Chapter 10, pp. 556-601.

Halvorsen, B. and K. Salensminde, 1998. Differences between willingness to pay estimates from open ended and discrete choice contingent valuation methods: The effects of heteroscedasticity. *Land Economics,* 74(2): 262-282.

Hanemann, M.W., 1984. Welfare evaluation in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics,* 66: 332-341.

Hanemann, M.W., 1991. Willingness-to-pay and willingness-to-accept : How much can they differ? *American Economic Review,* 8: 635-647.

Hanemann, M.W., 1994. Valuing the environment through contingent valuation. *Journal of Economic Perspectivees,* 8: 19-43.

Hanley, N., R.E. Wright and V. Adamowicz, 1998. Using choice experiments to value the environment: Design issues, current experience and future prospects. *Environmental and Resource Economics,* 11(3-4): 413-428.

Harrison, G.W., R.M. Harstad and E. Ruststrom, 2002. Experimental methods and elicitation of values. Working paper, University of South Carolina, Department of Economics.

Heineck, G., 2004. Religion, attitudes towards working mothers and wives' full-time employment: Evidence for Austria, Germany, Italy, the UK, and the US' ÖIF. Working Paper No.39-04. Department of Economics, University of Granada, Spain.

Henson, S., 1996. Consumer willingness to pay for reductions in the risk of food poisoning in the UK. *Journal of Agricultural Economics,* 47(3): 403-420.

Holden, S. and S. Chema, 1996. Delivery of animal health services: Kenya. Interim report/discussion document. May 1996. Livestock in Development, Crewkerne, Somerset.

Holden, S., S. Ashley and P. Bazeley, 1996. Improving the delivery of animal health services in developing countries: A literature Review, Livestock in Development, Somerset, UK.

Holden, S., 1999. The economy of the delivery of veterinary services. *Revue Scientifique et Technique. Officer International des Epizooties*, 18: 425–439.

Holmes, T.P. and R.A. Kramer, 1995. An independent sample test of yea-saying and starting point bias in dichotomous-choice contingent valuation. *Journal of Environmental Economics and Management,* 29(1): 121-132.

Hooton, N. and D. Moran, 2003. The demand for community based animal health services: Are farmers willing to pay? Chapter 8. *In* community based animal health workers: Threat or oppurtunity? The IDL Group, Crewkerne. pp: 12-13.

Howe, C.W., B.J. Lee and L.L. Bennett, 1994. Design and analysis of contingent valuation surveys using the nested Tobit model. *Review of Economics and Statistics,* 76(2): 385-389.

James, L., C. Heffernan and A.E. Sidahmed, 1999. IFAD and the delivery of veterinary services to the rural poor. Technical paper, IFAD, Rome.

Jarvis, L.S., 1986. Livestock development in Latin America. The World Bank, Washington, DC.

Johannesson, M., 1996. Theory and methods of economic evaluation of health care. Series: Developments in health economics and public policy , Vol. 4. pp.264.

Johannesson, M., B. Jonsson and L. Borgquist, 1991. Willingness-to-pay for antihypertensive therapy: Results of a Swedish pilot study. *Journal of Health Economics,* 10(4): 461-474.

Johannesson, M., P.O. Johansson and B. Jonsson, 1992. Economic evaluation of drug therapy. A review of the contingent valuation method. *Pharmaco Economics,* 1: 325-337.

Johannesson, M., B. Liljas and P.O. Johansson, 1998. An experimental comparison of dichotomous choice contingent valuation questions and real purchase decisions. *Applied Economics,* 30(5): 643-647.

Johnson, K.B., J.G. Brown and C.J. Whitehead, 1998. Estimation of the value of public goods generated by improved sport stadiums and arenas using the contingent valuation method. A paper presented at the annual meeting of the Western Economic Association in Lake Tahoe, Nevada, June 28-July 2,1998.

Johnston, F.R. and W.H. Desvousges, 1997. Estimating stated preferences with rated-pair data: Environmental, health and employment effects of energy programs. *Journal of Environmental Economics and Management,* 34: 79-99.

Jordan, J.L. and A.H. Elnagheeb, 1994a. Consequences of using different question formats in contingent valuation: A Monte Carlo study. *Land Economics,* 70(1): 97-110.

Jordan, J.L. and A.H. Elnagheeb, 1994b. Differences in contingent valuation estimates from referendum and checklist questions. *Journal of Agricultural and Resource Economics,* 19(1): 115-128.

Jorgensen, BS., G.J. Syme, B.J. Bishop and B.E. Nancarrow, 1999. Protest responses in contingent valuation. *Environmental and Resource Economics*, 14(1): 131-150.

Kahneman, D. and J.L. Knetsch, 1992. Contingent valuation and the value of public goods: Reply. *Journal of Environmental Economics and Management*, 22: 90-94.

Kanninen, B.J., 1995. Bias in discrete response contingent valuation. *Journal of Environmental Economics and Management,* 28:114-125.

Kartamulia, I., A. Misniwaty and H. Knipscheer, 1995. Development of a private health delivery network in North Sumatra, Indonesia. *Agriculture and Human Values*, 12: 39–44.

Kealy, M.J. and R.W. Turner, 1993. A test of the equality of closed-ended and open-ended contingent valuations. *American Journal of Agricultural Economics,* 75(2): 321-331.

Kleeman, G., 1999. Responses of the livestock services delivery and its management to the Asian economic crisis. Proceedings of the workshop on the implications of the Asian economic crisis for the livestock industry held in Bangkok on 6–9 July 1999. Organised by FAO, UN.

Kline, J. and D. Wichelns, 1998. Measuring heterogeneous preferences for preserving farmland and open space. *Ecological Economics,* 26(2): 211-224.

Koma, L.M.P.K., 2000. Can private veterinarians survive in Uganda? *In* David Leonard (Ed.), Africa's changing markets for health and veterinary services: The new institutional issues, Macmillan Press Ltd, London and St.Martin's Press Inc, New York.

Krupnick, A.J. and M.L. Cropper, 1992. The effect of information on health risk valuations. *Journal of Risk and Uncertainty,* 5: 29-48.

Kunzru, O.N., K.L. Sagar, S. Kumar and P. Singh, 1989. Constraints perceived by the livestock owners in adoption of artificial insemination. *Indian Journal of Extension Education,* 3: 114-115.

Langford, I.H., 1994. Using a generalized linear mixed model to analyse dichotomous choice contingent valuation data. *Land Economics,* 70(4): 507-514.

Langford, I.H., A. Kontogianni, M.S. Skourtos, S. Georgiou, and I.J. Bateman, 1998. Multivariate mixed models for open-ended contingent valuation data - Willingness to pay for conservation of monk seals. *Environmental and Resource*
Economics, 12(4): 443-456.

Leonard, D., 1985. The supply of veterinary services. Discussion paper 191, Harvard Institute for International Development, Cambridge, MA, USA.

Leonard, D.K., 1993. Structural reform of the veterinary profession in Africa and the new institutional economics. *Development and Change,* 24: 227-267.

Leonard, D.K., 1985. African practice and the theory of user fees. *Agricultural Administration,* 18: 137-157.

Leonard, D.K., 1990. Research proposal on the organisation of animal health services in Africa. Paper presented at the international livestock centre for Africa. Addis Ababa**.** Processed

Leonard, K.L., 2001. When both states and markets fail: Asymmetric information and the role of NGOs in African health care, Department of Economics, Columbia University, New York.

Leyland, T., 1996. The world without rinderpest: Outreach to inaccessible areas. The case for a community based approach with reference to southern Sudan. *In* Proc. Food and Agriculture Organisation (FAO), Technical consultation on the global rinderpest eradication programme, Rome, 22-24 July. FAO Animal Production and Health Paper, 129. FAO Rome. pp.173.

List, J.A. and J.F. Shogren, 1998. Calibration of the differences between actual and hypothetical valuations in a field experiment. *Journal of Economic Behaviour and Organization,* 37: 193-205.

Loehman, E. and Vo Hu De, 1982. Application of stochastic choice modelling to policy analysis of public goods: A case study of air quality improvements. *Review of Economics and Statistics,* 54: 474-480.

Long, S., 1997. Regression models for categorical and limited dependent variables. Thousand Oaks, Sage Publications, California.

Loomis, J., K. Traynor and T. Brown, 1999. Trichotomous choice: A possible solution to dual response objectives in dichotomous choice contingent valuation questions. *Journal of Agricultural and Resource Economics,* 24(2): 572-583.

Louviere, J.J and H. Timmermans, 1990. Stated preference and choice models applied to recreation research: A review. *Leisure sciences,* 12: 9-32.

Louviere, J.J., D.A. Hanser and J.D. Swait, 2000. Stated choice methods: Analysis and application. Cambridge University Press, Cambridge.

Lusk, J.L. and T.C. Schroeder, 2002. Incentive compatibility of choice experiments. Working paper, Department of Agricultural Economics, Mississippi state University, Mississippi.

Lusk, J.L. and D. Hudson, 2004. Willingness-to-pay estimates and their relevance to Agribusiness decision making. *Review of Agricultural Economics,* 26(2): 152-169.

Luzar, E.J and J.K. Cosse, 1998. Willingness-to-pay or intention to pay: The attitude behaviour relationship in contingent valuation. *Journal of Socio Economics,*
27(3): 427-444.

Mackenzie, J., 1993. A comparison of contingent preference models. *American Journal of Agricultural Economics,* 75(3): 593-603.

Macmillan, D. and N. Lienhoop, 2003. Valuing non-market benefits using the 'Market Stall' approach. Agricultural Economics Conference, Plymouth, March 2003.

Mansfield, C., 1998. A consistent method for calibrating contingent value survey data. *Southern Economic Journal,* 64(3): 665-681.

Mataria, A., C. Donaldson, S. Luchini, J.P. Moatti, 2004. A stated preference approach to assessing health care-quality improvements in Palestine: From theoretical validity to policy implications. *Journal of Health Economics,* 23: 1285–1311.

McDonald, J.F. and R.A. Moffitt., 1980. The use of Tobit analysis. *The Review of Economics and Statistics,* 62: 318-321.

McInerney, J.P., K.S. Howe and J.A. Schepers, 1992. A framework for the economic analysis of disease in farm livestock. *Preventive Veterinary Medicine,* 123: 137-154.

Milgrom, P.R and R.J. Weber, 1982. A theory of auction and competitive bidding. *Econometrica,* 50: 1089-1122.

Mitchell, R.C. and R.T. Carson, 1981. An experiment in determining willingness-to-pay for national water quality improvements. Draft report submitted to U.S. Environmental Protection Agency, Office of Policy Analysis. Washington, DC.

Mlangwa, J.E.D. and D.N. Kisauzi, 1994. Systems approach to animal health services delivery in sub-Saharan Africa: The case of privatization. *Revue Scientifique et Technique. Officer International des Epizooties,* 13, Paris: 673–685**.**

Morey, E., K. Rossmann, L. Chestnut and S. Ragland, 1997. Valuing acid deposition injuries to cultural resources. On-line Discussion Papers, Prepared for: National Acid Precipitation Assessment Program, Washington DC. http://www.colorado.edu/Economics/morey/monument/index.html

Morrison, M., J. Bennett and R. Blamey, 1999. Valuing improved wetland quality using choice modelling. *Water Resources Research,* 35(9): 2805-2814.

Mpelumbe, I.S., 1994. Perspectives on the privatization of the veterinary practice in the context of livestock production in Africa. Rapports de synthese sur les themes techniques presentes au comite international ou aux commissions regionales. pp. 73-87.

Mugunieri, L., J. Omiti, and P. Irungu, 2003. Policy requirements to accommodate community-based animal health workers in Kenya. IPAR Policy Brief, 9(2): 1-4.

Mullahy, J., 1986. Specification and testing of some modified count data models. *Journal of Econometrics*, 33: 341-365.

Nader, A., 1996. Profile of the veterinary services in the Republic of Argentina, http://www.fao.org/waicent/faoinfo/agricult/aga/agah/vets-1-2/leng.htm

Noronha, K.V.M.S. and M.V. Andrade, 2002. Social inequality in the access to health care services in Brazil. Discussion paper No. 172, Cedeplar/Face/Ufmg, Belo Horizonte. pp. 1-41.

O'Conor, R.M., M. Johannesson and P.O. Johansson, 1999. Stated preferences, real behaviour and anchoring: Some empirical evidence. *Environmental and Resource Economics,* 13(2): 235-248.

Odeyemi, I.A.O., 1994. A review of the policy to privatize animal health delivery services in Nigeria. Report submitted to Edinburgh University Development Fund, University of Edinburgh.

Okwiri, F.O., J.K. Kajume and R.D. Odondi, 2001. An assessment of the economic viability of private animal health service delivery in pastoral areas of Kenya. Global Providers International Ltd, Nairobi for OAU/IBAR, Nairobi.

Ozayan, A., 1997. Market Analysis of New Minced Meat Products Made From Undersized Crawfish. Unpublished Thesis, submitted to Department of agricultural Economics and Agribusiness, Louisiana State University .

Ozuna, T., K.Y. Jang and J.R. Stoll, 1993. Testing for misspecification in the referendum contingent valuation approach. *American Journal of Agricultural Economics,* 75(2): 332-338.

Pamela, S.A.W., H.J. Wynne, H.W. Ploeger and D.K. Leonard, 2003. Path analysis of subsistence farmers' use of veterinary services in Zimbabwe. *Preventive Veterinary Medicine,* 61: 339-358.

Pigou, A.C., 1946. The Economics of Welfare. 4 th Ed. London, Macmillan.

Prabaharan, R., 2000. Livestock – research investment crucial. The Hindu Survey of Indian Agriculture, (The Hindu, Chennai). pp.137–140.

Pradhan, P., V. Ahuja and P. Venkatramaiah, 2002. Livestock services and the poor. *In* Papers, proceedings and presentations of the international workshop held at Bhubaneswar, India, October 28-29. pp. 231-237.

Quiggin, J., 1998. Individual and household willingness to pay for public goods. *American Journal of Agricultural Economics,* 80(1): 58-63.

Rajarethinam, P., 2002. Pudukottai livestock development project: An alternative service delivery system to reach the poor. Livestock services and the poor. *In* Papers, proceedings and presentations of the international workshop held at Bhubaneswar, India, October 28-29. pp. 231-237.

Rajasree, B., 2000. Farmers' perception on privatising animal husbandry extension services. Unpublished M.V.Sc., Theses submitted to Tamil Nadu Veterinary and Animal Sciences University, Chennai- 51.

Rajasree, B and R. Subramanian, 2003. Willingness of farmers to pay for Animal Husbandry Extension Services. *Journal of Extension Education,* 14: 3543-3549.

Ramadas, R.S. and S.N. Ghotge, 2002. Towards sustainable community livestock healthcare delivery systems: Issues and options – The ANTHRA Experience. Livestock services and the poor. *In* Papers, proceedings and presentations of the international workshop held at Bhubaneswar, India, October 28-29. pp: 115-140.

Ramsey, J.B., 1969. Tests for specification errors in classical linear least squares regression analysis. *Journal of the Royal Statistical Society, Series B,* 31: 350-371.

Randall, A., B. Ives and C. Eastman, 1974. Bidding games for valuation of aesthetic environmental improvements. *Journal of Environmental Economics and Management*, 1: 132-149.

Randall, A., J.P. Hoehn and G.S. Tolley, 1981. The structure of contingent markets: Some results of a recent experiments. Paper presented at American Economics Association annual meeting, 1981.

Ravishankar, A. and S.P. Birthal, 1999. The livestock sector in India: A country report with special emphasis on trade with southeast Asian economies. Proceedings of the workshop on the implications of the Asian economic crisis for the livestock industry held in Bangkok on 6-9 July 1999. pp. 213-232.

Ready, R.C., J.C. Whitehead and G.C. Blomquist, 1995. Contingent valuation when respondents are ambivalent. *Journal of Environmental Economics and Management*, 29(2): 181-196.

Ready, R.C., J.C. Buzby and D. Hu, 1996. Differences between continuous and discrete contingent value estimates. *Land Economics*, 72(3): 397-411.

Reaves, D.W., R.A. Kramer and T.P. Holmes, 1999. Does question format matter? Valuing an endangered species. *Environmental and Resource Economics,* 14(3): 365-383.

Reiser, B., and M. Shechter, 1999. Incorporating zero values in the economic valuation of environmental program benefits. *Environmetrics,* 10(1): 87-101.

Riddel, M. and J. Loomis, 1998. Joint estimation of multiple CVM scenarios under a double bounded questioning format. *Environmental and Resource Economics,* 12(1): 77-98.

Roe, B., K.J. Boyle and M.F. Teisl, 1996. Using conjoint analysis to derive estimates of compensating variation. *Journal of Environmental Economics and Management,* 31(2): 145-159.

Rowe, R.D., W.D. Schulze and W.S. Breffle, 1996. A test for payment card biases. *Journal of Environmental Economics and Management,* 31(2): 178-185.

Ryan, M. and F.S. Miguel, 2000. Testing for consistency in willingness to pay experiments. *Journal of Economic Psychology,* 21(3): 305-317.

Sambidi, R.P., 2003. Factors affecting plant location decisions of U.S. broiler executives. Unpublished Thesis, submitted to Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College. pp. 1-108.

Schulze, W.D., D.S. Brookshire, E.G. Walther, K.K. MacFarl and M.A. Thayer, R.L. Whitworth, S. Ben-David, W. Malm, and J. Molenar, 1983. The economic benefits of preserving visibility in the National Parklands of the southwest. *Natural Resources Journal,* 23:149-173.

Selvakumar, K.N., N. Meganathan, M. Prabu and V. Palanichamy, 2002. Assessment of research priorities for livestock sector in Tamil Nadu. Report submitted to National Center for Agricultural Economics and Policy Research, New Delhi; Department of AH Economics, Madras Veterinary College, Tamil Nadu Veterinary and Animal Sciences University, Chennai- 51. pp.1-38.

Sellar, C., J.R. Stoll and J.P. Chavas, 1985. Validation of empirical measures of welfare change: A comparison of non-market techniques. *Land Economics,* 61: 156-175.

Sen, A., 2001. Profile of private veterinary practitioners (PVPs): An exploratory study in West Bengal State. M.V.Sc., Thesis submitted to Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh.

Sen, A. and M. Chander, 2003. Privatization of veterinary services in developing countries: A review. *Tropical Animal Health and Production,* 35: 223-236.

Shantanukumar and S.V.N. Rao, 1999. Awareness and utilization of dairy production inputs and services by the farmers of Bihar. *Rural India,* 155-157.

Shogren, J.F and J.A. Herriges, 1996. Starting point bias in dichotomous choice valuation with follow-up questioning. *Journal of Environmental Economics and Management,* 30: 112-131.

Shultz, S., J. Pinazzo, M. Cifuentes, 1998. Opportunities and limitations of contingent valuation surveys to determine national park entrance fees: Evidence from Costa Rica. *Environment and Development Economics,* 3(1): 131-149.

Singh, S., P.S. Birthal and B.S. Rathore, 1998. Review of animal health services in India. *Indian Journal of Animal Sciences,* 68: 420–424.

Smith, V.K., and C. Mansfield, 1998. Buying time: Real and hypothetical offers. *Journal of Environmental Economics and Management,* 36(3): 209-224.

Sulaiman, V.R. and V.V. Sadamate, 2000. Privatising agricultural extension in India, Policy paper 10, National Centre for Agricultural Economics and Policy Research (NCAP), New Delhi.

Tambi, N.E., W.A. Mukhebi, W.O. Maina and H.M. Solomon, 1999. Probit analysis of livestock produces' demand for private veterinary services in the high potential areas of Kenya. *Agricultural Systems,* 59: 163-176.

Tambour, M. and N. Zethraeus, 1998. Nonparametric willingness-to-pay measures and confidence statements. *Medical Decision Making,* 18(3): 330-336.

Thirunavukkarasu, M., 2003. An economic analysis of artificial breeding of bovines in Tamil Nadu. Report of ICAR adhoc scheme, Department of AH Statistics and Computer Applications, Madras Veterinary College, Chennai, India.

Thome, O., C. Mestre and A. Correze, 1995. The privatization of veterinary services: Who gains? *Hommes et Animaux,* 1995, 46–48.

Tobin, J., 1958. Estimation of relationships for limited dependent variables. *Econometrica,* 26: 24-36.

Trujillo, J.M.P., 1996. Veterinary services in Mexico. http://www.fao.org/ag/aga/agah/vets-l-2/3eng.htm.

Tulachan, P.M. and A. Neupane, 2000. Livestock in the mixed farming systems of the Hindu Kush-Himalayas. Trends and sustainability, FAO, Rome and International Centre for Integrated Mountain Development, Kathmandu.

Turkson, P.K. and C.F. Brownie, 1999. Perceived constraints to privatization of delivery of veterinary services in Ghana. *Tropical Animal Health and Production,* 31(2): 103-114.

Umali, D., G. Feder and C. De Haan, 1992. The balance between public and private sector activities in the delivery of livestock services. World Bank Discussion Papers No. 63, The World Bank, Washington, D.C.

Umali, D.L., G. Feder and C. De Haan, 1994. Animal health services: Finding the balance between public and private delivery. *The World Bank Research Observer,* 9(1): 71-96.

Umrani, A.P., 2001. Privatizing veterinary services. The Dawn, 22 Jan http: //www.dawn.com /2001/01/22/ebr12.htm.

Viscusi, W.K., W.A. Magat and J. Huber, 1991. Pricing environmental health risks: Survey assessments of risk-risk and risk-dollar trade-offs for chronic bronchitis. *Journal of Environmental Economics and Management,* 21(1): 32-51.

Welsh, M.P. and G.L. Poe, 1998. Elicitation effects in contingent valuation: Comparisons to a multiple bounded discrete choice approach. *Journal of Environmental Economics and Management,* 36(2): 170-185.

Werner, M., 1999. Allowing for zeros in dichotomous-choice contingent-valuation models. *Journal of Business & Economic Statistics,* 17(4): 479-486.

Whitehead, J.C., T.J. Hoban and W.B. Clifford, 1994. Specification bias in contingent valuation from omission of relative price variables. *Southern Economic Journal,* 60(4): 995-1009.

Whitehead, J.C., T.J. Hoban and W.B. Clifford, 1995. Measurement issues with interested, continuous/interval contingent valuation data. *Journal of Environmental Management,* 43: 129-39; 151-170.

Whitehead, J.C., G.C. Blomquist, R.C. Ready and J.C. Huang, 1998. Construct validity of dichotomous and polychotomous choice contingent valuation questions. *Environmental and Resource Economics,* 11(1): 107-116.

Winrock International, 1992. Assessment of animal agriculture in sub-Saharan Africa. Winrock International Institute for agricultural Development Morrilton, Arkansas.

Wise, J.K. and C.L. Adams, 1999. Size and organization of private veterinary practices. *Journal of the American Veterinary Medical Association,* 215: 790–791.

Wittink, D.R. and P. Cattin, 1989. Commercial use of conjoint analysis: An update. *Journal of Marketing,* Vol. 53.

Woods, P.S.A., 2000. The importance of proximity, transport and gender as transaction costs in the use of veterinary services in Zimbabwe. *In* Leonard. D.K. (Ed.). 2000, Restructuring Africas health and veterinary services: Issues from the New Institutional Economics, Macmillan, London. pp. 67-92.

World Bank, 1995. Toward gender equality: The role of public policy. The World Bank, Washington, DC.

World Bank, 1996. India's livestock sector review: Enhancing growth and development, Washington, DC.

Yoo, S.H., S.J. Kwak and T.Y. Kim, 2000. Dealing with zero response data from contingent valuation surveys: Application of least absolute deviations estimator. *Applied Economics Letters,* 7(3): 181-184.

APPENDIX

ANIMAL DISEASES/DISORDERS CATEGORISATION

Acute medical cases	Chronic medical cases	Acute surgical cases	Chronic surgical cases	Obstetrical cases	Gynaecological cases
• Milk fever • Mastitis • Ephemeral fever • Acidosis • Ketosis • Theileriosis • Fever • Pneumonia • Babesiosis • Indigestion	• Enteritis • Dermatitis • Anorexia • Snoring disease • Wasting diseases • GI worms • Ectoparasitic infestations	• Horn fracture • Laminitis • Lameness • Fracture • Thelitis • Bloat • Impaction • Incisions and lacerations • Displaced abomasum	• Maggot wound • Arthritis • Infected wounds • Abscess • Sprain • Yoke gall • Chronic luxation of patella	• Dystocia • Retained placenta • Uterine prolapse • Mummification • Maceration • Uterine torsion	• Metritis • Repeat breeding • Infantile genitalia • Cystic ovary

Table 5.1
AVERAGE LAND OWNERSHIP AMONG SAMPLE FARMERS

(In number)

Category of farmers	LUD districts			LD districts			Overall
	Thanjavur	Sivagangai	Total	Coimbatore	Villupuram	Total	
Marginal farmers	45 (1.41)	21 (1.32)	66 (1.38)	47 (1.25)	32 (1.24)	79 (1.25)	145 (1.31)
Small farmers	20 (4.03)	36 (3.91)	56 (3.95)	14 (4.08)	21 (4.02)	35 (4.04)	91 (3.98)
Large farmers	15 (9.19)	23 (7.26)	38 (8.02)	19 (8.24)	27 (7.83)	46 (8.00)	84 (8.01)
Total	80 (3.52)	80 (4.19)	160 (3.86)	80 (3.41)	80 (4.19)	160 (5.42)	320 (3.83)

Note: Marginal farmer: Less than 2.5 ac.; Small farmer: 2.5 to 5.0 ac.; Large farmer: More than 5 ac. of land.

Figures in parentheses indicate average land holding size

Table 5.2
AVERAGE ANIMAL OWNERSHIP AMONG SAMPLE FARMERS

Type of animal	LUD districts			LD districts			Overall
	Thanjavur	Sivagangai	Total	Coimbatore	Villupuram	Total	
Cow (Indigenous)	0.43 (34)	0.30 (24)	0.36 (58)	0.15 (12)	0.20 (16)	0.18 (28)	0.27 (86)
Cow (Crossbred)	0.94 (75)	1.01 (81)	0.98 (156)	1.78 (142)	1.55 (124)	1.66 (266)	1.32 (422)
Bullocks	1.19 (95)	0.89 (71)	1.04 (166)	0.95 (76)	0.93 (74)	0.94 (150)	0.99 (316)
Young cattle	1.53 (122)	1.51 (121)	1.52 (243)	1.49 (119)	1.60 (128)	1.54 (247)	1.53 (490)
Total cattle	**4.08 (326)**	**3.71 (297)**	**3.89 (623)**	**4.36 (349)**	**4.28 (342)**	**4.32 (691)**	**4.11 (1314)**
Buffalo (Non-Descript)	0.33 (26)	0.35 (28)	0.34 (54)	0.35 (28)	0.25 (20)	0.30 (48)	0.32 (102)
Buffalo (Graded)	0.11 (9)	0.10 (8)	0.11 (17)	0.25 (20)	0.24 (19)	0.24 (39)	0.18 (56)
Young buffalo	0.24 (19)	0.28 (22)	0.26 (41)	0.28 (22)	0.25 (20)	0.26 (42)	0.26 (83)
Total buffalo	**0.68 (54)**	**0.73 (58)**	**0.70 (112)**	**0.88 (70)**	**0.74 (59)**	**0.81 (129)**	**0.75 (241)**
Sheep	0.25 (20)	0.63 (50)	0.44 (70)	1.28 (102)	1.60 (128)	1.44 (230)	0.93 (300)
Goat	1.15 (92)	1.50 (120)	1.33 (212)	1.59 (127)	1.50 (124)	1.57 (251)	1.45 (463)
Total small ruminants	**1.40 (112)**	**2.13 (170)**	**1.76 (282)**	**2.86 (229)**	**3.15 (252)**	**3.01 (481)**	**2.38 (763)**
Total VLU	**3.85 (307.93)**	**3.66 (293.19)**	**3.76 (601.12)**	**4.63 (370.33)**	**4.40 (352.24)**	**4.52 (722.57)**	**4.14 (1323.69)**

Figures in parentheses indicate total number of animals in respective category;

VLU: Veterinary Livestock Units, where, 1 cow or buffalo or bullock=1 VLU; 2 young cattle or buffaloes=1VLU; 5 sheep or goats=1 VLU

Table 5.3
AVERAGE LIVESTOCK WEALTH AMONG DIFFERENT LAND HOLDING CATEGORIES

(in Numbers)

Land category	Cattle					Buffalo				Sheep	Goat	Total small ruminants
	Cow (Ind.)	Cow (CB)	Bulls/ Bullocks	Young Cattle	Total	Buffalo (ND)	Buffalo (Gra.)	Young Buffalo	Total			
LUD districts												
Marginal farmers	0.25 (14)	0.91 (51)	0.25 (14)	1.34 (75)	0.69 (154)	0.21 (12)	0.11 (6)	0.27 (15)	0.20 (33)	0.18 (10)	1.73 (97)	0.96 (107)
Small farmers	0.29 (11)	0.74 (28)	1.55 (59)	1.26 (48)	0.96 (146)	0.58 (22)	0.18 (7)	0.29 (11)	0.35 (40)	0.47 (18)	1.03 (39)	0.75 (57)
Large farmers	0.50 (33)	1.14 (77)	1.41 (93)	1.82 (120)	1.22 (323)	0.30 (20)	0.06 (4)	0.23 (15)	0.20 (39)	0.64 (42)	1.15 (76)	0.89 (118)
Total	0.36 (58)	0.98 (156)	1.04 (166)	1.52 (243)	0.97 (623)	0.34 (54)	0.11 (17)	0.26 (41)	0.23 (112)	0.44 (70)	1.33 (212)	0.88 (282)
LD districts												
Marginal farmers	0.09 (3)	1.20 (42)	0.23 (8)	1.11 (39)	0.66 (92)	0.40 (14)	0.43 (15)	0.40 (14)	0.41 (43)	0.43 (15)	2.11 (74)	1.27 (89)
Small farmers	0.22 (10)	1.48 (68)	1.00 (46)	1.65 (76)	1.09 (200)	0.46 (21)	0.11 (5)	0.26 (12)	0.28 (38)	0.37 (17)	1.54 (71)	0.96 (88)
Large farmers	0.19 (15)	1.97 (156)	1.22 (96)	1.67 (132)	1.26 (399)	0.16 (13)	0.24 (19)	0.20 (16)	0.20 (48)	2.50 (198)	1.34 (106)	1.92 (304)
Total	0.18 (28)	1.66 (266)	0.94 (150)	1.54 (247)	1.08 (691)	0.30 (48)	0.24 (39)	0.26 (42)	0.27 (129)	1.44 (230)	1.57 (251)	1.50 (481)
Overall												
Marginal farmers	0.17 (17)	1.02 (93)	0.24 (22)	1.25 (114)	0.68 (246)	0.29 (26)	0.23 (21)	0.32 (29)	0.28 (76)	0.27 (25)	1.88 (171)	1.08 (196)
Small farmers	0.25 (21)	1.14 (96)	1.25 (105)	1.48 (124)	1.03 (346)	0.51 (43)	0.14 (12)	0.27 (23)	0.31 (78)	0.42 (35)	1.31 (110)	0.86 (145)
Large farmers	0.33 (48)	1.61 (233)	1.30 (189)	1.74 (252)	1.24 (722)	0.23 (33)	0.16 (23)	0.21 (31)	0.20 (87)	1.66 (240)	1.26 (182)	1.46 (422)
Total	0.27 (86)	1.32 (422)	0.99 (316)	1.53 (490)	1.03 (1314)	0.32 (102)	0.18 (56)	0.26 (83)	0.25 (241)	0.94 (300)	1.45 (463)	1.19 (763)

Figures in parentheses indicate total number of animals in respective category

Table 5.4
STATUS QUO LEVEL OF SOME ECONOMIC FACTORS IN THE STUDY AREA

Economic factors	LUD districts	LD districts	Overall	't' value
Milk price (Rs./litre)	8.08 (0.053)	8.10 (0.07)	8.09 (0.04)	0.317^{NS}
Quantity of milk sold (litre/day)	8.32 (0.40)	12.43 (0.55)	10.39 (0.36)	6.015**
Household annual income (Rs.'000)	63.01 (3.77)	67.13 (2.76)	65.08 (2.33)	0.881^{NS}
Livelihood share of livestock	0.33 (0.20)	0.39 (0.18)	0.36 (0.01)	3.122**

Figures in parentheses indicate standard errors.
*NS- Not-significant (P≥ 0.05); ** Highly significant (P≤ 0.01)*

Table 5.5
PER CENT OF SAMPLE FARMERS HAVING ACCESS TO ANIMAL HEALTH AND BOVINE BREEDING SERVICES

Service provider category	LUD districts			LD districts			Overall
	Thanjavur	Sivagangai	Total	Coimbatore	Villupuram	Total	
Ethnic/ traditional healer	70.00	67.50	68.75	74.00	69.00	71.50	70.13
Pharmacy	53.50	49.46	51.48	59.26	58.60	58.93	55.21
Private veterinary clinic	42.50	41.28	41.89	3.75	34.36	19.06	30.47
Public veterinary centre	98.75	99.23	98.99	100.00	98.98	99.49	99.24
Co-op. veterinary centre	0.00	0.00	0.00	18.00	15.00	16.50	8.25
Home services by veterinarian	36.44	34.80	35.62	56.10	54.60	55.35	45.49
Home services by para-veterinarian	41.25	41.00	41.13	58.40	57.55	57.98	49.55
Private inseminator	8.75	0.00	4.38	0.00	0.00	0.00	2.19
Natural breeding	64.00	75.00	69.50	72.50	81.25	76.88	73.19

Table 5.6
GENERAL PERCEPTIONS OF FARMERS ON QUALITY OF LIVESTOCK SERVICES (scores)

S. No.	Quality attribute	Ethnic/ Traditional	Pharmacy shop	Public veterinary Centre	Private veterinary clinic	Co-op. Veterinary centre	Home services by veterinarian	Home services by para-veterinarian
1.	If you need veterinary aid, you can access service provider without any trouble	0.80	1.00	0.93	1.00	0.71	1.00	1.00
2.	You wait for long time before you see the service provider	0	0	0.93	0.83	0.14	0.69	0.18
3.	It is easy for you to receive veterinary aid during emergency	1.00	0.71	0.13	0.06	0	0.98	1.00
4.	If you have a question, you can reach service provider for help without any problem	0.14	0	0.99	1.00	1.00	1.00	0.83
5.	Do you think the staff members are adequately trained?	0	NA	1.00	1.00	1.00	0.98	0.64
6.	The provider treats you kindly and takes adequate care on your livestock	0.75	1.00	0.93	1.00	1.00	1.00	1.00
7.	Does the provider spend enough time for diagnosis and treatment?	0.90	NA	0.93	1.00	1.00	1.00	1.00
8.	Is the examination and treatment space sufficient?	0	NA	0.86	0.67	0.40	NA	NA
9.	Is the waiting area clean and sufficient?	NA	NA	0.56	0.82	0.36	NA	NA
10.	Are the equipment adequate?	NA	NA	0.76	0.34	0.18	NA	NA
11.	Are the working hours convenient for you?	NA	NA	0.30	1.00	0.25	0.93	0.88
12.	Is the location of provider convenient to you?	1.00	0.80	0.30	1.00	0.50	NA	NA
13.	Sometimes you go without livestock services you needed, because it is too expensive	0	0.71	0.01	0.44	0	0.55	0.59
14.	All things are considered, you are satisfied with the livestock services you receive	0.64	0.57	0.96	0.89	0.71	0.97	0.95
15.	You think there is a serious problem with the provision of livestock services	0	0	0.04	0.14	0	0.08	0.10
Average score		**0.44**	**0.53**	**0.64**	**0.75**	**0.48**	**0.83**	**0.74**

NA – Not applicable for the specific service provider

Table 5.7
UPTAKE OF ANIMAL HEALTH CARE SERVICES BY THE FARMERS IN LUD DISTRICTS (No. of cases)

Disease/ Disorder	Species of animal	Public veterinary centre			Home service by veterinarian			Home service by para-veterinarian			Private veterinary clinic			Ethnic/ Traditional healing			Pharmacy			Total		
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Chronic medical cases	Cattle	51	1.27	72.86	2	2.00	2.86	….	….	….	….	….	….	12	1.00	17.14	5	1.00	7.14	70	1.23	100.00
	Buffalo	6	1.00	100.00	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	6	1.00	100.00
	SR	3	1.00	33.33	….	….	….	….	….	….	….	….	….	2	1.00	22.22	4	1.00	44.44	9	1.00	100.00
	All	60	1.23	70.59	2	2.00	2.35	….	….	….	….	….	….	14	1.00	16.47	9	1.00	10.59	85	1.19	100.00
Acute medical cases	Cattle	42	2.55	43.30	50	1.90	51.55	5	1.20	5.15	….	….	….	….	….	….	….	….	….	97	2.14	100.00
	Buffalo	….	….	….	….	….	….	2	2.00	100.00	….	….	….	….	….	….	….	….	….	2	2.00	100.00
	SR	4	2.00	100.00	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	4	2.00	100.00
	All	46	2.50	44.66	50	1.90	48.54	7	1.43	6.80	….	….	….	….	….	….	….	….	….	103	2.14	100.00
Chronic surgical cases	Cattle	20	2.85	74.07	7	2.00	25.93	….	….	….	….	….	….	….	….	….	….	….	….	27	2.67	100.00
	Buffalo	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….
	SR	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….
	All	20	2.85	74.07	7	2.00	25.93	….	….	….	….	….	….	….	….	….	….	….	….	27	2.67	100.00
Acute surgical cases	Cattle	24	2.49	63.16	9	2.44	23.68	5	2.60	13.16	….	….	….	….	….	….	….	….	….	38	2.47	100.00
	Buffalo	….	….	….	1	3.00	100.00	….	….	….	….	….	….	….	….	….	….	….	….	1	3.00	100.00
	SR	2	3.00	100.00	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	2	3.00	100.00
	All	26	2.50	63.41	10	2.50	24.39	5	2.60	12.20	….	….	….	….	….	….	….	….	….	41	2.51	100.00
Obstetrical cases	Cattle	….	….	….	29	1.24	70.73	12	1.33	29.27	….	….	….	….	….	….	….	….	….	41	1.27	100.00
	Buffalo	….	….	….	5	1.40	55.56	4	3.00	44.44	….	….	….	….	….	….	….	….	….	9	2.11	100.00
	SR	….	….	….	….	….	….	….	….	….	….	….	….	1	1.00	100.00	….	….	….	1	1.00	100.00
	All	….	….	….	34	1.26	66.67	16	1.75	31.37	….	….	….	1	1.00	1.96	….	….	….	51	1.41	100.00
Gynaecological cases	Cattle	26	2.69	86.67	1	3.00	3.33	….	….	….	3	1.00	10.00	….	….	….	….	….	….	30	2.53	100.00
	Buffalo	2	3.00	100.00	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	2	3.00	100.00
	SR	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….
	All	28	2.71	87.50	1	3.00	3.13	….	….	….	3	1.00	9.38	….	….	….	….	….	….	32	2.56	100.00
All types of cases	Cattle	163	2.20	53.80	98	1.77	32.34	22	1.59	7.26	3	1.00	0.99	12	1.00	3.96	5	1.00	1.65	303	1.94	100.00
	Buffalo	8	1.50	40.00	6	1.67	30.00	6	2.67	30.00	….	….	….	….	….	….	….	….	….	20	1.90	100.00
	SR	9	1.89	56.25	….	….	….	….	….	….	….	….	….	3	1.00	18.75	4	1.00	25.00	16	1.50	100.00
	All	180	2.16	53.10	104	1.77	30.68	28	1.82	8.26	3	1.00	0.88	15	1.00	4.42	9	1.00	2.65	339	1.92	100.00

A: Number of uptakes; B: Average number of visits required to treat a case; C: Per cent to total with respect to a particular disease; SR: Small ruminants;
…. Not calculated for want of observations

Table 5.8
UPTAKE OF ANIMAL HEALTH CARE SERVICES BY THE FARMERS IN LD DISTRICTS (No. of cases)

Type of disease/ disorder	Species of animal	Public veterinary centre			Home service by veterinarian			Home service by para-veterinarian			Private veterinary clinic			Ethnic/ Traditional healing			Pharmacy			Total		
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Chronic medical cases	Cattle	33	1.21	73.33	2	1.00	4.44	1	1.00	2.22	1	1.00	2.22	5	1.00	11.11	3	1.00	6.67	45	1.16	100.00
	Buffalo	….	….	….	….	….	….	….	….	….	….	….	….	6	1.00	100.00	….	….	….	6	1.00	100.00
	SR	12	1.00	66.67	….	….	….	….	….	….	….	….	….	4	1.00	22.22	2	1.00	11.11	18	1.00	100.00
	All	45	1.15	65.22	2	1.00	2.90	1	1.00	1.45	1	1.00	1.45	15	1.00	21.74	5	1.00	7.25	69	1.10	100.00
Acute medical cases	Cattle	66	2.11	40.99	79	1.85	49.07	16	1.25	9.94	….	….	….	….	….	….	….	….	….	161	1.89	100.00
	Buffalo	….	….	….	….	….	….	7	1.43	100.00	….	….	….	….	….	….	….	….	….	7	1.43	100.00
	SR	11	2.00	100.00	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	11	2.00	100.00
	All	77	2.09	43.02	79	1.85	44.13	23	1.30	12.85	….	….	….	….	….	….	….	….	….	179	1.88	100.00
Chronic surgical cases	Cattle	6	2.00	75.00	2	2.00	25.00	….	….	….	….	….	….	….	….	….	….	….	….	8	2.00	100.00
	Buffalo	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….
	SR	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….
	All	6	2.00	75.00	2	2.00	25.00	….	….	….	….	….	….	….	….	….	….	….	….	8	2.00	100.00
Acute surgical cases	Cattle	10	2.90	62.50	6	2.00	37.50	….	….	….	….	….	….	….	….	….	….	….	….	16	2.56	100.00
	Buffalo	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….
	SR	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….
	All	10	2.90	62.50	6	2.00	37.50	….	….	….	….	….	….	….	….	….	….	….	….	16	2.56	100.00
Obstetrical cases	Cattle	2	3.00	4.17	33	1.12	68.75	13	1.23	27.03	….	….	….	….	….	….	….	….	….	48	1.23	100.00
	Buffalo	….	….	….	8	2.00	72.73	3	2.00	27.27	….	….	….	….	….	….	….	….	….	11	2.00	100.00
	SR	….	….	….	….	….	….	5	1.00	71.43	….	….	….	2	1.00	28.57	….	….	….	7	1.00	100.00
	All	2	3.00	3.03	41	1.29	62.12	21	1.29	31.82	….	….	….	2	1.00	3.03	….	….	….	66	1.33	100.00
Gynaecological cases	Cattle	57	2.65	96.61	2	3.00	3.39	….	….	….	….	….	….	….	….	….	….	….	….	59	2.66	100.00
	Buffalo	5	3.00	100.00	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	5	3.00	100.00
	SR	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….
	All	62	2.67	96.88	2	3.00	3.13	….	….	….	….	….	….	….	….	….	….	….	….	64	2.68	100.00
All types of cases	Cattle	174	2.16	51.63	124	1.67	36.80	30	1.23	8.90	1	1.00	0.30	5	1.00	1.48	3	1.00	0.89	337	1.87	100.00
	Buffalo	5	3.00	17.24	8	2.00	27.59	10	1.60	34.48	….	….	….	6	1.00	20.69	….	….	….	29	1.79	100.00
	SR	23	1.48	63.89	….	….	….	5	1.00	13.89	….	….	….	6	1.00	16.67	2	1.00	5.56	36	1.31	100.00
	All	202	2.09	50.25	132	1.69	32.84	45	1.29	11.19	1	1.00	0.25	17	1.00	4.23	5	1.00	1.24	402	1.81	100.00

A: Number of uptakes; B: Average number of visits required to treat a case; C: Per cent to total with respect to a particular disease; SR: Small ruminants;
…. Not calculated for want of observations.

Table 5.9
OVERALL UPTAKE OF ANIMAL HEALTH CARE SERVICES IN THE STUDY AREA (No. of cases)

Disease/ disorder	Species of animal	Public veterinary centre			Home service by veterinarian			Home service by para-veterinarian			Private veterinary clinic			Ethnic/ Traditional healing			Pharmacy			Total		
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Chronic medical cases	Cattle	84	1.25	73.04	4	1.67	3.48	1	1.00	0.87	1	1.00	0.87	17	1.00	14.78	8	1.00	6.96	115	1.21	100.00
	Buffalo	6	1.00	50.00	….	….	….	….	….	….	….	….	….	6	1.00	50.00	….	….	….	12	1.00	100.00
	SR	15	1.00	55.56	….	….	….	….	….	….	….	….	….	6	1.00	22.22	6	1.00	22.22	27	1.00	100.00
	All	105	1.21	68.18	4	1.67	2.60	1	1.00	0.65	1	1.00	0.65	29	1.00	18.83	14	1.00	9.09	154	1.16	100.00
Acute medical cases	Cattle	108	2.28	41.86	129	1.87	50.00	21	1.24	8.14	….	….	….	….	….	….	….	….	….	258	1.99	100.00
	Buffalo	….	….	….	….	….	….	9	1.56	100.00	….	….	….	….	….	….	….	….	….	9	1.56	100.00
	SR	15	1.93	100.00	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	15	1.93	100.00
	All	123	2.24	43.62	129	1.87	45.74	30	1.34	10.64	….	….	….	….	….	….	….	….	….	282	1.98	100.00
Chronic surgical cases	Cattle	26	2.67	74.29	9	2.00	25.71	….	….	….	….	….	….	….	….	….	….	….	….	35	2.50	100.00
	Buffalo	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….
	SR	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….
	All	26	2.67	74.29	9	2.00	25.71	….	….	….	….	….	….	….	….	….	….	….	….	35	2.50	100.00
Acute surgical cases	Cattle	34	2.59	62.96	15	2.28	27.78	5	2.60	9.26	….	….	….	….	….	….	….	….	….	54	2.50	100.00
	Buffalo	….	….	….	1	3.00	100.00	….	….	….	….	….	….	….	….	….	….	….	….	1	3.00	100.00
	SR	2	3.00	100.00	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	2	3.00	100.00
	All	36	2.61	63.16	16	2.35	28.07	5	2.60	8.77	….	….	….	….	….	….	….	….	….	57	2.54	100.00
Obstetrical cases	Cattle	2	3.00	2.25	62	1.18	69.66	25	1.28	28.09	….	….	….	….	….	….	….	….	….	89	1.25	100.00
	Buffalo	….	….	….	13	1.76	65.00	7	2.57	35.00	….	….	….	….	….	….	….	….	….	20	2.04	100.00
	SR	….	….	….	….	….	….	5	1.00	62.50	….	….	….	3	1.00	37.50	….	….	….	8	1.00	100.00
	All	2	3.00	1.71	75	1.28	64.10	37	1.49	31.62	….	….	….	3	1.00	2.56	….	….	….	117	1.37	100.00
Gynaecological cases	Cattle	83	2.66	93.26	3	3.00	3.37	….	….	….	3	1.00	3.37	….	….	….	….	….	….	89	2.62	100.00
	Buffalo	7	3.00	100.00	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	7	3.00	100.00
	SR	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….	….
	All	90	2.69	93.75	3	3.00	3.13	….	….	….	3	1.00	3.13	….	….	….	….	….	….	96	2.65	100.00
All types of cases	Cattle	337	2.18	52.66	222	1.72	34.69	52	1.39	8.13	4	1.00	0.63	17	1.00	2.66	8	1.00	1.25	640	1.91	100.00
	Buffalo	13	2.07	26.53	14	1.83	28.57	16	2.00	32.65	….	….	….	6	1.00	12.24	….	….	….	49	1.83	100.00
	SR	32	1.56	61.54	….	….	….	5	1.00	9.62	….	….	….	9	1.00	17.31	6	1.00	11.54	52	1.39	100.00
	All	382	2.12	51.55	236	1.75	31.85	73	1.53	9.85	4	1.00	0.54	32	1.00	4.32	14	1.00	1.89	741	1.87	100.00

A: Number of uptakes; B: Average number of visits required to treat a case; C: Per cent to total with respect to a particular disease; SR: Small ruminants;
…. Not calculated for want of observations

Table 5.10
UPTAKE OF BOVINE BREEDING SERVICES BY THE SAMPLE FARMERS

(No. of inseminations or services)

Service provider	Species	LUD districts	LD districts	Overall
Public veterinary centre	Cattle	150 (2.73)	307 (1.98)	457 (2.18)
	Buffalo	26 (2.00)	22 (2.20)	48 (2.09)
	Total	**176 (2.59)**	**329 (1.99)**	**505 (2.17)**
Home service by veterinarian	Cattle	110 (1.72)	10 (2.00)	120 (1.74)
	Buffalo	6 (1.50)	2 (2.00)	8 (1.33)
	Total	**116 (1.71)**	**12 (2.00)**	**128 (1.73)**
Home service by para-veterinarian	Cattle	5 (1.67)	…	5 (1.67)
	Buffalo	…	…	…
	Total	**5 (1.67)**	…	**5 (1.67)**
Private veterinary clinic	Cattle	38 (1.90)	14 (2.33)	52 (2.00)
	Buffalo	6 (2.00)	4 (2.00)	10 (2.00)
	Total	**44 (1.91)**	**18 (2.25)**	**62 (2.00)**
Natural breeding	Cattle	30 (3.00)	60 (3.16)	90 (3.10)
	Buffalo	14 (1.40)	27 (1.93)	41 (1.71)
	Total	**44 (2.20)**	**87 (2.64)**	**131 (2.47)**
All	Cattle	333 (2.19)	391 (2.11)	724 (2.15)
	Buffalo	52 (1.73)	55 (2.04)	107 (1.88)
	Total	**385 (2.12)**	**446 (2.10)**	**831 (2.11)**

Figures in parentheses indicate number of inseminations required per conception.

… Not calculated for want of observations.

Table 5.11: AVERAGE COST OF ANIMAL HEALTH CARE SERVICES IN LUD DISTRICTS (in Rs.)

Service provider	Cost category	Chronic medical cases			Acute medical cases			Chronic surgical cases			Acute surgical cases			Obstetrical cases			Gynaecological cases		
		C	B	SR	C	B	SR	C	B	SR	C	B	SR	C	B	SR	C	B	SR
Public veterinary centre	Service	0	0	0	0	…	0	0	…	…	0	…	0	…	…	…	0	0	…
	Labour	17.84 (1.35)	13.34 (1.05)	16.67 (1.67)	33.69 (2.62)	…	15.00 (2.88)	45.24 (3.85)	…	…	27.71 (2.65)	…	52.50 (7.50)	…	…	…	35.76 (2.06)	45.00 (…)	…
	Drugs	5.00 (1.74)	0	5.00 (5.00)	4.28 (3.16)	…	0	2.85 (2.85)	…	…	0	…	0	…	…	…	0	0	…
	Total	22.84 (1.86)	13.34 (1.05)	21.67 (4.41)	37.97 (4.27)	…	15.00 (2.88)	48.09 (5.74)	…	…	27.71 (2.65)	…	52.50 (7.50)	…	…	…	35.76 (2.06)	45.00 (…)	…
Home service by veterinarian	Service	125.00 (25.00)	…	…	135.60 (8.95)	…	…	91.67 (5.27)	…	…	137.77 (10.21)	175.00 (…)	…	117.24 (9.37)	110.00 (10.00)	…	200	…	…
	Labour	0	…	…	0	…	…	0	…	…	2.77 (2.77)	0	…	0	0	…	0	…	…
	Drugs	87.50 (12.50)	…	…	103.50 (8.21)	…	…	51.67 (7.37)	…	…	91.67 (13.17)	150.00 (…)	…	58.27 (7.28)	62.00 (9.69)	…	150.00 (…)	…	…
	Total	212.50 (37.50)	…	…	239.10 (15.92)	…	…	143.34 (2.11)	…	…	232.23 (21.33)	325.00 (…)	…	175.51 (15.09)	172.00 (11.57)	…	350.00 (…)	…	…
Home service by para-veterinarian	Service	…	…	…	75.00 (11.18)	62.50 (12.50)	…	…	…	…	119.00 (21.47)	…	…	87.50 (9.97)	187.50 (23.94)	…	…	…	…
	Labour	…	…	…	0	0	…	…	…	…	0	…	…	0	0	…	…	…	…
	Drugs	…	…	…	40.00 (6.13)	50.00 (…)	…	…	…	…	55.00 (12.25)	…	…	46.25 (7.95)	68.75 (11.96)	…	…	…	…
	Total	…	…	…	115.00 (16.95)	112.50 (12.50)	…	…	…	…	174.00 (28.75)	…	…	133.75 (17.65)	256.25 (32.87)	…	…	…	…
Ethnic/ traditional healing	Service	0	…	0	…	…	…	…	…	…	…	…	…	…	…	0	…	…	…
	Labour	1.67 (1.13)	…	5.00 (5.00)	…	…	…	…	…	…	…	…	…	…	…	0	…	…	…
	Drugs	21.67 (2.64)	…	5.00 (5.00)	…	…	…	…	…	…	…	…	…	…	…	10.00 (…)	…	…	…
	Total	23.34 (3.49)	…	10.00 (…)	…	…	…	…	…	…	…	…	…	…	…	10.00 (…)	…	…	…
Private veterinary clinic	Service	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	46.67 (3.34)	…	…
	Labour	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	5.00	…	…
	Drugs	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	38.34 (4.41)	…	…
	Total	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	90.00 (5.00)	…	…
Pharmacy	Service	0		0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Labour	0		0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Drugs	19.00 (1.87)	…	12.50 (1.44)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Total	19.00 (1.87)	…	12.50 (1.44)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…

…. Not calculated for want of observations; Figures in parentheses indicate standard errors; C-Cattle; B-Buffalo; SR: Small ruminants;

Table 5.12: AVERAGE COST OF ANIMAL HEALTH CARE SERVICES IN LD DISTRICTS (in Rs.)

Service provider	Cost category	Chronic medical cases			Acute medical cases			Chronic surgical cases			Acute surgical cases			Obstetrical cases			Gynaecological cases		
		C	B	SR	C	B	SR	C	B	SR	C	B	SR	C	B	SR	C	B	SR
Public veterinary centre	Service	0		0	0	…	0	0	…	…	0	…	…	0	…	…	0	0	…
	Labour	16.62 (1.33)	…	7.92 (1.43)	27.27 (2.04)	…	19.09 (0.61)	20.00 (2.58)	…	…	40.00 (3.87)	…	…	37.50 (7.50)	…	…	29.82 (2.15)	33.75 (3.75)	…
	Drugs	1.17 (1.17)	…	0.17 (0.12)	6.96 (3.03)	…	0	0	…	…	40.00 (17.55)	…	…	0	…	…	0	0	…
	Total	17.79 (1.74)	…	8.08 (1.35)	34.24 (3.61)	…	19.09 (0.61)	20.00 (2.58)	…	…	80.00 (20.16)	…	…	37.50 (7.50)	…	…	29.82 (2.15)	33.75 (3.75)	…
Home service by veterinarian	Service	50.00 (…)	…	…	170.31 (8.22)	…	…	150.00 (50.00)	…	…	166.67 (10.54)	…	…	153.04 (10.86)	237.50 (30.98)	…	175.00 (25.00)	…	…
	Labour	0	…	…	0.37 (8.22)	…	…	0	…	…	0	…	…	0	0	…	0	…	…
	Drugs	50.00 (…)	…	…	123.48 (6.61)	…	…	95.00 (55.00)	…	…	125.00 (11.18)	…	…	59.39 (4.74)	59.37 (8.09)	…	150.00 (…)	…	…
	Total	100.00 (…)	…	…	294.17 (13.57)	…	…	245.00 (105.00)	…	…	291.67 (20.06)	…	…	212.42 (13.80)	296.87 (32.54)	…	325.00 (25.00)	…	…
Home service by para-veterinarian	Service	50.00 (…)	…	…	76.56 (7.03)	71.42 (10.11)	…	…	…	…	…	…	…	98.07 (9.16)	125.00 (…)	50.00 (…)	…	…	…
	Labour	0	…	…	0	0	…	…	…	…	…	…	…	0	0	0	…	…	…
	Drugs	50.00 (…)	…	…	51.56 (3.58)	64.28 (9.22)	…	…	…	…	…	…	…	34.61 (3.51)	75.00 (…)	40.00 (6.13)	…	…	…
	Total	100.00 (…)	…	…	128.12 (9.37)	135.71 (17.97)	…	…	…	…	…	…	…	132.69 (12.13)	200.00 (…)	90.00 (6.13)	…	…	…
Ethnic/ traditional healing	Service	0	0	0	…	…	…	…	…	…	…	…	…	…	…	0	…	…	…
	Labour	0	0	0	…	…	…	…	…	…	…	…	…	…	…	0	…	…	…
	Drugs	14.00 (1.87)	12.50 (1.12)	45.00 (11.25)	…	…	…	…	…	…	…	…	…	…	…	12.50 (2.50)	…	…	…
	Total	14.00 (1.87)	12.50 (1.12)	45.00 (11.25)	…	…	…	…	…	…	…	…	…	…	…	12.50 (2.50)	…	…	…
Private veterinary clinic	Service	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Labour	5.00 (…)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Drugs	40.00 (…)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Total	45.00 (…)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
Pharmacy	Service	0	…	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Labour	0	….	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Drugs	25.00 (2.88)	…	17.50 (2.50)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Total	25.00 (2.88)	…	17.50 (2.50)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…

…. Not calculated for want of observations; Figures in parentheses indicate standard errors; C-Cattle; B-Buffalo; SR: Small ruminants;

Table 5.13: OVERALL AVERAGE COST OF ANIMAL HEALTH CARE SERVICES IN THE STUDY AREA (in Rs.)

Service provider	Cost category	Chronic medical cases			Acute medical cases			Chronic surgical cases			Acute surgical cases			Obstetrical cases			Gynaecological cases		
		C	B	SR	C	B	SR	C	B	SR	C	B	SR	C	B	SR	C	B	SR
Public veterinary Centre	Service	0	0	0	0	…	0	0	…	…	0	…	0	0	…	…	0	0	…
	Labour	17.35 (0.96)	13.34 (1.05)	9.67 (1.51)	29.76 (1.64)	…	18.00 (0.95)	39.62 (3.65)	…	…	31.32 (2.37)	…	52.50 (7.50)	37.50 (7.50)	…	…	31.68 (1.63)	37.50 (3.35)	…
	Drugs	3.47 (1.16)	0	1.13 (0.99)	5.93 (2.22)	…	0	2.22 (2.22)	…	…	11.76 (5.89)	…	0	0	…	…	0	0	…
	Total	20.83 (1.34)	13.34 (1.05)	10.80 (1.95)	35.69 (2.75)	…	18.00 (0.95)	41.85 (5.02)	…	…	43.08 (7.31)	…	52.50 (7.50)	27.50 (7.50)	…	…	31.68 (1.63)	37.50 (3.35)	…
Home service by Veterinarian	Service	100.00 (28.86)	…	…	156.86 (6.27)	…	…	106.25 (13.97)	…	…	149.34 (8.12)	175.00 (…)	…	136.29 (7.55)	388.46 (26.03)	…	183.33 (16.66)	…	…
	Labour	0	…	…	0.24 (0.24)	…	…	0	…	…	1.67 (1.67)	0	…	0	0	…	0	…	…
	Drugs	75.00 (14.43)	…	…	115.74 (5.21)	…	…	62.50 (13.69)	…	…	105.00 (9.82)	150.00 (…)	…	58.87 (4.21)	60.38 (5.97)	…	150.00 (…)	…	…
	Total	175.00 (43.31)	…	…	272.83 (10.58)	…	…	168.75 (25.94)	…	…	256.00 (16.56)	325.00 (…)	…	195.16 (10.37)	248.84 (26.54)	…	333.33 (16.66)	…	…
Home service by para-veterinarian	Service	50.00 (…)	…	…	76.19 (5.84)	75.00 (8.34)	…	…	…	…	119.00 (21.47)	…	…	93.00 (6.69)	160.71 (17.97)	50.00	…	…	…
	Labour	0	…	…	0	0	…	…	…	…	0	…	…	0	0	0	…	…	…
	Drugs	50.00 (…)	…	…	48.81 (3.22)	61.12 (7.34)	…	…	…	…	55.00 (12.24)	…	…	40.20 (4.31)	71.42 (6.53)	40.00 (6.13)	…	…	…
	Total	100.00 (…)	…	…	125.00 (8.09)	136.12 (13.89)	…	…	…	…	174.00 (28.74)	…	…	134.50 (10.35)	232.14 (20.92)	90.00 (6.13)	…	…	…
Ethnic/ traditional healing	Service	0	0	0	…	…	…	…	…	…	…	…	…	…	…	0	…	…	…
	Labour	1.17 (0.81)	0	1.67 (1.67)	…	…	…	…	…	…	…	…	…	…	…	0	…	…	…
	Drugs	19.42 (2.09)	12.50 (1.12)	9.17 (2.01)	…	…	…	…	…	…	…	…	…	…	…	11.67 (1.67)	…	…	…
	Total	20.58 (2.71)	12.50 (1.12)	10.83 (0.83)	…	…	…	…	…	…	…	…	…	…	…	11.67 (1.67)	…	…	…
Private veterinary clinic	Service	20.00 (…)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	46.66 (3.33)	…	…
	Labour	5.00 (…)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	5.00 (…)	…	…
	Drugs	20.00 (…)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	38.33 (4.41)	…	…
	Total	45.00 (…)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	90.00 (5.00)	…	…
Pharmacy	Service	0	…	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Labour	0	…	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Drugs	21.25 (1.83)	…	14.16 (1.53)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Total	21.25 (1.83)	…	14.16	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…

				(1.53)															

…. Not calculated for want of observations; Figures in parentheses indicate standard errors; C-Cattle; B-Buffalo; SR: Small ruminants;

Table 5.14: VISIT COST OF ANIMAL HEALTH CARE SERVICES IN LUD DISTRICTS (in Rs.)

Service provider	Cost category	Chronic medical cases			Acute medical cases			Chronic surgical cases			Acute surgical cases			Obstetrical cases			Gynaecological cases		
		C	B	SR	C	B	SR	C	B	SR	C	B	SR	C	B	SR	C	B	SR
Public veterinary centre	Service	0	0	0	0		0	0	…	…	0	…	0	…	…	…	0	0	…
	Labour	14.00 (1.28)	13.34 (1.05)	16.67 (1.67)	13.23 (0.65)	…	8.57 (1.25)	15.83 (0.82)	…	…	11.27 (1.08)	…	17.50 (2.50)	…	…	…	13.28 (0.71)	15.00 (…)	…
	Drugs	3.92 (1.71)	0	5.00 (…)	1.68 (1.05)	…	0	1.00 (0.71)	…	…	0	…	0	…	…	…	0	0	…
	Total	17.93 (1.91)	13.34 (1.05)	21.67 (4.41)	14.91 (1.24)	…	8.57 (1.25)	16.84 (1.21)	…	…	11.27 (1.08)	…	17.50 (2.50)	…	…	…	13.28 (0.71)	15.00 (…)	…
Home service by veterinarian	Service	62.50 (12.50)	…	…	71.36 (3.37)	…	…	45.84 (2.64)	…	…	56.36 (3.64)	175.00 (…)	…	94.45 (6.92)	78.57 (10.00)	…	200.00 (…)	…	…
	Labour	0	…	…	0	…	…	0	…	…	1.13 (…)	0	…	0	0	…	0	…	…
	Drugs	43.73 (6.25)	…	…	54.47 (3.29)	…	…	25.83 (3.69)	…	…	37.50 (4.19)	150.00 (…)	…	46.95 (4.53)	44.28 (13.36)	…	150.00 (…)	…	…
	Total	106.25 (18.75)	…	…	125.84 (5.94)	…	…	71.67 (1.05)	…	…	95.00 (6.88)	325.00 (…)	…	141.38 (9.13)	122.85 (21.72)	…	350.00 (…)	…	…
Home service by para-veterinarian	Service	…	…	…	62.50 (10.00)	41.67 (6.25)	…	…	…	…	45.76 (7.13)	…	…	65.62 (6.02)	62.50 (7.98)	…	…	…	…
	Labour	…	…	…	0	0	…	…	…	…	0	…	…	0	0	…	…	…	…
	Drugs	…	…	…	33.34 (6.12)	33.34 (12.50)	…	…	…	…	21.15 (3.06)	…	…	34.68 (3.29)	22.92 (3.98)	…	…	…	…
	Total	…	…	…	95.84 (15.81)	75.00 (18.75)	…	…	…	…	66.93 (7.33)	…	…	100.32 (8.66)	85.42 (10.56)	…	…	…	…
Ethnic/ traditional healing	Service	0		0	…	…	…	…	…	…	…	…	…	…	…	0	…	…	…
	Labour	1.67 (1.12)		5.00 (…)	…	…	…	…	…	…	…	…	…	…	…	0	…	…	…
	Drugs	21.67 (2.63)		5.00 (…)	…	…	…	…	…	…	…	…	…	…	…	10.00 (…)	…	…	…
	Total	23.34 (3.50)		10.00 (…)	…	…	…	…	…	…	…	…	…	…	…	10.00 (…)	…	…	…
Private veterinary clinic	Service	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	46.67 (3.30)	…	…
	Labour	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	5.00	…	…
	Drugs	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	38.34 (4.41)	…	…
	Total	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	90.00 (5.00)	…	…
Pharmacy	Service	0		0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Labour	0		0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Drugs	19.00 (1.87)		12.50 (1.44)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Total	19.00 (1.87)		12.50 (1.44)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…

…. Not calculated for want of observations; Figures in parentheses indicate standard errors; C-Cattle; B-Buffalo; SR: Small ruminants;

Table 5.15
VISIT COST OF ANIMAL HEALTH CARE SERVICES IN LD DISTRICTS (in Rs.)

Service provider	Cost category	Chronic medical cases			Acute medical cases			Chronic surgical cases			Acute surgical cases			Obstetrical cases			Gynaecological cases		
		C	B	SR	C	B	SR	C	B	SR	C	B	SR	C	B	SR	C	B	SR
Public veterinary centre	Service	0	…	0	0	…	0	0	…	…	0	…	…	0	…	…	0	0	…
	Labour	13.78 (0.96)	…	7.92 (1.44)	12.95 (0.82)	…	9.54 (0.31)	10.00 (2.01)	…	…	13.79 (0.66)	…	…	12.50 (2.50)	…	…	11.25 (0.71)	11.25 (1.25)	…
	Drugs	0.97 (1.17)	…	0.17 (0.12)	3.30 (1.25)	…	0	0	…	…	13.79 (5.34)	…	…	0	…	…	0	0	…
	Total	14.75 (1.54)	…	8.08 (1.36)	16.25 (1.18)	…	9.54 (0.31)	10.00 (2.01)	…	…	27.58 (5.35)	…	…	12.50 (2.50)	…	…	11.25 (0.71)	11.25 (1.25)	…
Home service by veterinarian	Service	50.00 (…)	…	…	92.15 (13.57)	…	…	75.00 (25.00)	…	…	83.34 (5.27)	…	…	136.48 (9.64)	118.75 (23.57)	…	58.34 (8.34)	…	…
	Labour	0	…	…	0.21 (3.64)	…	…	0	…	…	0	…	…	0	0	…	0	…	…
	Drugs	50.00 (…)	…	…	66.82 (0.37)	…	…	47.50 (27.50)	…	…	62.50 (5.59)	…	…	82.97 (3.01)	29.68 (5.66)	…	50.00 (…)	…	…
	Total	100.00 (…)	…	…	159.17 (2.99)	…	…	122.50 (52.50)	…	…	145.84 (10.03)	…	…	189.45 (10.84)	148.43 (27.45)	…	108.34 (8.34)	…	…
Home service by para-veterinarian	Service	50.00 (…)	…	…	61.25 (3.95)	50.00 (0.00)	…	…	…	…	…	…	…	79.68 (11.45)	62.50 (…)	50.00 (…)	…	…	…
	Labour	0	…	…	0	0	…	…	…	…	…	…	…	0	0	0	…	…	…
	Drugs	50.00 (…)	…	…	41.25 (4.10)	45.00 (3.57)	…	…	…	…	…	…	…	28.13 (4.38)	37.50 (…)	40.00 (6.12)	…	…	…
	Total	100.00 (…)	…	…	102.50 (7.03)	95.00 (3.57)	…	…	…	…	…	…	…	107.82 (15.47)	100.00 (…)	90.00 (6.12)	…	…	…
Ethnic/ traditional healing	Service	0	0	0	…	…	…	…	…	…	…	…	…	…	…	0	…	…	…
	Labour	0	0	0	…	…	…	…	…	…	…	…	…	…	…	0	…	…	…
	Drugs	14.00 (1.87)	12.50 (1.11)	11.25 (1.25)	…	…	…	…	…	…	…	…	…	…	…	12.5 (2.50)	…	…	…
	Total	14.00 (1.87)	12.50 (1.11)	11.25 (1.25)	…	…	…	…	…	…	…	…	…	…	…	12.5 (2.50)	…	…	…
Private veterinary clinic	Service	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Labour	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Drugs	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Total	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
Pharmacy	Service	0	…	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Labour	0	…	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Drugs	25.00 (2.88)	…	17.50 (2.50)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Total	25.00 (2.88)	…	17.50 (2.50)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…

…. Not calculated for want of observations; Figures in parentheses indicate standard errors; C-Cattle; B-Buffalo; SR: Small ruminants;

Table 5.16: OVERALL VISIT COST OF ANIMAL HEALTH CARE SERVICES IN THE STUDY AREA (in Rs.)

Service provider	Cost category	Chronic medical cases			Acute medical cases			Chronic surgical cases			Acute surgical cases			Obstetrical cases			Gynaecological cases		
		C	B	SR	C	B	SR	C	B	SR	C	B	SR	C	B	SR	C	B	SR
Public veterinary centre	Service	0	0	0	0	…	0	0	…	…	0	…	0	0	…	…	0	0	…
	Labour	13.92 (0.85)	13.34 (1.05)	9.67 (1.51)	13.06 (0.55)	…	9.32 (0.38)	14.86 (0.86)	…	…	12.11 (0.81)	…	17.50 (2.50)	12.50 (2.50)	…	…	11.91 (0.54)	12.50 (1.12)	…
	Drugs	2.78 (1.14)	0	1.14 (0.99)	2.61 (0.86)	…	0	0.84 (0.56)	…	…	4.55 (1.76)	…	0	0	…	…	0	0	…
	Total	**16.69 (1.32)**	**13.34 (1.05)**	**10.81 (1.95)**	**15.67 (0.86)**	**…**	**9.32 (0.38)**	**15.69 (1.13)**	**…**	**…**	**16.65 (2.02)**	**…**	**17.50 (2.50)**	**12.50 (2.50)**	**…**	**…**	**11.91 (0.54)**	**12.50 (1.12)**	**…**
Home service by veterinarian	Service	60.00 (8.34)	…	…	83.96 (2.76)	…	…	53.13 (6.98)	…	…	65.88 (4.52)	58.34 (…)	…	115.75 (6.51)	106.53 (16.27)	…	61.12 (5.56)	…	…
	Labour	0	…	…	0.13 (0.24)	…	…	0	…	…	0.74 (0.84)	0	…	0	0	…	0	…	…
	Drugs	45.00 (4.17)	…	…	61.95 (2.32)	…	…	31.25 (6.84)	…	…	46.33 (4.65)	50.00 (…)	…	50.00 (2.65)	34.14 (6.43)	…	50.00 (…)	…	…
	Total	**105.00 (11.03)**	**…**	**…**	**146.04 (4.61)**	**…**	**…**	**84.37 (12.97)**	**…**	**…**	**112.94 (8.61)**	**108.34**	**…**	**165.75 (7.65)**	**140.65 (18.76)**	**…**	**111.12 (5.56)**	**…**	**…**
Home service by para-veterinarian	Service	50.00 (…)	…	…	61.53 (3.71)	48.22 (1.34)	…	…	…	…	45.76 (7.13)	…	…	72.65 (6.73)	62.50 (4.26)	50.00 (…)	…	…	…
	Labour	0	…	…	0	0	…	…	…	…	0	…	…	0	0	0	…	…	…
	Drugs	50.00 (…)	…	…	39.43 (3.51)	39.28 (4.17)	…	…	…	…	21.15 (3.06)	…	…	31.41 (2.74)	27.78 (3.63)	40.00 (6.13)	…	…	…
	Total	100.00 (…)	**…**	**…**	**100.96 (6.37)**	**87.50 (5.01)**	**…**	**…**	**…**	**…**	**66.93 (7.33)**	**…**	**…**	**104.85 (9.11)**	**90.28 (6.55)**	**90.00 (6.13)**	**…**	**…**	**…**
Ethnic/ traditional healing	Service	0	0	0	…	…	…	…	…	…	…	…	…	…	…	0	…	…	…
	Labour	1.17 (0.81)	0	1.67 (1.67)	…	…	…	…	…	…	…	…	…	…	…	0	…	…	…
	Drugs	19.42 (2.09)	12.50 (1.12)	9.17 (2.01)	…	…	…	…	…	…	…	…	…	…	…	11.67 (1.67)	…	…	…
	Total	**20.58 (2.71)**	**12.50 (1.12)**	**10.84 (0.84)**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**11.67 (1.67)**	**…**	**…**	**…**
Private veterinary clinic	Service	20.00 (…)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	46.67 (3.34)	…	…
	Labour	5.00 (…)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	0	…	…
	Drugs	20.00 (…)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	38.34 (4.41)	…	…
	Total	45.00 (…)	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**90.00 (5.00)**	**…**	**…**
Pharmacy	Service	0	…	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Labour	0	…	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Drugs	21.25 (1.83)	…	14.17 (1.54)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	Total	**21.25 (1.83)**	**…**	**14.17 (1.54)**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**

…. Not calculated for want of observations; Figures in parentheses indicate standard errors; C-Cattle; B-Buffalo; SR: Small ruminants;

Table 5.17
FACTORS INFLUENCING COST OF ANIMAL HEALTH CARE SERVICES
(Dependant variable: Average visit cost in Rs.)

Explanatory variables	Coefficients			
	LUD districts	LD districts	Overall	
			Model 1	Model 2
Constant	-87.37**	-135.45**	-119.36**	-122.31**
	(9.41)	(10.74)	(7.33)	(7.33)
Veterinarian[a]	103.44**	131.72**	122.29**	122.55**
	(7.57)	(10.08)	(6.51)	(6.46)
Para-veterinarian[a]	71.18**	83.53**	78.42**	78.16**
	(9.46)	(11.00)	(7.61)	(7.56)
Place of service[b]	102.69**	120.14**	115.02**	115.27**
	(4.25)	(5.50)	(3.62)	(3.60)
Acute medical cases[c]	-3.40	16.32*	9.83*	7.77*
	(5.81)	(6.88)	(4.64)	(4.64)
Acute surgical cases[c]	-9.37	21.73*	6.86	7.40
	(7.47)	(11.18)	(6.61)	(6.56)
Chronic surgical cases[c]	-10.23	6.65	0.74	1.75
	(8.31)	(14.06)	(7.59)	(7.53)
Obstetrical cases[c]	7.60	27.94**	20.18**	19.24**
	(6.30)	(7.98)	(5.31)	(5.27)
Gynecological cases[c]	1.26	10.24	3.73	1.27
	(7.55)	(8.25)	(5.83)	(5.82)
Source of drug: Medical shop[d]	-9.80*	30.89**	15.39**	14.87**
	(4.56)	(5.09)	(3.60)	(3.58)
Follow-up cases[e]	-2.76	-26.39**	-16.85**	-15.71**
	(4.91)	(4.64)	(3.56)	(3.55)
Value of animal affected (Rs.'000)	0.36	1.07*	1.02**	0.97**
	(0.43)	(0.45)	(0.33)	(0.33)
Annual household income (Rs.'000)	0.04**	0.14**	0.04*	0.04**
	(0.02)	(0.05)	(0.02)	(0.02)
Livelihood share of livestock	17.98*	1.59	15.47*	10.35
	(9.24)	(10.95)	(7.47)	(7.55)
Distance from nearest public veterinary centre (travel time in minutes)	-0.08	0.16	0.06	0.06
	(0.13)	(0.13)	(0.10)	(0.10)
District versatility	--	--	--	9.94**
				(2.84)
Adjusted R^2	0.706	0.801	0.741	0.745
N	337	401	738	738
F	58.55	115.97	138.64	144.80

[a] reference category: Traditional healing; [b] reference category: Centre; [c] reference category: Chronic medical cases; [d] reference category: Service provider; [e] reference category: Single visit; [f] reference category: Livestock underdeveloped

Model-1: For study area without area specific attribute; **Model-2:** For study area with area specific attribute.

Figures in parentheses indicate standard errors.

** Significant (P≤0.05); ** Highly significant (P≤0.01)*

Table 5.18
AVERAGE COST OF BOVINE BREEDING SERVICES

(in Rs./service)

Service provider	Cost category	LUD districts			LD districts			Overall		
		Cow	Buffalo	Total	Cow	Buffalo	Total	Cow	Buffalo	Total
Public veterinary centre	Semen	15.00 (0.00)	15.00 (0.00)	15.00 (0.00)	15.00 (0.00)	15.00 (0.00)	15.00 (0.00)	15.00 (0.00)	15.00 (0.00)	15.00 (0.00)
	Labour	13.07 (0.54)	15.19 (0.59)	13.38 (0.46)	12.39 (0.42)	12.95 (2.19)	12.42 (0.41)	12.58 (0.33)	14.17 (0.84)	12.73 (0.31)
	Total	**28.07 (0.55)**	**30.19 (0.59)**	**28.30 (0.47)**	**26.99 (0.45)**	**28.05 (2.18)**	**27.06 (0.44)**	**27.58 (0.33)**	**29.17 (0.84)**	**27.73 (0.31)**
Home service by veterinarian	Semen	58.32 (2.01)	48.33 (11.55)	57.80 (2.00)	52.50 (2.50)	35.00 (0.00)	49.58 (3.56)	57.83 (1.90)	45.00 (9.80)	57.03 (1.88)
	Labour	0	0	0	0	0	0	0	0	0
	Total	**58.32 (2.01)**	**48.33 (11.55)**	**57.80 (2.00)**	**52.50 (2.50)**	**35.00 (0.00)**	**49.58 (3.56)**	**57.83 (1.90)**	**45.00 (9.80)**	**57.03 (1.88)**
Home service by para-veterinarian	Semen	50.00 (0.00)	…	50.00 (0.00)	…	…	…	50.00 (0.00)	…	50.00 (0.00)
	Labour	0	…	0	…	…	…	0	…	0
	Total	**50.00 (0.00)**	…	**50.00 (0.00)**	…	…	…	**50.00 (0.00)**	…	**50.00 (0.00)**
Private veterinary clinic	Semen	34.74 (0.78)	35.00 (0.00)	34.77 (0.67)	35.00 (0.00)	35.00 (0.00)	35.00 (0.00)	34.81 (0.56)	35.00 (0.00)	34.84 (0.46)
	Labour	4.87 (0.27)	5.00 (0.00)	4.89 (0.24)	5.36 (0.19)	5.00 (0.00)	5.28 (0.15)	5.00 (0.20)	5.00 (0.00)	5.00 (0.17)
	Total	**39.61 (0.56)**	**40.00 (0.00)**	**39.66 (0.48)**	**40.36 (0.19)**	**40.00 (0.00)**	**40.28 (0.15)**	**39.81 (0.40)**	**40.00 (0.00)**	**39.84 (0.33)**
Natural breeding	Semen	28.17 (3.54)	38.21 (0.39)	31.36 (2.66)	39.18 (1.80)	44.26 (2.31)	40.74 (1.44)	35.55 (1.79)	42.20 (1.66)	37.61 (1.36)
	Labour	1.67 (0.73)	0.00 (0.00)	1.14 (0.54)	1.97 (0.48)	0.00 (0.00)	1.36 (0.33)	1.87 (0.40)	0.00 (0.00)	1.29 (0.28)
	Total	**29.83 (3.42)**	**38.21 (0.39)**	**32.50 (2.54)**	**41.15 (1.56)**	**44.26 (2.31)**	**42.10 (1.29)**	**37.42 (1.66)**	**42.20 (1.66)**	**38.90 (1.27)**
All	Semen	33.23 (1.33)	27.40 (2.15)	32.44 (1.18)	20.11 (0.68)	31.58 (2.37)	21.52 (0.70)	26.30 (0.73)	29.53 (1.64)	26.71 (0.68)
	Labour	6.59 (0.48)	8.17 (1.08)	6.81 (0.44)	10.20 (0.43)	5.55 (1.18)	9.63 (0.42)	8.54 (0.33)	6.82 (0.82)	8.32 (0.31)
	Total	**39.82 (1.08)**	**35.58 (1.39)**	**39.25 (0.94)**	**30.31 (0.55)**	**37.13 (1.78)**	**31.15 (0.54)**	**34.83 (0.58)**	**36.36 (1.14)**	**35.03 (0.53)**

Figures in parentheses indicate standard errors.

… Not calculated for want of observations.

Table 5.19
FACTORS INFLUENCING COST OF BOVINE BREEDING SERVICES
(Dependant variable: Average insemination cost in Rs.)

Explanatory variables	Coefficients			
	LUD districts	LD districts	Overall	
			Model 1	Model 2
Constant	18.78** (7.22)	35.83** (4.60)	28.50** (4.05)	28.26** (4.06)
Source of semen: Privately purchased[a]	16.90** (1.55)	10.69** (1.69)	15.04** (1.09)	15.18** (1.11)
Source of semen: Natural service[a]	5.52** (1.52)	8.56** (0.80)	7.63** (0.77)	7.61** (0.77)
Place of service[b]	14.36** (1.76)	14.02** (2.77)	15.01** (1.32)	15.11** (1.33)
Species: Cow[c]	1.77 (1.48)	-2.08 (1.17)	-0.09 (0.93)	-0.01 (0.94)
Repeated insemination[d]	-10.85** (1.48)	-9.31** (0.81)	-9.71** (0.77)	-9.76** (0.77)
Milk price (Rs. per litre)	1.29 (0.81)	-0.40 (0.40)	0.21 (0.42)	0.22 (0.42)
Quantum of milk sold (litre per day)	0.37** (0.14)	0.26** (0.08)	0.32** (0.07)	0.31** (0.07)
Annual household income (Rs.'000)	-0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Livelihood share of livestock	-4.39 (3.84)	1.37 (2.87)	-0.39 (2.33)	-0.27 (2.33)
Mean household education	-2.19 (1.23)	-0.33 (0.86)	-1.03 (0.73)	-0.99 (0.73)
Distance from nearest public veterinary centre (travel time in minutes)	0.04 (0.04)	0.01 (0.02)	0.02 (0.02)	0.03 (0.02)
Veterinary livestock units owned	-0.22 (0.39)	-0.92** (0.18)	-0.72** (0.18)	-0.73** (0.18)
District versatility	--	--	--	0.50 (0.70)
Adjusted R^2	0.640	0.559	0.619	0.619
N	282	356	638	638
F	42.68	38.45	87.23	80.50

[a] reference category: Public veterinary centre; [b] reference category: Centre; [c] reference category: Buffalo
[d] reference category: Single insemination; [e] reference category: Livestock underdeveloped
Model-1: For study area without area specific attribute; **Model-2:** For study area with area specific attribute.
Figures in parentheses indicate standard errors.
*** Highly significant ($P \leq 0.01$)*

Table 5.20
AVERAGE TIME COSTS ASSOCIATED WITH ANIMAL HEALTH CARE SERVICES

(In minutes)

Category	Service provider type	Travel time	Waiting time	Service time	Total time
Livestock underdeveloped districts	Public veterinary centre	23.05	22.35	12.11	57.51
	Home service by veterinarian	0.00	23.01	23.59	47.00
	Home service by para-veterinarian	0.00	22.01	21.07	43.08
	Ethnic/ traditional healer	9.07	12.00	11.00	32.07
	Private veterinary clinic	14.00	15.00	5.00	34.00
	Pharmacy	12.07	2.07	4.44	18.58
Livestock developed districts	Public veterinary centre	21.32	20.10	14.50	56.32
	Home service by veterinarian	0.00	15.38	25.18	40.56
	Home service by para-veterinarian	0.00	11.22	24.00	35.22
	Ethnic/ traditional healer	10.29	12.35	10.59	33.23
	Private veterinary clinic	20.05	15.00	5.00	40.05
	Pharmacy	15.00	4.28	5.00	24.28

Table 5.21
AVERAGE TIME COSTS ASSOCIATED WITH BOVINE BREEDING SERVICES

(In minutes)

Category	Service provider type	Travel time	Waiting time	Service time	Total time
Livestock underdeveloped districts	Public veterinary centre	40.30	27.28	5.34	73.32
	Home service by veterinarian	0.00	5.33	6.03	11.36
	Home service by para-veterinarian	0.00	0.00	5.00	5.00
	Private veterinary clinic	10.11	6.47	5.00	21.58
	Natural breeding	6.31	5.24	4.52	16.07
Livestock developed districts	Public veterinary centre	37.55	29.27	5.13	72.35
	Home service by veterinarian	0.00	27.07	5.00	32.07
	Home service by para-veterinarian	0.00	0.00	5.00	5.00
	Private veterinary clinic	10.38	7.06	5.00	22.44
	Natural breeding	8.31	6.39	7.22	22.32

Table 5.22
DEMAND FOR ANIMAL HEALTH CARE SERVICES: ESTIMATES OF DOUBLE HURDLE MODEL - First Stage (Probit Estimation)

Explanatory variables	PUBLIC SERVICES			PRIVATE SERVICES		
	Coefficient	SE	'Z' value	Coefficient	SE	'Z' value
Age of head of the family	-0.0127 (-0.0009)	0.0130 (0.0011)	-0.98 (-0.83)	-0.0383* (-0.0060)	0.0172 (0.0037)	-2.22 (-1.61)
Mean household education	-0.0352 (-0.0262)	0.2596 (0.0243)	-1.36 (-1.08)	-0.2240 (-0.0352)	0.5297 (0.0850)	0.42 (0.41)
Milk price (Rs./lt.)	0.1112* (0.0083)	0.0477 (0.0049)	2.33 (1.70)	0.5302 (0.0832)	0.5126 (0.0755)	1.03 (1.10)
Quantity of milk sold (litre/day)	-0.0211 (-0.0016)	0.0328 (0.0025)	-0.64 (-0.63)	-0.0681 (-0.0107)	0.0569 (0.0102)	-1.20 (-1.04)
Average visit cost (Rs.)	-0.0733** (-0.0055)	0.0083 (0.0025)	-8.85 (-2.22)	0.0657** (0.0103)	0.0148 (0.0041)	4.43 (2.51)
Acute medical cases	0.9396** (0.0912)	0.2737 (0.0476)	3.43 (1.91)	-3.1245** (-0.7101)	0.8700 (0.1782)	-3.59 (-3.99)
Acute surgical cases	0.5408 (0.0608)	0.4311 (0.0623)	1.25 (0.98)	-1.8476** (-0.5677)	0.5048 (0.1597)	-3.66 (-3.55)
Chronic surgical cases	0.1800 (0.0155)	0.4217 (0.0415)	0.43 (0.37)	-4.4441** (-0.9404)	0.8306 (0.0433)	-5.35 (-21.73)
Obstetrical cases	-1.8386** (-0.0614)	0.5895 (0.0336)	-3.12 (-1.82)	3.0907** (0.1911)	0.6044 (0.0957)	5.11 (2.00)
Gynaecological cases	1.5107** (0.2815)	0.4892 (0.1520)	3.09 (1.85)	-4.4949** (-0.9686)	0.8906 (0.0316)	-5.05 (-30.70)
Distance from nearest public veterinary centre (travel time in minutes)	-0.0657** (-0.0049)	0.0111 (0.0026)	-5.91 (-1.86)	0.0896** (0.0141)	0.0194 (0.0065)	4.61 (2.15)
Value of animal affected (in Rs.'000)	0.0203 (0.0015)	0.0311 (0.0023)	0.65 (0.64)	0.4125** (0.0647)	0.1462 (0.0259)	2.82 (2.50)
Livelihood share of livestock	-1.5997* (-0.1189)	0.7352 (0.0811)	-2.18 (-1.47)	-1.1038 (-0.1732)	1.1135 (0.2176)	-0.99 (-0.80)
Annual household income (Rs.'000)	-0.0061** (-0.0005)	0.0024 (0.0003)	-2.59 (-1.68)	-0.0019 (-0.0003)	0.0035 (0.0006)	-0.53 (0.53)
Veterinary livestock units owned	0.0815 (0.0061)	0.0898 (0.0076)	0.91 (0.80)	-0.0130 (-0.0021)	0.1379 (0.0212)	-0.09 (-0.10)
Possession of crossbred cow/graded buffalo (dummy)	0.0520 (0.0289)	0.3297 (0.0222)	1.58 (1.30)	1.7714 (0.4873)	0.7833 (0.2391)	2.26 (2.04)
Waiting time (minutes)	0.0036 (0.0003)	0.0055 (0.0004)	0.65 (0.67)	0.0013 (0.0002)	0.0110 (0.0017)	0.12 (0.12)
Quality of services	0.5894** (0.0438)	0.1093 (0.0227)	5.39 (1.93)	1.7108** (0.2685)	0.2941 (0.1287)	5.82 (2.09)
District versatility	-0.6962** (-0.0501)	0.2416 (0.0327)	-2.88 (-1.53)	0.3833 (0.0618)	0.4120 (0.0656)	0.93 (0.94)
Constant	2.7091*	1.0644	2.55	-20.9360**	6.1984	-3.38
Number of observations	741	….	….	741	….	….
Wald χ^2 (19)	127.17	….	….	76.25	….	….
Prob > χ^2	0.0000	….	….	0.0000	….	….
Pseudo R^2	0.8574	….	….	0.9585	….	….
Log pseudo likelihood	-134.0695	….	….	-68.6399	….	….

Marginal effects are given in parentheses under coefficients with their respective standard errors (SE) and 'Z' values.
** Significant ($P \leq 0.05$)** Highly significant ($P \leq 0.01$)*

Table 5.23
DEMAND FOR ANIMAL HEALTH CARE SERVICES: ESTIMATES OF DOUBLE HURDLE MODEL – Second Stage (Zero truncated Poisson regression)

Explanatory variables	PUBLIC SERVICES			PRIVATE SERVICES		
	Coefficient	SE	'Z' value	Coefficient	SE	'Z' value
Age of head of the family	-0.0004 (0.0005)	0.0049 (0.0058)	0.08 (0.08)	0.0043 (0.0024)	0.0080 (0.0045)	0.53 (0.53)
Mean household education	-0.0983 (-0.1176)	0.1072 (0.128)	-0.92 (-0.92)	0.0090 (0.0051)	0.1612 (0.0911)	0.06 (0.06)
Milk price (Rs./lt.)	-0.0213 (-0.0255)	0.0245 (0.0293)	-0.87 (-0.87)	-0.0320 (-0.0181)	0.1120 (0.0632)	-0.29 (-0.29)
Quantity of milk sold (litre/day)	0.0011 (0.0013)	0.0121 (0.015)	0.09 (0.09)	0.0181 (0.0102)	0.0130 (0.0074)	1.40 (1.38)
Average visit cost (Rs.)	-0.0042 (-0.0050)	0.0054 (0.0065)	-0.77 (-0.77)	-0.0033* (-0.0018)	0.0016 (0.0009)	-1.99 (-1.98)
Acute medical cases	1.0482** (1.5817)	0.2236 (0.3892)	4.69 (4.06)	2.4047** (1.9613)	0.7335 (0.7979)	3.28 (2.46)
Acute surgical cases	1.1008** (2.1707)	0.2406 (0.6783)	4.57 (3.20)	2.6501** (6.3625)	0.7465 (4.3357)	3.55 (1.47)
Chronic surgical cases	1.1178** (2.2758)	0.2504 (0.7487)	4.46 (3.04)	2.7237** (7.5659)	0.7853 (5.6512)	3.47 (1.34)
Obstetrical cases	1.4812** (4.0350)	0.5311 (2.7050)	2.79 (1.49)	1.8531* (1.6694)	0.7411 (0.9500)	2.50 (1.76)
Gynaecological cases	1.2004** (2.1002)	0.2231 (0.5007)	5.38 (4.19)	2.4947** (6.0218)	0.8159 (4.8459)	3.06 (1.24)
Distance from nearest public veterinary centre (travel time in minutes)	-0.0310** (-0.0371)	0.0078 (0.0091)	-3.97 (-4.06)	0.0164* (0.0093)	0.0065 (0.0037)	2.55 (2.51)
Value of animal affected (in Rs.'000)	-0.0388* (-0.0465)	0.0155 (0.0182)	-2.50 (-2.55)	0.0967** (0.0546)	0.0224 (0.0133)	4.32 (4.10)
Livelihood share of livestock	-0.0465 (-0.0556)	0.3369 (0.4032)	-0.14 (-0.14)	0.3610 (0.2039)	0.3821 (0.2153)	0.94 (0.95)
Annual household income (Rs.'000)	-0.0003 (-0.0004)	0.0012 (0.0014)	-0.26 (-0.26)	0.0003 (0.0002)	0.0005 (0.0003)	0.69 (0.69)
Veterinary livestock units owned	-0.0097 (-0.0116)	0.0253 (0.0303)	-0.38 (-0.38)	0.0191 (0.0108)	0.0379 (0.0214)	0.51 (0.50)
Possession of crossbred cow/graded buffalo (dummy)	0.0371 (0.0439)	0.1493 (0.1745)	0.25 (0.25)	-0.1984 (-0.1199)	0.2200 (0.1424)	-0.90 (-0.84)
Waiting time (minutes)	-0.0007 (-0.0008)	0.0024 (0.0028)	-0.28 (-0.28)	0.0002 (0.0001)	0.0028 (0.0016)	0.08 (0.08)
Quality of services	0.3647** (0.4365)	0.0999 (0.1206)	3.65 (3.62)	0.3297** (0.1862)	0.1001 (0.0582)	3.29 (3.20)
District versatility	-0.0425 (-0.0504)	0.1090 (0.1286)	-0.39 (-0.39)	-0.0688 (-0.0390)	0.1530 (0.0874)	-0.45 (-0.45)
Constant	-1.0269	0.9325	-1.10	-6.3350**	1.3843	-4.58
Number of observations	382	….	….	359	….	….
Wald χ^2 (19)	262.36	….	….	228.86	….	….
Prob > χ^2	0.0000	….	….	0.0000	….	….
Pseudo R^2	0.2491	….	….	0.2978	….	….
Log pseudo likelihood	-395.4902	….	….	-269.8073	….	….

Marginal effects are given in parentheses under coefficients with their respective standard errors (SE) and 'Z' values.
** Significant (P≤ 0.05)** Highly significant (P≤ 0.01)*

Table 5.24
DEMAND FOR BOVINE BREEDING SERVICES: ESTIMATES OF DOUBLE HURDLE MODEL - First Stage (Probit Estimation)

Explanatory variables	PUBLIC SERVICES			PRIVATE SERVICES		
	Coefficient	SE	'Z' value	Coefficient	SE	'Z' value
Milk price (Rs. per litre)	0.0736 (0.0283)	0.0728 (0.0280)	1.01 (1.01)	0.6986** (0.0658)	0.1154 (0.0147)	6.06 (4.47)
Quantity of milk sold (litre/day)	-0.0583** (-0.0224)	0.0140 (0.0054)	-4.15 (-4.15)	0.1522** (0.0143)	0.0250 (0.0029)	6.09 (4.90)
Average insemination cost (Rs.)	-0.0799** (-0.0307)	0.0121 (0.0046)	-6.60 (-6.69)	0.1007** (0.0095)	0.0122 (0.0020)	8.24 (4.87)
Success of insemination	-0.1848 (-0.0706)	0.1165 (0.0444)	-1.59 (-1.59)	0.5377** (0.0484)	0.1926 (0.0167)	2.79 (2.90)
Species of animal	0.1288 (0.0500)	0.1656 (0.0648)	0.78 (0.77)	0.5030 (0.0351)	0.2901 (0.0167)	1.73 (2.11)
Distance from nearest public veterinary centre (travel time in minutes)	0.0023 (0.0009)	0.0040 (0.0015)	0.59 (0.59)	0.0184** (0.0017)	0.0059 (0.0005)	3.13 (3.28)
Mean household education	-0.0036 (-0.0014)	0.1320 (0.0507)	-0.03 (-0.03)	-0.2102 (-0.0198)	0.2101 (0.0188)	-1.00 (-1.05)
Veterinary livestock units owned	-0.0207 (-0.0080)	0.0356 (0.0137)	-0.58 (-0.58)	-0.1705** (-0.0161)	0.0570 (0.0053)	-2.99 (-3.04)
No. of crossbred cows owned	0.1649** (0.0633)	0.0620 (0.0239)	2.66 (2.65)	-0.0146 (-0.0014)	0.1029 (0.0098)	-0.14 (-0.14)
No. of graded buffaloes owned	-0.0864 (-0.0332)	0.0805 (0.0309)	-1.07 (-1.08)	-0.5844** (-0.0551)	0.1429 (0.0174)	-4.09 (-3.16)
Value of animal inseminated (in Rs.'000)	0.0000 (0.0000)	0.0000 (0.0000)	0.75 (0.75)	0.0000 (0.0000)	0.0000 (0.0000)	1.05 (1.08)
Annual household income (Rs.'000)	0.0002 (0.0001)	0.0008 (0.000)	0.31 (0.31)	-0.0008 (-0.0001)	0.0013 (0.0001)	-0.67 (-0.65)
District versatility	0.2971* (0.1141)	0.1256 (0.0481)	2.37 (2.37)	-1.2935** (-0.1490)	0.2588 (0.0309)	-5.00 (-4.82)
Constant	2.4351**	0.8649	2.82	-10.4140**	1.2409	-8.39
Number of observations	632	….	….	632	….	….
Wald χ^2 (13)	118.62	….	….	148.22	….	….
Prob > χ^2	0.0000	….	….	0.0000	….	….
Pseudo R^2	0.4013	….	….	0.2495	….	….
Log pseudo likelihood	-274.5529	….	….	-319.2912	….	….

Marginal effects are given in parentheses under coefficients with their respective standard errors (SE) and 'Z' values.
** Significant (P≤ 0.05)** Highly significant (P≤ 0.01)*

Table 5.25
DEMAND FOR BOVINE BREEDING SERVICES: ESTIMATES OF DOUBLE HURDLE MODEL – Second Stage (Zero truncated Poisson regression)

Explanatory variables	PUBLIC SERVICES			PRIVATE SERVICES		
	Coefficient	SE	'Z' value	Coefficient	SE	'Z' value
Milk price (Rs.per litre)	-0.0553 (-0.0074)	0.0871 (0.0117)	-0.64 (-0.63)	0.6737** (0.0133)	0.1971 (0.0033)	3.42 (3.97)
Quantity of milk sold (litre/day)	0.0162 (0.0022)	0.0174 (0.0023)	0.93 (0.93)	0.0377** (0.0007)	0.0130 (0.0002)	2.91 (3.06)
Average insemination cost (Rs.)	-0.1250** (-0.0167)	0.0102 (0.0034)	-12.24 (-4.95)	-0.0109* (-0.0002)	0.0043 (0.0001)	-2.52 (-2.38)
Success of insemination	2.0148** (0.2836)	0.4273 (0.0425)	4.72 (6.67)	16.3137** (0.6261)	0.2682 (0.0913)	60.82 (6.86)
Species of animal	-0.5929 (-0.1021)	0.3295 (0.0800)	-1.80 (-1.28)	0.5122 (0.0083)	0.4638 (0.0062)	1.10 (1.34)
Distance from nearest public veterinary centre (travel time in minutes)	-0.0001 (-0.0000)	0.0032 (0.0004)	-0.04 (-0.04)	0.0072 (0.0001)	0.0073 (0.0001)	0.99 (0.99)
Mean household education	-0.3324 (-0.0444)	0.1808 (0.0243)	-1.84 (-1.83)	-0.2299 (-0.0045)	0.2021 (0.0041)	-1.14 (-1.11)
Veterinary livestock units owned	-0.0732* (-0.0098)	0.0376 (0.0053)	-1.95 (-1.85)	0.0566 (0.0011)	0.0725 (0.0014)	0.78 (0.79)
No. of crossbred cows owned	0.1189 (0.0159)	0.0778 (0.0106)	1.53 (1.50)	0.2884** (0.0057)	0.0995 (0.0019)	2.90 (2.93)
No. of graded buffaloes owned	0.4681** (0.0625)	0.1491 (0.0225)	3.14 (2.78)	-0.2987 (-0.0059)	0.3476 (0.0069)	-0.86 (-0.85)
Value of animal inseminated (in Rs.'000)	0.0001* (0.0000)	0.0000 (0.0000)	2.16 (2.26)	0.0002** (0.0000)	0.0000 (0.0000)	5.68 (6.78)
Annual household income (Rs.'000)	-0.0009 (-0.0001)	0.0008 (0.000)	-1.18 (-1.18)	0.0002 (0.0000)	0.0002 (0.0000)	1.04 (1.00)
District versatility	0.2607 (0.0338)	0.2031 (0.0272)	1.28 (1.24)	-0.0121 (-0.0002)	0.2327 (0.0045)	-0.05 (-0.05)
Constant	1.2809	1.1419	1.12	-12.4607**	1.5040	-8.29
Number of observations	379	….	….	253	….	….
Wald χ^2 (13)	311.85	….	….	126.45	….	….
Prob > χ^2	0.0000	….	….	0.0000	….	….
Pseudo R^2	0.5031	….	….	0.3202	….	….
Log pseudo likelihood	-146.7268	….	….	-147.0984	….	….

Marginal effects are given in parentheses under coefficients with their respective standard errors (SE) and 'Z' values.
** Significant (P≤0.05)** Highly significant (P≤0.01)*

Table 5.26
FACTORS DETERMINING WILLINGNESS TO PAY FOR ANNUAL HEALTH CARE SERVICES FOR COWS (Results of Interval Regression)

Explanatory variables	Services at centre		Services at home	
	Coefficient	'Z' value	Coefficient	'Z' value
Sex of respondent	0.9229 (6.6932)	0.14	6.7562 (6.8516)	0.99
Age of respondent	-0.3094 (0.2775)	-1.11	-0.1705 (0.2840)	-0.60
Mean household education	14.1634** (5.4162)	2.62	14.0550** (5.5443)	2.54
Annual household income (Rs.'000)	0.2833** (0.0538)	5.27	0.2611** (0.0551)	4.74
Livelihood share of livestock	3.1544 (9.9533)	0.32	8.8367 (10.1884)	0.87
Possession of crossbred (dummy)	33.3465** (8.1324)	4.10	37.0119** (8.3238)	4.45
No. of cows and buffaloes owned	1.0895 (2.7809)	0.39	1.2467 (2.8465)	0.44
Milk price (Rs./litre)	-0.3309 (3.7069)	-0.09	-0.4310 (3.7945)	-0.11
Quantity of milk sold (litre/day)	7.7375** (0.7055)	10.97	7.1239** (0.7221)	9.87
Distance from nearest public veterinary centre (travel time in min.)	0.1283 (0.1681)	0.76	1.2884** (0.1721)	7.49
District versatility	23.3172** (5.0377)	4.63	24.6125** (5.1566)	4.77
Constant	45.5401** (32.0376)	1.42	55.4255 (32.7939)	1.69
/lnsigma	3.6026** (0.0448)	80.38	3.6268** (0.0448)	81.05
Sigma	36.6929 (1.6445)	….	37.5913 (1.6822)	….
Number of observations	268	….	268	….
LR χ^2 (11)	335.81	….	347.92	….
Prob > χ^2	0.0000	….	0.0000	….
Log likelihood	-488.1513	….	-494.4117	….

** *Highly significant (P≤ 0.01)*
Figures in parentheses indicate standard errors.

Table 5.27
MEAN WTP VALUES FOR ANNUAL HEALTH CARE FOR COWS

(Rs.)

District	In-centre services	At home services
LUD districts	172.50 (3.22)	230.65 (3.29)
LD districts	232.62 (3.24)	293.15 (3.32)
Overall	202.34 (2.28)	261.66 (2.34)

Figures in parentheses indicate standard errors.

Table 5.28
FACTORS DETERMINING WILLINGNESS TO PAY FOR ANNUAL HEALTH CARE SERVICES FOR BUFFALOES (Results of Interval Regression)

Explanatory variables	Services at centre		Services at home	
	Coefficient	'Z' value	Coefficient	'Z' value
Sex of respondent	13.9085* (6.1784)	2.25	11.8500* (6.1713)	1.96
Age of respondent	0.0742 (0.2547)	0.29	0.1205 (0.2534)	0.48
Mean household education	4.4694 (6.1421)	0.73	3.5479 (6.1507)	0.58
Annual household income (Rs.'000)	-0.0059 (0.1436)	-0.04	-0.1251 (0.1438)	-0.87
Livelihood share of livestock	-31.4414 (23.2609)	-1.35	-35.1504 (23.2501)	-1.51
Possession of graded buffaloes (dummy)	19.2132* (7.6092)	2.52	11.9833 (7.6108)	1.57
No. of cows and buffaloes owned	-1.5102 (2.3608)	-0.64	-1.4788 (2.3534)	-0.63
Milk price (Rs./litre)	-0.0681 (3.1049)	-0.02	1.4436 (3.1042)	0.47
Quantity of milk sold (litre/day)	4.8809** (0.8535)	5.72	5.2323** (0.8531)	6.13
Distance from nearest public veterinary centre (travel time in min.)	-0.5000** (0.1893)	-2.64	0.3902* (0.1896)	2.06
District versatility	22.4895** (5.5165)	4.08	26.9129** (5.5114)	4.88
Constant	55.7569 (34.2781)	1.63	66.3716 (34.3231)	1.93
/lnsigma	2.6455** (0.1153)	22.94	2.6439** (0.1156)	22.87
Sigma	14.0907 (1.6252)	….	14.0682 (1.6261)	….
Number of observations	59	….	59	….
LR χ^2 (11)	121.99	….	134.33	….
Prob > χ^2	0.0000	….	0.0000	….
Log likelihood	-56.8649	….	-56.7963	….

** Significant (P≤ 0.05); ** Highly significant (P≤ 0.01)*

Figures in parentheses indicate standard errors.

Table 5.29
MEAN WTP VALUES FOR ANNUAL HEALTH CARE FOR BUFFALOES

(Rs.)

District	In-centre services	At home services
LUD districts	106.57 (2.89)	152.45 (2.89)
LD districts	165.99 (2.93)	221.12 (2.93)
Overall	135.78 (2.06)	186.20 (2.06)

Figures in parentheses indicate standard errors.

Table 5.30
FACTORS DETERMINING WILLINGNESS TO PAY FOR ANNUAL HEALTH CARE SERVICES FOR BULLOCKS (Results of Interval Regression)

Explanatory variables	Services at centre		Services at home	
	Coefficient	'Z' value	Coefficient	'Z' value
Sex of respondent	18.7228 (9.9763)	1.88	15.8610 (10.1126)	1.57
Age of respondent	-0.4371* (0.1942)	-2.25	-0.4616* (0.1968)	-2.35
Mean household education	1.0613 (4.6745)	0.23	-3.0535 (4.7399)	-0.64
Annual household income (Rs.'000)	0.1245** (0.0472)	2.64	0.1563** (0.0479)	3.26
Livelihood share of livestock	-14.0877 (13.7367)	-1.03	-19.4448 (13.9382)	-1.40
Bullock rented (dummy)	64.1685** (5.0622)	12.68	63.0591** (5.1301)	12.29
Veterinary livestock units owned	2.3583 (1.3144)	1.79	2.6489* (1.3326)	1.99
Distance from nearest public veterinary centre (travel time in min.)	-0.8147** (0.1524)	-5.35	0.4561** (0.1545)	2.95
District versatility	17.7272** (4.2230)	4.20	17.4180** (4.2817)	4.07
Constant	118.3500** (16.3931)	7.22	125.0011** (16.6242)	7.52
/lnsigma	3.0708** (0.0648)	47.36	3.0861** (0.0647)	47.73
Sigma	21.5596 (1.3979)	….	21.8916 (1.4154)	….
Number of observations	146	….	146	….
LR χ^2 (9)	137.87	….	118.48	….
Prob > χ^2	0.0000	….	0.0000	….
Log likelihood	-193.2788	….	-195.2967	….

** Significant (P≤ 0.05); ** Highly significant (P≤ 0.01)*
Figures in parentheses indicate standard errors.

Table 5.31
MEAN WTP VALUES FOR ANNUAL HEALTH CARE FOR BULLOCKS

(Rs.)

District	In-centre services	At home services
LUD districts	128.18 (2.57)	170.50 (2.61)
LD districts	132.36 (2.76)	175.37 (2.80)
Overall	130.12 (1.88)	172.77 (1.91)

Figures in parentheses indicate standard errors.

Table 5.32
FACTORS DETERMINING WILLINGNESS TO PAY FOR ANNUAL HEALTH CARE SERVICES FOR SHEEP (Results of Interval Regression)

Explanatory variables	Services at centre		Services at home	
	Coefficient	'Z' value	Coefficient	'Z' value
Sex of respondent	0.5483 (8.1757)	0.07	4.0071 (11.7342)	0.34
Age of respondent	-1.0574** (0.2469)	-4.28	-0.9460** (0.3178)	-2.98
Mean household education	4.6998 (8.4720)	0.55	9.0862 (11.6783)	0.78
Annual household income (Rs.'000)	0.0006 (0.0235)	0.02	-0.0159 (0.0288)	-0.55
Livelihood share of livestock	38.8246** (11.6192)	3.34	39.6263** (16.2813)	2.43
No. of sheep owned	0.6534* (0.3026)	2.16	0.5132 (0.3975)	1.29
Veterinary livestock units owned	-4.7646** (1.3601)	-3.50	-5.3020** (1.7657)	-3.00
Distance from nearest public veterinary centre (travel time in min.)	0.4809** (0.1680)	2.86	1.1322** (0.2313)	4.89
Mutton price in the area (Rs./Kg.)	-0.2192 (0.5031)	-0.44	-0.6261 (0.6777)	-0.92
District versatility	-5.0738 (7.3138)	-0.69	2.8332 (10.1074)	0.28
Constant	108.4480 (64.1598)	1.69	154.6278 (86.9549)	1.78
/lnsigma	2.0013** (0.2545)	7.86	2.4466 (0.1722)	14.20
Sigma	7.3989 (1.8832)	….	11.5485 (1.9892)	….
Number of observations	32	….	32	….
LR χ^2 (10)	35.03	….	31.77	….
Prob > χ^2	0.0001	….	0.0004	….
Log likelihood	-18.6385	….	-26.1744	….

** Significant (P≤ 0.05); ** Highly significant (P≤ 0.01)*
Figures in parentheses indicate standard errors.

Table 5.33
MEAN WTP VALUES FOR ANNUAL HEALTH CARE FOR SHEEP

(Rs.)

District	In-centre services	At home services
LUD districts	60.99 (2.56)	89.31 (3.68)
LD districts	52.73 (2.42)	86.07 (3.24)
Overall	56.34 (1.77)	87.49 (2.43)

Figures in parentheses indicate standard errors.

Table 5.34
FACTORS DETERMINING WILLINGNESS TO PAY FOR ANNUAL HEALTH CARE SERVICES FOR GOAT (Results of Interval Regression)

Explanatory variables	Services at centre		Services at home	
	Coefficient	'Z' value	Coefficient	'Z' value
Sex of respondent	-1.5860 (4.3870)	-0.36	1.9022 (4.1845)	0.45
Age of respondent	-0.4812** (0.1735)	-2.77	-0.2881 (0.1643)	-1.75
Mean household education	3.1376 (3.7518)	0.84	3.8373 (3.5741)	1.07
Annual household income (Rs.'000)	0.0251 (0.0563)	0.45	0.0014 (0.0531)	0.03
Livelihood share of livestock	4.9132 (11.2989)	0.43	-9.7685 (10.7110)	-0.91
No. of goats owned	-0.8060 (0.9665)	-0.83	-1.7682* (0.9163)	-1.97
Veterinary livestock units owned	3.4034** (1.2087)	2.82	2.8355* (1.1454)	2.48
Distance from nearest public veterinary centre (travel time in min.)	-0.6110** (0.1277)	-4.79	0.4957** (0.1208)	4.11
Chevon price in the area (Rs./Kg.)	-0.2939 (0.4551)	-0.65	-0.3091 (0.4348)	-0.71
District versatility	13.9443** (4.6.71)	3.03	13.8032** (4.3885)	3.15
Constant	115.8411* (60.1068)	1.96	116.6066* (57.4548)	2.03
/lnsigma	2.6605** (0.0839)	31.72	2.5923** (0.0846)	30.66
Sigma	14.3028 (1.1997)	….	13.3605 (1.1297)	….
Number of observations	109	….	109	….
LR χ^2 (10)	60.25	….	51.02	….
Prob > χ^2	0.0000	….	0.0000	….
Log likelihood	-106.1642	….	-99.7237	….

** Significant (P≤ 0.05); ** Highly significant (P≤ 0.01)*
Figures in parentheses indicate standard errors.

Table 5.35
MEAN WTP VALUES FOR ANNUAL HEALTH CARE FOR GOATS

(Rs.)

District	In-centre services	At home services
LUD districts	51.53 (2.51)	87.42 (2.37)
LD districts	67.68 (1.94)	100.01 (1.85)
Overall	61.61 (1.54)	95.27 (1.46)

Figures in parentheses indicate standard errors.

Table 5.36
FACTORS DETERMINING WILLINGNESS TO PAY FOR BOVINE BREEDING SERVICES PER CONCEPTION (Results of Interval Regression)

Explanatory variables	Cow				Buffalo			
	Services at centre		Services at home		Services at centre		Services at home	
	Coefficient	'Z' value	Coefficient	'Z' value	Coefficient	'Z' value	Coefficient	'Z' value
Sex of respondent	0.9090 (3.3519)	0.27	-0.5526 (3.7991)	-0.15	-12.6983 (6.8211)	-1.86	-0.0756 (5.6362)	-0.01
Age of respondent	-0.0211 (0.1247)	-0.17	-0.0737 (0.1412)	-0.52	0.0004 (0.3643)	0.00	-0.2917 (0.2992)	-0.98
Mean household education	7.7236** (2.6355)	2.93	6.0772* (2.9888)	2.03	24.2462** (8.3864)	2.89	16.0111* (6.9152)	2.32
Annual household income (Rs.'000)	0.1009** (0.0249)	4.05	0.1232** (0.0283)	4.36	-0.1811 (0.1658)	-1.09	-0.1427 (0.1362)	-1.05
Livelihood share of livestock	-19.6901* (9.5219)	-2.07	-10.9298 (10.7878)	-1.01	12.0057 (32.1792)	0.37	25.9330 (26.3892)	0.98
No. of cows and buffaloes owned	0.2443 (1.0069)	0.24	0.4547 (1.1416)	0.40	0.5403 (2.0337)	0.27	0.9813 (1.6635)	0.59
Possession of crossbred cow/graded buffalo (dummy)	15.7678** (4.4060)	3.58	14.0316** (4.9904)	2.81	38.2284** (9.3259)	4.10	33.9886** (7.6239)	4.46
Quantity milk sold (litre/day)	4.3868** (0.3821)	11.48	4.4099** (0.4329)	10.19	1.8829** (0.6110)	3.08	2.6207** (0.5011)	5.23
Milk price (Rs./litre)	-2.5316 (1.9531)	-1.30	-3.8356 (2.2120)	-1.73	-6.1388 (7.6347)	-0.80	-4.3275 (6.2314)	-0.69
Distance from nearest public veterinary centre (travel time in min.)	-0.0572 (0.0867)	-0.66	0.6732** (0.0981)	6.86	-0.6186* (0.2678)	-2.31	0.5942** (0.2198)	2.70
District versatility	11.0174** (3.0066)	3.66	11.0393** (3.4070)	3.24	34.4960** (7.0758)	4.88	42.4083** (5.7899)	7.32
Constant	57.4806** (16.6823)	3.45	90.2483** (18.8965)	4.78	153.5784* (74.7430)	2.04	132.0909* (61.0696)	2.16
/Insigma	2.9192** (0.0490)	59.62	3.0609** (0.0476)	64.33	2.8293** (0.1116)	25.36	2.5802** (0.1209)	21.35
Sigma	18.5263 (0.9071)	….	21.3460 (1.0157)	….	16.9344 (1.8897)	….	13.1999 (1.5955)	….
Number of observations	270	….	270	….	56	….	56	….
LR χ^2 (11)	297.00	….	277.99	….	85.72	….	129.45	….
Prob > χ^2	0.0000	….	0.0000	….	0.0000	….	0.0000	….
Log likelihood	-320.7213	….	-354.6893	….	-62.4224	….	-51.0475	….

** Significant (P≤ 0.05); ** Highly significant (P≤ 0.01)*
Figures in parentheses indicate standard errors.

Table 5.37
MEAN WTP VALUES PER CONCEPTION IN COWS AND BUFFALOES

Rs.

District	Cow		Buffalo	
	In-centre services	At home services	In-centre services	At home services
LUD districts	97.61 (1.71)	142.66 (1.93)	116.33 (3.61)	152.82 (2.96)
LD districts	128.21 (1.72)	176.15 (1.95)	153.30 (3.36)	214.82 (2.74)
Overall	112.80 (1.21)	159.28 (1.37)	136.14 (2.46)	186.04 (2.01)

Figures in parentheses indicate standard errors.

Table 5.38
RATING OF QUALITY ATTRIBUTES OF PUBLIC VETERINARY CENTRES FOR IMPROVEMENTS

Sl. No.	Characters	LUD districts	LD districts	Overall
a.	Geographical proximity of the public veterinary centre	I (64.15)	I (69.73)	I (66.94)
b.	Waiting time before meeting the service provider	V (51.88)	V (51.51)	V (51.70)
c.	Attitude of the public veterinary centre's staff	VI (33.98)	VI (33.96)	VI (33.97)
d.	Receiving adequate information on the sickness and treatment of animals	VII (25.65)	VII (25.88)	VII (25.76)
e.	Being able to find the prescribed treatments	IV (53.39)	IV (55.66)	IV (54.53)
f.	Chance of recovery after visiting the centre	III (60.59)	III (57.95)	III (59.27)
g.	Chance of conception after inseminating at the centre	II (64.01)	II (61.52)	II (62.77)

(Figures in parentheses indicate Garret's scores.)

Table 5.39
CHARACTERIZATION OF QUALITY *STATUS QUO* LEVEL

Attributes	Categories	No. of respondents	Per cent willing to pay
Geographical proximity	Very far	43 (13.44)	97.67
	Far	153 (47.81)	89.54
	Average distance	77 (24.06)	63.64
	Close or very close	47 (14.69)	19.15
Waiting time	Very long	7 (2.19)	100.00
	Long	128 (40.00)	92.19
	Average	156 (48.75)	80.77
	Not long or Not long at all	29 (9.07)	41.38
Staff attitude	Very bad	65 (20.31)	100.00
	Bad	74 (23.13)	98.65
	Good	181 (56.56)	5.52
Drug availability	All	211 (65.93)	24.64
	Some	74 (24.13)	89.19
	None	35 (10.94)	94.28
Service provider-farmer relationship	**Mean score: 76.43**	320	39.06
Chance of recovery	**Mean score: 72.63**	320	53.75
Chance of conception	**Mean score: 48.28**	282	79.69

Figures in parentheses indicate percentages to respective attributes.

Table 5.40
MEAN TRAVEL TIME (current) AND WTP VALUES FOR IMPROVING GEOGRAPHICAL PROXIMITY OF PUBLIC VETERINARY CENTRES

District	Travel time (min.)	WTP (Rs.)
LUD districts	35.19 (1.20)	6.16 (0.58)
LD districts	34.02 (1.11)	9.25 (0.42)
Overall	34.41 (1.22)	8.12 (0.37)
't' value	0.96 ^{NS}	4.03**

Figures in parentheses indicate standard errors.

^{NS} *Not-significant ($P \geq 0.05$); ** Highly significant ($P \leq 0.01$)*

Table 5.41
FACTORS INFLUENCING PARTIAL WTP VALUES FOR IMPROVEMENT IN GEOGRAPHICAL PROXIMITY (Results of Tobit regression)

Explanatory variables	Tobit coefficients	Marginal effects for the probability being uncensored	Marginal effects for E(WTP | 0 < WTP)
Distance from the public veterinary centre: **Very far**	15.6762** (1.6892)	0.2531**	13.0146**
Distance from the public veterinary centre: **Far**	12.7866** (1.4106)	0.4729**	8.1868**
Distance from the public veterinary centre: **Average**	7.7755** (1.5422)	0.2162**	5.5907**
District versatility	2.1093** (0.7956)	0.0819**	1.3277**
Sex of respondent	1.7261 (1.2290)	0.0732	1.0395
Age of respondent	0.0611 (0.0478)	0.0024	0.0385
Educational level of respondent	0.5094 (0.7103)	0.0198	0.3208
Milk price (Rs. per litre)	0.3770 (0.5325)	0.0146	0.2374
Quantity of milk sold (litre per day)	0.2402* (0.0950)	0.0093*	0.1512*
Possession of crossbred cows/ graded buffaloes (dummy)	3.3170** (1.1919)	0.1473*	1.9438**
Veterinary livestock units owned	-0.0539 (0.2221)	-0.0021	-0.0339
Annual household income (in Rs. '000)	-0.0002 (0.0004)	-0.0000	-0.0001
Livelihood share of livestock	-2.5305 (2.3804)	-0.0982	-1.5936
Purpose of visit to public veterinary centre (AI/Treatment)	3.1942** (0.8693)	0.1344**	1.9306**
No. of visits made during the last year	0.1697 (0.1445)	0.0066	0.1069
Constant	-19.2100** (5.0858)		
Sigma	6.2360 (0.2992)		
No. of observations	320		
No. of censored observations	83		
LR $\chi^2(15)$	197.24		
Prob > χ^2	0.0000		
Pseudo R^2	0.1066		
Log likelihood	-826.3011		
RESET (probability > F)	0.1775		

Figures in parentheses indicate standard errors.

** Significant (P≤0.05); ** Highly significant (P≤0.01)*

Table 5.42
MEAN WAITING TIME (current) AND WTP VALUES FOR REDUCING WAITING TIME IN PUBLIC VETERINARY CENTRES

District	Waiting time (min.)	WTP (Rs.)
LUD districts	31.30 (0.32)	7.38 (0.40
LD districts	32.32 (1.13)	8.45 (0.41)
Overall	32.16 (0.59)	8.12 (0.29)
't' value	0.85 ^{NS}	2.56*

Figures in parentheses indicate standard errors.

^{NS} *Not-significant (P≥ 0.05); ** Highly significant (P≤ 0.01)*

Table 5.43
FACTORS INFLUENCING PARTIAL WTP VALUES FOR REDUCING WAITING TIME (Results of Tobit regression)

Explanatory variables	Tobit coefficients	Marginal effects for the probability being uncensored	Marginal effects for E(WTP | 0 < WTP)
Current waiting time: **Very long**	16.6711** (2.4692)	0.0894**	15.7681**
Current waiting time: **Long**	8.2935** (1.2015)	0.2142**	6.4601**
Current waiting time: **Average**	5.7282** (1.1651)	0.1699**	4.2863**
District versatility	0.6038 (0.6281)	0.0174	0.4526
Sex of respondent	0.8243 (0.9318)	0.0256	0.6055
Age of respondent	-0.0164 (0.0364)	-0.0005	-0.0123
Educational level of respondent	-0.9331 (0.5637)	-0.0269	-0.6997
Milk price (Rs. per litre)	0.1420 (0.4153)	0.0041	0.1065
Quantity of milk sold (litre per day)	0.1745* (0.0789)	0.0050*	0.1309*
Possession of crossbred cows/ graded buffaloes (dummy)	0.6978 (0.9287)	0.0212	0.5157
Veterinary livestock units owned	-0.4923** (0.1783)	-0.0142**	0.3691**
Annual household income (in Rs. '000)	-0.0001 (0.0001)	-0.0000	-0.0001
Livelihood share of livestock	0.5347 (1.8149)	0.0154	0.4009
Purpose of visit to public veterinary centre (AI/Treatment)	2.3091** (0.6843)	0.0744**	1.6805**
No. of visits made during the last year	-0.0874 (0.1117)	-0.0025	-0.0655
Constant	-1.3434 (4.0482)		
Sigma	5.0868 (0.2326)		
No. of observations	320		
No. of censored observations	57		
LR χ^2(15)	110.34		
Prob > χ^2	0.0000		
Pseudo R^2	0.0603		
Log likelihood	-859.5848		
RESET (probability > F)	0.1099		

Figures in parentheses indicate standard errors.

** Significant (P≤ 0.05); ** Highly significant (P≤ 0.01)*

Table 5.44
MEAN ATTITUDE SCORES (current) AND WTP VALUES FOR IMPROVING ATTITUDE OF STAFF IN PUBLIC VETERINARY CENTRES

District	WTP (Rs.)
LUD districts	6.00 (0.48)
LD districts	4.41 (0.48)
Overall	5.20 (0.34)
't' value	2.35*

Figures in parentheses indicate standard errors.
** Significant (P≤0.05)*

Table 5.45
FACTORS INFLUENCING PARTIAL WTP VALUES FOR IMPROVING ATTITUDE OF STAFF (Results of Tobit regression)

Explanatory variables	Tobit coefficients	Marginal effects for the probability being uncensored	Marginal effects for E(WTP | 0 < WTP)
Attitude of public veterinary centre staff: **Very bad**	18.0775** (1.1659)	0.7015**	11.7650**
Attitude of public veterinary centre staff: **Bad**	18.2316** (1.1477)	0.7344**	11.5236**
District versatility	-0.9131 (0.8572)	-0.0662	-0.3604
Sex of respondent	-2.5009* (1.2298)	-0.1742*	-1.0830
Age of respondent	0.1337** (0.0498)	0.0097**	0.0528**
Educational level of respondent	1.9296** (0.7217)	0.1401**	0.7613**
Milk price (Rs. per litre)	-0.0116 (0.5599)	-0.0008	-0.0046
Quantity of milk sold (litre per day)	-0.0214 (0.1064)	-0.0016	-0.0084
Possession of crossbred cows/ graded buffaloes (dummy)	0.0633 (1.2569)	0.0046	0.0249
Veterinary livestock units owned	-0.1208 (0.2436)	-0.0087	-0.0477
Annual household income (in Rs. '000)	-0.0001 (0.0005)	-0.0000	-0.0001
Livelihood share of livestock	-1.4097 (2.3915)	-0.1023	-0.5562
Purpose of visit to public veterinary centre (AI/Treatment)	0.5651 (0.9110)	0.0411	0.2207
No. of visits made during the last year	0.5580** (0.1475)	0.0405**	0.2202**
Constant	-13.4357* (5.4564)		
Sigma	5.4435 (0.3388)		
No. of observations	320		
No. of censored observations	172		
LR χ^2(14)	385.66		
Prob > χ^2	0.0000		
Pseudo R^2	0.2777		
Log likelihood	-501.5144		
RESET (probability > F)	0.0924		

Figures in parentheses indicate standard errors.
** Significant (P≤0.05); ** Highly significant (P≤0.01)*

Table 5.46
MEAN WTP VALUES FOR IMPROVING DRUG AVAILABILITY IN PUBLIC VETERINARY CENTRES

District	WTP (Rs.)
LUD districts	4.81 (0.61)
LD districts	8.32 (0.75)
Overall	6.58 (0.49)
't' value	3.64**

Figures in parentheses indicate standard errors.
*** Highly significant (P≤0.01)*

Table 5.47
FACTORS INFLUENCING PARTIAL WTP VALUES FOR IMPROVING DRUG AVAILABILITY (Results of Tobit regression)

Explanatory variables	Tobit coefficients	Marginal effects for the probability being uncensored	Marginal effects for E(WTP | 0 < WTP)
Drug availability in centre: **No drug/AI**	22.3519** (2.1260)	0.5967**	12.7242**
Drug availability in centre: **Some drug/AI**	16.9117** (1.6521)	0.5634**	7.7744**
District versatility	4.5282** (1.4620)	0.1750**	1.5652**
Sex of respondent	0.9444 (2.2515)	0.0367	0.3198
Age of respondent	-0.0836 (0.0883)	-0.0033	-0.0288
Educational level of respondent	-1.7584 (1.3457)	-0.0685	-0.6067
Distance from public veterinary centre (travel time in min.)	0.0868 (0.0506)	0.0034	0.0300
Milk price (Rs. per litre)	2.5276** (0.9133)	0.0985**	0.8721*
Quantity of milk sold (litre per day)	0.3525** (0.1719)	0.0137*	0.1216*
Possession of crossbred cows/ graded buffaloes (dummy)	5.3462* (2.2338)	0.2013*	1.6939*
Veterinary livestock units owned	-0.7274 (0.4601)	-0.0284	-0.2510
Annual household income (in Rs. '000)	-0.0076 (0.0146)	-0.0003	-0.0026
Livelihood share of livestock	5.5467 (5.0787)	0.2162	1.9137
Purpose of visit to public veterinary centre (AI/Treatment)	1.8443 (1.5984)	0.0716	0.6250
No. of visits made during the last year	-0.4772 (0.2688)	-0.0186	-0.1646
Constant	-33.1395** (8.9838)		
Sigma	10.1976 (0.6494)		
No. of observations	320		
No. of censored observations	172		
LR $\chi^2(15)$	209.14		
Prob > χ^2	0.0000		
Pseudo R^2	0.1412		
Log likelihood	-636.2080		
RESET (probability > F)	1.0484		

Figures in parentheses indicate standard errors.
** Significant (P≤0.05); ** Highly significant (P≤0.01)*

Table 5.48
MEAN SPFR SCORES (current) AND WTP VALUES FOR IMPROVING RELATIONSHIP WITH SERVICE PROVIDER IN PUBLIC VETERINARY CENTRES

District	SPFR Score	WTP (Rs.)
LUD districts	73.61 (0.77)	3.93 (0.42)
LD districts	79.20 (0.22)	3.88 (0.45)
Overall	76.43 (0.43)	3.91 (0.31)
't' value	7.05**	0.08 NS

Figures in parentheses indicate standard errors.
*NS Not-significant (P≥ 0.05); ** Highly significant (P≤ 0.01)*

Table 5.49
FACTORS INFLUENCING PARTIAL WTP VALUES FOR IMPROVING SPFR (Results of Tobit regression)

Explanatory variables	Tobit coefficients	Marginal effects for the probability being uncensored	Marginal effects for E(WTP | 0 < WTP)
Service provider-Farmer relationship **(SPFR): Score**	-0.4590** (0.0983)	-0.0165**	-0.1458**
District versatility	2.0614 (1.6480)	0.0741	0.6550
Sex of respondent	1.2625 (2.3270)	0.0450	0.3917
Age of respondent	0.0816 (0.0852)	0.0029	0.0259
Educational level of respondent	2.8898* (1.2627)	0.1040*	0.9181*
Distance from public veterinary centre (travel time in min.)	0.1068** (0.0544)	0.0038*	0.0339*
Milk price (Rs. per litre)	-0.7998 (1.0573)	-0.0288	-0.2541
Quantity of milk sold (litre per day)	0.2783 (0.1884)	0.0100	0.0884
Possession of crossbred cows/ graded buffaloes (dummy)	-0.2499 (2.2275)	-0.0090	-0.0797
Veterinary livestock units owned	-0.6982 (0.4353)	-0.0251	-0.2218
Annual household income (in Rs. '000)	-0.0004 (0.0009)	-0.0001	-0.0001
Livelihood share of livestock	-1.9110 (4.5220)	-0.0688	-0.6071
Purpose of visit to public veterinary centre (AI/Treatment)	5.1437** (1.7449)	0.1797**	1.5618**
No. of visits made during the last year	0.0328 (0.2791)	0.0012	0.0104
Constant	23.6783 (12.1984)		
Sigma	10.8163 (0.7941)		
No. of observations	320		
No. of censored observations	195		
LR χ^2(14)	46.01		
Prob > χ^2	0.0000		
Pseudo R^2	0.0379		
Log likelihood	-583.3064		
RESET (probability > F)	0.0872		

Figures in parentheses indicate standard errors.
** Significant (P≤ 0.05); ** Highly significant (P≤ 0.01)*

Table 5.50
MEAN RECOVERY SCORES (current) AND WTP VALUES FOR IMPROVING CHANCE OF RECOVERY IN PUBLIC VETERINARY CENTRES

District	Score	WTP (Rs.)
LUD districts	69.81 (0.67)	5.28 (0.49)
LD districts	75.40 (0.53)	6.40 (0.53)
Overall	72.63 (0.45)	5.84 (0.36)
't' value	6.55**	1.54 NS

Figures in parentheses indicate standard errors.

*NS Not-significant (P≥ 0.05); ** Highly significant (P≤ 0.01)*

Table 5.51
FACTORS INFLUENCING PARTIAL WTP VALUES FOR IMPROVING CHANCE OF RECOVERY FROM DISEASES (Results of Tobit regression)

Explanatory variables	Tobit coefficients	Marginal effects for the probability being uncensored	Marginal effects for E(WTP | 0 < WTP)
Chance of recovery: **Score**	-0.4295** (0.0749)	-0.0192**	-0.1848**
District versatility	4.1881** (1.2604)	0.1852**	1.8050**
Sex of respondent	1.0999 (1.7737)	0.0496	0.4616
Age of respondent	0.0608 (0.0690)	0.0027	0.0261
Educational level of respondent	-0.5057 (1.0200)	-0.0226	-0.2176
Distance from public veterinary centre (travel time in min.)	-0.0062 (0.0413)	-0.0003	-0.0027
Milk price (Rs. per litre)	0.1583 (0.7916)	0.0071	0.0681
Quantity of milk sold (litre per day)	0.1183 (0.1348)	0.0053	0.0509
Possession of crossbred cows/ graded buffaloes (dummy)	3.4866* (1.7472)	0.1584*	1.4059*
Veterinary livestock units owned	-0.2212 (0.3269)	-0.0099	-0.0952
Annual household income (in Rs. '000)	-0.0001 (0.0001)	-0.0000	-0.0001
Livelihood share of livestock	-0.1395 (3.4177)	-0.0062	-0.0600
No. of visits made during the last year	0.0163 (0.2125)	0.0007	0.0070
Acute medical cases	10.5223** (1.4657)	0.3759**	5.6711**
Acute surgical cases	9.5044** (2.0887)	0.3252**	5.3184**
Chronic surgical cases	10.0680** (2.7213)	0.3267**	5.8386**
Obstetrical cases	10.7635** (3.9763)	0.3317**	6.4397*
Gynaecological cases	1.6410 (2.1499)	0.0712	0.7400
Constant	21.0799* (8.4249)		
Sigma	8.5877 (0.5155)		
No. of observations	320		
No. of censored observations	148		
LR χ^2(18)	110.33		
Prob > χ^2	0.0000		
Pseudo R^2	0.0718		
Log likelihood	-713.0634		
RESET (probability > F)	0.4119		

Figures in parentheses indicate standard errors.

** Significant (P≤ 0.05); ** Highly significant (P≤ 0.01)*

Table 5.52
MEAN CONCEPTION SCORES (current) AND WTP VALUES FOR IMPROVING CHANCE OF CONCEPTION IN PUBLIC VETERINARY CENTRES

District	Score	WTP (Rs.)
LUD districts	45.33 (0.54)	12.58 (0.63)
LD districts	50.87 (0.59)	10.93 (0.60)
Overall	48.28 (0.44)	11.71 (0.44)
't' value	6.89**	1.89 NS

Figures in parentheses indicate standard errors.
*NS Not-significant (P≥ 0.05); ** Highly significant (P≤ 0.01)*

Table 5.53
FACTORS INFLUENCING PARTIAL WTP VALUES FOR IMPROVING CHANCE OF BOVINE CONCEPTION (Results of Tobit regression)

Explanatory variables	Tobit coefficients	Marginal effects for the probability being uncensored	Marginal effects for E(WTP | 0 < WTP)
Chance of conception: **Score**	-0.3035** (0.0686)	-0.0044**	-0.2491**
District versatility	-2.9227** (1.0198)	-0.0422**	-2.4047**
Sex of respondent	-0.2723 (1.3069)	-0.0039	-0.2244
Age of respondent	-0.0896 (0.0535)	-0.0013	-0.0735
Educational level of respondent	-0.4462 (0.8297)	-0.0065	-0.3662
Distance from public veterinary centre (travel time in min.)	-0.0364 (0.0309)	-0.0005	-0.0299
Milk price (Rs. per litre)	2.3778** (0.5551)	0.0346**	1.9516**
Quantity of milk sold (litre per day)	0.2982** (0.1147)	0.0043*	0.2447**
Possession of crossbred cows/ graded buffaloes (dummy)	8.9111** (1.4633)	0.2662**	6.1430**
No. of cows and buffaloes owned	-0.7959 (0.4635)	-0.0116	-0.6532
Annual household income (in Rs. '000)	-0.0000 (0.0001)	-0.0000	-0.0000
Livelihood share of livestock	-0.7126 (2.8495)	-0.0104	-0.5848
No. of visits made during the last year	0.0406 (0.1499)	0.0006	0.0333
Constant	4.501 (5.9997)		
Sigma	6.5666 (0.3357)		
No. of observations	252		
No. of censored observations	42		
LR $\chi^2(13)$	103.26		
Prob > χ^2	0.0000		
Pseudo R^2	0.0654		
Log likelihood	-738.0030		
RESET (probability > F)	0.8127		

Figures in parentheses indicate standard errors.
** Significant (P≤ 0.05); ** Highly significant (P≤ 0.01)*

Table 5.54
CONSTRAINTS IN AVAILING LIVESTOCK SERVICES FROM PUBLIC VETERINARY CENTRES (Results of Garrett's ranking)

S.No.	Constraints	Animal health services	Bovine breeding services
1.	Long distance	I (69.71)	I (69.54)
2.	Long waiting time	II (61.03)	II (61.60)
3.	Inadequate drugs in the veterinary centres	III (53.99)	III (53.40)
4.	Poor quality inputs in the centres	IV (50.18)	IV (50.00)
5.	Inconvenient working hours of the veterinary centres	V (42.88)	V (42.71)
6.	Poor quality service	VI (40.60)	VI (40.06)
7.	Labour scarcity to take the animal to the centre	VII (32.56)	VII (32.77)
8.	Inadequacy of trained staff	VIII (31.23)	VIII (31.80)
9.	Poor attitude of the staff in the centre	IX (24.63)	IX (23.60)
10.	High cost	X (0.00)	X (0.00)

Figures in parentheses indicate mean Garrett's scores.

Table 5.55
CONSTRAINTS IN AVAILING LIVESTOCK SERVICES FROM PRIVATE SERVICE PROVIDERS (Results of Garrett's ranking)

S.No.	Constraints	Animal health services	Bovine breeding services
1.	Too high service charges	I (76.29)	I (74.98)
2.	Huge drug and semen cost	II (63.08)	II (63.13)
3.	Delay in availing appointment	III (52.76)	III (52.62)
4.	Non-availability of service personnel	IV (43.79)	IV (44.14)
5.	Long waiting time	V (43.00)	V (42.63)
6.	Long travel time	VI (42.50)	VI (43.25)
7.	Lack of trained veterinarians	VII (32.62)	VII (32.92)
8.	Inconvenient working hours	VIII (31.11)	VIII (31.80)
9.	Inadequate infrastructure	IX (31.04)	IX (30.00)
10.	Poor attitude of service personnel	X (0.00)	X (0.00)

Figures in parentheses indicate mean Garrett's scores.