VILLAGE LEVEL LIVESTOCK AND POULTRY PRODUCTION UNDER THE INDUSTRIALIZATION SCENARIO

V. RAJAGANAPATHY

Thesis submitted in partial fulfillment of the requirement for the degree of

Doctor of Philosophy

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University, Thrissur

2007

Department of Livestock Production Management
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR-680651
KERALA, INDIA

DECLARATION

I hereby declare that the thesis entitled **"VILLAGE LEVEL LIVESTOCK AND POULTRY PRODUCTION UNDER THE INDUSTRIALIZATION SCENARIO"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

V. Rajaganapathy

Mannuthy
Date: 24.12.07

V. RAJAGANAPATHY

CERTIFICATE

Certified that the thesis entitled **"VILLAGE LEVEL LIVESTOCK AND POULTRY PRODUCTION UNDER THE INDUSTRIALIZATION SCENARIO"** is a record of research work done independently by **V. Rajaganapathy**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him.

Mannuthy
Date: 24.12.07

Dr. Francis Xavier
(Chairman, Advisory Committee)
Professor and Head
Cattle Breeding Farm
Thumburmuzhi
Kerala Agricultural University

CERTIFICATE

We, the undersigned members of the Advisory Committee of **V. Rajaganapathy,** a candidate for the degree of Doctor of Philosophy in Livestock Production Management, agree that the thesis entitled **"VILLAGE LEVEL LIVESTOCK AND POULTRY PRODUCTION UNDER THE INDUSTRIALIZATION SCENARIO"** may be submitted by V. Rajaganapathy, in partial fulfilment of the requirement for the degree.

Dr. Francis Xavier
(Chairman, Advisory Committee)
Professor and Head
Cattle Breeding Farm
Thumburmuzhi

Dr. P.C. Saseendran
Professor and Head
Department of Livestock Production Management
College of Veterinary and
Animal Sciences, Mannuthy
(Member)

Dr. Joseph Mathew
Associate Professor
Department of Livestock Production Management
College of Veterinary and
Animal Sciences, Mannuthy
(Member)

Dr. T.V. Viswanathan
Professor and Head
Department of Animal Nutrition
College of Veterinary and
Animal Sciences, Pookot, Wayanad
(Member)

Dr. George T. Oommen
Professor
Department of Livestock Products Technology
College of Veterinary and
Animal Sciences, Mannuthy
(Member)

28/03/08

External Examiner
(Dr T. Sivakumar Ph.D)
Professor and Head
Dept of LPM, MVC
Chennai-7.

ACKNOWLEDGEMENT

I consider it my privilege to express my deep sense of gratitude first and foremost to my Chairman of my advisory committee Dr. Francis Xavier, Professor and Head, Cattle Breeding Farm, Thumburmuzhi whose highly perceptive mind in planning, guiding and supervising the research work with constant pains taking effort, offering timely suggestion and most generous contribution of time and valid thoughts have helped me immeasurably in my endeavour to prepare and finalize this manuscript.

I am indebted and thankful to the members of the advisory committee Dr. P.C. Saseendran, Professor and Head and Dr. Joseph Mathew, Associate Professor, Department of Livestock Production Management for their expert guidance, constant encouragement, constructive ideas, inspiring and motivating advice and help during the period of my study and preparation of the thesis.

I am very much thankful to Dr. T.V. Viswanathan, Professor and Head, Department of Animal Nutrition, College of Veterinary and Animal Sciences, Pookot, Wayanad and Dr. George T. Oommen, Professor, Department of Livestock Products Technology, College of Veterinary and Animal Sciences, Mannuthy as members of the Advisory committee for the valuable suggestions, constructive criticism, fruitful discussions, critical supervision and timely help rendered to me for the successful completion of my work.

My sincere gratitude and thanks to Dr. G. Butchaiah, Dean, Rajiv Gandhi College of Veterinary and Animal Sciences, Pondichery for sanctioning study leave and deputing me to carry out doctoral programme and for his keen interest in the progress of my work.

I would like to express my sincere thanks to Dr. A.D. Mercy, Professor and Head, Department of Animal Nutrition, Mannuthy for the timely help, and for the laboratory facilities provided to carry out this study. I wish to thank

Mrs.K.S. Sujatha Professor and Head, Department of Statistics for statistical analysis of the data.

My sincere gratitude and thanks to Dr. K.S. Anil, Associate Professor, Department of Livestock Production Management, Pookot, Dr. A. Kannan, Associate Professor, CPPR, Mannuthy, Dr. Latha, Associate Professor, Department of Veterinary Public Health, COVAS, Pookot, Dr. V. Ramnath Associate Professor, Department of Physiology, COVAS, Mannuthy and Dr. John Abraham Assistant Professor, Department of Livestock Production Management, COVAS, Pookot for their support and help, valuable ideas and suggestions during the study period.

I record my thanks to the Dean, College of Veterinary and Animal Sciences, Mannuthy for the facilities provided for the research work. I am thankful to Kerala Agricultural University for permitting me to undergo for my doctoral programme in the COVAS, Mannuthy.

I remember with gratitude the help and encouragement extended by Dr. D. Sreekumar, Professor and Head, and Dr. P. Ponnuvel, Assistant Professor, Department of Livestock Production Management, Rajiv Gandhi College of Veterinary and Animal Sciences, Pondicherry.

The whole hearted cooperation, help and motivation offered to me by my colleagues Dr. M. Murgan, Dr.Ajith, Dr. Shyama, Dr. Jeyamurgan, Dr. Senthil, Dr. Sekar, Dr. Prejith, Dr. Biya, Dr. Acty, Dr. Geetha, Dr. Siji, PG colleagues Dr. Chitra, Dr. Muhammad Aslam and Dr. Nisanth are gratefully acknowledged. I also thank Mrs. Sarada, Mrs. Suneesha Mrs. Divya, Mr. Mohanan and Mr. Reghu Department of Livestock Production and Management for the help rendered during the study.

I owe my sincere gratitude to Dr. N. Sudhodanan, Senior Veterinary Surgeon, Chittoor to carry out the field work and for the collection of samples during my study.

I thank Mr. Ravidran Peagles for the timely help rendered in typing this manuscript.

I express my deep sense of gratitude to my parents, to my wife and to my daughters for their understanding, affection, sacrifice and heartful blessings and support throughout my study period.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

1. INTRODUCTION

Environmental pollution is a major global problem posing serious risk to man and animals. The development of modern technology and the rapid industrialization are among the foremost factors for general pollution. The environmental pollutants, spread through different channels, many of which finally enter into the food chain of livestock and man. There is increasing concern about environmental pollutants emanating into the livestock production systems.

Pollution is posing a serious problem in India, threatening the animal and human health and quality of environment. Environmental pollution in most developing countries is often attributed to negative effect of technological developments, like rapid urbanization and industrialization, with poor planning in waste disposal and management (Swarup and Dwivedi, 1998).

Recently, in Kerala there was news raised on ground water contamination with heavy metals. The global environmental action group urged the state government to close down a bottling plant in Palakkad district for supplying inferior waste from the plant as fertilizer. The government reports say that ground water samples collected contained 65.7 μ gm of Pb and more than 10 μ gm of Cd per litre.

Heavy metal pollution has become a serious health concern in recent years, because of industrial and agricultural development. Heavy metals of industrial biowaste contaminate the drinking water, food and air. The toxic heavy metals of great concern are Cd, Pb and Hg which are usually associated with harmful effects in men and animals.

It is recognized that heavy metals may exercise a definite influence on the control of biological functions, affecting hormone system and growth of different body tissues (Teresa *et al.*, 1997). Many heavy metals accumulate in one or more of the body organs with differing half-lives. These heavy metals apart from acute or chronic poisoning can be transferred to next generation and have potential toxicity from the viewpoint of public health.

Various anthropogenic activities such as burning of fossil fuel, mining and metallurgy, industries and transport sectors redistribute toxic heavy metals into the environment, which persist for a considerably longer period and are translocated to different components in environment affecting the biota. These toxicants are accumulated in the vital organs including liver and kidney and exert adverse effects on domestic and wild populations. (Kotwal et al., 2005)

The effluents from the livestock systems can affect the micro and macro environment, *viz.,* water, atmosphere and food chain. Due to the rapid population growth there is phenomenal increase in the demand for livestock products and this situation has led to changes in the farming system from 'subsistence farming' to 'commercial' and from extensive/pastoral livestock systems to more intensive systems of production which causes adverse impacts on the environment.

Number of environmental cum medical surveys mainly involving human population in industrial, mining and urban areas have documented occurrence of toxicities due to effluents. There has also been a major pollution catastrophe in the country in December 1984, the Bhopal Gas tragedy, due to leakage of the poisonous gas Methyl isocyanide (MIC).

Pollution of the environment has significant impact on living organisms. Reports from developed countries have documented adverse impact of pollution on domestic and wild animals in the form of specific chemical toxicities, behavioural changes and population decline. Pesticides, heavy metals and other agro-chemicals are some of the major causes of environmental toxicity in farm animals.

Heavy mortality in cattle in Maharashtra, Punjab, Rajasthan, and Delhi, due to industrial lead poisoning and death of animals due to leakage of MIC gas during Bhopal tragedy are some examples of industrial pollution catastrophe on domestic animals in India. The impacts of pollution on animals result in serious economic losses and economic consequences over and above health hazards. In India, heavy mortality in cattle and buffaloes due to industrial lead toxicity was responsible for decline in dairy animal population and significant financial losses to farmers (Swarup and Dwivedi 1998).

According to the World Health Organization report (1995) about five million people die of diseases caused by drinking impure water. The incidence of air and water pollution from heavy metals has reached such an alarming level that environmentalists are finding it difficult to enforce effective control measures.

The non-essential heavy metals have, directly or indirectly, an adverse effect on biological activities. The presence of these metals in water degrades their quality, which eventually affect human health. Even the essential metals at higher concentration are toxic.

The livestock systems are prone to general problems of pollution emanating from industrial activity. Pollution of soil and herbage by heavy metal contamination and industrial contamination from nuclear accidents are occurring throughout the world.

Hence the study focuses on:

a. Assessing the impact of industrialization and pollution on village livestock husbandry.

b. evaluating the effect and the extent of the pollution on water, soil, forage and biological samples in the selected areas.

c. pollution *vis*-a–*vis* production. Assessing of livestock production. Measurements of pollution and the production systems (affected and control area).

d. development of suitable recommendations for better and sustainable animal husbandry systems for the area.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1. SURVEY

Nutritional status of animals and incidence of nutritional deficiency conditions were assessed using a Performa given to each farmer. Varghese (1998) assessed the mineral status of cattle in Kerala. This survey covered all the districts under the different agro- climatic regions in the state. Soil, fodder and blood samples were collected and evaluated for major and trace elements.

In Tamilnadu, Arunachalam and Thiagarajan (2000) studied constraints in rural livestock farming. Selection of the farmers was made by stratified random sampling technique. Three hundred farmers were interviewed in person with the help of tested questionnaire. The state of livestock farming was studied with respect to the farmers' perception of the prevalence of constraints such as breeding, feeding, health care and marketing of livestock products.

Buddhi *et al.* (2004) surveyed the ground water quality among the residents of Pithampur industrial area. The survey indicated that the ground water quality of Pithampur area was good before the establishment of the industries and has deteriorated significantly after the establishment of industries. The major problem indicated by the residents were related to health and crop yield. It was also observed that the ground water quality of oldest industrial region was more affected.

Kannan (2005) reported the improvement of integrated pig farming system in Kerala. He surveyed the socio-economic and educational levels of pig farmers and management practices like feeding, housing, breeding and marketing. He analyzed and evaluated the problems and constraints in pig production systems.

2.2. LIVESTOCK SYSTEMS

In rural areas of Haryana around 73 per cent of household depend on livestock farming for supplementary income and about 27 per cent of the total income earned by a household is from dairy farming (Taneja, 1998).

In Indian livestock scenario, milch animals are found in the rural areas and owned by cultivators. Crop residues and byproducts are the major source of feed. The bulk of the milk is produced in rural areas, which meet the bulk of milk needs of urban population (Vaidyanathan, 1998).

As per FAO (2000) integrating crops and livestock, helps in diversifying the sources of income and employment for the resource-poor farmer. The market for livestock products, offers an opportunity for augmenting their income, even for those who do not have access to land and capital resources.

In India small-scale mixed crop-livestock farming was the dominant form of production system. Livestock production in relation to crop-livestock system in India was evaluated. Farmers maintained non-working animals as a source of calves, milk and manure (Rao and Birthal, 2005).

2.3. HEAVY METALS IN WATER SAMPLES

In a Nigerian research, Beavington (1975) analyzed the water samples in different areas of rivulet and in harbour in Wollongong. The results indicated biologically significant contamination of water by heavy metals. Various sources contributed to the levels of heavy metals in the rivulet and harbour water, the major part came from the industrial outfalls.

Laxen and Harrison (1977) studied the sources of Pb input to the highway environment and the subsequent waterborne dispersal to the receiving waters in U.K. The impact on the surface water was confined to the Pb contained in surface runoff, as the Pb dispersed to roadside soils was effectively immobilized in the top 10 cm of soil. The concentration of Pb in highway runoff reached levels far in excess of those normally encountered in surface waters.

In Andhra Pradesh Bhat and Krishnamachari (1980) measured the Pb concentration in well water which contained 0.1 to 1.5 ppm of Pb.

Kataria (1995) examined heavy metals in polluted water of Pipriya township in Madya Pradesh. The main source of Cu is from some food materials, water and cooking utensils. Contamination of surface water has been attributed to industrial waters having Cu ranging from 0.16 to 1.20 ppm. Cu and Hg causes toxic and lethal effect to aquatic flora and fauna.

Li-wenfan *et al.* (1995) studied the influence of Pb, Cd, Cu and Zn pollution on the health of sheep. They analyzed the water used for irrigating the fields in the area near a refining factory. The Pb, Cd, Cu and Zn concentration in samples of water from polluted areas was significantly higher than that of unpolluted controls.

Saad and Fahmy (1996) investigated the distribution of Mn, Cu, Zn and Cd in the surface and bottom water layers in the Bankalah region of Saudi Arabia. The mean concentration of Mn, Zn, Cu and Cd was 6.68, 6.52, 1.69 and 1.05 ppm, respectively.

Dey *et al.* (1997) analyzed the effluents sample to study the mineral concentration around a fertilizer factory. The estimated mean concentration of Zn, Cu, Pb and Cd were 2.500 ± 0.050, 0.500 ± 0.010, 1.464 ± 0.349, 0.006 ± 0.001 ppm respectively.

Chakraborti *et al.* (1998) studied the ground water As contamination in a residential area due to industrial effluent discharge in Calcutta. The concentration of As from water tube wells in the polluted area, ranged from 0.05 to 23.08 ppm. All the tube wells except one deep tube well had an As concentration above the

WHO recommended value (0.01 ppm). They reported high concentrations of As near the effluent discharge area of the factory ACPL, which was producing chemical compounds.

The concentration of Cu, Cd, Fe, Cr, Mn, Pb and Zn in ground water at Dhanbad, Bihar was studied by Prasad and Jaiprakas (1999). The concentration of heavy metals was found to be below the permissible levels although concentration of Fe and Mn was found above the permissible limits at a few stations. The Heavy Metal Pollution Index (HPI) of ground water was found to be far below the index limit of 100 points indicating that the ground water was not polluted with heavy metals in spite of the prolific growth of mining and allied industrial activities near the town.

Kooklue *et al.* (2000) evaluated the concentration of heavy metals like Cd, Pb, Cr, Cu and Zn in sea water collected from the Istanbul Bosphorus. The concentration ranges of Cr, Cd, Pb, Cu and Zn in sea water were 0.89-3.93, 0.32-2.00, 1.29- 4.41, 0.60- 35.2 and 0.13-1.38 ppm, respectively.

The distribution and characterization of heavy metals in water in Jeedimetla industrial area in Andhra Pradesh showed concentration of some of the trace elements. As (1.5- 23.3 ppb), Cu (4.2 -13.7 ppb), Cd (0.60-31.8 ppb) and Pb (0.10- 0.50 ppb) were found. The concentration of these elements was found to be far above the permissible level in water (Govil, 2001).

The micronutrient content in water in eastern and southern dry zones of Karnataka was analyzed and Cu, Zn and Fe content at 10.1 ± 2.24 and 8.2 ± 0.67, 0.7 ± 0.06 and 0.07 ± 0.004 and 196 ± 70.80 and 136 ± 22.10 ppm respectively were reported by Gowda *et al.* (2001a).

Mineral status of water in coastal agri-eco zone of Karnataka and had Cu, Zn and Fe at 3.9 ± 0.30, 40.00 ± 1.30 and 49.40 ± 3.21 ppb respectively in a study by Gowda *et al.* (2001b)

Lokhande and Sathe (2001) monitored and assessed the heavy metals like Fe, Cd, Ni, Zn, Cur and Pb contents in the industrial effluents from Ambarnath area in Maharashtra. The Cd concentration varied from 1.0 to 9.1ppm. The amount of Cu varied from 8.0 to10.2 ppm. Variations in the Pb content of the effluent ranged from 0.1 to 10.4 ppm.

The distribution and behaviour of Zn, Pb, Fe, Mn, Cu, Cr and Cd of aquatic ecosystems in the vicinity of an under ground lead-zinc mine was observed by Marques *et al.* (2001). Zn, Cd and Mn were found in water. Fe, Pb, Cu and Cr appeared as an adsorbed fraction in the solid phases. The concentrations of the metals were conditioned by the waters from the mine galleries, by the leached waste, by the surface runoff and by overflow from the spillway of the pond.

Prasad and Bose (2001) evaluated concentration of seven heavy metals (Cu, Cd, Fe, Cr, Mn, Pb and Zinc) for surface and spring water near a limestone mining area in Himachal Pradesh during pre- and post monsoon seasons. The concentrations of heavy metal have been found to be below the permissible levels of drinking water quality standards.

In Lucknow district of Uttar Pradesh, India, most of the water bodies are being used for the cultivation of the edible aquatic plants. It was found to be contaminated with a variety of toxic metals like Fe, Cu, Cr, Mn and Pb. The concentrations of Cr, Pb and Fe in the water were much higher than the recommended permissible limits by WHO (Rai *et al.*, 2001).

Gowda *et al.* (2003) reported that the Pb and Cd level in water samples of polluted areas were higher and close to the upper safe limits of 0.1 ppm and 0.05 ppm respectively which was standardized by the National Academy of Sciences in 1974. They analyzed the water samples in industrially polluted areas in Bangalore. It had higher Pb (0.17 ± 0.01 ppm), Cd (0.05 ± 0.001 ppm), Cu (33.63 ± 10.89 ppm) and Zn (41.09 ± 22.28 ppm).

Rani and Reddy (2003) examined the concentration of Mn, Cr, Zn, Mo, Pb, Co, Cd and Fe in the highly polluted Hussain Sagar lake. The results showed that the concentration of Fe, Zn and Co is high when compared to WHO and ICMR standards. The value of other heavy metals was found within permissible limits.

Impact of effluents from a car battery manufacturing plant in Nigeria on water, soil and food qualities were studied by Orisakwe *et al.* (2004). The authors analyzed Hg, As, Pb, Cd and Ni in tap and cassava waters, soil, dried cassava tuber and edible fruit samples from the company. Results showed that Pb had lowest (0.02 to 0.20 ppm) concentration in water samples.

Sinha (2004) analyzed the level of Cu, Pb, Ni, Co, Mn and Zn in water from Sai river at Rae Bareli in Uttar Pradesh during different seasons. Moderate concentration of Cu was found in the river water whereas Pb (0.05-0.1 ppm) and Mn (0.100-2.200 ppm) were present in higher concentrations.

In Bhopal, the surface water of lower lake had Cu (0.12 to 0.165 ppm), Zn (0.086 to 0.163 ppm), Pb (0.03 to 0.12 ppm) and Cd (0.014 to 0.41 ppm). Concentration of heavy metals like Cd and Pb in surface water was found above permissible limits. Zn and Cu were found below the permissible limits for drinking water. Heavy metal contamination of the lake water was found to occur due to a high degree of anthropogenic stress including idol immersion activity (Gupta *et al.*, 2005).

Haque *et al.* (2005) estimated the heavy metal concentration in surface water of the rivers and estuaries of Sundarban mangrove forest in Bangladesh. The concentrations of Cu, Pb, and Cd seasonally varied from 0.025 to 0.136, 0.205 to 0.598 and 0.0045 to 0.013 ppm, respectively.

Manjappa *et al.* (2005) studied the level of Fe, Mn, Cu, Pb, Cd and Hg in water and sediments of the river Bhadra in Karnataka. The Copper concentration in river water ranged between 14.8 to 21ppm. The Pb content in river water ranged from 6.2 to 29.6ppm. The Cd concentration in river water varied between 2.1 and 4.9 µg/L except Fe and Mn all other were within the limits of BIS standards.

Ping (2005) measured the concentration of heavy metals in water in the vicinity of the Baiyin mining area in China. It was found that the waste gases and waste water produced by melting metals in factories caused Pb, Cd, Cu and Zn pollution in the surrounding environment.

Piska *et al.* (2005) assessed the heavy metal pollution and its toxic effect on ground water quality of Jeedimetla in Andhra Pradesh. The heavy metals values were above the permissible limits of WHO. The ground water was highly polluted and is unfit for domestic, irrigation and fishery uses.

The extent of heavy metal contamination which was higher in untreated sewage water of Musi river near Hyderabad was studied by Raj *et al.* (2006). Sewage water collected all along the Musi river at different sites was contaminated with Cd, Cr, Ni, Pb, Co, Zn, Cu, Fe and Mn with a mean content of 0.025, traces, 0.062, 0.21, 0.053, 0.003, 0.011 ppm, traces and traces, respectively. Samples analyzed had excess amounts of heavy metals than the WHO permissible limits.

2.4. HEAVY METALS IN SOIL SAMPLES

Lead concentration examined in soil of Andhra Pradesh was 24 to 183 ppm (Bhat and Krishnamachari, 1980).

Fodder plot soil showed 36.8ppm of lead in industrial area of Punjab (Sidhu *et al.*, 1994).

Li-wenfan *et al.* (1995) studied the influences of Pb. Cd, Cu and Zn pollution on the health of sheep. They analysed the soil samples in the area near a refining factory which had higher content of Pb, Cd and Cu.

Burhenne *et al.* (1997) found high level of heavy metal concentrations in soil. Pb, Cd, Cu and Hg were 1360, 29.7, 817 and 40.8 ppm of soil dry matter respectively.

Yadav and Khirwar (1999) studied the soil - plant - animal relationship of copper in milch buffaloes of Jind district in Haryana. Average Cu content of soil was 0.74 ± 0.02 with a range of 0.32 to 1.26 ppm.

Govil (2001) determined the extent of heavy metal pollution in soil in Jeedimetla industrial area in Andhra Pradesh. Soil samples revealed very high concentrations of Cu (400 ppm), Zn (1000 ppm), Pb (1600 ppm) and Ni (700 ppm).

Micronutrient status of soil in eastern and southern dry zones of Karnataka was studied by (Gowda *et al.*, 2001a, 2001b). Cu, Zn and Fe content varied from 6.2 ± 1.52 and 5.7 ± 0.51 ppm, 8.1 ± 1.63 and 7.3 ± 1.04 ppm and 217.9 ± 24.33 and 710.6 ± 85.4 ppm respectively.

Sujatha *et al.* (2001) found higher concentrations of heavy metal in soil sample from a lake in Mysore state, Karnataka compared to the WHO standards, indicating metal toxicity.

Gowda *et al.* (2002) assessed the mineral status Mg, Cu, Zn and Fe of soil samples of animals in hilly and central zone of Karnataka.

Das *et al.* (2003) assessed the mineral status of soil and feed in two agro climatic zones of West Bengal. Concentrations of trace elements Fe, Cu, Mn and Zn in the soil of both the red laterite (zone-1) and new alluvial (zone-2) agro climatic zones were above the respective minimum critical levels.

Fatoki (2003) examined surface soil samples collected from seven locations perpendicular to three major roads in Eastern Cape. Pb, Cd, Zn concentration was determined in the soil samples which reduced with distance from road traffic.

Gowda *et al.* (2003) studied the status of pollutants in soil in industrial area in Bangalore. They found that the average soil pH was acidic (6.54 ± 0.45ppm) in industrial areas as compared to normal areas. The Pb (35.30 ± 6.70 ppm), Cu (95.30 ± 23.90 ppm), Zn (69.0 ± 21.94 ppm), and Fe (1267±150ppm) levels in soil of industrial areas was much higher than those of normal areas. Cd was not detected in the soil samples.

The soil contaminants of heavy metals were studied in different parts of India (Parkpian *et al.*, 2003; Singh *et al.*, 2003).

Bansal (2004) found that the soils under sewer water irrigation had higher concentrations of Zn, Cu, Pb and Cd when compared to fields irrigated by underground water.

Longhurst *et al.* (2004) measured the concentration of As, Cd, Cu and Pb in New Zealand pastoral topsoil in both farmed and non-farmed sites. Results showed that there was a significant enrichment of Cd in the farmed soils over non-farmed soils.

Soils irrigated with the effluents had higher contents of micronutrients and heavy metals as compared to the corresponding well irrigated soils (Patel *et al.*, 2004).

Sharma and Joshi (2004) estimated the soil mineral status in cattle of Garhwal region of Uttaranchal state. Soil Cu ranged from 0.35 to 0.45 ppm and was significantly deficient against critical value (0.60ppm).

Dhok *et al.* (2005) studied the mineral status in relation to goats nutrition in Akola district in Maharashtra. They reported that Cu content in soil was 282.14 ± 17.66 ppm.

Garg and Totawat (2005) studied the heavy metal accumulation, movement and distribution in the soil profiles near Zn smelter plant in Udaipur, Rajasthan. Higher level of heavy metals was recorded in the area which was situated in the close proximity of the effluent discharge point.

Kumar *et al.* (2005) studied the status of micro-minerals profile in buffaloes of Agra region in Uttar Pradesh. The average concentration of Cu, Zn, Fe and Co in soil was 1.66 ± 0.20, 1.14 ± 0.05, 45.02 ± 4.71 and 0.40 ± 0.02 ppm, respectively.

Paul *et al.* (2005) assessed the trace element status in goat feeds and in vital body tissues of Black Bengal goats. They analyzed the soil concentration of Cr, Cu, Zn, Fe and Mn and mean values were 1.62 ± 0.13, 1.48 ± 0.02, 2.26 ± 0.04, 96.62 ± 1.23 and 63.20 ± 1.24 ppm respectively.

The micronutrient content of soil in the different villages and their availability to lactating cows were studied by many researchers in different parts of India (Prasad *et al.*, 2005; Yadav and Khirwar, 2005).

Anuratha (2006) investigated the heavy metal concentration in soil of the vicinity of industries around Coimbatore city. The concentration of Cd in all the industrial areas was found above the normal level. Pb was found above maximum tolerable concentration in all sites except in the textile industrial area.

Khan *et al.* (2006) evaluated the mineral status of soils in Southwestern Punjab-Pakistan. The concentrations of some trace minerals in soil varied greatly among seasons and sampling periods.

Nikhil (2006) determined the content and accumulation of heavy metals in soil of Jharia coal field of Jharkhand. It was noticed that the polluted soil were substantially contaminated with metals including Cr, Fe, Ni, Pb, Zn and Cu present in significant level.

2.5. HEAVY METALS IN FODDER SAMPLES

Dobrzanski *et al.* (1994) assessed the effect of pollution from Cu industry on heavy metals concentration in green forage used in dairy cattle of Poland. Green forage from different farms within the copper mining area of Legnica-Glogow had twice the content of Cu, Pb and Cd than samples from another area.

Sidhu *et al.* (1994) in the industrial area of Punjab explored the fodder sample fed to animals for heavy metals. It contained Pb concentration of 102 to 382 mg/kg.

Li-wenfan *et al.* (1995) studied the influence of Pb, Cd, Cu and Zn pollution of the environment on the health of sheep and goats. Their concentration in samples of grass from polluted areas was significantly higher than that of unpolluted controls.

Dey *et al.* (1996) examined the fodder samples in a polluted area and recorded the mean Pb concentration in forages as 706.67 ± 73 ppm.

Saad and Fahmy (1996) investigated the accumulation of Mn, Cu, Zn and Cd in the zooplanktons of Bankalah region in Saudi Arabia. The mean concentration of Cu, Zn, Mn and Cd was 195.92, 179.18, 40.72 and 3.82 mg/g dry weight, respectively.

Dey *et al.* (1997) analyzed the fodder samples and recorded the mean Cu, Pb, Cd concentration in forages as 1.116 ± 0.110, 46.16 ± 10.57, 1.075 ± 0.091 ppm, respectively.

Yadav and Khirwar (1999) studied the soil- plant –animal relationship of Cu in milch buffaloes of Jind district in Haryana. The mean Cu content found in sorghum stover was 20.02 ± 0.92ppm.

The micronutrient content of the fodder straw in eastern, central and southern dry zones of Karnataka and coastal agro-eco zone Cu, Zn and Fe content varied from 11 and 9 mg/kg DM (ppm), 41 and 27mg/kg DM (ppm), 429 and 458 mg/kg DM (ppm), respectively (Gowda *et al.*, 2001a, Gowda *et al.*, 2001b and Gowda *et al.,* 2002).

Arnold *et al.* (2002) studied the feeds grown in the vicinity of an Aluminum factory in Germany. The distribution of Fl and Al in the carcasses of cattle maintained in that area was also observed.

Das *et al.* (2002) conducted a survey on soil-plant-animal relationship and examined the micronutrient status of dairy cattle in the new alluvial zone of West Bengal. Concentrations of Ca, P, Cu, Zn and Fe in the commonly used feeds and fodder were within the normal range of variation.

Linden *et al.* (2002) studied the Cd level in organic and conventional pig production systems. The Cd levels in organic and conventional feeds were 39.9 and 51.8 μg/kg respectively. Organic feeds contained two per cent potato protein which contributed 17 per cent of the Cd content and conventional feeds contained five per cent beet fibre, which contributed 38 per cent of the total Cd content.

Das *et al.* (2003) assessed the mineral status of fodders and grazing buffaloes in two agro climatic zones of West Bengal. Concentration of Cu in paddy straw and in green roughage was higher in zone-1 than that in zone-2.

The Pb (2.40–145 ppm), Cd (0.50-10 ppm) and Cu (43- 251 ppm), Zn (19-50 ppm) and Iron (338-11600 ppm) content in the vegetation in an industrial area was found higher as compared to normal areas (Gowda *et al.,* 2003).

Parkpian *et al.* (2003) monitored Pb and Cd contamination in grazing land located near a highway. Grass had a Pb and Cd content of 0.76 ± 0.05 to 6.62 ± 0.18 ppm and 0.17 ± 0.01 to 0.73 ± 0.09 ppm, respectively. They found that plants growing nearer to the highway are usually exposed to more heavy metal accumulations than those away from the highway.

Rozso *et al.* (2003) detected the Pb content of forages and roughages produced in agricultural regions and the neighboring cities, industrial plants and busy highways. Pb contamination of plants from industrial areas and nearby busy roads was higher than that of plants from agricultural areas.

Singh *et al.* (2003) evaluated the trace element status of crossbred cattle from sub-mountainous belt of Punjab in relation to soil and fodder. The average values of Cu in non-leguminous fodder sample ranged from 4.31 ± 0.32 to 5.45 ± 0.45 ppm.

Bansal (2004) studied the uptake of heavy metals by crop plants in Aligarh district. The results indicated that the plants grown on sewer water irrigation had higher concentration of Zn, Cu, Cd, Cr, and Ni as compared to fields irrigated by underground water.

Palacios *et al.* (2004) reported Lead poisoning of horses in the vicinity of a battery recycling plant based on clinical signs and as well as on laboratory findings. Lead levels in the aerial part of herbage samples ranged from 113 to 4741mg/kg.

Sharma and Joshi (2004) estimated the fodder mineral status in cattle of Garhwal region of Uttaranchal state. Fodder Cu content ranged from 7.13 to 9.01 ppm which was significantly lower than its critical limit of 10 ppm.

Bianu and Nica (2005) measured the Cd, Pb and Zn concentrations in hay, green Lucerne and feed grains fed to horses in Copsa Mica Romania near a non-ferrous metal processing plant. It was detected that there were very high Pb and Cd levels in the hay, Lucerne, feed grains and maize stalks.

Dhok *et al.* (2005) studied the mineral status of goats in relation to common tree leaves fed in Akola district in Maharashtra. The Cu content in various tree leaves ranged between 106.25 ±15.85 to 220.00 ± 21.79 ppm.

Mor (2005) examined the Cd and Pb contents in livestock feeds taken from four agricultural areas of Bursa, Turkey. Among the live stock feeds used, the higher level of Pb was found in grass and the lower level was obtained from the straw.

Paul *et al.* (2005) assessed the trace element status in the feed of Black Bengal goats. The concentration of Cr, Cu, Zn, Fe and Mn in the green roughage and mean value was 0.80 ± 0.01, 49.13 ±1.29, 36.89 ± 0.83, 353.71 ± 1.53 and 96.58 ± 1.14ppm respectively.

Ping (2005) measured the concentration of heavy metals in forage fed to animals in the vicinity of the Baiyin mining area in China. The contents of Pb and Cd were 9 and 680 times higher in forages and 10 and 35 times higher in grain, respectively, as compared with the control area.

Prasad *et al.* (2005) examined the micronutrient content of feeds in the adopted villages and assessed their availability to lactating cows. The fodder and paddy straw contained more silica and low in Cu content whereas in green fodders Cu, Fe and Mn was present above the critical level.

Somasundaram *et al.* (2005) analyzed the fodder samples fed to the dairy animals for the micronutrient and heavy metal concentration in Tamilnadu Agricultural University, Coimbatore. The mean values of micronutrient were, viz., Cu, Zn, Fe and Mn; 15.99, 48.4, 379.60, 47.16 mg/kg; heavy metal viz., Cr, Ni, Pb, Cd; 134.8, 202.9, 64.02, 15.92mg/kg, respectively. The concentration of micronutrient was in normal range and hence no toxicity whereas the heavy metal concentration fell under toxic level based on the critical level of trace metal in plants.

Yadav and Khirwar (2005) studied the inter-relationship of soil micro-nutrient with feed stuffs in Jind district of Haryana. The concentration of Cu, Zn, Fe and Mn in sorghum stover samples were in the range of 4.41-41.20, 27.12-40.96, 235.80-442.25 and 27.33-62.02 respectively. Soil Cu content had significant positive correlation with Cu content of green berseem, sorghum stover and wheat straw. The Cu and Fe content of soil significantly affected their respective concentrations in feedstuffs.

Khan *et al.* (2006) evaluated the mineral status of soils and forages in Southwestern Punjab-Pakistan. The concentrations of some trace minerals Fe, Zn and Se in forages were affected by seasonal changes.

Raj *et al.* (2006) analyzed plants for Cd, Cr, Ni, Pb, Co, Zn, Cu, Fe and Mn in the sewage contaminated area. Plants grown on polluted soil irrigated with sewage water recorded higher level of heavy metals. The average value of Cd in plant was 0.79mg/kg, Pb 19.22mg/kg, Cu 12.76mg/kg, Cr 4.90mg/kg, Ni 4.34mg/kg, Co 2.39 mg/kg, Zn 44.88 mg/kg, Fe 459 mg/kg and Mn 92.86 mg/kg.

2.6. HEAVY METALS IN MILK SAMPLES

In Andhra Pradesh, Bhat and Krishnamachari (1980) measured the Pb concentration in milk. The milk sample contained 0.05 to 0.15 ppm of Pb level in cattle.

The heavy metal contents were detected in milk and dairy products. Heavy metal content were low in blood, and thus their excretion *via* the milk was of almost negligible value. The mean level of Pb, Cd, Hg and As recorded in milk were 0.02, 0.0015, 0.005 and 0.004 mg/kg, respectively. The mean levels of Pb, Cd, Hg and As in the dairy product, cheese were 0.08, 0.05, 0.015 and 0.003 mg/kg respectively (Strauch, 1983).

Dobrzanski *et al.* (1994) assessed the effect of pollution from Cu industry on heavy metals concentration in milk of dairy cattle in Poland. Milk from different farms within the copper mining area of Legnica-Glogow had higher content of Cu, Pb and Cd from samples of another area.

Dey *et al.* (1996) observed higher concentration of Pb (1.13 ± 0.38 ppm) in milk from buffaloes reared in polluted areas of Delhi which was higher than the concentration of (0.24 ± 0.03 ppm) in milk from rural area.

Dwivedi *et al.* (1997) recorded mean Cd level in cows and buffaloes from different industrial areas as 0.008 ± 0.001, 0.012 ± 0.003 and 0.008 ± 0.001µg/ ml of milk respectively.

Swarup *et al.* (1997) found that the mean Pb concentration in urban milk samples from Kanpur city was 0.32±0.04 ppm and rural milk sample had a Pb level of 0.24±0.03 ppm. The mean Cd level in the milk samples of cows in urban and rural area was 0.013±0.003ppm and 0.04±0.001 ppm respectively.

The soil –plant –animal relationship of Cu in milch buffaloes of Jind district in Haryana was studied by Yadav and Khirwar (1999). They analyzed the Cu content of milk in buffaloes to be 0.57 ± 0.20 mg/kg on an average.

Simsek *et al.* (2000) determined the heavy metals in milk samples collected from three different regions an industrial region, a rural and a heavy traffic intensity region in Turkey. The average amounts in the samples from the three regions were respectively 0.032, 0.049 and 0.018 mg/kg for Pb, 0.05, 0.009 and 0.0002 mg/kg for As and 0.58, 0.96 and 0.39 mg/kg for Cu. The highest heavy metal content was found in the milk samples collected from industrial region followed by traffic intensive region and rural region.

Dwivedi *et al.* (2001) recorded varying degrees of Pb poisoning in cows and buffaloes near a primary Lead-Zinc smelter in India. The affected animals revealed considerably high levels of Pb and Cd in milk, 0.75 ± 0.19 ppm and 0.05 ± 0.01 ppm respectively.

Gowda *et al.* (2003) studied the status of pollutants and trace elements in dairy animals in industrial area of Bangalore. The samples of milk in industrial areas contained higher Pb (0.47 ± 0.06 ppm) and Cd (0.05 ± 0.01 ppm) respectively. The metals originate from various sources including cattle grazing on land, which naturally contains high levels of these metals or contaminated by industrial or by other human activities.

Parkpian *et al.* (2003) assessed milk sample to monitor Pb and Cd contamination from grazing land located at different distances from highway. The analysis revealed that improvements on farm management had significant reduction in elevated levels of Pb and Cd in soil and plants and minimizes the amount of Pb and Cd in milk.

Milk from cows in agricultural regions and the neighbouring cities with industrial plants and busy highways were measured for Pb content. The Pb and microelement content of milk samples from cows grazing along busy roads was higher than that of milk from agricultural areas (Rozso *et al.*, 2003).

Somasundaram *et al.* (2005) conducted a trial in Jersey cross animals to evaluate the heavy metal transfer from the contaminated feeds to dairy animals. They observed that the Pb, Cd, Ni and Cr content in milk ranged from traces to 0.046; 0.02 to 0.056; traces to 35.48 and 0.07 to 22.5 mg/kg, respectively.

Swarup *et al.* (2005b) estimated the level of Pb in milk from cows reared in areas around different industrial localities and found positive correlation between blood and milk Pb levels. The highest milk Pb level (0.84 ± 0.11 ppm) was detected in animals reared in the vicinity of lead-zinc smelting unit.

The extent of heavy metal contamination in untreated sewage water of Musi river near Hyderabad and impact of irrigation with this water on soil- plant- milch animal continuum was studied. A high amount of the heavy metals in milk were detected in all the samples collected, except Cu. All the heavy metals except zinc were in toxic limits to an extent of 100% (Raj *et al.*, 2006).

2.7. HEAVY METALS IN MEAT AND ORGANS

Strauch (1983) reported heavy metal contents in liver and kidney, especially from older cattle (milking cows, breeding animals), kept in polluted areas as well as from horses. Animal derived foodstuff showed heavy metals in it. The content of Pb and Cd in liver and kidney of wild animals in polluted area was 20 and 16 mg/kg and 30 and 100 mg/kg, respectively. The content of Pb in both liver and kidney of wild animals in low polluted area was 1 to 5 mg/ kg. The level of Cd in liver and kidney of wild animals in low polluted area was 4 and 10 mg/ kg, respectively.

Baars *et al.* (1986) estimated the environmental pollution with heavy metals of marshland of the Scheldt estuary and its effect on sheep. The content of Cd and Pb in liver was low, but the Cu content was up to 600mg /kg dry matter. In kidney tissue the Cd content was generally low, but Pb averaged 1 mg/kg and Cu ranged from 6 to 30 mg/kg.

Pb, Cd, Cu and Zn accumulation in meat were studied by many researchers (Sidhu *et al.*, 1994; Avram *et al.*, 2000).

Alonso *et al.* (2002) examined the effects of low-level environmental contamination on trace metal metabolism in cattle from the rural and relatively uncontaminated region of Galicia (NW Spain). Correlations between toxic Cd, Pb and As and essential trace elements Cu and Zn were evaluated in liver, kidney and muscle of cattle from throughout Galicia. There was a significant positive association between renal Cd and Zn residues and a significant negative correlation between kidney Cd and Cu.

Cd level in organic and conventional pig production systems was assessed by Linden *et al.* (2002). It was 39.9 and 51.8 μg/kg respectively in organic and conventional feeds. Differences in feed composition and bioavailability of Cd from the feed components were considered for the different kidney levels of Cd.

Samples of muscle tissue, liver and kidney were analyzed and measured by Ulrich *et al.* (2002) in Hg, Cd and Pb in the swine farms of the district of Hodonin, Czech Republic. The concentration of Hg and Cd were higher in liver, kidney and muscle samples.

Alonso *et al.* (2003) reported heavy metal accumulation in the organs of animals reared under cattle production systems of Spain. Cd and Pb accumulation in kidney, liver and muscle were noted. The heavy metal accumulation in the liver of dairy cattle was related not only to higher dietary intake, but also to the higher hepatic metabolism associated with milk production.

Das *et al.* (2003) assessed the mineral status of soil, feeds and grazing buffaloes in two agro climatic zones of West Bengal. Assessment of liver Cu indicated Cu deficiency in both the agro climatic zones. It was much below the minimum critical concentration of 75 ppm.

Drozd *et al.* (2003) observed the level of Cd, Pb and Hg in the skeletal muscles, heart muscle, liver and kidneys of Red deer from three natural forests of lublin region of Poland. Highest level of Cd and Pb accumulation were in the skeletal and heart muscles.

Hristov *et al.* (2003) investigated the contamination of pigs with Cd and Pb from different regions of North Bulgaria. Differences in the contamination of internal organs were assessed in relation to the industrial pollution of the region with Pb and Cd and their concentration was below the permitted levels.

Massanyi *et al.* (2003) estimated the concentrations of Pb, Cd and Hg in liver and kidney of the brown hare in relation to season, age and sex in the west

Slovakian lowland. The concentration of Pb and Cd in liver and in kidneys was highest during the winter period.

Toxic and essential metals in muscle, bone, liver and kidney of bovines, grazing on the municipal waste water spreading field in Morocco were observed. Bovines were found to be contaminated by toxic metals. Specific target organs for metal bioaccumulation showed higher heavy metal accumulation (Sedki *et al.*, 2004).

In Romania, Bianu and Nica (2005) measured the Cd, Pb and Zn concentrations in horse tissue near a non- ferrous metal processing plant. Very high levels of Cd (40-100 times higher than normal levels) and high levels of Pb (3-6 times higher than normal levels) were detected in the various organs of the horses.

Lemos *et al.* (2005) observed Pb poisoning in cattle, grazing in pasture contaminated by industrial waste. Pb concentration in liver and kidney was very high in cattle grazing in contaminated pasture.

Miranda *et al.* (2005) evaluated the contribution of anthropogenic pollution to toxic metal residues (Cd, Pb and As) in cattle in an industrialized area in Spain. They investigated possible implications of toxic metal exposure for metabolism of essential trace elements (Cu, Zn, Fe and Zn). Samples of kidney, liver and muscle from calves were obtained from an industrialized area and from a rural area. Cd and Pb contents in the liver and kidney were moderately and significantly higher in calves from the industrialized area (Cd:Liver 29.6, Kidney 161; Pb: Liver 38.1, Kidney 38.3 mg/kg) than in calves from the rural area (Cd: Liver 22.9, Kidney 96.4: Pb: Liver 20.7, Kidney15.9 mg/kg).

Skalicka *et al.* (2005) reported presence of higher Cu level in muscle, heart, liver and kidney of cows from a polluted area.

In game animals Venalainen *et al.* (2005) measured the level of heavy metals. The levels of metals in the animal tissues reflected the general heavy metal pollution of the environment in the area studied.

Znamirowska *et al.* (2005) studied the accumulation of heavy metals in the horse organs. They found that Pb accumulation in meat and in liver averaged 0.048 mg/ kg and 0.205mg / kg, respectively.

Mollerka and Ribeiro (2006) studied sheep fed with commercial concentrate containing Cu and observed the signs of chronic Cu poisoning. The mean Cu level in the concentrate was 11.37mg/ kg. The Cu levels in the liver and kidney were 1641 and 305 mg/ kg, respectively.

2.8. HEAVY METALS IN EGG

Dey and Dwivedi (2000) reported Pb and Cd concentration in egg samples ranged between 0.142 and 0.936μg /g and 0.030 and 0.180 μg /g respectively. In this study, the majority of the samples had Pb and Cd concentrations that exceeded 0.020 μg and 0.005 μg respectively which are normal background levels for Pb and Cd in eggs. The mean Pb concentration recorded was higher than concentration found in hens egg from Canada, Taiwan, China, Finland and Hungary.

In a study in United States (Vodela *et al.*, 1997), broiler breeder hens were used to determine the effect of drinking water containing a low concentration of a chemical mixture (As 0.8 ppm, benzene 1.3 ppm, Cd 5.1 ppm, Pb 6.7 ppm, and Trichloroethylene 0.65 ppm) and a high (10 times greater than the low concentration of the chemical mixture) level of the chemical mixture. These chemicals are present in ground water near hazardous waste sites. Water consumption and body weight decreased in hens provided with high concentration of the chemical mixture. The low concentration of the chemical mixture significantly decreased egg production and egg weight.

2.9. HEAVY METALS IN BLOOD SAMPLES

Dobrzanski *et al.* (1994) assessed the effect of pollution from Cu industry in bovine blood serum of dairy cattle from 30 farms in Poland. Blood serum from different farms within the copper mining area of Legnica-Glogow had twice the content of Cu, Pb and Cd of samples from another area, 80 km away.

Lead toxicity was reported in bovine in an industrial area in Punjab by Sidhu *et al.* (1994). Blood Pb concentration ranged from 19.5 to 73.1 ppm in ruminants. The Pb content in erythrocytes varied from 23.4 to 42.9 ppm. Normal blood Pb level in ruminants is 5 to 22.5 μg/ 100 ml.

Vyas (1996) reported the pathological response of Ochratoxin -A, Cd and Hg toxicities in ducks. Field samples of soil, water, feed, biological materials were analyzed for the presence of Hg and Cd.

Heavy metals (Pb and Cd) in blood of cows and buffaloes were studied in different parts of India (Dey *et al.*, 1997; Swarup *et al.*, 1997).

Nair (1999) studied the effect of Cu, Zn and Mn supplemented diet at different levels in ducks. Samples of water, plants, sediment, blood and other biological samples were estimated for Cu, Zn and Mn.

Yadav and Khirwar (1999) compared the soil – plant –animal relationship of Cu in milch buffaloes of Jind district in Haryana. They observed that Cu content of blood in buffaloes averaged 0.46 ± 0.06 ppm.

Dwivedi *et al.* (2001) recorded varying degrees of Pb poisoning in cows and buffaloes near a primary Lead-Zinc smelter in India. A blood level of

1.43 ± 0.07 ppm Pb and 0.11 ± 0.01 ppm Cd was detected in the vicinity of the smelter.

Micronutrient profiling in blood samples of animals in eastern and southern dry zones of Karnataka were done by Gowda *et al.* (2001a). Cu, Zn and Fe content in plasma were 0.97 ± 0.13 and 0.90 ± 0.06 ppm, 1.58 ± 0.38 and 0.62 ± 0.07 and 1.92 ± 0.28 and 1.86 ± 0.27 respectively in eastern and southern dry zone. About 20-25 % of the animals exhibited low P, Cu and Fe values than the normal range in the eastern dry zone. On the other hand the average P and Zn content in blood plasma of animals in Southern dry zone was below the normal level. A similar study in coastal agro eco zone was also done by Gowda *et al.* (2001b) in Karnataka.

Patra *et al.* (2001) estimated the trace minerals in blood of young calves. The blood concentration of Pb, Cu, Co and Zn were 1.06 ± 0.05 ppm, 0.82 ± 0.04 ppm, 0.51 ± 0.01 ppm and 4.67 ± 0.18 ppm, respectively in 28 days of exposure to Pb. Increase in blood Pb concentration in lead-exposed calves was associated with a decrease in blood Cu and increase in Co concentration.

Das *et al.* (2002) detected mean plasma concentrations of Ca, P, Cu, Zn and Fe in calves, heifers and milch animals as well as in dry cows. Anoestrous cows had shown lower plasma Ca, P and Cu concentrations. Higher plasma values were observed for Cu and Fe in high yielder.

Similar studies were done in other parts of India (Gowda *et al.*, 2002 and Das *et al.*, 2003).

In an industrial area in Bangalore Gowda *et al.* (2003) analyzed blood of dairy animals for heavy metals which showed comparatively higher Pb (0.09 ± 0.003 ppm) and Cd (0.065 ± 0.014 ppm), whereas the Cu and Zn levels in the blood plasma were similar to the normal values.

Singh *et al.* (2003) evaluated the trace element status of crossbred cattle from sub-mountainous belt of Punjab in relation to soil, fodder and blood plasma. The average values of Cu, Mo, Fe, Zn, Co and Mn in plasma were 12.08 ± 0.27, 10.237 ± 0.018, 123.79 ± 4.97, 32.07 ± 1.64, 12.20 ± 0.50 and 3.81 ± 0.24 ppm respectively.

In environmental pollution incidence, Marcal *et al.* (2004) analyzed water, soil, grass and mineral salt samples to investigate the sources of toxicity in animals. Animals from the vicinity of a factory making batteries for motor vehicles were monitored for the presence of inorganic Pb by clinical examination and haematological analysis. The results showed that animal health was harmed due to environmental pollution.

Heavy metal presence in equine blood was observed by Dey and Dwivedi (2004) and Bianu (2005).

Dhok *et al.* (2005) estimated the serum mineral content in goats and the Cu level was 124.91 ± 6.67 ppm.

Kumar *et al.* (2005) studied the status of micro-minerals, hormone and vitamin profile in buffaloes of Agra region of Uttar Pradesh. The average serum concentration of Cu, Zn, Fe and Co in adult buffaloes was 0.718 ± 0.037, 1.598 ± 0.197, 1.774 ± 0.066 and 0.047 ± 0.004 ppm, respectively.

Park *et al.* (2005) studied concentrations of Cd, Pb, Hg and Cr in dog serum in Korea. The metal concentrations of Cd, Hg, Pb and Cr in dog serum was 0.21 ± 0.01, 1.10 ± 0.49, 0.68 ± 0.19 and 0.66 ± 0.15 ppm respectively.

Singh *et al.* (2005) estimated the macro mineral status of crossbred cattle of Shiwalik hills, Punjab in relation to soil and fodder. The average values of Ca, P and Mg in plasma samples of crossbred cattle were 2.22 ± 0.03, 1.87 ± 0.04 and 0.97 ± 0.02 ppm respectively.

Somasundaram *et al.* (2005) in Jersey cross animals evaluated the metal transfer from contaminated feeds to animals. Pb, Cd, Cu serum concentration was higher in this study.

Swarup *et al.* (2005) studied the blood Pb level in animals reared in areas around different industrial localities and to find out the correlation between blood and milk Pb level in cows. Significantly ($P<0.05$) higher blood Pb level was recorded in animals reared around Lead-zinc smelting factories followed by closed Pb but functional Zn smelter, Al processing unit and steel manufacturing plant, as compared to values recorded for control animals.

Patra *et al.* (2006) and Singh *et al.* (2006) estimated heavy metals in blood profile of cows and sheep in the industrial localities.

Raj *et al.* (2006) recorded a high amount of the heavy metals in serum samples collected with the mean concentration of Cd, Pb, Cu, Cr, Ni, Co, Zn, Fe and Mn was 0.022, 0.385, 0.302, 0.140, 0.029, 0.077, 0.496, 24.16 and 0.04 ppm, respectively in animals consuming fodder grown in land irrigated by polluted water.

2.10. HEAVY METAL S IN DUNG SAMPLES

Dung samples contained 4.7 to 38 ppm of Pb in cattle of Andhra Pradesh (Bhat and Krishnamachari 1980).

Sidhu *et al.* (1994) found that the Pb concentration in dung of the ruminants due to industrial pollution in Punjab varied from 48.7 to 146.1 ppm.

Nisha (2000) assessed the Cd toxicity in water, forage and biological samples in cattle of Eloor industrial area in Kerala. The study reported higher concentrations of Cd in all the samples examined in Eloor industrial area.

In pigs, Linden *et al.* (2002) evaluated the Cd level. The Cd levels in organic and conventional feeds were 39.9 and 51.8 µg / kg respectively. They concluded that organic pigs had a higher Cd level in manure indicating a higher Cd exposure from the environment, such as ingestion of soil.

Gowda *et al.* (2003) reported that the samples of dung examined from dairy cattle in the industrial areas contained higher Pb (0.55 ± 0.18 ppm) and Cd (0.032 ± 0.01) than the samples from the control area.

Parkpian *et al.* (2003) investigated lead and Cd contamination in grazing land located near a highway. Analysis of the manure showed considerable amounts of Pb and Cd content of 2.55-3.34 and 0.14-0.31 ppm respectively. Long term simultaneous application of fertilizer and manure on the commercial farm showed higher metal accumulation in the soil and plants than that of the cooperative farm.

It was found that Cu, Pb, Cd and Cr concentrations in animal manures were high in China. The copper concentration in manure sample reached as much as 1726.3mg/kg (Long *et al.*, 2004)

Mor (2005) found the Cd and Pb contents in cattle manure taken from four agricultural areas exposed to different degrees of environmental pollution. The levels of Cd and Pb contamination in the manures of the cattle, in the areas far from industries, traffic or urbanization, were less than those that were closer to heavy traffic and industrial activities. The highest heavy metal content was found in cattle manure collected from the region with heavy traffic, followed by industrial and rural region.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

Kerala, a narrow strip of land in Southern part of the Indian peninsula is situated between 76° 23' to 77° 23' longitudes and 9° 44' to 10 °18' latitudes on the Northern hemisphere. The state has an abundant rainfall *viz* South-West and North-East monsoons with two spells of dry weather. The climate is hot and humid due to proximity to sea and thick vegetation.

3.1 LOCATION OF THE AREA

The study was conducted in *Plachimada* village in *Perumatty* Panchayat of Palakkad district herein after referred as industrial area and *Nallepilly* village in *Nallepilly* Panchayat in *Chittoor* taluk of Palakkad district, herein after referred as control area, during the period of September 2005 to December 2006. A survey was conducted and samples were collected at random from both the study areas from 30 different locations.

3.2. SURVEY

The socio-economic status of the selected area for the existing livestock production systems was observed among the farming communities of the two study area with a structured schedule (Appendix I) and the amplitude of the industrialization in livestock production in the selected area was assessed and analyzed.

3.3. COLLECTION OF SAMPLES

3.3.1. Water, Soil and Fodder

Water samples were collected by observing sampling rules from the wells and underground bore wells of *Plachimada* (industrial area) and also from *Nallepilly* (control area) in nitric acid washed polyethylene plastic containers. Similarly, soil samples (8-10"depth) and green fodder/ paddy straw/ grass samples were collected at random as per (Kabata and Pendias1992) from the industrial area and from the control area. The samples were collected in sterile clean standard plastic containers, scientifically maintained, stored and processed for further analysis as per standard procedures (A.O.A.C. 1990).

3.3.2. Biologicals

Milk samples were collected from the lactating cows reared in the industrial area and the samples from control area. The udder and teats of the animal were washed with water and milk samples were collected in standard sterilized vials. The vials were sealed immediately and transported to the laboratory in ice packed containers and stored in refrigerator until further analysis.

Samples of blood were collected from the healthy lactating cows both from the industrial area and from the control area in sterilized vials using Heparin as anticoagulant. The vials were sealed immediately after collecting the samples and carried to the laboratory in ice packed containers and stored in refrigerator until further analysis.

Similarly, other biological samples like meat, egg and dung were collected at random from both the industrial and control area and stored under refrigeration for further laboratory analysis.

3.4. PREPARATION OF SAMPLES

3.4.1. Soil

About five gram of soil (air-dried ground and sieved) was taken in an Erlenmeyer flask. 20 ml of extracting solution was added (0.05N Hydrochloric acid in 0.025N sulphuric acid). The flask was placed in a mechanical shaker for 15 minutes. The content was filtered through Whatman# 42 filter paper into a 50 ml volumetric flask and diluted to 50 ml with extracting solution and the concentration of the elements was determined using Atomic Absorption Spectrophotometer.

3.4.2. Plant tissue, Meat, Egg, Blood and Dung

About one gram of ground dried plant /egg/ meat sample was taken and placed in a small beaker. 10 ml of concentrated Nitric acid was added and allowed to stand overnight. The beaker was heated carefully on a hot plate until the production of red nitrous oxide fumes had ceased. Cooled the content of the beaker and a small amount (two-four ml) of 70 per cent Perchloric acid was added. Heated again and allowed evaporating to a small volume. The sample was transferred to 50 ml flask and diluted to volume with distilled water.

3.4.3. Milk Sample

About five ml of milk was taken in a 100 ml volumetric flask and 50 ml of 24 per cent Trichloroacetic acid was added and diluted to volume with deionised water. The samples were shaken at five minute intervals for 30 minutes and filtered. Transfered five ml aliquot of the filtrate to a 50 ml volumetric flask, and one ml of five per cent Lanthanum solution was added, and made to volume with deionised water.

3.5. ANALYSIS OF THE SAMPLES

Presence of heavy metals in the samples of water, soil, forage/ paddy straw, milk, meat, egg, blood and dung from the industrialized area and from the control area were analyzed. Presence of lead, cadmium, arsenic and copper were evaluated using Atomic absorption spectrophotometer (AAS- Perkin Elmer model no: 3110) as per the standard procedure (A.O.A.C 1990).

3.6. STATISTICAL ANALYSIS OF DATA

The data collected by socio-economic status survey of the agro-ecological zone was analyzed as per Snedecor and Cochran (1994). The laboratory analysis data was processed and analyzed by students 't' test utilizing Statistical Package of Social Scientists (SPSS).

RESULTS

4. RESULTS

4.1 SURVEY OF IMPACT OF INDUSTRIES ON FARMING SYSTEMS

A detailed survey was done among fifty farmers from Plachimada (industrial area) and Nallepilly (control area) villages respectively. They were interviewed with a schedule and the data was tabulated. The Census report (1996) showed a population of 29658 in Perumatty Panchayat and 149821 in Chittoor. In 2001, it was 27693 and 158510 in Perumatty Panchayat and Chittoor respectively. There was a decrease in human population in Perumatty Panchayat during the last six years. Fig.1 and 2 depicts the two study areas in Palakkad district.

The geographical area of Plachimada is 14.89 sq.km with 10.42 sq.km of cultivable area which is about 70 per cent of the geographical area and an irrigated area of 5.21 sq.km which is about 50 per cent of the cultivable area. The location of the study area and satellite picture of Plachimada-water shed is presented in Fig. 3 and Fig. 4 and 4a respectively.

Chittoor is geographically 261.24 sq.km with cultivable area of 18287 hectares which is 70 per cent of the geographical area and irrigated area is 9144 hectares which is 50 per cent of the total cultivable area.

The livestock census (2001) in Perumatty Panchayat holding Plachimada showed 2928 crossbred female and 469 males. The non-descript cattle was 3153, females and 1016, males. The buffalo population was 798 cows and 280 bulls. Doe and buck were 2343 and 1537, respectively. The population of chicken both desi and crossbred were 3314. In Plachimada –the industrial area- the livestock census showed a decreasing trend during six year period. The crossbred cattle were 524 in 1995 census but it declined to 463 in 2001 census. The female crossbred cattle population also declined from 489 to 361 in six years time.

Fig 1. Map of Kerala

Fig 2. Study area in Palakkad District, Kerala State.

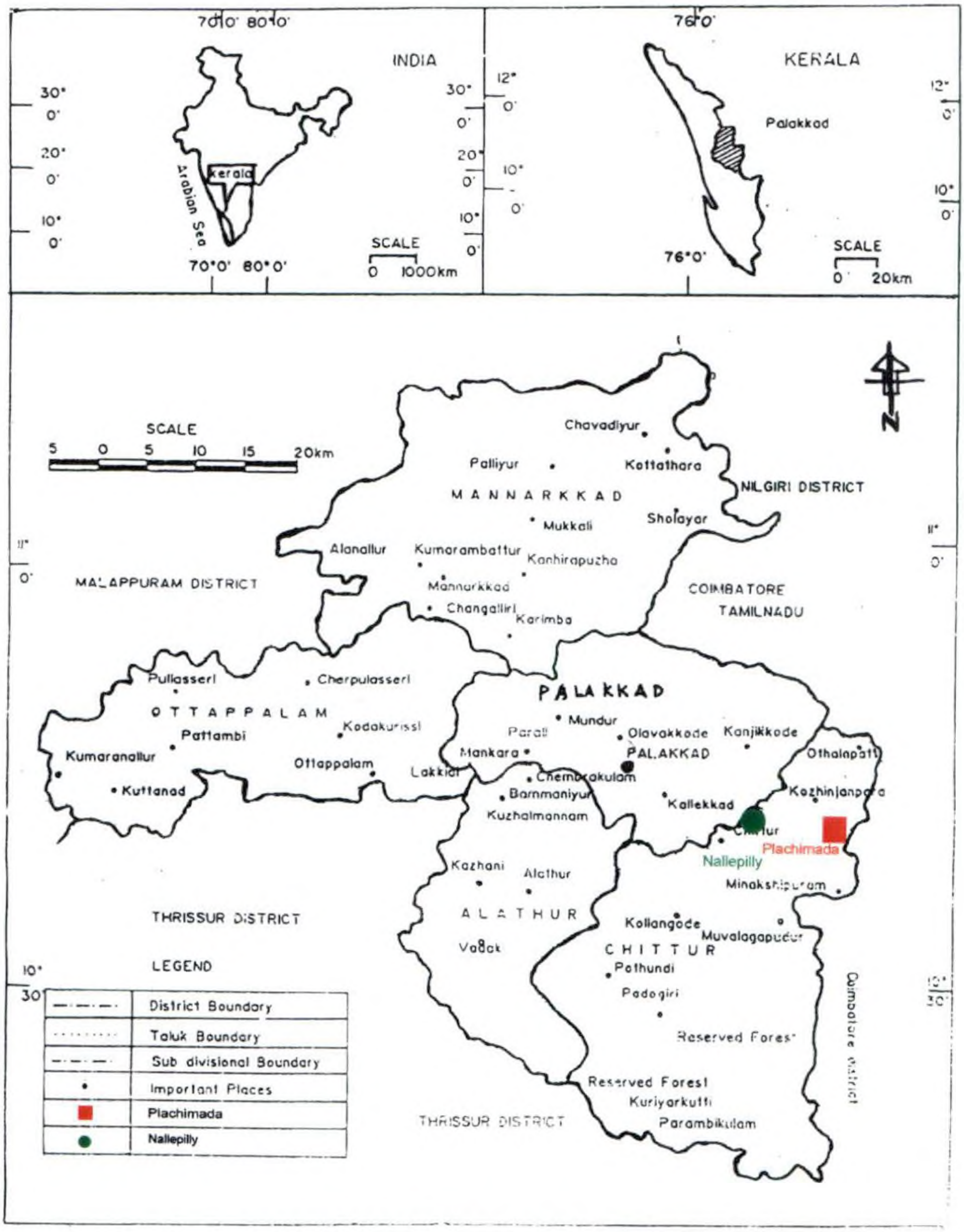


Fig 3. Palakkad District Map

Fig 4. Satellite picture of the industrial area

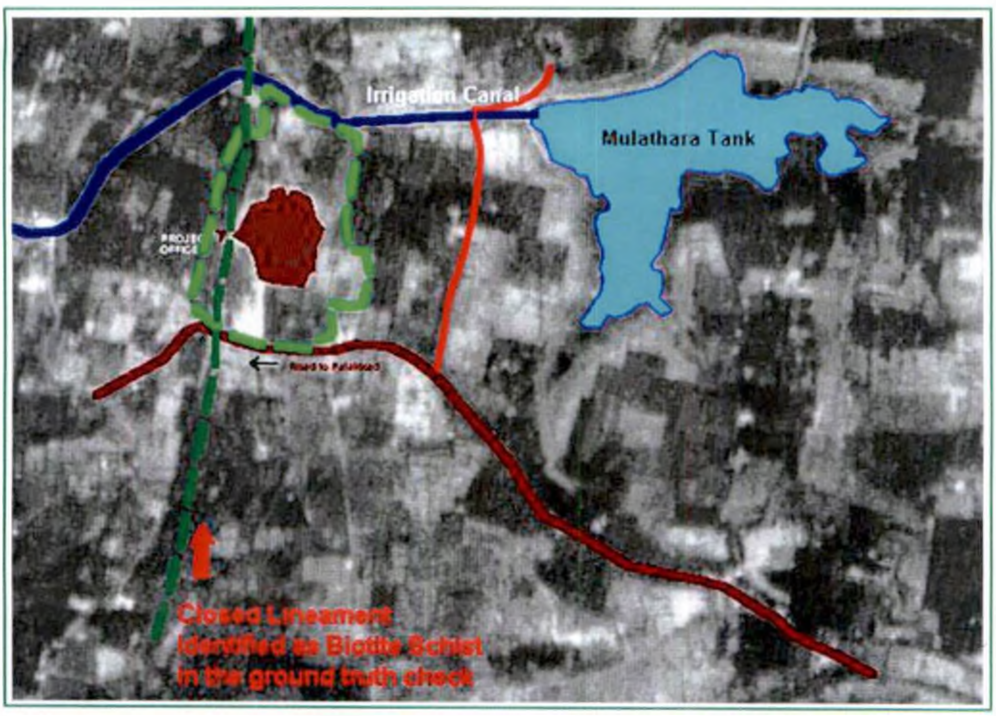
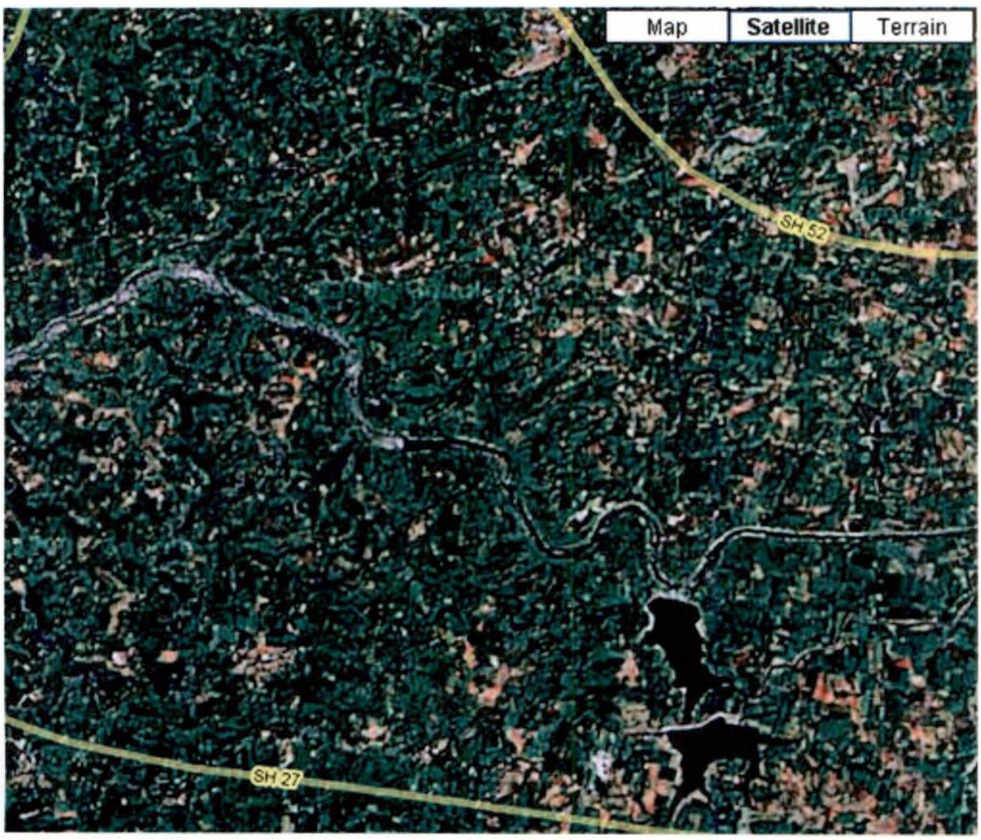


Fig 4a. Satellite picture of the industrial area



The census reports in Nallepilly- the control area- showed an increasing trend in crossbred cattle population. It was 748 in 1995 and 837 in 2001. The female crossbred cattle were 562 and 628, respectively.

4.1.1 Socio-economic Status of the Farmer

Socio-economic status of the farmer is derived as a percentage of data collected in the industrial area and control area under study. 72 to 75 per cent of people between the age of 31 to 50 were engaged in agricultural farming for livelihood. Moreover it was full time livelihood sustenance for 68 per cent of people in Plachimada and 76 per cent in Nallepilly. It was part time engagement for 32 per cent in Plachimada and 24 per cent in Nallepilly. About 20 per cent of the farmers were in the age group of above 50. This denotes that middle aged persons are more involved in the agricultural and animal husbandry activities.

4.1.2 Educational Status

The educational status of the farmers was evaluated in the study area. Around 82 per cent and 47 per cent in industrial and control area had high school education. About 13 per cent and 43 per cent farmers had higher secondary qualification in the industrial and control area and about five per cent and 10 per cent had a degree in the industrial and control area, respectively.

4.1.3 Farm Income

Average monthly income per family was less than Rs. 2000 in 63 per cent farmers in industrial area and 36 per cent in control area. About 32 per cent in industrial area had income up to Rs.4000 per month and 28 per cent fall in Rs.4000 income group in control area. Only five per cent farmers earn upto Rs.6000 per month in industrial area whereas it was 24 per cent in Nallepilly area. 12 per cent had an income of more than Rs. 6000 per month in control area.

4.1.4 Landholding Status

Major group of farmers (78 per cent) own one acre of land in industrial area whereas it was 36 per cent in control area. Percentage of farmers holding land upto four acres was 78 and 42 respectively in Plachimada and Nallepilly. Minority (five per cent) had more than five acres of land holding in Plachimada and 22 per cent in Nallepilly.

4.1.5 Crops

About two per cent and eight per cent of farmers undertook paddy cultivation in industrial and control area, respectively. 15 per cent of farmers were engaged in fodder cultivation in the control area. Coconut plantations were held by five per cent in industrial area and by 13 per cent in control area. 93 per cent farmers were engaged in other agricultural activities in the industrial area and 64 per cent in the control area.

4.1.6 Animals

78 and 85 per cent of farmers owned cattle in Plachimada and Nallepilly respectively. 17 per cent and 12 per cent had poultry in Plachimada and Nallepilly respectively. Goats were raised only by five per cent and three per cent farmers in Plachimada and Nallepilly, respectively.

4.1.7 Farming Experience

Livestock farming was major income source for 68 per cent of people in Plachimada area and it was 74 per cent of people in Nallepilly area whereas livestock farming provided additional income for 32 per cent in Plachimada area and 26 per cent in Nallepilly area.

15 per cent farmers in Plachimada area and 11 per cent farmers in Nallepilly area had less than four years of farming experience. 68 per cent had four to eight years of farming experience in Plachimada whereas it was 61 per

cent in Nallepilly area. Persons having more than 10 years of farming experience were 17 per cent in Plachimada area and 28 per cent in Nallepilly area.

4.1.8 Farming Status

There was intensive (seven per cent), semi-intensive (68 per cent) and backyard (25 per cent) system of farming in Plachimada. In Nallepilly area it was 55 per cent, 24 per cent and 21 per cent respectively.

4.1.9 Livestock Housing

In Plachimada area farmers followed a housing system of simple type (61 per cent), concrete (nine per cent) and backyard shelter (30 per cent) whereas it was 46, 40 and 14 per cent respectively in Nallepilly area.

4.1.10 Livestock Feeding

Concentrate feeding was practiced by 42 per cent of farmers in Plachimada area and 85 per cent in Nallepilly area. Green fodder was fed by 38 per cent in Plachimada area and 76 per cent in control area.

4.1.11 Marketing of Products

In Plachimada area 30 per cent of farmers obtained less than five litres of milk per day per cow and it was 10 per cent in Nallepilly area. Six to eight litres of milk per day per cow was obtained by 48 per cent of farmers in Plachimada area and 55 per cent in Nallepilly area. About 10 litres of milk per day was obtained by 22 per cent and 35 per cent of farmers in the Plachimada and Nallepilly area respectively.

Direct marketing of milk (46%) was done by majority of farmers in Plachimada; 34 per cent sold milk to middleman and 20 per cent sold it to co-operative societies. In Nallepilly area, 20 per cent adopted direct marketing and 15 per cent sold milk to middle man and 65 per cent gave milk to co-operative societies. The economic viability of the farming system was seven per cent and 24 per cent in Plachimada and Nallepilly area respectively.

4.1.12 Effect of Industrialization on Livestock System

In the industrial area 48 per cent of people lived within one km distance from the industry and 36 per cent lived within two to four km distance and 16 per cent lived within five km distance. In Nallepilly 97 per cent of the people lived away from industrial units. Linkage of the farmer with regard to close proximity of house to industry and grazing area was 85 per cent in the Plachimada area. The change desired by farmers in the existing farming system due to the effect of pollution, land availability, fodder resources, economic viability and close location of the industry was 92 and 24 per cent in industrial area and in control area respectively.

4.2 EFFECT AND EXTENT OF POLLUTION

4.2.1 Water

Heavy metal presence in water samples collected from the industrial area and control area are given in Table 1 and shown in Fig 5 and 6. The water samples collected from the industrial area and control area showed highly significant quantities of Cd in both zones and a significant level incase of Pb. The level of Cu and As were non significant. The permitted level of Cu, Cd, Pb and As given by WHO is 2.0, 0.005, 0.01 and 0.01 mg/L. The presence of Cd and Pb in water from the industrial area was more than the control zone and the WHO (1995) recommendations.

4.2.2 Soil

Soil samples collected from the industrial area and control area had heavy metals in it and is presented in Table 2 and Fig. 7 and 8. The soil samples collected from the industrial area and control area showed highly significant quantities of Cu, Cd and Pb in both zones. Arsenic level was non significant in

Table 1 Heavy metals content in water (mg/L)

Industrial area					Control area			
Sl No	Copper	Cadmium	Lead	Arsenic	Copper	Cadmium	Lead	Arsenic
1	0.1	0.06	0.03	0.04	0.06	0.01	0.05	0.01
2	0.09	0.05	0.13	0.05	0.09	0.04	0.01	0
3	0.12	0.06	0.1	0	0.04	0.02	0.03	0
4	0.1	0.06	0.09	0	0.06	0.02	0.04	0
5	0.07	0.05	0.12	0.02	0.08	0.03	0.06	0.05
6	0.08	0.07	0.1	0.05	0.03	0.01	0.07	0.03
7	1.24	0.06	0.08	0	0.05	0.03	0.04	0
8	0.05	0.06	0.05	0	0.12	0.02	0.07	0
9	1.13	0.05	0.07	0.04	0.23	0.03	0.06	0
10	0.07	0.06	0.09	0.03	0.07	0.02	0.04	0.04
11	0.15	0.06	0.09	0	0.15	0.02	0.08	0.05
12	0.27	0.08	0.05	0	0.1	0.01	0.07	0
13	0.34	0.08	1.23	0	0.23	0.06	0.03	0.05
14	0.1	0.07	1.02	0.06	0.27	0.03	0.07	0.01
15	0.12	0.08	1.04	0	0.15	0.01	0.05	0
16	0.23	0.08	0.06	0.01	0.19	0.05	0	0
17	0.13	0.06	0.03	0	0.07	0	0	0
18	1.05	0.04	0.05	0	0.25	0.05	0.06	0.05
19	1.07	0.05	0.09	0.06	0.34	0.01	0.07	0.04
20	0.09	0.05	0.05	0	0.3	0.04	0.07	0
21	0.06	0.08	0.07	0.01	0.24	0	0	0
22	0.11	0.06	0.06	0.05	0.35	0	0	0
23	0.07	0.07	0.03	0.07	0.23	0	0.05	0.02
24	0.05	0.06	0.05	0	0.34	0.01	0.07	0.03
25	0.04	0.06	0.09	0.06	0.16	0.06	0.04	0
26	0.13	0.05	0.07	0	0.19	0	0	0
27	0.06	0.07	0.1	0.02	0.07	0.07	0.07	0.02
28	0.19	0.08	0.09	0.05	0.05	0.01	0.03	0.01
29	0.05	0.09	0.06	0	0.14	0.02	0.05	0.04
30	0.03	0.06	0.05	0	0.22	0.05	0.06	0.01
Mean±SE	**0.24 ±0.06**	**0.06 ±0.002**	**0.17 ±0.005**	**0.020 ±0.004**	**0.16 ±0.018**	**0.024 ±0.003**	**0.044 ±0.004**	**0.015 ±0.003**

Fig 5. Heavy Metals in Water-Industrial Area

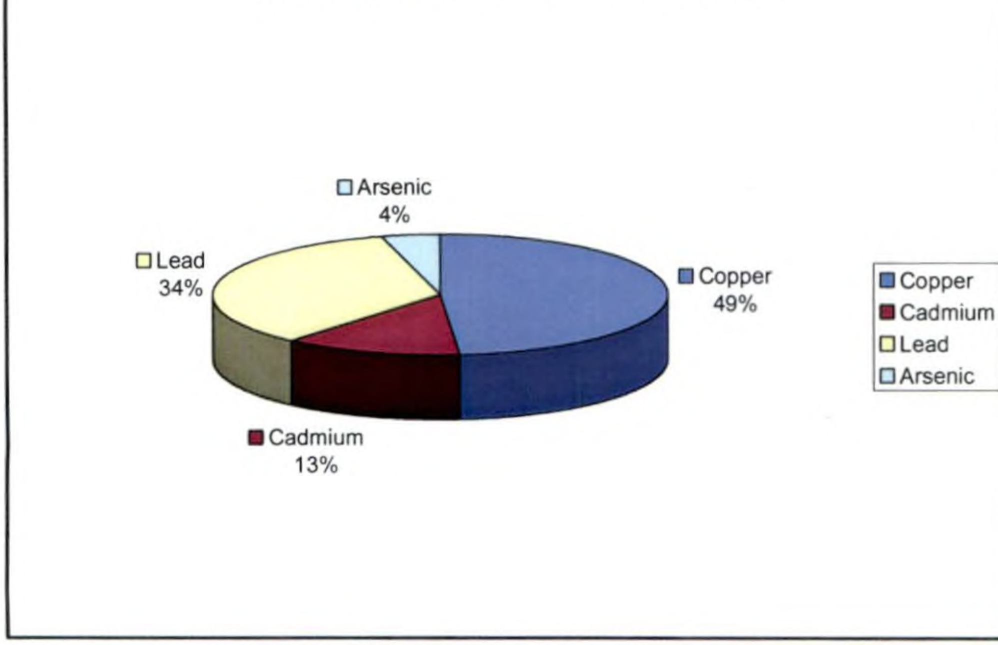


Fig 6. Heavy Metals in Water-Control Area

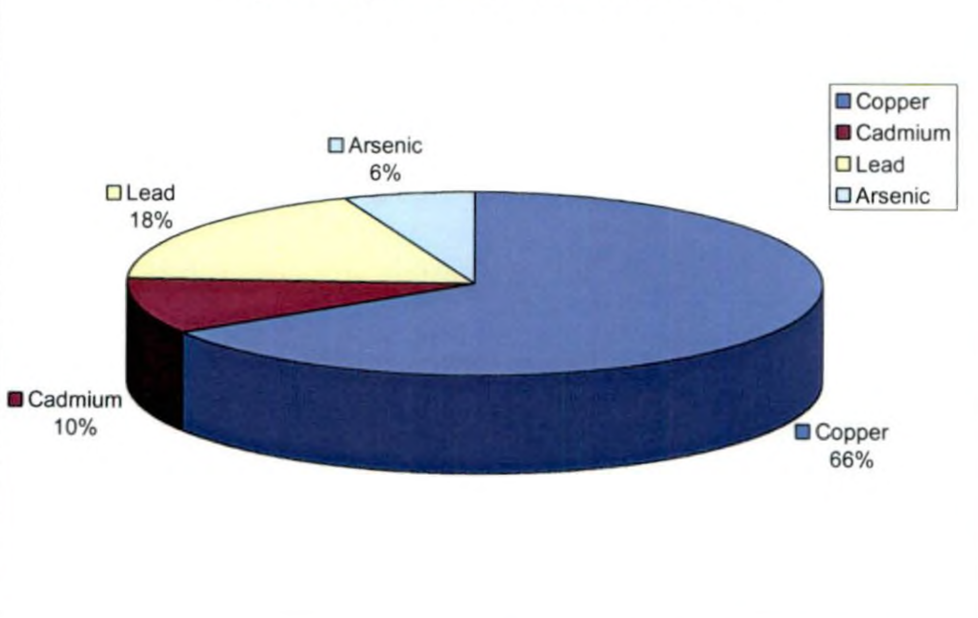


Table 2 Heavy metals content in soil (mg/kg)

SI. No.	Industrial area				Control area			
	Copper	Cadmium	Lead	Arsenic	Copper	Cadmium	Lead	Arsenic
1	0.59	1.39	2.69	0.02	0.4	0.48	0.2	0.06
2	0.59	1.59	4.49	0.03	0.58	0.27	0.3	0.05
3	0.39	1.58	0.69	0	0.6	0.19	0.16	0.07
4	0.89	1.49	0.39	0.05	0.76	0	0	0
5	1.29	1.45	5.29	0.04	0.89	0.59	0.18	0.09
6	0.99	0.99	1.39	0	0.28	0.18	0.2	0.07
7	1.19	1.49	0.99	0	0.5	0.38	0.3	0.02
8	0.88	1.37	0.78	0	0.29	0.57	0.4	0.07
9	0.98	1.58	1.48	0.04	0.58	0.49	0.23	0
10	0.49	1.79	0.89	0.05	0.67	0.38	0.27	0.05
11	0.49	1.38	3.56	0.04	0.59	0.59	0.18	0.07
12	0.99	1.58	3.97	0.03	0.38	0.37	0.15	0.09
13	0.79	1.39	0.89	0.02	0.39	0	0.19	0
14	0.19	1.57	2.26	0.02	0.28	0	0	0
15	0.59	1.69	3.39	0.04	0.68	0	0	0
16	0.79	1.68	1.19	0	0.76	0.19	0.12	0.06
17	0.69	1.58	0.89	0	0.58	0	0	0
18	0.77	1.63	0.67	0	0.49	0	0	0
19	0.59	1.69	1.09	0.03	0.27	0.27	0.2	0.03
20	0.79	1.79	0.89	0.02	0.19	0	0	0
21	0.98	1.18	1.08	0.03	0.28	0	0.25	0.02
22	0.69	0.99	2.08	0.03	0.38	0.28	0.16	0
23	1.09	0.69	1.49	0	0.57	0.18	0.34	0
24	1.19	0.89	2.68	0	0.79	0.29	0.2	0.09
25	0.69	1.18	1.87	0.04	0.27	0.19	0.23	0.02
26	0.89	1.49	0.69	0	0.19	0	0	0
27	1.48	1.09	0.99	0.05	0.98	0.37	0.32	0.03
28	1.75	1.36	3.11	0.03	0.48	0.18	0.46	0.07
29	0.89	0.89	2.68	0.04	0.49	0	0.14	0.05
30	1.39	1.29	1.78	0	0.29	0	0	0
Mean±SE	**0.86±.061**	**1.39±.052**	**1.87±.23**	**0.021±.003**	**0.49±.03**	**0.21±.003**	**0.17±.02**	**0.033±.006**

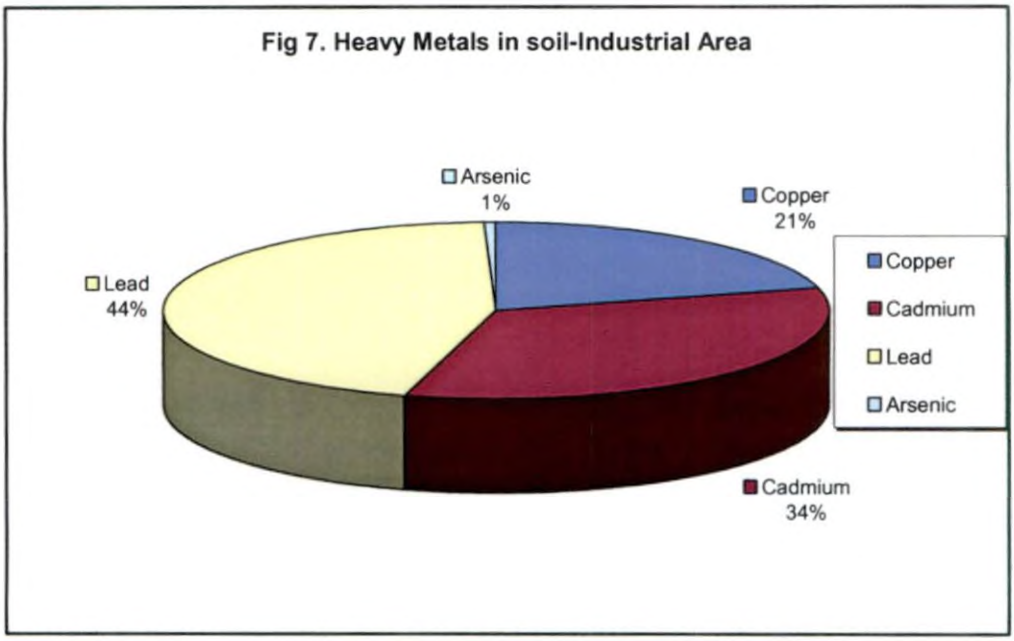


Fig 7. Heavy Metals in soil-Industrial Area
Arsenic
1%
Copper
21%
Lead
44%
Cadmium
34%
Copper
Cadmium
Lead
Arsenic

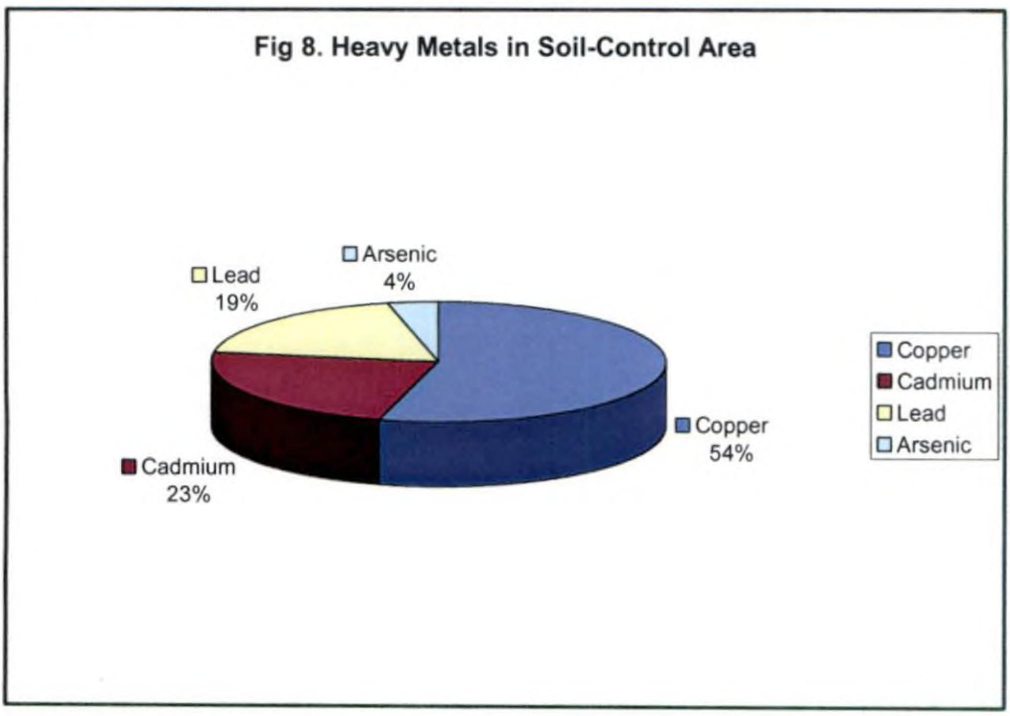


Fig 8. Heavy Metals in Soil-Control Area
Arsenic
4%
Lead
19%
Copper
54%
Cadmium
23%
Copper
Cadmium
Lead
Arsenic

industrial and control area. The permitted level of Cu, Cd, Pb and As given by WHO is 2.0, 0.05, 0.01 and 0.01 mg/kg. The presence of Cd and Pb in the soil of industrial area was more than the control zone and the WHO recommendations.

4.2.3 Fodder

Heavy metal present in fodder samples collected from the industrial area and control area are presented in Table 3 and Fig 9 and 10. The fodder samples collected from the industrial area and control area showed highly significant quantities of Cu, Cd, Pb and As in both zones. The permitted level of Copper, Cd, Pb and As given by WHO is 0.05, 0.05, 0.01 and 0.01 mg/kg. The presence of Cu, Cd and Pb in the fodder of industrial area was more than the control zone and the WHO (1995) recommendations.

4.2.4 Milk

Milk samples collected from the industrial area and control area showed heavy metal presence in it and are given in Table 4 and shown in Fig 11 and 12. The milk samples collected from the industrial area and control area showed highly significant quantities of Cu, Cd and Pb in both zones and a significant level incase of Arsenic. The permitted level of Cu, Cd, Pb and As given by WHO is 0.05, 0.01, 0.02 and 0.05 mg/L. The presence of Cu, Cd and Pb in the milk from industrial area was more than that of milk from the control zone and the WHO (1995) recommendations.

4.2.5 Meat

Heavy metal present in meat samples collected from the industrial area and control area are given in Table 5 and Fig. 13 and 14. The meat samples collected from the industrial area and control area showed highly significant quantities of Cu, Cd and Pb in both study areas and a low level in case of Arsenic. The permitted level of Cu, Cd, Pb and As given by WHO is 0.05, 0.05, 0.1 and 0.05 mg/kg. The presence of Cu, Cd and Pb in the meat from industrial

Table 3 Heavy metals in content Fodder (mg/kg)

Sl. No.	Industrial area				Control area			
	Copper	Cadmium	Lead	Arsenic	Copper	Cadmium	Lead	Arsenic
1	9.83	15.73	7.86	0.04	7.86	5.85	5.96	0
2	7.93	11.89	5.94	0.05	7.93	1.93	5.78	0.02
3	7.94	19.86	9.93	0.03	5.95	3.87	0	0
4	7.92	17.83	13.86	0.04	7.92	0.98	0	0
5	7.92	13.85	13.85	0.05	3.95	0.78	0	0
6	5.95	15.88	11.91	0	5.95	0.98	3.92	0.03
7	0	14	16	0	0	5.76	1.95	0.03
8	7.95	13.92	19.88	0	1.98	1.87	1.87	0.02
9	3.97	15.88	1.38	0.03	1.98	0.81	1.79	0
10	3.85	13.44	1.15	0	1.92	5.36	3.75	0.03
11	5.78	11.56	0.96	0	1.92	5.41	1.96	0.02
12	1.97	11.82	0.98	0.05	5.9	3.92	3.87	0
13	3.92	11.75	0	0	0	0	0	0
14	27.91	9.97	0.59	0.02	1.99	0	0	0
15	1.96	11.78	1.37	0.04	1.95	3.85	0	0
16	1.97	5.93	7.91	0.05	3.76	1.96	1.97	0.01
17	0	11.79	5.89	0.01	0	0	0	0
18	1.97	1.97	11.83	0.03	0	0	0	0
19	43.34	3.94	9.85	0.04	3.97	3.76	1.86	0.02
20	23.71	7.9	7.9	0	0	0	0	0
21	15.77	5.91	9.86	0	5.85	1.67	3.68	0.03
22	13.59	3.88	5.82	0	0	0	0	0
23	9.9	7.92	7.92	0.05	0	1.94	5.69	0.01
24	15.59	3.89	5.84	0.03	7.92	3.75	3.87	0.01
25	11.75	1.95	11.75	0.01	3.76	5.88	7.78	0.01
26	9.71	1.5	3.88	0	0	0	0	0
27	17.58	1.36	13.67	0.05	3.93	7.93	3.96	0.01
28	27.21	1.55	9.71	0.04	5.97	3.58	1.89	0
29	9.92	1.38	9.92	0.01	0	0	0	0
30	13.89	1.38	5.95	0.05	1.78	1.89	3.94	0.01
Mean±SE	**9.93±1.51**	**7.73±1.00**	**7.61±.79**	**0.02±.003**	**3.13±.51**	**2.45±.41**	**2.18±.41**	**0.008±.002**

Fig 9. Heavy Metals in Fodder-Industrial Area

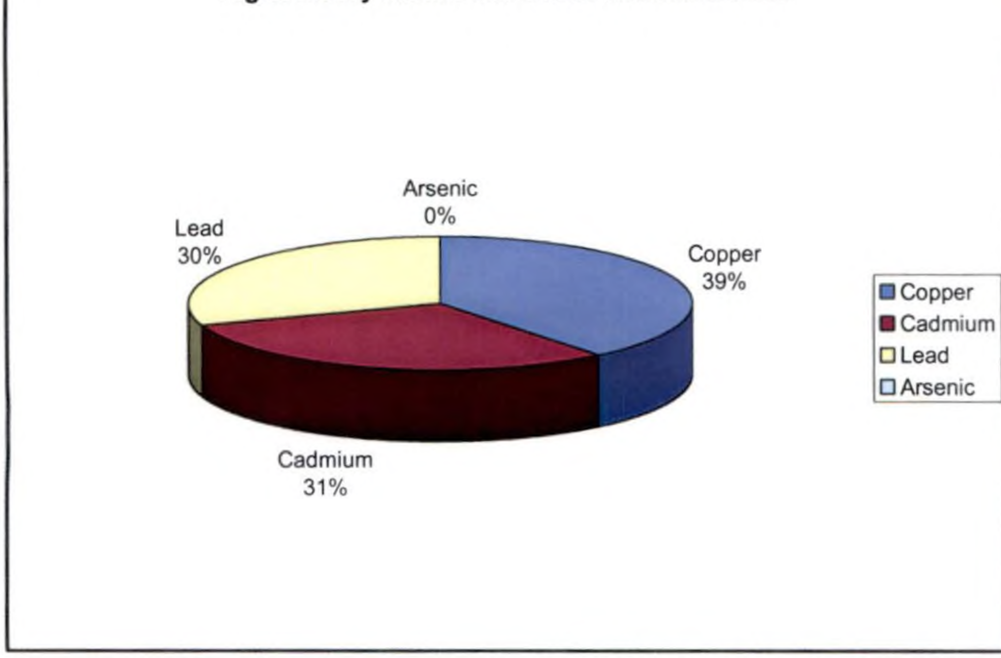


Fig 10. Heavy Metals in Fodder-Control Area

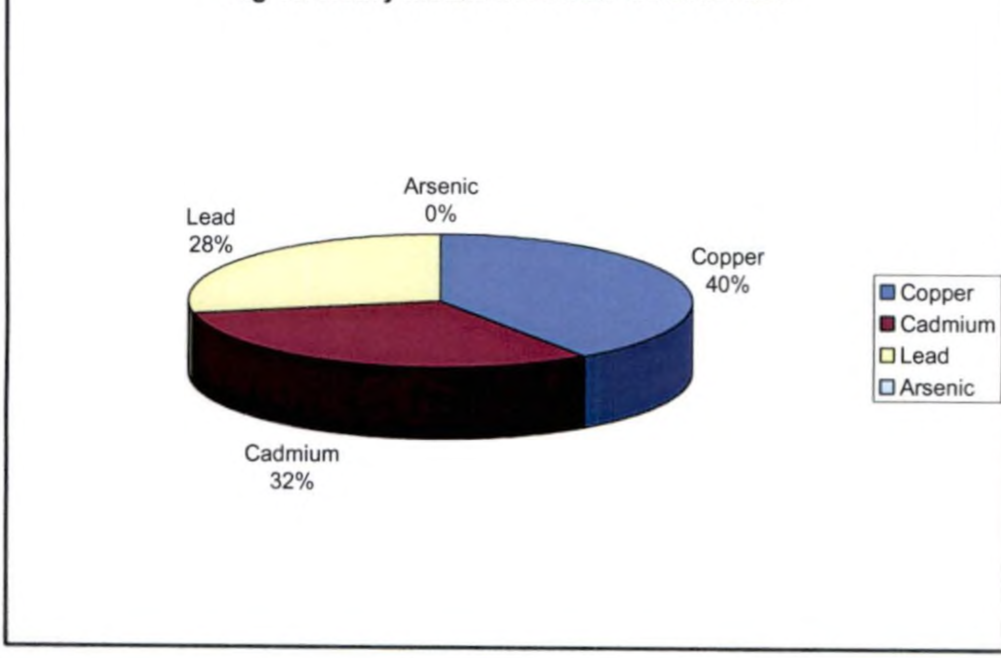


Table 4 Heavy metals content in Milk (mg/L)

Sl. No.	Industrial area				Control area			
	Copper	Cadmium	Lead	Arsenic	Copper	Cadmium	Lead	Arsenic
1	0.4	0.7	2.1	0.04	0.03	0.04	0.03	0.01
2	0.2	1.6	3.06	0	0	0	0	0
3	0.4	0.8	2.62	0.05	0	0	0	0
4	0.3	1.8	1.03	0	0.02	0.03	0.04	0.03
5	0.7	1.8	1.5	0.03	0.04	0.03	0.03	0
6	0.8	1.7	0.9	0	0.03	0.02	0.05	0
7	1.05	1.5	2.5	0.01	0	0	0	0
8	1.2	0.6	2.4	0	0	0	0	0
9	0.5	1.6	0.9	0.05	0.02	0.05	0.03	0.04
10	0.7	1.6	0.9	0.04	0.03	0.03	0.03	0.01
11	0	0.6	0.4	0	0.05	0.04	0.04	0
12	0.5	1.4	0.42	0.02	0	0.02	0	0
13	0.3	1.4	0.83	0	0	0	0	0
14	0.6	1.8	0.81	0.03	0.06	0.04	0.05	0
15	0.4	1.6	0.85	0.02	0.04	0.03	0.07	0
16	0.7	1.7	0.91	0.06	0.07	0.04	0.03	0
17	1.09	1.6	1.16	0.05	0	0	0	0
18	0.8	1.6	2.07	0	0	0	0	0.02
19	0.3	0.7	1.4	0.03	0.1	0.05	0.04	0.03
20	0.4	1.9	0	0	0.09	0.05	0.06	0.01
21	0	1.5	0.75	0.03	0.07	0.02	0.03	0
22	0.5	1.2	1.2	0	0	0	0	0
23	0.7	1.03	1.53	0.05	0	0	0	0
24	1.4	1.2	0.92	0	0.05	0.03	0.05	0.03
25	0.3	0.9	1.36	0	0	0	0.03	0
26	0.5	0.8	0.7	0	0	0	0	0
27	0.8	1.07	0.96	0.04	0.04	0.01	0.05	0
28	0.9	1.82	2.3	0.05	0.03	0.03	0.06	0.05
29	0.6	1.4	1.8	0	0.06	0.02	0.04	0
30	0.4	1.1	1.5	0	0.05	0.02	0.03	0
Mean±SE	**0.58±.06**	**1.33±.07**	**1.32±.13**	**0.02±.003**	**0.02±.005**	**0.02±.003**	**0.02±.004**	**0.007±.002**

Fig 11. Heavy Metals in Milk-Industrial Area

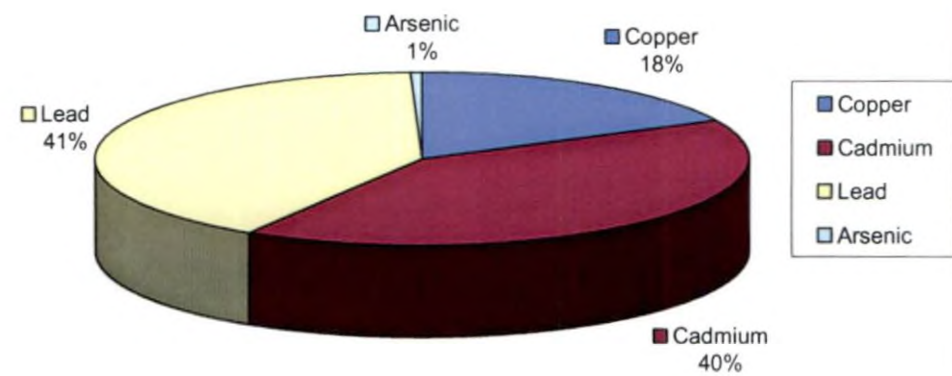


Fig 12. Heavy Metals in Milk- Control Area

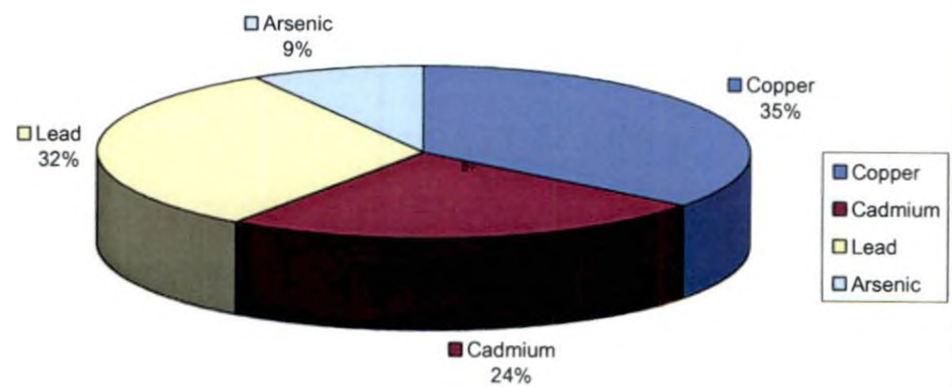


Table 5 Heavy metals content in Meat (mg/kg)

SI. No.	Industrial area				Control area			
	Copper	Cadmium	Lead	Arsenic	Copper	Cadmium	Lead	Arsenic
1	0.02	0.06	0.05	0	0.03	0.01	0.01	0
2	0.04	0.07	0.04	0	0.05	0.02	0.03	0
3	0.07	0.06	0.05	0	0.04	0.02	0.05	0
4	0.05	0.08	0.03	0.05	0.05	0.04	0.03	0
5	0.08	0.12	0.05	0	0.04	0.03	0.03	0
6	0.06	0.09	0.07	0	0.03	0	0	0
7	0.07	0.12	0.02	0	0.06	0	0	0
8	0.03	0.1	0.04	0	0	0	0	0
9	0.05	0.08	0.06	0.06	0	0	0.01	0
10	0.06	0.1	0.1	0.05	0.03	0.03	0.05	0
11	0.06	0.07	0.05	0	0.04	0.05	0.01	0
12	0.05	0.07	0.09	0	0.07	0.02	0.04	0
13	0.04	0.09	0.11	0.01	0	0	0	0
14	0.07	0.07	0.07	0	0	0	0	0
15	0.08	0.12	0.08	0	0.06	0.03	0.03	0
16	0.01	0.06	0.11	0.04	0.03	0.02	0.03	0
17	0.12	0.07	0	0	0.04	0.04	0.04	0
18	0.09	0.07	0	0.05	0.03	0.05	0.02	0
19	0.11	0.03	0.08	0.02	0.06	0.02	0.05	0
20	0.13	0.12	0.07	0	0.05	0.03	0.02	0
21	0.07	0.11	0.05	0	0.05	0.04	0.05	0
22	0.1	0.15	0.07	0	0.03	0.02	0.03	0
23	0.12	0.17	0.06	0.5	0.02	0.03	0.04	0
24	0.09	0.19	0.06	0	0.04	0.03	0.02	0
25	0.07	0.21	0	0.07	0	0	0	0
26	0.06	0.13	0	0	0	0	0	0
27	0.08	0.09	0.12	0.03	0.03	0.02	0.03	0
28	0.06	0.06	0.1	0.05	0.04	0.04	0.05	0
29	0.05	0.08	0.07	0.06	0	0	0	0
30	0.11	0.06	0.04	0.05	0.02	0.04	0.04	0
Mean±SE	**0.07±.005**	**0.09±.007**	**0.05±.006**	**0.03±.01**	**0.03±.003**	**0.02±.003**	**0.02±.003**	**0**

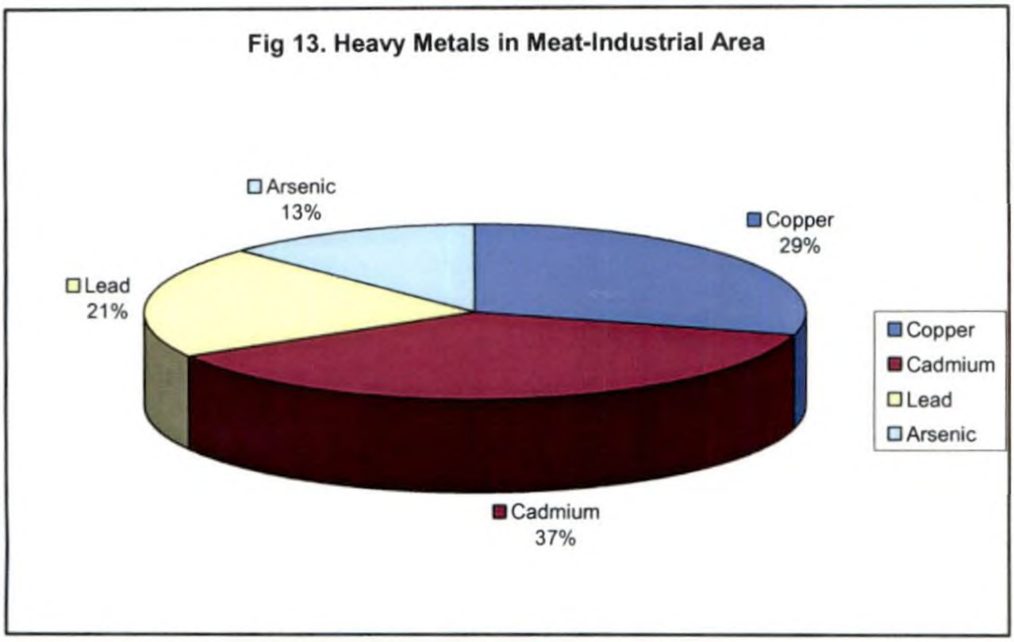


Fig 13. Heavy Metals in Meat-Industrial Area
Arsenic
13%
Copper
29%
Lead
21%
Cadmium
37%
Copper
Cadmium
Lead
Arsenic

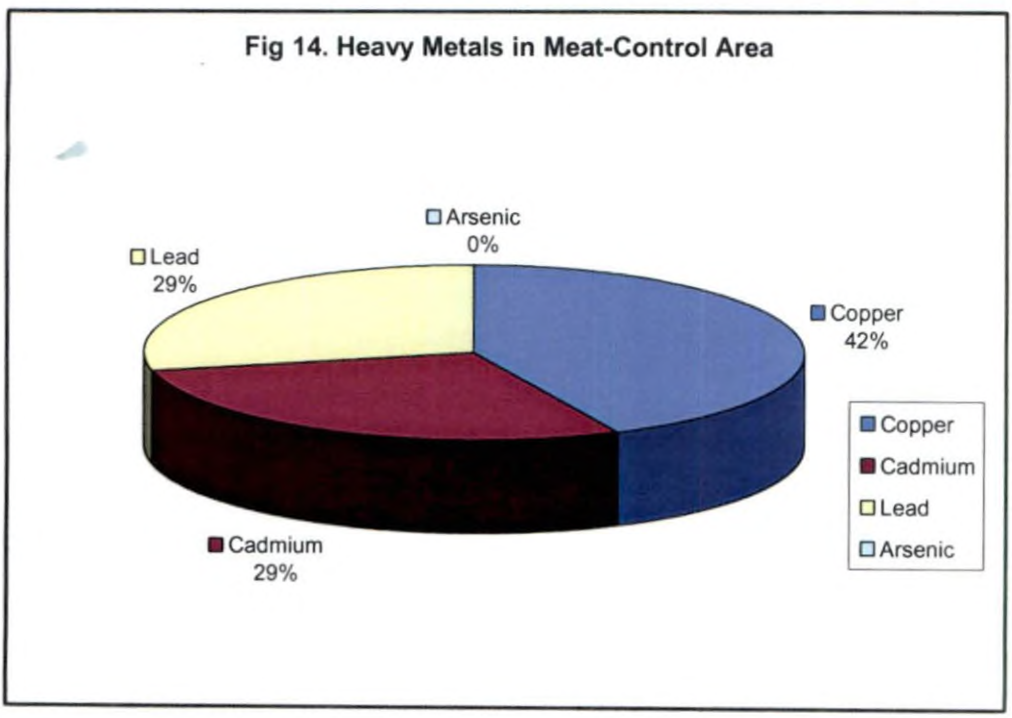


Fig 14. Heavy Metals in Meat-Control Area
Arsenic
0%
Lead
29%
Copper
42%
Cadmium
29%
Copper
Cadmium
Lead
Arsenic

area was more than meat from the control zone and the WHO (1995) recommendations.

4.2.6 Egg

Egg samples collected from the birds in industrial area and control area showed presence of heavy metals. They are depicted in Table 6 and Fig 15 and 16. The egg samples collected from the industrial area and control area showed highly significant quantities of Cu, Cd and Pb in both study areas and traces of As. The permitted level of Cu, Cd, Pb and As (WHO) is 0.05, 0.05, 0.01 and 0.01 mg/kg. The presence of Cu, Cd and Pb in the egg samples of industrial area was more than that of control zone and the WHO recommendations.

4.2.7 Blood

The blood samples collected from the industrial area and control area showed highly significant quantities of Cu, Cd, Pb and As in both zones. Heavy metal present in blood samples collected from the industrial area and control area are given in Table 7 and Fig 17 and 18. The permitted level of Cu, Cd, Pb and As (WHO) is 0.5, 0.05, 0.01 and 0.01 mg/L. The presence of Cu, Cd and Pb in the blood from industrial area was found to be more than that of control zone and the permitted levels as per WHO recommendations.

4.2.8 Dung

Heavy metal present in dung samples collected from the industrial area and control area are given in Table 8 and shown in Fig 19 and 20. Highly significant quantities of Cu, Cd and Pb were detected in both zones. The permitted level of Cu, Cd, Pb and As given by World Health Organization is 0.05, 0.05, 0.01 and 0.01 mg/kg. The presence of Copper, Cadmium and Lead in the dung of industrial area was more than that of control zone and varied from that of WHO recommendations on minimum permitted levels.

Table 6 Heavy metals content in Egg (mg/kg)

SI. No.	Industrial area				Control area			
	Copper	Cadmium	Lead	Arsenic	Copper	Cadmium	Lead	Arsenic
1	0.02	0.15	0.05	0.05	0.02	0.01	0.03	0
2	0.03	0.13	0.06	0.02	0.04	0.03	0.01	0
3	0	0.12	0	0	0.06	0.04	0	0
4	0.05	0.14	0.07	0	0.03	0.02	0	0
5	0	0.14	0	0	0.04	0	0	0
6	0.07	0.12	0.04	0	0.03	0	0	0
7	0.03	0.13	0.04	0	0.05	0	0	0
8	0	0.15	0	0	0	0	0	0
9	0.07	0.16	0.06	0.05	0.06	0.02	0.02	0
10	0.02	0.13	0.05	0.04	0.05	0.01	0.03	0
11	0.04	0.16	0.07	0	0.04	0.01	0	0
12	0.03	0.16	0.05	0	0.04	0.03	0	0
13	0	0.12	0	0	0	0	0.03	0
14	0	0.15	0	0	0.05	0	0	0
15	0.08	0.12	0.09	0.05	0.06	0.04	0	0
16	0.02	0.15	0.05	0.02	0	0.03	0.04	0
17	0.03	0.16	0	0	0	0	0	0
18	0.05	0.16	0.07	0.05	0.02	0.02	0	0
19	0.07	0.15	0.03	0.04	0.01	0.01	0.02	0
20	0.03	0.15	0.05	0.05	0.04	0	0.03	0
21	0.07	0.1	0.05	0.06	0.03	0.01	0.02	0
22	0.14	0.12	0	0	0.02	0.02	0	0
23	0.16	0.08	0.03	0.05	0.05	0.01	0	0
24	0.12	0.09	0	0	0	0	0	0
25	0.15	0.06	0	0	0.03	0.02	0.01	0
26	0.09	0.04	0.03	0.02	0	0	0.03	0
27	0.17	0.09	0.06	0	0.05	0.01	0	0
28	0.19	0.12	0.07	0	0.07	0.02	0	0
29	0.22	0.08	0.06	0.03	0.02	0	0	0
30	0.16	0.09	0.04	0	0.06	0.03	0.03	0
Mean±SE	**0.07±.01**	**0.12±.005**	**0.03±.005**	**0.01±.004**	**0.03±.003**	**0.01±.002**	**0.01±.002**	**0**

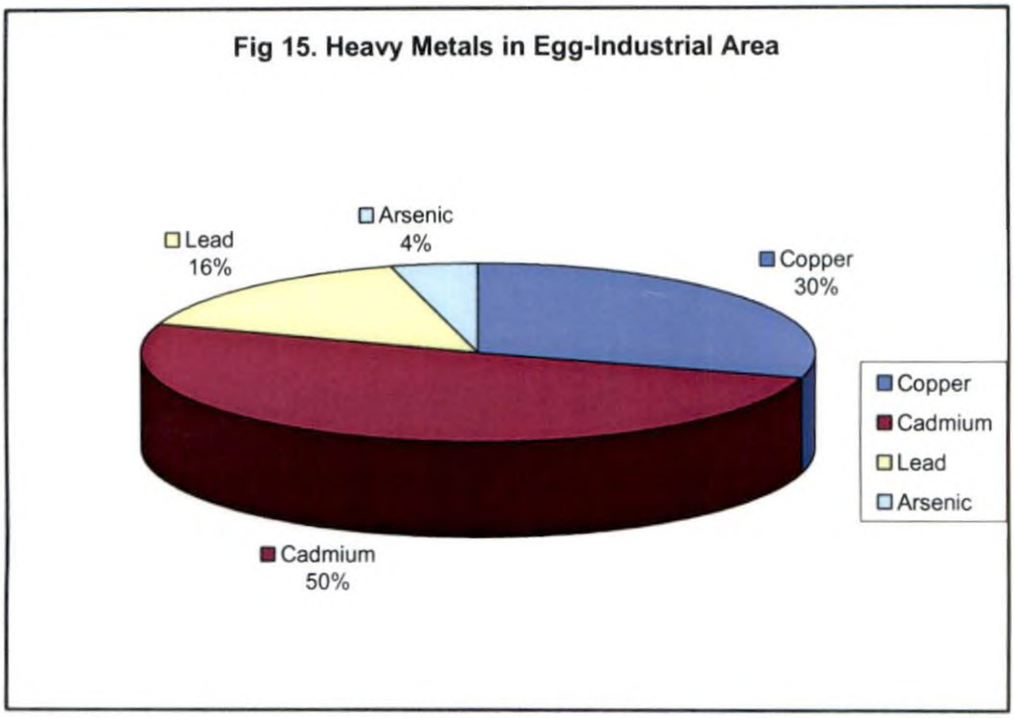


Fig 15. Heavy Metals in Egg-Industrial Area
Arsenic
4%
Lead
16%
Copper
30%
Copper
Cadmium
Lead
Arsenic
Cadmium
50%

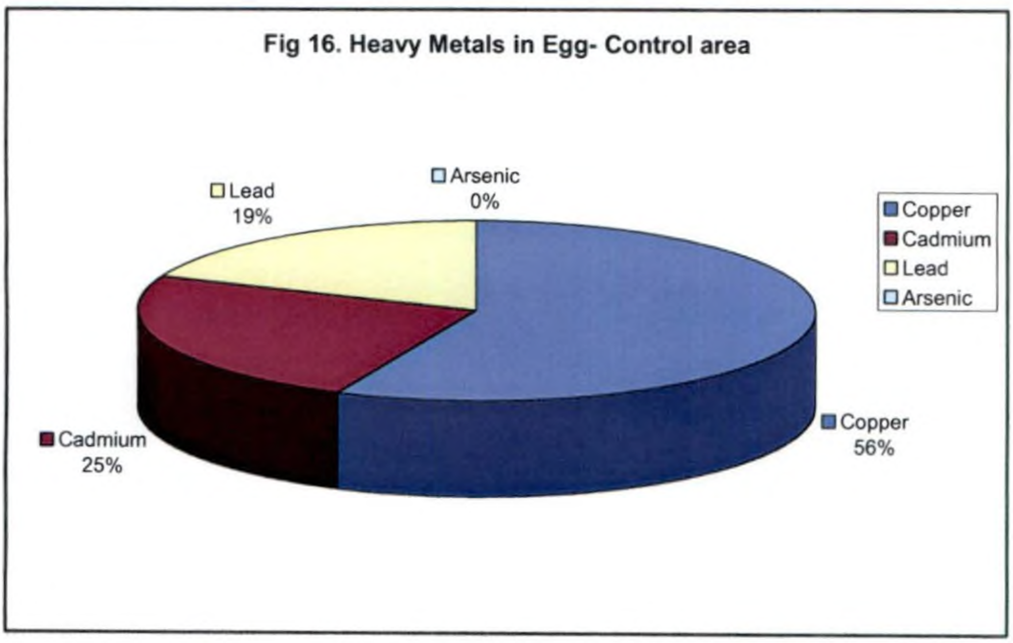


Fig 16. Heavy Metals in Egg- Control area
Lead
19%
Arsenic
0%
Copper
Cadmium
Lead
Arsenic
Cadmium
25%
Copper
56%

Table 7 Heavy metals content in Blood (mg/L)

SI. No.	Industrial area				Control area			
	Copper	Cadmium	Lead	Arsenic	Copper	Cadmium	Lead	Arsenic
1	0.09	0.18	0.15	0.05	0.07	0	0.02	0.01
2	0.17	0.17	0.13	0	0.03	0.01	0.03	0
3	0.16	0.07	0.12	0	0.09	0.01	0.03	0
4	0.21	0.12	0.15	0	0.08	0	0	0
5	0.15	0.15	0.09	0.05	0.1	0.02	0	0.01
6	0.06	0.1	0.03	0	0.12	0.04	0.04	0
7	0.05	0.07	0.07	0	0.03	0.06	0.03	0
8	0.07	0.09	0.05	0.06	0	0.03	0	0
9	0.2	0.13	0.04	0.02	0.01	0	0	0.02
10	0.08	0.11	0.1	0.05	0.03	0.02	0.06	0.01
11	0.09	0.15	0.05	0	0.02	0.02	0.04	0
12	0.19	0.12	0.22	0.08	0.07	0.03	0.03	0
13	0.07	0.1	0.1	0	0.09	0	0	0
14	0.05	0.09	0.07	0.02	0.12	0.02	0.03	0
15	0.24	0.07	0.09	0	0.1	0.03	0.05	0.01
16	0.14	0.03	0.08	0.01	0.08	0.05	0.07	0
17	0.17	0.06	0.06	0	0.01	0	0	0
18	0.16	0.07	0.03	0.05	0.06	0	0	0
19	0.07	0.09	0.19	0.01	0.05	0.01	0.03	0
20	0.09	0.05	0.05	0.03	0.07	0.01	0.03	0
21	0.28	0.07	0.12	0.05	0.13	0	0	0
22	0.15	0.09	0.1	0	0.15	0	0	0.02
23	0.13	0.14	0.15	0.06	0.09	0	0	0
24	0.04	0.07	0.09	0	0.07	0.02	0.05	0
25	0.2	0.05	0.07	0	0.01	0.03	0.06	0.01
26	0.12	0.05	0.08	0	0.02	0	0	0
27	0.1	0.09	0.14	0.05	0.05	0	0	0
28	0.06	0.12	0.18	0.07	0.06	0.03	0.07	0.01
29	0.05	0.1	0.13	0.02	0.08	0.02	0.09	0
30	0.17	0.04	0.09	0.05	0.1	0.02	0.04	0.01
Mean±SE	**0.12±.011**	**0.09±.007**	**0.10±.008**	**0.02±.004**	**0.06±.007**	**0.01±.002**	**0.02±.004**	**0.003±.001**

Fig 17. Heavy Metals in Blood-Industrial Area

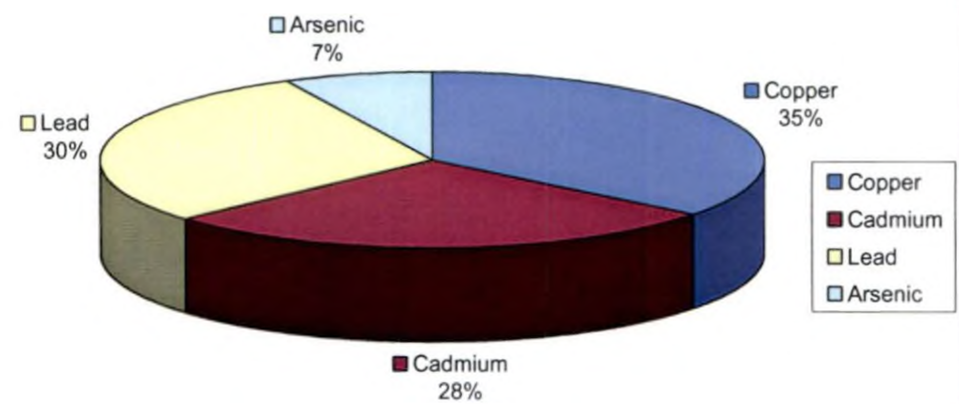


Fig 18. Heavy Metals in Blood-Control Area

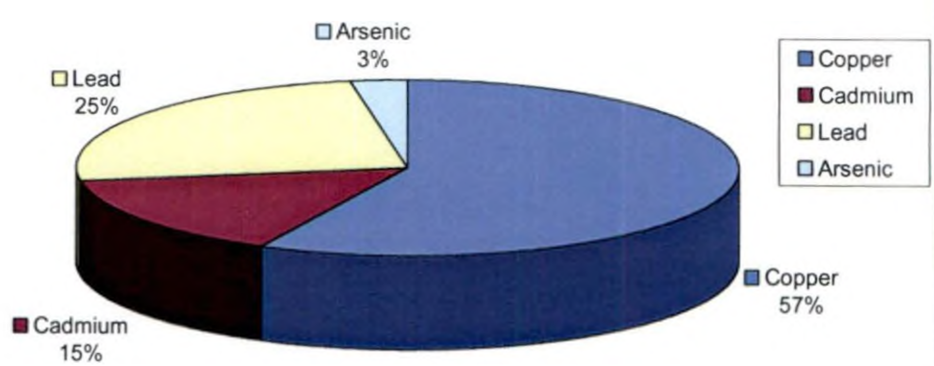


Table 8 Heavy metals content in Dung (mg/kg)

SI. No.	Industrial area				Control area			
	Copper	Cadmium	Lead	Arsenic	Copper	Cadmium	Lead	Arsenic
1	0.32	0.07	0.08	0	0.12	0.02	0.01	0
2	0.36	0.08	0.12	0.05	0.07	0	0	0
3	0.34	0.09	0.24	0	0.09	0	0.03	0
4	0.33	0.09	0.18	0.05	0.05	0	0.03	0
5	0.36	0	0.15	0	0.07	0.01	0.05	0
6	0.11	0.1	0.14	0	0.09	0.03	0.02	0
7	0.09	0.24	0.16	0.01	0.15	0	0.03	0
8	0.09	0.23	0.09	0.03	0.11	0	0	0
9	0.11	0.24	0.06	0.04	0.14	0.01	0	0
10	0.16	0.25	0.05	0.05	0.06	0.01	0.04	0
11	0.08	0.24	0.04	0	0.05	0	0	0
12	0.1	0.22	0.07	0	0.08	0	0.01	0
13	0.07	0.22	0.08	0	0.07	0	0.04	0
14	0.09	0.25	0.12	0	0.16	0	0.03	0
15	0.1	0.24	0.1	0	0.22	0.02	0.03	0
16	0.1	0.24	0.09	0	0.2	0.04	0	0
17	0.08	0.23	0.11	0	0.06	0	0	0
18	0.21	0.25	0.13	0.06	0.12	0	0.05	0
19	0.07	0.2	0.16	0.04	0.15	0.01	0.03	0
20	0.11	0.18	0.09	0.05	0.04	0.03	0.01	0
21	0.16	0.12	0.07	0.05	0.09	0.02	0	0
22	0.24	0.15	0.08	0	0.14	0	0	0
23	0.1	0.1	0.05	0	0.08	0	0	0
24	0.07	0.08	0.07	0.02	0.06	0	0	0
25	0.34	0.09	0.1	0	0.09	0.03	0.02	0
26	0.16	0.11	0.09	0	0	0	0	0
27	0.23	0.12	0.08	0.01	0.09	0.02	0	0
28	0.15	0.14	0.07	0.04	0.12	0.01	0.03	0
29	0.12	0.12	0.09	0.05	0.18	0.03	0	0
30	0.14	0.09	0.06	0.02	0.15	0.02	0.05	0
Mean±SE	**0.16±.01**	**0.15±.01**	**0.10±.008**	**0.01±.004**	**0.10±.009**	**0.01±.002**	**0.01±.003**	**0**

Fig 19. Heavy Metals in Dung-Industrial Area

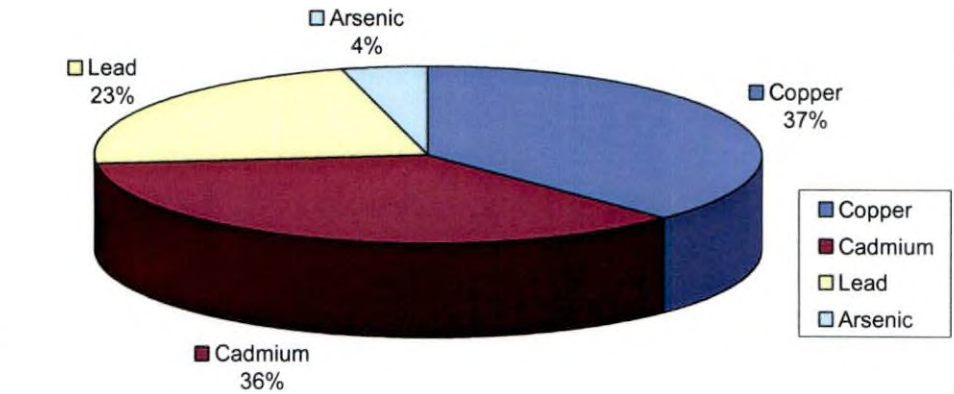
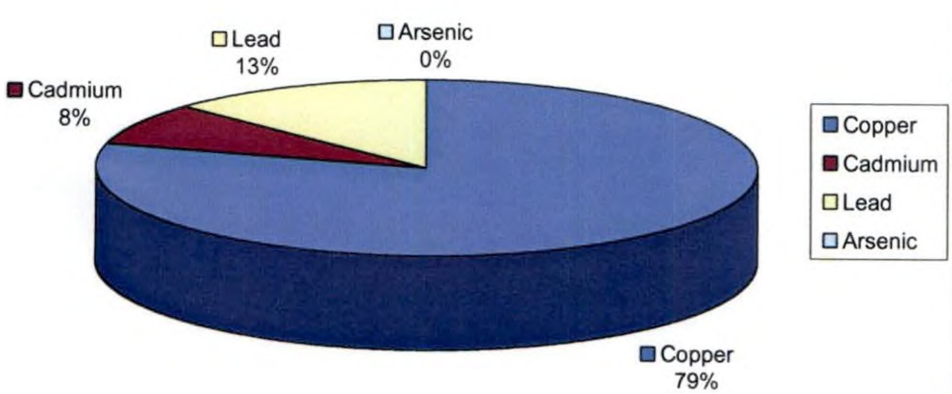


Fig 20. Heavy Metals in Dung-Control Area



4.3 CORRELATION OF FODDER AND BLOOD HEAVY METALS WITH OTHER BIOLOGICAL SAMPLES OF INDUSTRIAL AREA

In correlation tests only Fodder and Blood heavy metals content showed significant and highly significant correlation with heavy metals in biological samples collected from the industrial area (Table 9). Fodder Pb level showed a highly significant correlation ($P<0.01$) with milk Pb content. Fodder Cd and blood Cd were significantly correlated. The dung Pb and fodder Pb were also significant. Fodder As and milk As were significant whereas Blood Cu and milk Cu was highly significant ($P<0.01$). Blood Cu and dung Cu were also found significant ($P<0.05$).

4.4 CORRELATION OF FODDER AND BLOOD HEAVY METALS WITH OTHER BIOLOGICAL SAMPLES OF CONTROL AREA

In the control area, the Fodder and Blood heavy metal content showed correlation with other biological samples (Table 10). Fodder Cu had a significant negative correlation between milk and dung. Blood and fodder Cd was positively correlated. Fodder Pb and milk and dung Pb showed significance. Fodder As and milk As were significantly correlated. In blood the Cu content of milk and dung showed a positive significant correlation.

Table 9 Correlation of fodder heavy metal content to milk, blood and dung heavy metal content – Industrial area

	Copper		Cadmium	Lead			Arsenic
	Milk	Dung	Blood	Milk	Blood	Dung	Milk
Fodder Cu							
Fodder Cd			0.433*				
Fodder Pb				0.501**		0.454*	
Fodder As							0.409*
Blood Cu	-0.472**	0.366*					
Blood As							

* (P<0.01)
** (P<0.05)

Table 10 Correlation of fodder heavy metal content to milk, blood and dung heavy metal content- control area

	Copper		Cadmium	Lead			Arsenic
	Milk	Dung	Blood	Milk	Blood	Dung	Milk
Fodder Cu	-0.431*	-0.364*					
Fodder Cd			0.326*				
Fodder Pb				0.437*		0.364*	
Fodder As							0.358*
Blood Cu	0.359*	0.327*					
Blood As							

* (P<0.01)
** (P<0.05)

DISCUSSION

5. DISCUSSION

5.1 SURVEY ON IMPACT OF INDUSTRIES ON FARMING SYSTEMS

The impact of industries on the livestock farming systems were studied and analyzed in both industrial and control area. The survey showed that there was a decreasing trend in the human and livestock population in the industrial area and an increase in the control area.

Industrial unit's establishment and functioning affects the eco system and livestock farming systems in agrarian hamlets. The present survey on farming system in two areas very clearly emphasizes that development of an industrial belt in a traditional agrarian hamlet influences the livestock farming systems. The present decreasing trend in human and livestock population in the industrial area throws light into the displacement scenario, whereas in the Nallepilly village where the control area is located is purely retained as an agricultural zone and in the past years the area showed an increasing trend in livestock farming system. Similar trends are reported through surveys by many researchers. The present trend agrees with the reports by Varghese (1998) and Nisha (2000).

5.1.1 Socio-Economic Status of the Farmer

Farmer's socio economic status closely link with their age. Middle aged farmers (31-50 years) were into farming than the younger generation in the study areas. The change in the vision, attitude and aptitude of the younger generation is subjected to the wider perspective of development happening in the region and that often affects the vocation they choose and that in turn may redefine the village level socio economic status. This is akin to the findings of Taneja (1998). This type of a socio economic structural change was observed by Kannan (2006) in another farming village of Kerala when a mixed farming system involving pig husbandry was tested.

Majority of the farmers in this survey were found to be involved in full time agriculture and animal husbandry activities in the study area with average monthly income of Rs.2000 in industrial area. These findings agree with that of the above researchers. Plachimada with its tribal ambiance clearly elucidates that as custodians of tradition the middle aged farmers carry on the farming systems. This is similar to a survey result by Oladele (2001) about a Nigerian farming village.

5.1.2. Educational Status

The survey throws light into the fact that literacy rate of the farmers surveyed was comparatively better in the control area than that of the industrial area. The predominance of tribal hamlets in the industrial area may be one reason for this. Similar studies on the educational status of the farmers were recorded by Arunachalam and Thiagarajan (2000) and Kannan (2005) and the present observation is also in concurrence with their findings.

5.1.3. Farm Income

Most of the farmers surveyed had an income of less than Rs 2000 per month in the industrial area. 32 per cent surveyed in industrial belt earned more than Rs. 4000 and it is 28 per cent in Control area. This may clearly state that the income of the residents near an industry increased a little which may be an indirect influence of the advent of an Industry. The income generated through farming by the farmers was higher in the control area than that of the industrial area. The infringement of Industrial culture and opportunity to get works in industry and associated areas may be a reason for the farming community slowly moving away from their traditional livelihood sustenance modalities which in turn reflects on a lower farm income for a major share of farming population.. Similar fluctuation in farming income from agricultural and animal husbandry activities were akin to reports by Varghese (1998) and Arunachalam and Thiagarajan (2000) in Kerala and Tamil Nadu respectively..

5.1.4. Landholding Status

A higher percentage of farmers were possessing land in the control area compared to that of industrial area. The land holding status indirectly denotes the percentage of farmers involved in the farming activities. Conversion of land for industrial development in Plachimada may be one reason for the diminishing farm land holding status. This observation is in tune with that of Rao and Birthal (2005) where they have stated that small scale mixed crop livestock farming is common in India and it is the dominant form of farming system. It is interesting to observe that only farm landholders of one acre and above stayed back after the advent of an Industry and the small farmers were forced to leave the place or abandon farming to turn to other livelihood sustenance modalities.

5.1.5 Crops

Cultivation of crops and plantations were less both in industrial and control area. Conversion of farming lands for other utilities and lesser irrigation facilities may be a reason for the negative shift in the crops and coconut plantation areas in the whole of the study zones. This might have Lead to adoption of small-scale farming and livestock systems here. This is in agreement with the findings of Vaidyanathan (1998) where he has stated that small-scale mixed crop-livestock farming is becoming common and the dominant form of production system in India is with crop residues and byproducts as the major source of feed for livestock. Most of the farmers were involved in mixed agricultural farming in the study area. The present observation that the paddy cultivation in the industrial area has come down may be due to the general trend in the reluctance of farmers to carry on with paddy cultivation and also the irrigation problems they may foresee due to water intensive industry that has come up. More over paddy is also a water intensive crop.

5.1.6. Animals

Majority of the farmers in the control area were having dairy cattle with fodder cultivation. Depending upon the land availability and economic resources the farmers mostly involved in dairy farming. The study revealed that most of the farmers were engaged in agricultural and livestock farming as the main source of income in the control area, which are in agreement as reported, by Arunachalam and Thiagarajan (2000). Great diversity and complexity in the agricultural crops and Livestock species raised was a feature of this traditional agrarian hamlet earlier. This may be for diversifying the sources of income and employment for the resource poor farmers. This observation is in agreement with a similar survey, Chawatama *et al.* (2005) in Zimbabwe where they found that the main motivation of agricultural production in all districts surveyed was for subsistence. The decreasing trend in livestock holding in the industrial belt as evidenced in the present survey may be attributed to shortage of drinking water, reduction in grazing land and also shrinking fodder lands.

5.1.7. Farming Experience

The study revealed that the major source of income was through livestock farming in both industrial and control area. It was found that majority of the farmers had four to eight years of farming experience in both the zones. The number of years the farmers were involved in the farming activity indirectly shows their interest and economic viability in the farming activity. This reveals that Plachimada and Nallepilly were places where farmers traditionally had rich experience in agriculture and livestock farming systems. Varghese (1998) and Singh *et al.* (2005) throws light into similar agrarian attitudes and farming experience in villages both in the state and in the country respectively.

5.1. 8. Farming Status

Semi intensive system was practiced by majority of the farmers. Most of the farmers had few numbers of livestock due to limited land and feed resources and poor economic status of the farmers in industrial area making them to follow the semi intensive system. In control area intensive system was followed mostly by the farmers due to better economic returns and availability of agricultural by-products. These findings corroborate with Arunachalam and Thiagarajan (2000) and Rao and Birthal (2005). Ramrao *et al.* (2005) studied the farming status in Chahattisgarh in central India and published a different finding. The human-land-livestock status is the pivotal point in their study also suggests integration in livestock agriculture farming and hence is not in agreement with the present observations.

5.1.9. Livestock Housing

Animal housing was scientific and according to the advice of the Animal Husbandry officers in control area whereas in industrial area it was lean-to-type/simple type of housing. The type of housing indirectly indicates the economic status of the farmers. Studies on animal shelter reported by Arunachalam and Thiagarajan (2000) are in agreement with the present findings in this view. The climatic changes in the recent years and the fast changing weather profile of Palakkad district in general may also be a reason for the adoption of scientific housing practices for livestock by the farmers. The economical status and the impact of Industry may be the reason for adopting lean- to – type temporary and simple housing for livestock in Industrial area. Sivakumar *et al.* 2006) also opined that the traditional livestock housing is cheaper in a similar survey in Tamil Nadu.

5.1.10 Livestock Feeding

Livestock feeding cost comes to 75 per cent of the total cost and hence controls the livestock production in any area. Concentrate and green fodder feeding was practiced only by about 40 per cent farmers in the industrial area. This lower percentage of concentrate and green fodder feeding may be due to lack of awareness and limited feed resources of the farmers and also due to poor economic status prevailing in the farming community of the industrial area. This is in agreement with Vaidyanathan (1998) and Yadav and Khirwar (2005). But Arunachalam and Thiagarajan (2000) listed out the constraints in feeding that affects the cost of livestock rearing in Tamil Nadu.

5.1.11. Marketing of Products

Milk less than five liters per day from an animal as stated in the present survey was not economical due to high feeding cost and time input in management practices adopted by the local farmers. Economic viability of rearing cattle was better in control area. Major quantity of milk was sold directly and through middleman in the industrial area. The constraints in marketing were fetching lower price for milk given to middleman and to the cooperative society. In control area major portion of milk was marketed through cooperative society only. These findings are in agreement with those of Arunachalam and Thiagarajan (2000) where they state that lack of marketing facilities insufficient price and lack of training opportunity were the salient problems in Tamil Nadu; and FAO (2000) also published data similar to this on livestock products marketing constraints.

5.1.12. Effect of Industrialization on Livestock System

Most of the farmers surveyed stayed within one km distance from the industry. The nearness of the industry to the grazing lands which they presume polluted; may be affecting their livestock. The nearness of the industry to the animal habitation is one of the reasons for a negative shift in agriculture and farming activity.

There are similar studies in other industrial belts the world over. Arnold *et al.* (2002), Ping (2005) in China; found that industrial activities affected livestock. The present survey also reveals such a scenario. In Hyderabad, Piska *et al.* (2005) observed a similar observation in a polluted farming area. They observed that the effluents from an industry affected the ground water and that in turn affected the livestock including fishes. The present survey results also corroborate with the observations of Nisha (2000) about environmental pollution in an industrial area in Kerala and Buddhi *et al.* (2004) in Pithampur area in India.

5.2. EFFECT AND EXTENT OF POLLUTION

5.2.1. Water

Heavy metals Pb and Cd in the drinking water of the industrial area studied were above the permitted WHO (1995) standard values. The higher concentration of heavy metals may be due to the contamination of the area with industrial wastes and discharges from the nearby industries. Similar higher levels of heavy metals above permissible levels in drinking water were also reported in other industrial locations by Dey *et al.* (1997), Muse et al (1999), Kooklue *et al.* (2000), Govil (2001), Lokhande and Sathe (2001), Jananeethi (2002), Gowda *et al.* (2003), Sinha (2004), Gupta *et al.* (2005) and Haque *et al.* (2005). The present observation is agreeable to the above reports.

Prasad and Jaiprakas (1999) evaluated the ground water sources in Dhanbad town and found that the drinking water was not polluted with heavy metals. This is not in agreement with the present finding though both the studies were in industrial areas. In Plachimada area, the location of the present study; the land is paddy land and the seepage of heavy metals from industrial waste may reach the adjoining farmers land easily as the irrigation net work is interlinked with the effluent drainage and seepage also. The area in the present observation is a low lying land and the climate is also having a specialty, like six months of heavy monsoon which may take the pollutants easily to the nearby wells and water sources. But the control area in the present study, had reasonably unpolluted drinking water except for the presence of Cd little above permissible limit. The presence of Cd in control area may be due to the accumulation of the heavy metal in soil due to continuous application of phosphate fertilizers. While most of the heavy metals, except Cu and Zn, are not essential for plant growth or livestock health, through water and soil the heavy metals can enter into the food chain and may affect the vegetation and animals in the surrounding area (Longhurst *et al.*, 2004).

Prasad and Bose (2001) found clean drinking water devoid of heavy metals in a limestone mining area in Himachal Prasdesh. The present study is not in agreement with the above findings. The difference in the soil type, topography and the specialty in the climate of Plachimada region along with the type of industry and type of waste generated may be a reason why the water samples give different results with a higher level of heavy metals near an industry. Pb and Cd level in the water samples of polluted areas was higher as reported by Gowda *et al.* (2003) which is akin to the present analysis.

5.2.2. Soil

The soil samples analysed for the heavy metals showed Cu, Cd, Pb and As. Pb and Cd values are above the permissible limits of WHO standards in industrial area as compared to normal areas. Cu and As in soil are almost within the permissible levels. The higher level of Pb and Cd in soil may be due to contamination by industrial effluents and discharges to the surrounding region by the industries, polluting the nearby areas.

A higher concentration of the heavy metals in soil than normal similar to the present finding is reported by Burhenne *et al.* (1997), Das et al. (1997), Govil (2001), Gowda *et al.* (2003), Mondal et al (2003), Bansal (2004), Garg and Totawat (2005), Anuratha (2006) and Nikhil (2006). In the control area the presence of Cd and Pb are slightly higher than the WHO permitted level. This may be due to the increased application of Phosphatic fertilizers for agricultural purpose. Cadmium applied in super phosphate fertilizer may remain in the soil of cultivated layer. Most of the heavy metals (except Cu and Zn) are not essential for plant growth so plant uptake and even soil contamination was a significant point of entry of heavy metals into the food-chain. But when compared to the industrial area level this is under lower range. This process is detailed in a similar study by Nikhil (2006). They report that uptake of some heavy metals by plant species was on lower side of the limit and as such no disorder was observed in Jharia coal field area in Dhanabad. A very low amount of heavy metals like Pb, Cd and Ni were observed in deeper surface of the soil than surface soil indicating low mobility of these metals down the profile. This may be due to nature of organic matter and clay which restrict their movement to the lower depths (Garg and Totawat, 2005). So in the present observation it may be concluded that the slightly higher level of heavy metals in the soil of the control area may be due to the unutilized heavy metals from Phosphatic fertilizers that may leach into the soil .But in the industrial area though there is lesser usage of fertilizer due to lesser agricultural operations the heavy metal content in the soil samples collected were high and it may be reaching the upper soil strata from pollutants.

5.2.3. Fodder

The fodder samples were analysed both in industrial and control areas for Cu, Cd, Pb and As content. Arsenic level is almost within permitted levels. The Cu, Cd and Pb concentration in the industrial area are higher than the permissible limits recommended by WHO limits. The higher content of heavy metals in fodder indicates that the water and soil sources are contaminated by the industrial effluents in the industrial area. Similar higher levels of the heavy metals in fodder were detected by Swarup *et al.* (1993), Dey *et al.* (1997), Gowda *et al.* (2003), Rozso *et al.* (2003), Bansal (2004), Ping (2005), Somasundarum *et al.* (2005) and Raj *et al.* (2006) near industrial belts and the present study is in agreement with all these research reports. Continuous uptake of lead and cadmium through contaminated water and vegetation leads to cumulative toxicity and impaired micronutrient utilization (McDowell, 1992). Several cases of outbreak and death in animals due to consumption of contaminated fodder with heavy metals had been reported (Sidhu *et al.*, 1994) in industrial areas. Dey *et al.* (1997) reported that the mineral concentration in forage depends on type of fodder, season and soil mineral concentrations. They have also noted influence of factory effluent on low copper profile in pasture grass and subsequently in animals. Hence in the present study also like the above report, the possibility of heavy metals entering the animal systems through drinking water and fodder is a likely possibility. Fodder acts as a source of heavy metals accumulated in both the study places. This may be due to the chemical intensive agricultural practices in the study area but in the industrial area studied there is a higher content of heavy metals in fodder which may be due to pollution by industrial wastes and effluents from the factories polluting water, soil and vegetation of the surrounding areas.

5.2.4. Milk

The heavy metal content in milk in industrial area is comparatively higher than the control area. The Cu, Cd and Pb are at higher concentration than the WHO prescribed limits. This may be due to the contaminated feed and fodder materials and by water that had been consumed by the livestock. The animals let loose for grazing may get exposed to contaminated grass/fodder near the industrial area. In the control area a lower level of all the heavy metals were recorded when compared with permissible limits of WHO; suggesting that there may be least contamination in this agrarian zone by industrial pollutants.

Higher concentration of the heavy metals in milk of cattle and buffaloes in industrial areas had been reported by many researchers (Dey *et al.,* 1997, Dwivedi *et al.,* 1997, Swarup *et al.,* 1997, Simsek *et al.,* 2000, Gowda *et al.,* 2003, Somasundarum *et al.,* 2005 and Raj *et al.,* 2006). These reports are akin to the present findings. The mean Cd concentration in milk recorded in different industrial localities was significantly higher than that of industry free locality. The milk Cd levels from animals of textile and metallurgy based industrial localities were almost double than that of industry free rural localities. Higher concentration of heavy metals in milk of animals from industrial area appears to be due to greater ingestion of contaminated feed and water and inhalation of fumes and dusts emanated from the industrial activities (Dwivedi *et al.,* 1997).

The Pb and Cd concentration in milk of cows were significantly higher in urban localities than those of rural area. The results found by Swarup *et al.* (1997) indicated that animal population kept in urban areas which were exposed to toxic heavy metals such as Pb and Cd may carry higher concentration of these heavy metals in milk and blood. Comparatively higher level of Pb (0.47 ± 0.06 ppm) and Cd (0.05 ± 0.01 ppm) in milk samples of animals in a similar study by Gowda *et al.* (2003) is indicative of consumption of the toxic elements in higher proportion in the industrial area than the control zone. Most of the heavy metals in milk sample in another study showed increasing trend from 10^{th} day of the experiment (Somasundaram *et al.,* 2005). The concentrations of the heavy metals are higher than the maximum permissible limit in the industrial region. The higher metal accumulation in dairy cattle was related not only to higher dietary intake, but also due to the higher hepatic metabolism associated with milk production (Alonso *et al.,* 2003).

In the present analysis a higher concentration of heavy metals in milk of cattle in the industrial area was observed which may be due to ingestion of contaminated fodder from the grazing area and contaminated drinking water which is in agreement with all the previous reports. Milk and milk products represent an important part of children's diet, utmost care should be taken to ensure that the milk is not contaminated with toxic metals throughout production and supply chains since there may be a possibility of transmittance of heavy metals into human food chain through milk produced in industrial areas (Unnikrishnan *et al.,* 2005).

5.2.5. Meat

The heavy metals Cu and Cd observed in industrial area are above the permissible limits of WHO standards whereas arsenic is almost within the normal limits. The higher level of these metals in meat denotes that the feed or fodder may be contaminated by the heavy metals due to the industrial pollution. During the metabolism of the heavy metals some quantity may get deposited in the internal organs, bones and in the meat of the animals in the industrial area.

Similar higher levels of heavy metals like Pb, Cd and As in meat and organs of animals were reported by Strauch (1983), Gracey *et al.* (1984), Sidhu *et al.* (1994), Gould *et al.* (2002), Ulrich *et al.* (2002), Drozd *et al.* (2003), Alonso *et al.* (2003), Bianu and Nica (2005), Lemos *et al.* (2005), Miranda *et al.* (2005), Skalicka *et al.* (2005) and Venalainen *et al.* (2005).

It was found that in the present observations, concentration of some heavy metals in meat were little higher than the maximum permissible limits of WHO in the industrial region. This may be due to contamination of the soil, pasture and feed from industrial pollution. Animals generally get access to toxic metals through soil, water and forages contaminated by industrial effluents. These toxic metals are absorbed into the animal system and they are slowly eliminated through excretion, or deposited in the target organs. (Gowda *et al.*, 2003). Lead toxicities in bovines due to industrial pollution in Punjab were reported by Sidhu *et al.* (1994). They recorded lead concentration in liver (27.3 to 97.4 ppm), kidney (97.4 to 170.5 ppm) and in bone (10.0 to 19.5 ppm). Lead level of about 10 ppm in liver and 25 ppm in kidney were considered as an index to diagnose Lead toxicity. The concentrations were higher than the permissible limits indicating lead toxicity in buffaloes present in the industrial region.

Lemos *et al.* (2005) found a higher concentration of Pb in liver (39 to 431 ppm) and in kidney (245 ppm) of cows The Pb poisoning in cattle was due to grazing pasture contaminated by industrial waste. The source of Pb was fumes from a car battery recycling plant which had a failure in its filtering system. The present study also is in tune with this finding.

Higher level of Cu in the muscle and liver of cows near a metallurgical plant in Slovakia was recorded by Skalicka *et al.* (2005). The higher Cu concentrations cows were due to contamination of pasture with industrial sources of pollution.

In a study in Morocco, Bovines were found to be seriously affected by toxic metals, especially Cadmium. The mean concentration of Zn, Cu and Cd was 126, 112 and 5.1 µg/g in liver and 89.33, 57.23 and 10.3 µg/g in kidney respectively. The levels were higher in liver and kidney, specific target organs for metal bioaccumulation. The high Cd content seemed to contribute to a reduction in Zn and Cu levels (Sedki *et al.*, 2004). Similar higher concentration of heavy metals recorded in earlier studies confirm with the present findings in the industrial area of Palakkad.

The heavy metals level was less than the permissible limits in the control area. Similar to the present results lesser concentration of heavy metals in meat and organs than the permissible level was reported by Das *et al.* (2003) and Hristov *et al.* (2003). Presence of lead and cadmium in internal organs of Pigs from different regions in Bulgaria was investigated. (Hristov *et al.*, 2003) Differences were found in the contamination of internal organs (liver and kidney), in relation to the industrial pollution of the region.

5.2.6. Egg

The heavy metal cadmium was above the permissible limits of WHO standards whereas lead and copper were almost near the normal limits in the present observation. The higher level of Cd in egg might be due to the contamination of soil and insects and other eats of poultry fròm the industrial location and the birds reared in the industrial area have easy access to the contaminated sources of water, soil and feed. The heavy metals (except Cadmium) content in egg were within the permissible limits of WHO standards in industrial area and that is in agreement with the reports by Dey and Dwivedi (2000).

The egg, a major source of protein in the diet of the Indian population may influence the health status also. Per capita egg consumption has increased significantly in India during the past few years. Most Indian children consume one egg per day and the presence of toxic metals in their food is capable of producing subtle health hazards. It is concluded that eggs can be a contributing factor for higher Pb and Cd body burdens in the Indian population Dey and Dwivedi (2000). The heavy metal concentration in the control area was within the normal permissible limits. Another study on broiler breeder hens was used to determine the effect of drinking water containing a low concentration of chemical mixture (As, Cd, Pb, Benzene and Trichloroethylene) and high levels of the chemical mixture in the poultry health. These chemicals were present in ground water near a hazardous waste site (Vodela *et al.,* 1997). There was a linear relationship between increasing concentration of the chemical mixture in drinking water and decreasing body weight of hens. The low concentration of the chemical mixture significantly decreased egg production and egg weight, and increased percentage of embryonic mortality. These results suggest that reproductive function in hens is sensitive to adverse effects of contaminated drinking water.

5.2.7 Blood

The level of Cu, Cd, Pb and As in blood from livestock of the industrial area, was comparatively higher than the control area. Cu and As were within normal limits. Pb and Cd were at higher level than WHO prescribed limits. The higher level of these heavy metals in blood of cattle in industrial area might have come into play through contaminated fodder, water and an indirect influence of contaminated soil. Similar higher concentration of these heavy metals in blood of animals were detected by Kwatra et al. (1986), Sidhu *et al.* (1994), Dey *et al.* (1996, 1997), Swarup *et al.* (1997), Patra *et al.* (2001), Mondal et al (2003), Gowda *et al.* (2003), Bianu (2005), Somasundaram *et al.* (2005) and Raj *et al.* (2006) which are inline with the present findings. The mineral concentration in blood of buffaloes was measured around a fertilizer factory in Uttar Pradesh. The blood Cu, Pb and Cd levels ranged between 0.24 and 1.0ppm, 0.19 and 0.59 ppm, 0.010 and 0.016 ppm respectively (Dey *et al.*, 1997). These values were lower than the normal values (except Pb) and were comparable with the values of healthy animals. The higher Pb level in blood indicates pollution of surrounding area by chemicals and factory effluents in the industrial area. The trace minerals in blood of young calves during exposure to Pb were studied by Patra *et al.*, (2001). The blood Pb concentrations on day seven onwards were significantly higher than that of day zero value and also, the corresponding values of control group. Serial estimation of Pb concentration revealed many fold increases in blood Pb burden during the first week of exposure followed by gradual increase. There was a gradual decrease in Cu concentration up to day 14 and the levels recorded on day 14 and 21 were significantly lower than that of control animals.

Gowda *et al.* (2003) reported higher Pb (0.09 ± 0.03 ppm) and Cd (0.06 ± 0.01ppm) content in blood samples of cattle in industrial area of Bangalore. The higher level of heavy metals indicated consumption of toxic elements in higher proportion due to the wastes and effluents from the industrial area. Similarly the present findings of higher level of heavy metals in blood samples of livestock from industrial area confirm with the studies reported above, whereas the heavy metal content was well within the permissible limits in the control area.

5.2.8. Dung

The content of Cu, Pb and Cd in dung of livestock from industrial area was higher than that from the dung from the control area and was above the maximum permissible limits in the present study. The level of Arsenic is almost within the normal limits. The higher content of these heavy metals in dung indicates that livestock in the industrial area might have consumed the feed/fodder materials grown locally and consumed water from the locality. These along with the exposed soil sources might have contributed to the presence of the heavy metals in the dung samples. A higher concentration of heavy metals in dung similar to the present observation is reported by Sidhu *et al.,* (1994), Gowda *et al.* (2003), Long *et al.* (2004) and Mor (2005).

Sidhu *et al.* (1994) observed that dung had higher heavy metal content due to the fodder contaminated by the factories present in close proximity in the industrial region. Higher heavy metals (Pb and Cd) content in manure of cattle from the industrial region indicated that cattle were exposed to different degrees of environmental pollution and due to consumption of feeds grown in the industrial region. This is in agreement with the present finding.

Mor (2005) reported a high Cd and Pb level in cattle manure from a region with heavy traffic, followed by industrial region and the rural region. This indicated that the cattle maintained in the industrial area was more affected than rural area suggestive of industrial pollution contaminating water, soil and vegetation of the surrounding area which is in agreement with the present findings in industrial area .The heavy metals content in the manure of cattle living in the control area was within the permissible limits indicating a non-polluted environment.

5.3 CORRELATION OF FODDER AND BLOOD HEAVY METALS WITH OTHER BIOLOGICAL SAMPLES OF INDUSTRIAL AREA

Fodder Pb level showed highly significant correlations with milk Pb level, whereas fodder As and milk As and fodder Cd and milk Cd were significantly correlated. This denotes that an increase in fodder Pb, Cd and As levels might have resulted in a corresponding higher concentration of Pb, Cd and As in milk. This finding is in congruence with the results obtained by Sidhu *et al.* (1994) Dwivedi *et al.* (1997), Yadav and Khirwar (1999) and Gowda *et al.* (2003). The higher level of heavy metals in milk of animals may be due to ingestion of contaminated feed and water from the industrial area.

The fodder Cd and blood Cd levels were significantly correlated in the present study emphasizing that if fodder Cd were at higher level, then there was a corresponding increase of Cd in blood level of the animal consuming polluted feed/fodder and water. These findings corroborates with earlier reports of Sidhu *et al.* (1994) Dey *et al.* (1997), Patra *et al.* (2001), Das *et al.* (2002) and Somasundarum *et al.* (2005). Correlation occurs between fodder lead and dung lead in the present observation. This may be due to ingested feed and fodders contaminated with lead were getting excreted through the dung. The present findings are in agreement with Gowda *et al.* (2003) and Mor (2005). An increased level of copper in the blood and corresponding higher concentration in milk indicated ingestion of contaminated fodder and water by the animals from the industrial area. Similar observations were reported by Swarup *et al.* (1997), Swarup *et al.* (2005b) and Raj *et al.* (2006).

There was a higher concentration of Cu in the dung as and when there was an increase in the blood Cu level. This is in agreement with earlier reports of Sidhu *et al.* (1994) and Gowda *et al.* (2003). A higher Cu concentration in dung may be an indication that the level of Cu required is sufficient for body functions and the excess amount is excreted through dung.

5.4 CORRELATION OF FODDER AND BLOOD HEAVY METALS WITH OTHER BIOLOGICAL SAMPLES OF CONTROL AREA

Correlation of fodder and blood heavy metals with other biological samples was recorded in the control area also. There was a lesser concentration of Cu in milk and dung even there was a higher level of Cu in the fodder. This may be due to the utilization of copper for the physiological functions and other metabolic activities of the body. Similar studies had been reported earlier by Dey *et al.* (1996), Dwivedi *et al.* (1997) and Gowda *et al.* (2003).

The fodder and blood Cd was positively correlated in the present study. Similarly correlation between fodder lead with milk and dung were also significant. Fodder arsenic and milk arsenic were significantly correlated. This indicates that there was an increase in the concentration of blood Cd and in the milk; and dung lead level, when ever there was a higher level of these heavy metals in the fodder. These findings are in agreement with the findings of Dey *et al.* (1997), Patra *et al.* (2001) and Somasundarum *et al.* (2005). Copper content of milk and dung showed a positive significant correlation with that of blood. Similar observations were published by Sidhu *et al.* (1994), Swarup *et al.* (1997), Gowda *et al.* (2003), Swarup *et al.* (2005b) and Raj *et al.* (2006).

SUMMARY

6. SUMMARY

Industrial pollution threatening animal and the human health and quality of the environment is a major problem in India. Industrial effluents and waste, chemicals of industries contaminate the water, soil and surrounding vegetation and prove toxic to animals and human beings living in such areas.

The present study explored the impact of industrialization in village level livestock and poultry production and evaluated the level of toxic heavy metals in surrounding soil, water, forages and in biological samples from industrial area of Plachimada and in control area of Nallepilly. Based on the observation and scientific validations, changes in livestock farming system and methodologies to alleviate the extent of pollution were sorted out.

This study was conducted in Plachimada village in Perumatty Panchayat-industrial area- and Nallepilly village - control area- in Nallepilly Panchayat in Chittoor Taluk in Palakkad district. Survey of the existing Livestock husbandry systems was done in the selected study area using a schedule and the livestock population, husbandry systems, practices adopted and the amplitude of the industrialization in livestock production was assessed and analyzed. The satellite picture of the industrialized area was used for locating and identifying the water sources and collection of water samples. Collection of field samples of soil, fodder and water were done and examined for the presence of heavy metals. Similarly collection of biological samples milk, meat, egg, blood and dung from the livestock were taken both from industrial and control area and assessed for the heavy metals content. All the samples collected from the study area were scientifically analyzed and identified for the presence of heavy metals lead, cadmium, arsenic and copper by using Atomic Absorption Spectrophotometer.

A detailed survey was done among fifty farmers from the Plachimada (industrial area) and Nallepilly (control area) villages respectively. The farmers were interviewed with a schedule and the data was obtained. The socio-economic status of the farmers revealed that the middle aged persons were more involved in the agricultural and animal husbandry activities in the study area. The literacy rate was comparatively better in the control area than that of the industrial area. Most of the farmers had an average monthly income per family of Rs. 2000 in the study area. Survey showed that a higher percentage of farmers owned land in the control area compared to that of industrial area. Cultivation of crops and plantations were less in both industrial and control area. The study revealed that majority of the farmers possessed dairy cattle with major source of income from livestock farming in both zones. Survey indicated that semi-intensive system was practiced by majority of the farmers with simple type of housing. The feeding practices adopted by the farmers in the control area were comparatively better than industrial area which may be due to more land availability. Economic viability of rearing cattle was better in control area. Most of the farmers surveyed stayed very near to the industry in the industrial zone. The study revealed that nearness of the industry to the grazing lands may be affecting the livestock. Due to the close proximity of the industry to the farmers habitations, majority of the farmers desired a change in the existing systems. This may be due to the pollution, reduced land availability, shrinking fodder resources and poor economic viability of farming in the industrial area.

The heavy metals Cd (0.06±0.002) and Pb (0.17±0.005) in the drinking water of the industrial area was above the permissible limits laid down by WHO (1995). Cu (0.24±0.06) and As (0.02±0.004) in water were within the standards in the industrial area. In the control area all the heavy metals except Cd (0.02±0.003) in water were within the permissible level.

The heavy metals Cd (1.39±0.05) and Pb (1.87±0.23) in the soil of the industrial area was above the permissible limits of WHO (1995) whereas Cu (0.86±0.06) and As (0.02±0.003) in soil were within the standards in the industrial area. In the control area the heavy metals Cd (0.21±0.003) and Pb (0.17±0.02) in soil content were higher than the WHO permissible standards.

The Cu (9.93±1.51 and 3.13±0.51), Cd (7.73±1.00 and 2.45±0.41) and Pb (7.61±0.79 and 2.18±0.41) level in fodder samples were above the permissible limits of WHO (1995) in both industrial and control areas whereas arsenic content was present within permissible levels in both zones.

The milk samples of industrial area recorded a higher concentration of Cu (0.58±0.06), Cd (1.33±0.07) and Pb (1.32±0.13) than the WHO (1995) prescribed standards. All the heavy metals in milk were less than the permissible limits in the control area.

The heavy metals Cu (0.07±0.005) and Cd (0.09±0.007) in meat samples observed in industrial area were above the permissible limits of WHO standards whereas As (0.03±0.01) is within the normal limits. All the heavy metals in meat were less than the prescribed levels in the control area.

Cd (0.12±0.005) was higher and above the WHO prescribed limits whereas Pb (0.03±0.005) and Cu (0.07±0.01) were slightly above the normal standards in egg samples of industrial area. All the heavy metals in egg samples were within the prescribed limits in the control area.

The level of Cd (0.09±0.007) and Pb (0.10±0.008) in blood samples from livestock of industrial area was comparatively higher than WHO standards and the control area. Cu (0.12±0.01) and As (0.02±0.004) were within the prescribed limits.

In the control area all the heavy metals in blood samples were within the prescribed standards.

The content of Cu (0.16±0.01), Cd (0.15±0.01) and Pb (0.10±0.008) in dung of livestock from the industrial area was higher than the control area and was above the maximum permissible limits. As (0.01±0.004) level was within the normal limits. All the heavy metals except Cu (0.10±0.009) in dung were within the permissible limits in the control area indicating a non-polluted environment.

This study aimed also to find out the relationship between water, soil, plant and animal system. Correlation of fodder and blood heavy metals with other biological samples was done in industrial area. Fodder Pb showed a highly significant correlation with milk Pb content. Correlation between fodder As and milk As concentration was also significant. Correlation between fodder Cd with blood Cd was significant. Correlation was observed between fodder Pb with dung Pb values. A negative correlation was recorded between milk Cu with blood Cu which was highly significant. Correlation existed between blood Cu with dung Cu at a significant level.

Similarly correlation of fodder and blood heavy metals with other biological samples was done in control area also. Fodder Cu had a significant negative correlation between milk and dung Cu values. Blood and fodder Cd was significant and positively correlated. Correlation of fodder Pb with milk and dung Pb were significant. Fodder As and milk As were significantly correlated. In blood the Cu content of milk and dung showed a positive significant correlation.

The severity of health impact of pollution depends on kind of pollution and pollutants, presence of interacting chemicals, extent of route of exposure, and species, age, physiology and nutrition of the exposed population. So prolonged exposure to chemical pollutants such as heavy metals, pesticides, fluorides etc released from the industries are capable of inducing non-specific and sub-clinical effects in animals.

Bioaccumulation of toxic heavy metals, especially lead, cadmium and arsenic in milk, meat and in poultry products have evoked great concern during the recent years. Several studies revealed higher levels of heavy metals in milk, eggs and other tissues of animals living in the industrial area. From the present study it was found that the industrial area had contaminated water, soil, and fodder under observation. The heavy metal contamination was from copper, cadmium and lead whereas arsenic was almost within the permissible limits. The biological samples milk, meat, egg, blood and dung collected from the industrial zone were also contaminated with copper, cadmium and lead when compared with the control area samples. The level of heavy metals in the biological samples of industrial area was above the WHO permissible limits. Arsenic was present within the maximum permissible level in all the biological samples. It is also concluded that industrialization may add pollutants to the area thereby causing an indirect effect on livestock production systems and in turn to the human beings.

The following recommendations may be suggested:

1. Monitoring the level of pollution in water, soil, plants and fodder crops, animals and in man in industrial zones at regular intervals.

2. Create awareness among farming community to adopt better management practices in nourishing their stock avoiding contaminated food.

3. Encouragement of organic farming along with Phytoremediation techniques to counter the heavy metals accumulation in soil and water.

4. Treatment of discharges and effluents from the industries and implementation of strict rules and regulations.

5. Safe disposal of discharges and effluents after treatment to reduce contamination of the surrounding areas. Efficient waste management system to be adopted.

6. Recommendation of rearing indigenous animals and adoption of Mixed farming system to improve economic status of farmers.

7. Identify and growing of trees/ plants that may flush out the contaminants to reduce the level of toxic elements from the industrial zones.

REFERENCES

REFERENCES

Alonso, M. L., Benedito, J.L., Miranda, M., Castillo, C. and Hernandez, R.F. 2002. Interactions between toxic and essential trace metals in cattle from a region with low levels of pollution. *Archives Environ. Cont. Toxicol.* 42 (2): 165-172

Alonso, M.L., Montana, P. F., Miranda, M., Castillo, C., Hernandez, J. and Benedito, J.L. 2003. Cadmium and lead accumulation in cattle in NW Spain. *Vet. Human Toxicol.* 45 (3): 128-130

Anonymous. 1996. Perumatty Gramma Panchayat Development Report. Report from (KILA) Government of Kerala

Anonymous. 2001. Bureau of Economics and Statistics. Livestock Census report. Government of Kerala

Anuratha, A. 2006. Assessment of heavy metal pollution in the industrial sites of Coimbatore. *J. Ecotoxicol. Environ. Monit.* 16 (1): 13-17

A.O.A.C, 1990. Official methods of analysis of Association of official Analytical Chemists. 15th edn Vol-I Agricultural chemicals, contaminants; Drugs Virginia USA. pp.567

*Arnold, R., Forster, S., Holwich, W and Stolle, A. 2002. Contamination of cattle with aluminium and fluorine in the vicinity of an aluminium industry. *Vet. Bull.* 72 (12): 9528.

Arunchalam, S and Thiagarajan, M. 2000. Constraints in rural livestock farming in parts of Tamil Nadu. *Livestock Intl.* 3: 4-8

*Avram, N., Serdaru, M., Medrea, N., Tanasescu, V and Mehedintu, C. 2000. Heavy metals bio-accumulation and bio-concentration in tissues and organs of cattle in areas with heavy industrial pollution. Studies and researches in veterinary medicine 8: 83-88

Bansal, O.P. 2004. Uptake of heavy metals by crop plants. *Poll. Res.* 23 (3): 501-506

*Baars, A.J., Beek, H.V., Beeftink, W.G., Boom, J., Graaf, G.J. and Nieuwenhuize, J. 1986. Environmental pollution with heavy metals of marshland of the Scheldt estuary and its effect on sheep. *Central Diergeneeskundig-Insitut* 21-28

Beavington, F. 1975. Pollution by heavy metals of rivulet and harbour water in Wollongong. *Water Res.* 6 (9): 390-391

Bhat, R.U. and Krishnamachari, K.A.V.R. 1980. Environmental lead toxicity in cattle. *Bull. Envtl. Contamination Toxicol.* 25: 142-145

*Bianu, E. 2005. Cadmium and lead levels in horse blood and hair in a heavy metal polluted area of Romania. *Vet. Bull.* 75(1): 573

*Bianu, E and Nica, D. 2005. Chronic intoxication with cadmium in the horses at Corpsa Mica area. *Vet. Bull.* 75 (1): 574

BIS. 1991. Indian Standards: Drinking water-specification. First revision. Bureau of Indian standards, New Delhi

Buddhi, D., Tyagi, P., Sawhey, R.L and Kothari, R. 2004. Ground water quality of Pithampur industrial area: Opinion survey of the residents. *Indian J. Environ. Prot.* 24 (3): 167-172

*Burhenne, M., Schneider, I and Bukowsky, H. 1997. Heavy metal pollution in soils amended with sewage in south of Berlin. *Umweltwissenschaften- und-Schadstoff- Forschung* 9 (2): 94-96

Chakraborti, D., Samanta, G., Mandal, B.K., Roy Chowdhury, T., Chanda, C.R., Biswas, B.K., Dhar, R.K., Basu, G.K and Saha, K.C. 1998. Calcutta's industrial pollution: Groundwater arsenic contamination in a residential area and sufferings of people due to industrial effluent discharge-An eight-year study report. *Curr. Sci.* 74 (1): 346-355

Chawatama, S., Mutisi, C and Mupawaenda, A.C. 2005. The socio-economic status of small holder livestock production in Zimbabwe: a diagnostic study. Livestock Res. for Rural development 17 (12): 1-8

Das, K.C., Ghosh, N., Das, M.K and Sarkar, S. 1997. Status of certain microminerals in cattle in relation to soil and plants in Midnapore district of West Bengal. *Indian J. Anim. Sci.* 67 (1): 70-72

Das, P., Biswas, S., Ghosh, T.K. and Haldar, S. 2002. Micronutrient status of dairy Cattle in new alluvial zone of West Bengal. *Indian J. Anim. Sci.* 72 (2): 171-173.

Das, P., Haldar, S. and Ghosh, T.K. 2003. Mineral status of soil, feeds and grazing buffaloes in two agroclimatic zones of West Bengal. *Indian J. Dairy. Sci.* 56 (4): 223-229

Dey, S., Dwivedi, S.K. and Swarup, D. 1996. Lead concentration in blood, milk and feed of lactating buffaloes after acute poisoning. *Vet. Record* 138 (14): 336

Dey, S., Dwivedi, S.K. and Swarup, D. 1997. Mineral deficiency in buffalo around a fertilizer factory. *Indian J. Anim. Sci.* 67 (9): 780-781.

Dey, S. and Dwivedi, S.K. 2000. Toxic metals in Hens' Eggs in India: A preliminary repoıt. *Archives Envtl. Health.* 9: 1-2

Dey, S. and Dwivedi, S.K. 2004. Lead in blood of urban Indian horses. *Vet. Human Toxicol.* 46 (4): 194-195.

Dhok, A.P., Rekhate, D.H. and Wankhade, S.G. 2005. Mineral status of goats in relation to common tree leaves fed in Akola district. *Indian J. Anim. Sci.* 75 (1): 77-80.

*Dobrzanski, Z., Gorecka, H., Kolacz, R. and Gorecki, H.J. 1994. Effect of pollution from copper industry on heavy metal concentration in green forage, blood serum of dairy cattle and in milk. Proceedings of the 8th International Congress on Animal Hygiene, St. Paul Minnesota, USA. 12-16 September 1994 29-32.

*Drozd, L. 2003. Content of heavy metals in tissues of red deer (*Cervus elaphus*) from Lublin region *Vet. Bull.* 74 (1): 576.

Dwivedi, S.K., Swarup, D. and Dey, S. 1997. Cadmium level in bovine milk from different localities of India. *Indian J. Anim. Sci.* 67 (9): 758-759.

Dwivedi, S.K., Swarup, D., Dey, S. and Patra, R.C. 2001. Lead poisoning in cattle and buffalo near primary lead-zinc smelter in India. *Vet. Hum. Toxicol.* 43 (2): 93-94.

*Fatoki, O.S. 2003. Lead, Cadmium and Zinc accumulation on soil and vegetation along some selected major roads of Eastern Cape. *Intl. J. Environ. Studies* 60 (2): 199-204.

FAO. 2000. Agriculture towards 2015-30. Technical Interim Report, Economic and Social Department. FAO. Rome, Italy , FAO

Garg, K. and Totawat, K.L. 2005. Heavy metal accumulation, movement and distribution in soil profiles near zinc smelter effluent stream. *J. Indian Soc. Soil Sci.* 53(1): 141-144

Gould, D.H., Dargatz, D.A, Garry, F.B., Hamar, D.W. and Ross, P.F. 2002. Potentially hazardous sulfur conditions on beef cattle ranches in the United States. *J. Amer. Vet. Med. Assoc.* 221 (5): 673-677

Govil, K.P. 2001. Distribution and characterization of heavy metals in Jeedimetla industrial area, Andra Pradesh, India. *Poll. Res.* 20 (2): 245-255

Gowda, N.K.S., Prasad, C.S., Ramana, J.V and Ramachandra, K.S. 2001a. Micronutrient profile in soil, feed, fodders and blood samples of animals in eastern and southern dry zones of Karnataka. *Indian J. Anim. Sci.* 71(2): 150-154

Gowda, N.K.S., Prasad, C.S., Ramana, J.V. and Shivaramaiah, M.T. 2001b. Mineral status of soil, feeds, fodders and animals in coastal agri-ecozone of Karnataka. *Anim. Nutrition Feed Tech.* 1 (2): 97-104

Gowda, N.K.S., Prasad, C.S., Ramana, J.V. and Shivaramaiah, M.T. 2002. Assessment of mineral status in hilly and central dry zones of Karnataka and ways to supplement them. *Indian J. Anim. Sci.* 72 (2): 165-170

Gowda, N.K.S., Malathi, V.S., Jash, S. and Roy, K.S. 2003. Status of pollutants and trace elements in water, soil, vegetation and dairy animals in industrial area of Bangalore. *Indian J. Dairy Sci.* 56 (2): 86-90

Gupta, S.K., Savita. D and Tiwari, M.S.S. 2005. Assessment of heavy metals in surface water of lower lake, Bhopal India. *Poll. Res.* 24(4): 805-808

Gracey, J.F., Collins, D.S and Huey, R.J. 1984. Meat Hygiene 10th edition. W.B. Saunders Co. Ltd. pp.864

Haque, R.M., Ahamad, U.S., Chowdhury, A.D and Rahman, S.M. 2005. Seasonal variation of heavy metals concentration in surface water of the rivers and estuaries of Sundarban mangrove forest. *Poll. Res.* 24 (2): 463- 472

*Hristov, E., Kriov, K., Zaharinov, B. and Gugova, M. 2003. Presence of Lead and Cadmium in pig internal organs from different regions in North Bulgaria. *Vet. Bull.* 73 (2): 1329

Jananeethi., 2002. Report on the amplitude of environmental and human rights ramificatioin Reported by Jananeethi July pp13

Kannan, A. 2005. Evaluation and improvement of integrated pig farming systems in Kerala. Ph.D. Thesis submitted to Kerala Agricultural University. Thrissur pp. 115

Kannan, A., Xavier, F., Saseendran, P.C. and Murugan, M. 2006. Socio- economic status of pig farmers in Kerala. *Tamilnadu J. Vet. Anim. Sci.* 2 (5): 167-170

Kataria, H.C. 1995. Heavy metal water pollution of Pipariya Township of Madhya Pradesh. *J. Freshwater Biol.* 7(2): 105-107

Kabata, P.A. and Pendias, H. 1992. Trace Elements in Soils and Plants. Second Edn. CRC Press. Boca Raton, Florida FC.pp365

Khan, Z.I., Hussain, A., Ashraf, M. and Mc Dowell, E.R. 2006. Mineral status of soil and forages in Southwestern Punjab: Microminerals. *Asian-Aust. J. Anim. Sci.* 19 (8): 1139-1147

Kotwal, S.K., Sharma, R.K. and Srivastava, A.K. 2005. Industrial pollutants and animal health- A review. *Indian J. Anim. Sci.* 75(6): 713-722

Kooklue, Ue., Akman, S., Doener, G. 2000. Investigation of the heavy metal pollution of Istanbul Bosphorus sea water and mussels. *Environ. Bull.* 9 (11-12): 759-765

Kumar, P., Sharma, M.C and Joshi, C. 2005. Studies of micro- minerals, hormone and vitamin profile in buffaloes (*Bubalus bubalis*) of Agra region of Uttar Pradesh. *Indian J. Anim. Sci.* 75 (8): 909-914

Kwatra, M.S., Gill, B.S., Singh, R and Singh,M. 1986. Lead toxicosis in buffaloes and cattle in Punjab. *Indian J.Anim.Sci.* 6: 412-413

Laxen, D. P. H and Harrison, R. M.1977. The highway as a source of water pollution: as apparent with the heavy metal lead. *Water Res.* 11 (1): 1-11

Lemos,R.A.A., Driemeier,D., Guimaraes, E.B., Dutra, I.S., Mori,A.E and Barros, C.S.L. 2005. Lead poisoning in cattle grazing pasture contaminated by industrial waste. *Vet. Bull* 75 (5): 634

Linden, A., Anderson, K and Oskarsson, A. 2002. Cadmium in organic and conventional pig production *Vet. Bull* 72 (1): 300

Li-wenfan., Ping, Z.L., Zhou, M and Ping, Y.W. 1995. Influences of heavy metal pollution of the environment on the health of sheep. *Chinese J. Vet. Sci. &Tech.* 25 (10): 15-17

Lokhande,R.S and Sathe, C. N. 2001. Monitoring and assessment of heavy metal contents in the industrial effluents from Ambarnath M.I.D.C. area Maharashtra. *Poll. Res.* 20 (2): 239-243

*Long, C., Wang, Y.J., Zhou, D.M and Yuan,H. 2004. Heavy metals pollution in Poultry and livestock feeds and manures under intensive farming in Jiangsu Province, China. *J. Envtl. Sci.* 16 (3): 371-374

Longhurst, R. D., Roberts, A. H. C and Waller, J. E. 2004. Concentrations of Arsenic, Cadmium, Copper, Lead and Zinc in New Zealand pastoral top soils and herbage. *New Zealand J. Agrl. Res.* 47: 23-32

Manjappa, S., Puttaiah, E.T and Manjunath, N.T. 2005. Heavy metal distribution in Water and sediments of the river Bhadra near Bhardavathi town, Karnataka- India. *Poll. Res.* 24 (2): 447-450

*Marcal, W. S., Villegas-Navarro, A., Nascimento, M.R.L., Guerra, A.P., Fujihara,C. J. and Bruschi, A. B. M. 2004. Cattle and horses as biomonitor of the environmental pollution. *Vet. Bull.* 74 (4): 2914

*Marques, M., Martinez, C. E., Revira, J and Ordonez, S. 2001. Heavy metals pollution of aquatic ecosystems in the vicinity of a recently closed underground lead-zinc mine. *Environ. Geol.* 40 (9): 1125-1137

*Massanyi, P., Tataruch, F., Slameka, J., Toman, R and Jwiik, R. 2003. accumulation of lead, cadmium and mercury in liver and kidney of the brown hare (*Lepus europaecus*) in relation to the season, age and sex in the west Slovakian low land. *Vet. Bull.* 73 (12): 9398

McDowell, L.R. 1992 Mineral in animal and human nutrition. Academic Press Inc, California pp.354

Miranda, M., Alonso, M.L., Castillo, C., Hernandez, J and Benedito, J.L. 2005 Effects of moderate pollution on toxic and trace metal levels in calves from a polluted area of Northern Spain. Environ. Intl. 31: 543-548

*Mollerka, R. O and Ribeiri, L. A. O. 2006. Epidemiology of chronic copper poisoning on sheep show. *Vet. Bull.* 76 (7): 5277

Mondal, P., Biswas, P and Rajendran, D. 2003. Micronutrient status of soil, plant and dairy cattle in coastal saline zone of West Bengal. *Indian J. Anim. Sci.* 73 (9): 1077-1080

Mor, F. 2005. Cadmium and lead in livestock feed and cattle manure from four agricultural areas of Bürsa, Turkey. *Toxicol. Environ. Chem.* 87 (3): 329-334

Muse, J.O., Stripekis, J. D., Fernandez, F.M., Huicque, L., Tudino,M.B., Carducci,C.N and Troccoli, O. E. 1999. Seaweeds in the assessment of heavy metal pollution in the Gulf San Jorge, Argentina. *Environ. Pollut.* 104 (2): 315-322

Nair, A.M.C. 1999. A study on the effect of copper, zinc and mancozeb supplemented in ducks. Ph.D. Thesis submitted to Kerala Agricultural University, Thrissur.pp.203

Nikhil, K. 2006. Heavy metals in medicinal plants of Jharia coal field area, India. *Poll. Res.*25 (1): 1-7

Nisha, A.R. 2000. Assessment of cadmium toxicity in cattle of Eloor industrial area. M.V.Sc. thesis submitted to Kerala Agricultural University, Thrissur. pp124

Oladele, O.I. 2001. Farmers perception of the relevance of livestock production technologies of livestock production in Oyo state, Nigeria. Livestock Res. for rural development 13 (6): 1-8

Orisakwe, O.E., Asomugha, R., Afonne, O.J., Anisi, C.N., Obi, E and Dioka, C.E. 2004. Impact of effluents from a car battery manufacturing plant in Nigeria on water, soil and food qualities. *Arch. Environ. Health* 59 (4): 217

*Palacios, H., Iribarren, I., Ollalla, M. J and Calca, V. 2004. Lead poisoning of horses in the vicinity of a battery recycling plant. *Vet. Bull.* 74 (2): 1327

Park, K. 2001. Text book of Preventive and social Medicine. 16 th Edition pp 653

Park, S. H.., Lee, M. H and Kim, S. K. 2005. Studies on the concentrations of Cd, Pb, Hg and Cr in dog serum in Korea. *Asian-Aust. J. Anim. Sci.* 18 (11): 1623 -1627

*Parkpian, P., Shing, T.L., Laortanakul, P and Thunthaisong, N. 2003. Regional monitoring of lead and cadmium contamination in a tropical grazing land site, Thailand. *Environ. Monit. Assess.* 85 (2): 157-173

Patel, K. P., Pandya, R. R., Maliwal, G. L., Patel, K.C., Ramani, V.P and George, V. 2004. Heavy metal content of different effluents and relative availability in soils irrigated with effluent waters around major industrial cities of Gujarat. *J. Indian Soc. Soil Sci.* 52: 89-94

Patra, R.C., Swarup, D and Sahoo, A. 2001. Trace minerals in blood of young calves during exposure to Lead. *Indian. J. Anim.Sci.* 71 (6): 507-510

Patra, R. C., Swarup, D., Sharma, M.C and Naresh, R. K. 2006. Trace mineral profile in blood and hair from environmentally exposed to lead and cadmium around different industrial units. *J. Vet. Med. Assn* 53 (10): 511-517

Paul, T.K., Ghosh, T. K and Haldar, S. 2005. Assessment of trace element status in common goat feeds and in vital body tissues of Black Bengal bucks (*Capra hircus*) with special reference to Chromium. *Indian J. Anim. Sci.* 75 (4): 429-432

*Ping, Z. L. 2005. Effect of environmental lead and cadmium pollution on animal health. *Vet. Bull.* 75 (7): 5040

Piska, R.S., Swamy,P.Y and Parvathi, R. 2005. Heavy metal pollution and its toxic effect on ground water quality of Jeedimetla IDA. Hyderabad. *Indian J. Environ. Prot.* 24 (3): 177-181

Prasad, B and Bose, J.M. 2001. Evaluation of the heavy metal pollution index for surface and spring water near a limestone mining area of the lower Himalayas. *Environ. Geol.* 41: (1-2) 183-188

Prasad, B. and Jaiprakas, K. C. 1999. Evaluation of heavy metals in ground water near mining area and development of Heavy metal pollution index. *J. Environ. Sci. Health* 34 (1): 91-102

Prasad, C. S., Gowda, N.K.S., Ramana, J.V and Singh, K. 2005. Micronutrient content of soil, water, feeds and fodders in the adopted villages under IVLP and assessing their availability to lactating cows. *Indian J. Dairy. Sci.* 58 (1): 44-48

Raj, B.G., Patnaik, M.C., Babu, .S.P., Kalakumar, B., Singh, M.V and Shylaja, J. 2006. Heavy metal contaminants in water-soil-plant-animal continuum due to pollution of Musi river around Hyderabad in India. *Indian J. Anim. Sci.* 76 (2): 131-133

Rai, U. N., Sarita, S and Sinha,S. 2001. Distribution of metals in aquatic edible plants *Trapa natans* (Roxb.) Makino and Ipomia aquatica Forsk. *Envtl. Monitoring and Assesment.* 70: 241-252.

Ramrao, W. Y., Tiwari, S.P and Singh, P. 2005 Crop- livestock integrated farming system for augmenting socio-economic status of small holder tribal farmers of Chhattisgarh in Central India. Livestock Res. Rural development. 17 (8): 14-20

Rani, R.S. and Reddy, P.M. 2003. Preliminary studies on metal concentration on Hussain sagar Lake. *Poll. Res* . 22 (3): 377-380

Rao, P and Birthal. P. S. 2005. Review on raising livestock productivity in crop-livestock systems in India: Challenges and implications for research. *Indian J. Anim. Sci.* 75 (10): 1233-1237

*Rozso, K., Varhegyi, J., Mocsenyi, A R., Fugli, K. 2003. Lead content of the forages and the effect of lead exposure on ruminants. *Vet. Bull.* 73 (1): 510.

*Saad, M. A. H and Fahmy, M. A. 1996. Heavy metal pollution in coastal Red sea waters, Jeddah. J. King Abdulaziz Univ. *Mar. Sci.* Special Issue 7: 67-74

*Sedki, A., Lekouch, N., Gammon, S and Pineau, A., 2004. Toxic and essential trace metals in muscle, liver and kidney of bovines from a polluted area of Morocco. *Vet. Bull.* 74 (4): 2917

Sharma, M.C and Joshi, C. 2004. Soil, fodder and serum micromineral status and haemato biochemical profile in cattle of Garhwal region of Uttaranchal state. *Indian J. Anim. Sci.* 74 (7): 775-779

Sidhu, P. K., Sandhu, B. S., Singh, J and Kwatra, M. S. 1994. Lead toxicosis in bovine due to industrial pollution in Punjab. *Indian J. Anim. Sci.* 64 (12): 1359-1360

*Simsek, O., Gultekin, R., Oksuz, O and Kurultav, S 2000. The effect of environmental pollution on the heavy metal content of raw milk in Turkey. Nahrung 44 (5): 360-363

Singh.R., Randhawa, S.S and Randhawa, C.S. 2003. Trace element status of crossbred cattle from sub-mountainous belt of Punjab in relation to soil and fodder. *Indian J. Anim. Sci.* 73 (9):1072-1076.

Singh.R., Randhawa, S.S and Kumar, A. 2005. Macromineral status of crossbred cattle of Shiawalik hills in relation to soil and fodder. *Indian J. Anim. Sci.* 75 (10): 1179-1182

Singh.R, Randhawa, S. S and Kumar, A. 2006. Copper deficiency in grazing sheep and its management. *Indian. J. Anim. Sci.* 76 (5): 370-372

Sinha, D.K. 2004. Level of some heavy metals in waters from Sai river at Rae Bareli India for the pre-monsoon period and after onset of monsoon. *Poll. Res.* 23 (1): 113-116

Sivakumar, T., Gopi, H., Karthikeyan, S., Senthilkumar, S and Jaishankar, S. 2006. Socio- economic status of pig farmers in Kancheepuram district. Tamilnadu J. Vet. Anim. Sci. 2 (3): 73-77

*Skalicka, M., Korenekova, B. and Nad, P. 2005. Copper in livestock from polluted area. *Bull. Envtl. Cont. Toxicol.* 74 (4): 740-744.

Snedecor, G.W and Cochran, W.G. 1994. Statistical Methods, IOWA State University Press, IOWA, USA. pp313.

Somasundarum, J., Krishnasamy, R and Savithri, P. 2005. Bio transfer of heavy metals in Jersey cows. *Indian J. Anim. Sci.* 75 (11): 1257-1260

Strauch, D. 1983 Animal production and Environmental health, World Animal Series Vol 9 pp 435

Sujatha, S.D., Sathyanarayanan, S., Satish, P.N and Nagaraju, D. 2001. A sewage and sludge treated lake and its impact on the environment. *Envntl. Geology* 40: 1209-1213

Swarup, D., Dwivedi, S.K., Pandey, N.N and Sharma, S.C. 1993. Lead in feed and blood of bovine in varied environmental localities. *Indian J. Vet. Res* 2: 34-37

Swarup, D., Dwivedi, S.K and Dey, S. 1997. Lead and cadmium levels in blood and milk of cows from Kanpur city. *Indian J. Anim. Sci.* 67 (3): 222-223

Swarup, D and Dwivedi, S.K. 1998. Research on effects of pollution in livestock. *Indian J. Anim. Sci.* 68 (8) Special Issue: 814-824

Swarup, D and Patra, R.C. 2005a. Environmental pollution and its impact on domestic animals and wildlife. *Indian J. Anim. Sci.* 75 (2): 231-240

Swarup, D., Patra, R.C., Naresh, R.K and Shehhar, P. 2005b. Blood lead levels in lactating cows reared around polluted localities; transfer of lead into milk. *Sci. Total Environ.* 15: 349 (1-3): 67-71

Taneja, V. K. 1998. Women in livestock production and economics. *Indian Fmg.* 48:55-60

*Teresa, M., Vasconcelos, S.D and Tavares, H.M. 1997. Trace element concentrations in blood and hair of young apprentices of a technical-professional school. *Sci. Total Environ.* 205: 189-199

*Ulrich, R., Raszyk, J and Napravnik, A.2002. Variations in contamination by Mercury, Cadmium and Lead on swine farms in the district of Hodonin in 1994-1999. *Vet. Bull.* 72 (1): 309

Unnikrishnan, N., Bhavadasan, M. K., Surendra, N. B and Ram, C. 2005. Chemical residues and contaminants in milk: A review. *Indian J. Anim. Sci.* 75 (5): 592-598

*Vaidyanathan, A. 1998. Programme for research on mixed crop-livestock systems in South Asia: a tentative outline. Report submitted to ICRISAT Patancheru. Andra Pradesh India

Varghese, K. 1998. Assessment of mineral status of cattle in Kerala. M.V.Sc Thesis submitted to the Kerala Agricultural University, Thrissur.pp179

*Venalainen, E.R., Antitila, M. and Peltonen, K. 2005. Heavy metals in tissue samples of Finnish mouse (*Alces alces*). *Bulletin of Envtl. Contamination and Toxicolgy* 74 (3): 526-536

Vodela, J.K., Lenz, S.D., Renden, J.A., Mcelhenney, S.W.H and Kemppainen, W. (1997). Drinking water Contaminants (Arsenic, Cadmium, Lead, Benzene and Triochloroethylene). 2. Effects on Reproductive Performance, Egg quality and Embryo toxicity in Broiler Breeders. *Poultry Sci.* 76: 1493-1500

Vyas, M.S. 1996. Comparative study of the immuno- pathological response in Ochratoxin A, cadmium, Mercury toxicities in ducks. Ph.D.Thesis submitted to Kerala Agricultural University. Thrissur pp.489

World Health Organization. 1995. Guidelines for drinking water Quality, Volume I: recommendations, Geneva

Yadav, S and Khirwar, S. S. 1999. Soil-plant-animal relationship of copper in milch buffaloes of Jind district in Haryana. *Indian J. Anim. Sci.* 69 (9): 718- 721

Yadav, S and Khirwar. S. S. 2005. Inter-relationship of soil micronutrient with feedstuffs in Jind district of Haryana. *Indian J. Anim. Sci.* 75 (5): 531-533

*Znamirowska,A., Zin,M and Budzynski,M 2005. Studies of the accumulation of heavy metals in the horses tissues. *Vet. Bull.* 75(5): 635

* Originals not consulted

APPENDIX

APPENDIX- I – Question Schedule
Village level livestock production - Survey

1. Name of the person:

2. Address of the person:

3. Family details:

No of members of the family	Husband	Wife	Children	Others
Name				
Age				
Sex				
Education				
Occupation working Fulltime/Part time				
Income per Year				

3. Present land holding or landless

Own land / leased	
Total area:	
Type of land: dry/ wet	
Type of cultivation: paddy/ garden / plantain	
Crops available	
Farming experience: Yes/ No	

5. Cropping pattern:

Type of crops available	
Type of farming	
Market income per annum from 1. Agriculture 2. Livestock	

6. Water source

	for irrigation	for drinking
Well		
Canal		
Bore Well		
Rain fed		
Pond		
Tap water		

7. Number of animals/birds maintained:

Species maintained	No of heads	Type of housing	Manpower utilization	
			Family labour	Hired labour
Cattle				
Goat				
Pig				
Sheep				
Poultry				
Others				

8. Housing system for animals

	Cattle	Goat	Pig	Sheep	Poultry	Others	Total
Lean to type							
Concrete							
Cage							
Open System							
Backyard							
Raised system							

9. Waste disposal: Manure disposal
Drying / Spreading / Manure Pit / Bio Gas / Others

10. Feeding of livestock

Species maintained	Type of feed Conc/ Green fodder/ Grazing	Cost of feed	Feeding practices	Farming system	
			No of times per day	Intensive	Extensive
Cattle					
Goat					
Pig					
Sheep					
Poultry					
Others					

11. Watering livestock:
Cow/ Goat/ Sheep

	Summer	Monsoon
Sources of water		
Interval of watering / day		
Approximate quantity of water		

12. Type of farming:
    Intensive / extensive / semi extensive / Back yard / Integrated

13. Locality of the house / grazing area:
    Type of industries present
    Approximate distance to the industry
    Extent of farmer's link with industry:

14. Quantity of livestock products obtained:
    Milk
    Meat
    Egg
    Others

15. Channels of marketing the product:

	Direct	Co-operative society	Middleman
Milk			
Meat			
Egg			
Others			

16. Type of livestock farm interested to start: cow/ goat/ poultry/ rabbit
    Whether financial support required from institutions like bank: Yes/ No
    How much credit required: Rs.
    Credit period required: Short/ medium/ long term

17. Whether the present system of farming is profitable: Yes/ No
    Yearly expenditure on livestock
    Yearly income from livestock/ agriculture

18. What type of livestock rearing is profitable as per your opinion:
    Cattle/Goat/ Pig/Rabbit/Poultry

19. What are the inputs required for improving the present condition
    Feed / AI / Health care

20. Has the setting up of industry in your locality affect your Agriculture / Livestock production. If yes give details.

VILLAGE LEVEL LIVESTOCK AND POULTRY PRODUCTION UNDER THE INDUSTRIALIZATION SCENARIO

V. RAJAGANAPATHY

Abstract of the thesis submitted in partial fulfillment of the requirement for the degree of

Doctor of Philosophy

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University, Thrissur

2007

Department of Livestock Production Management
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR-680651
KERALA, INDIA

ABSTRACT

An in depth assessment and analysis of two villages, one an industrial area and the other an agrarian hamlet, was taken up. The effect of industrialization and pollution in village level livestock and poultry production and toxic heavy metals content as an indicator of pollution in water, soil, fodder and in biological samples were studied. Based on the observation and scientific validations, changes in livestock farming system and methodologies to alleviate the extent of pollution were sorted out.

This study was conducted in Plachimada village - industrial area - in Perumatty Panchayat and in Nallepilly village- control area in Nallepilly Panchayat in Chittoor taluk in Palakkad district. A detailed survey of the existing husbandry systems was done in the selected study area using a schedule. Collection of samples of water, soil, fodder and biological samples milk, meat, egg, blood and dung samples were collected and examined from both industrial and control area. The samples were analyzed for presence of heavy metals like copper, cadmium, lead and arsenic by using Atomic absorption spectrophotometer.

A detailed survey was done among fifty farmers from the Plachimada (industrial area) and Nallepilly (control area) villages respectively. The farmers were interviewed with a schedule and the data was obtained. The socio-economic status of the farmers indicated that the middle aged persons were more involved in the agricultural and animal husbandry activities. Most of the farmers had an average monthly income per family of Rs. 2000 in the study area. Cultivation of crops and plantations were less in both industrial and control area. The study revealed that majority of the farmers possessed dairy cattle with major source of income from livestock farming in both these study areas. Economic viability of rearing cattle was

better in control area than that of industrial area. Most of the farmers surveyed stayed very near to the industry in the industrial zone. The study revealed that nearness of the industry to the grazing lands may be affecting their livestock farming system.

The presence of heavy metals cadmium and lead in drinking water and soil samples of industrial area was more than that of the control zone and the WHO (1995) recommendations. The presence of copper and cadmium in meat samples was higher whereas cadmium and lead in blood samples of the industrial area was found more than that of the control zone and the permitted levels as per the WHO recommendations. The level of copper, cadmium and lead in fodder, milk, egg and dung samples of the industrial area was found more than that of the control zone and the permitted levels as per the WHO recommendations.

This study aimed also to find out the relationship between water, soil, plant and animal system. Correlation of fodder and blood heavy metals with other biological samples was done in industrial area. Fodder lead showed a highly significant correlation with milk lead content. Correlation between fodder arsenic and milk arsenic concentration was also significant. Correlation between fodder cadmium with blood cadmium was significant. Correlation was observed between fodder lead with dung lead values. Correlation existed between blood copper with dung copper at a significant level.

Similarly correlation of fodder and blood heavy metals with other biological samples was done in control area also. Blood and fodder cadmium was significant and positively correlated. Correlation of fodder lead with milk and dung lead were significant. Fodder arsenic and milk arsenic were significantly correlated. In blood the copper content of milk and dung showed a positive significant correlation.

The heavy metals lead, cadmium, arsenic and mercury from industrial pollution are of high environmental concern due to their toxicity even at low concentrations. These metals may persist in the system for several days due to cumulative nature and may cause severe health effects in man and animals. Bioaccumulation of toxic heavy metals, especially lead, cadmium and arsenic in milk, meat and in egg have evoked great concern during the recent years. Heavy metals contaminants may enter the animal system through pollution of air, water, soil, feed polluted by industrial sources.

From the present study it was found that the industrial area had contaminated water, soil, and fodder under observation. The heavy metal contamination was from copper, cadmium and lead whereas arsenic was almost within the permissible limits. The biological samples milk, meat, egg, blood and dung collected from the industrial zone were also contaminated with copper, cadmium and lead when compared with the control area samples. The level of heavy metals in the biological samples of industrial area was above the WHO permissible limits. Arsenic was present within the maximum permissible level in all the biological samples. It is also concluded that industrialization may add pollutants to the area thereby causing an indirect effect on livestock production systems and in turn to the human beings. The following recommendations may be suggested.

1. Monitoring the level of pollution in water, soil, plants and fodder crops, animals and in man in industrial zones at regular intervals.

2. Treatment of waste water and other discharges/effluents from industries with implementation of strict rules and regulations

3. Safe disposal of the discharges, effluents and waste materials from the industries and factories. Efficient waste management to be adopted.

4. To create awareness among farming community to adopt better management practices.

5. Encouragement of organic farming.

6. Recommendation of rearing indigenous animals and adoption of Mixed farming - system to improve economic status of farmers.

7. Phytoremediation may be done to decontaminate soil and water to reduce the soil heavy metal content.

8. Identify and growing of trees/ plants to reduce the level of toxic elements from the industrial zones.