2015

CROSS-SECTIONAL SURVEY OF THE PUNJAB


بسم الله الرحمن الرحيم

DEDICATED TO THE POOR LIVESTOCK FARMERS WHOSE LIVELIHOOD DEPENDS UPON LIVESTOCK AND RURAL POULTRY AND WHO STRIVE TO ENSURE FOOD SECURITY FOR ALL HUMAN BEINGS

FOREWORD

In Pakistan livestock sector is source of employment generation and helps to reduce income variability, providing income to pay for education, health, day to day and other special occasion needs. It contributes to food supply by converting low-value materials; inedible or unpalatable into high quality food like milk, meat and eggs. Consumption of even small amounts of animal-source foods has been shown to contribute substantially to ensuring dietary adequacy preventing under-nutrition and nutritional deficiencies.

A strong livestock sector can be a very good contributor to food security and reduces the poverty in rural areas. However, prevalent livestock diseases of economic importance undermine the efforts toward strengthening this sector. Livestock diseases play a crucial role in the life of dairy farmers because diseases not only lower the production but also weaken the farmers economically. Mortality resulting from diseases deprives the farmers from daily earnings. Morbidity due to diseases is responsible for short term and long term, product losses. These losses are economically more important as compared to mortality.

There was need to ascertain the status of these diseases in the country which are badly taxing the current productivity of various categories of livestock and poultry. The Livestock and Dairy Development Department, Government of the Punjab took this challenge and initiated this comprehensive cross-sectional study through the coordinated efforts of field and laboratory staff. The findings of this study provide guidelines for the researchers to develop their future researchable priorities and development agencies and department to devise their initiatives accordingly.

I congratulate Mr. Naseem Sadiq, Secretary Government of the Punjab, Livestock and Dairy Development Department and his team for conducting first ever comprehensive study across the province and earnest hope that their dedicated efforts will results in to viable action plans based on this survey to rescue farming communities.

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CROSS-SECTIONAL SURVEY OF THE PUNJAB

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EXECUTIVE SUMMARY

Livestock and rural poultry have significant impact on pro-poor development. Livestock and rural poultry play an important role in poverty alleviation and can uplift the socioeconomic conditions of our rural masses. According to Economic Survey of Pakistan (2014), contribution of livestock sector to National GDP in terms of value addition is 11.8%. Despite decades of neglect, increase in milk (3.2%); meat (4.5%) and rural poultry (13.64%) has been recorded in 2014 compared to previous year i.e. 2012-13. Parasitism and sub-clinical mastitis are important barriers affecting production potential of livestock. Allocating resources without establishing core issues / root causes leads to an inequitable system. First hand intelligence on the magnitude and impact of parasitism, sub-clinical mastitis and brucellosis is a prerequisite to allocating resources for their control. Secretary Livestock, Government of the Punjab realized the need for active surveillance in this grey area. Under the patronage of Chief Minister, Punjab, a cross-sectional survey of the whole Province was conducted from 28/12/2014 to 18/03/2015 to estimate the magnitude and impact of parasitism, sub-clinical mastitis and brucellosis on livestock population of the Punjab. Faecal, blood, milk and serum samples were randomly collected from each union council throughout the Province. The disease load (point prevalence) with respect to endo-parasites was 57.15%, 54.43%, 52.06 and 53.93% in cattle, buffalo, small ruminants and rural poultry, respectively. The point prevalence of anaplasmosis, theileriosis, babesiosis, sub-clinical mastitis and brucellosis was 4.14%, 3.23%, 4.84%, 19.92% and 5.16%, respectively. Estimated financial impact in terms of reduced revenues due to worm infestation and sub-clinical mastitis (in cattle and buffalo) is about Rs. 12,701,062,791 / month and Rs. 623,877,453 / month, respectively, in the Punjab province.

INTRODUCTION

Livestock and poultry are linchpins in the life of humans. Ruminants digest roughages and convert them into foods of high nutritive value for humans. Similarly, poultry convert inedible proteins into edible ones. Ruminants and poultry, therefore, broaden out the carrying capacity of the globe for human beings. Livestock and rural poultry are indispensable mainstay of the poorest and marginalized segments of the Punjabi society – women and the landless. The only disposable income of rural women, generally, comes from the sale of eggs and chickens. It is, therefore, imperative for all programs of rural development targeting the rural poor, the landless and the rural womenfolk, to set the improvement of the production, reproduction and productivity of livestock and rural poultry as its core objective.

Livestock & Dairy Development (L&DD) Department Punjab is charged with protecting and improving the health, quality and marketability of livestock & rural poultry and products thereof by preventing, controlling and / or eliminating diseases, and monitoring and promoting their health and productivity. Central to the ability to carry out that change, and the crux of appropriate application of disease control strategies is the timely, efficient and accurate collection and analysis of surveillance data. The main purpose of surveillance is to provide information to the policy makers of L&DD Punjab, thereby enabling them for appropriate and timely decisions for disease prevention and control. That is why disease surveillance is the core activity of L&DD Punjab.

Every country in this world has its own sort of animal disease surveillance system. This is because of the fact that surveillance-needs and surveillance-capabilities vary from country to country. In developed countries, with livestock based

economy that depends on exports of animals and animal-products, sophisticated surveillance systems are in operation with the core aim to protect trade. On the other hand an under-developed country, like Pakistan, with uncontrolled land borders with multiple other countries that have regular outbreaks of major livestock diseases is unable to maintain sophisticated surveillance systems and aims primarily at minimizing the impact of major animal diseases. It is illogical to establish a disease control program for an unimportant disease, while more important diseases remain uncontrolled. With limited funds, it would be appropriate for L&DD Punjab to prioritize surveillance of those diseases that have a direct impact on the well-being of the farmers.

Realizing the need for earnest efforts in this grey area, the Secretary Livestock Government of the Punjab envisioned launching a representative cross-sectional study throughout the Province for priority setting, scenario analysis and institution of remedial measures. The core objectives behind this study were:

- To determine magnitude of problem / prevalence of endo-parasitism, haemo-parasitism, sub-clinical mastitis and brucellosis in livestock population of the Province.
- To estimate the financial impact / reduced revenues, associated with endo-parasitism and subclinical mastitis.

METHODOLOGY

In order to assess magnitude and distribution of economically important livestock diseases, a cross sectional epidemiological survey was conducted by Directorate of Animal Disease Reporting and Surveillance from January, 2015 to March, 2015 under the banner of "*Mass Vaccination Campaign"* in 2391 union councils of 36 districts. A total of 17,061 villages and 55,586 farmers / households were visited by deputed staff of District Diagnostic Laboratories for collection of faecal, blood, serum and milk samples from livestock populations of these randomly selected households. Faecal (n=242106), blood (n=59665), serum (n=36910) and milk (n=87542) samples were collected and analyzed for detection of endo-parasites, haemo-parasites, brucellosis and sub-clinical mastitis by coprology (Gadahi *et al*., 2011), Field stained thin blood smears (Endriss *et al.,* 2005), Rose Bengal Plate Test (Senyael & Schoonman, 2010) and Whiteside Test (Shahid *et al*., 2011), respectively.

Estimation of Point Prevalence

Point prevalence is amount of disease in a population at a particular point in time. For aforementioned attributes point prevalence was estimated according to recommendations of Thrusfield (2005) using following model:

$$P = \frac{\text{Number of cases of disease at a particular point in time}}{\text{Population at risk at that point in time}}$$

Estimation of Reduced Revenues / Economic Losses

Endo-parasites are responsible for decreased weight gain and milk production. According to previous reports, decrease in milk yield @ 0.58 liter per animal per day (177.69 liters per lactation) has been recorded due to gastro-intestinal parasites. Reported yearly weight loss in beef cattle is 41 kg per head whereas 27% reduction in weight gain has been reported in small ruminants. Economic losses due to gastro-intestinal parasites were assessed on the basis of reduced weight gain and milk production keeping in view these previous investigations of Grisi *et al*. (2014) and Qamar *et al*. (2011).

Sub-clinical mastitis is reported to be associated with reduced milk yield and quality. Summary values of previous literature indicate 2-6% reduction in milk yield per animal per lactation. Economic losses for sub-clinical mastitis were, therefore, estimated following recommendations of these previous investigations of Sinha *et al*. (2014); Jemelijanos *et al*. (2014) and Seegers *et al*. (2003). Reference values of average daily milk yield of lactating cows and buffaloes in Punjab were recorded from special report published by Pakistan Bureau of Statistics in "Pakistan Livestock Census 2006".

Estimation of Sample Size

Sampling frame for the study was large and small ruminants (N=74421687) and rural poultry (N=39300000) of entire province whereas sampling unit was one animal / bird. Sample size was estimated according to recommendations of Kevin M Sullivan using updated 3.03, 2014 version of ***Open Epi*** (software for epidemiologic statistics).

Large and Small Ruminants

By specifying the values of

1. Population size (N) = 74421687
2. Anticipated frequency of outcome in the population
    i. For endo-parasites = **50%** (Raza *et al.,* 2007)
    ii. For haemo-parasites = **10%** (Zahid *et al.,* 2005)
    iii. For brucellosis = **5%** (Gul and Khan, 2007)
    iv. For sub-clinical mastitis = **20%** (Bilal *et al*., 2004)
3. Absolute precision = 1%

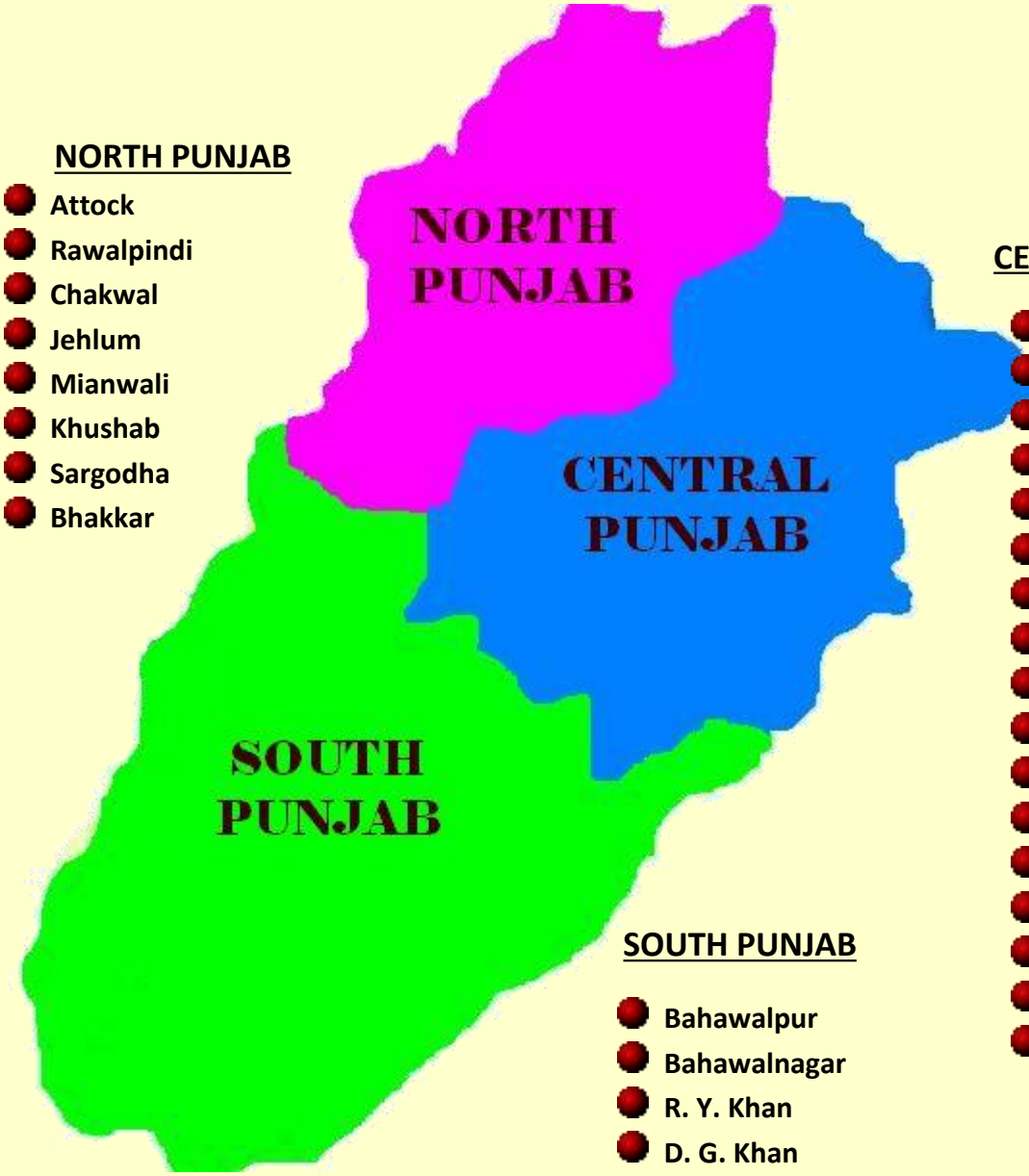
    Desired sample size (n)
    i. For endo-parasites = **9603**
    ii. For haemo-parasites = **3458**
    iii. For brucellosis = **1825**
    iv. For sub-clinical Mastitis = **6146**

Rural Poultry

1. Population Size (N) = 39300000)
2. Anticipated frequency of outcome in the population (For Gastro-intestinal Parasites) = 60% (Jatoi *et al*., 2013)
3. Absolute Precision = 1%

Desired Sample Size (n) = **9218**

For comparison, all districts of the Punjab are allocated to one of the three regions viz. North Punjab, Central Punjab and South Punjab.



NORTH PUNJAB

- Attock
- Rawalpindi
- Chakwal
- Jehlum
- Mianwali
- Khushab
- Sargodha
- Bhakkar

CENTRAL PUNJAB

- Gujranwala
- Gujrat
- Sialkot
- Hafizabad
- Mandi Bahauddin
- Narowal
- Lahore
- Sheikhupura
- Nankana Sahib
- Kasur
- Chiniot
- Faisalabad
- Jhang
- Toba Tek Singh
- Sahiwal
- Okara
- Pakpattan

SOUTH PUNJAB

- Bahawalpur
- Bahawalnagar
- R. Y. Khan
- D. G. Khan
- Rajan Pur
- Muzaffargarh
- Layyah
- Multan
- Khanewal
- Lodhran
- Vehari

Figure 1: Regions of the Punjab

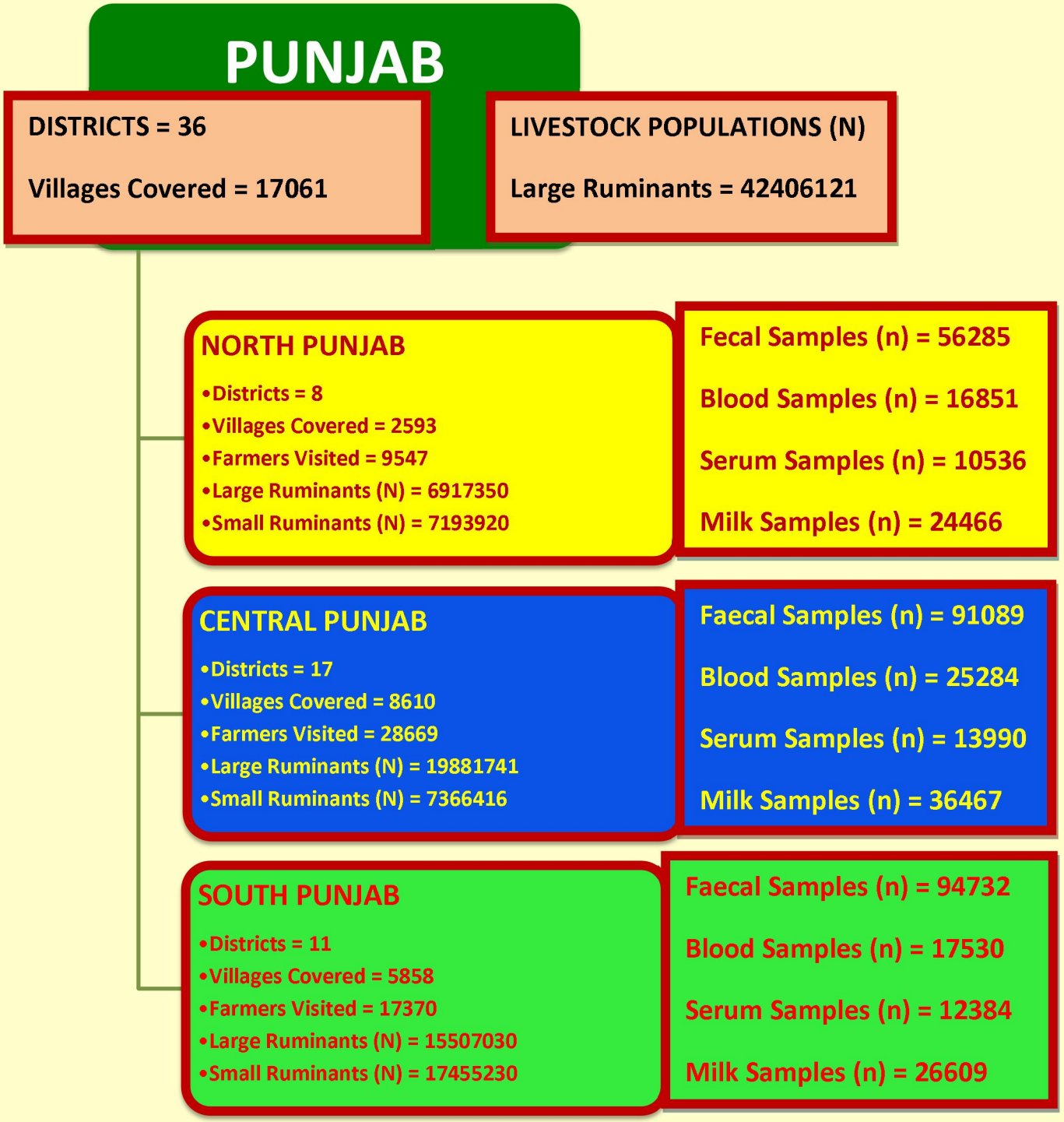


Figure 2: Flow Diagram of Number of Samples Collected from Different Regions of the Punjab

LIVESTOCK DISEASE RISK PROFILE OF THE PUNJAB

Number of positive samples for endo-parasites (127289/52.57%), haemo-parasites (6762/11.33%), brucellosis (1906/5.16%) and sub-clinical mastitis (17442/19.92%) is more than the desired sample size estimated for each mentioned parameter of present study. This increased number of positive cases indicates that results are more precise and are truly representing the disease status of respective population.

Endo-parasites

Faecal examination of small and large ruminants revealed the prevalence of different types of endo-parasites which is given below:

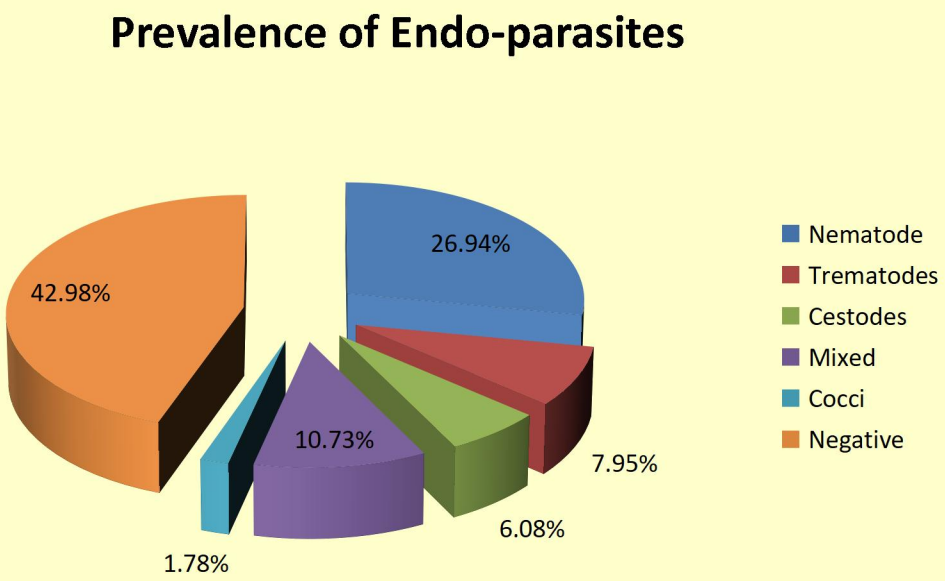
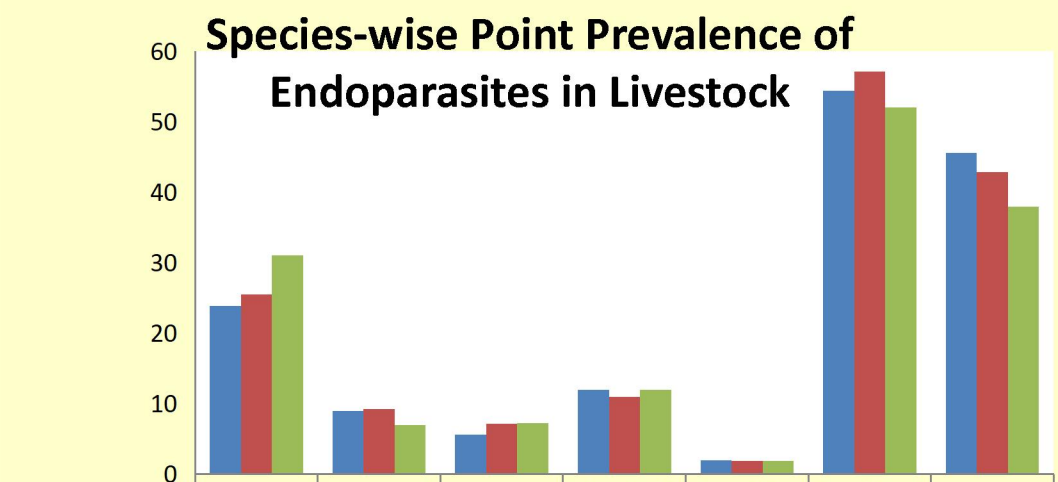


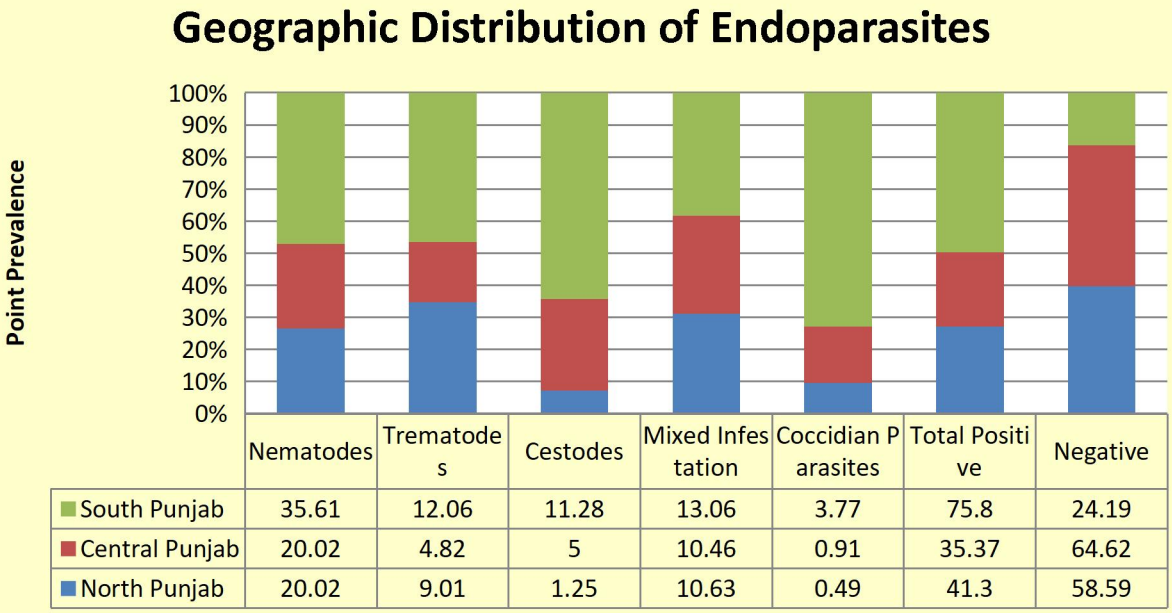
Chart 1: Prevalence of Endo-parasites in the Punjab

The species-wise and region-wise distribution of endo-parasites in livestock populations is given in the charts below:



	Nematode	Trematode	Cestode	Mixed Infestation	Coccidian Parasite	Total Positive	Negative
Buffalo	23.87	9	5.63	11.93	1.97	54.43	45.56
Cattle	25.46	9.26	7.17	10.99	1.91	57.15	42.84
Goat/Sheep	31.08	7	7.28	11.99	1.88	52.06	37.93

Chart 2: Species-wise Prevalence of Endo-parasites in Livestock



	Nematodes	Trematodes	Cestodes	Mixed Infestation	Coccidian Parasites	Total Positive	Negative
South Punjab	35.61	12.06	11.28	13.06	3.77	75.8	24.19
Central Punjab	20.02	4.82	5	10.46	0.91	35.37	64.62
North Punjab	20.02	9.01	1.25	10.63	0.49	41.3	58.59

Chart 3 : Geographic Distribution of Endo-parasites in Different Regions of the Punjab

Loss due to worm infestation is about Rs. 12701062791 / month in the Punjab province. The share of different regions of the Punjab in this much magnitude of loss is given in the chart below:

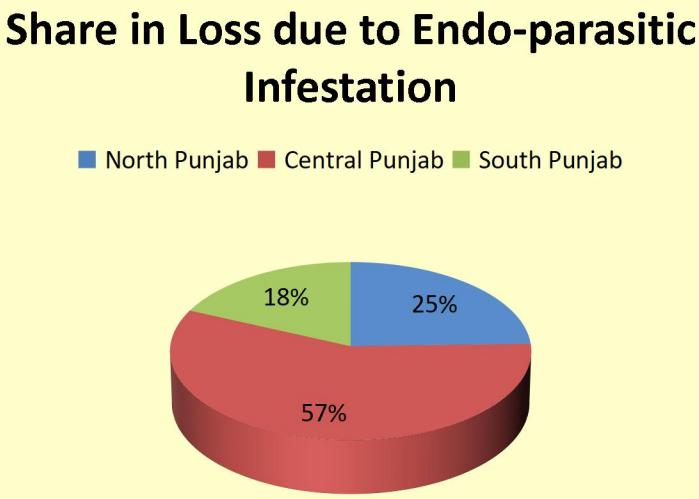


Chart 4: Share in Loss due to Endo-parasitic Infestation.

Highest percentage of loss is from Central Punjab (Rs. 4,021,449,937 / month) followed by North Punjab (Rs. 1,726,829,013 / month) and South Punjab (Rs. 1,284,446,206 / month).

In North Punjab the endo-parasitic infested population of large-ruminants is presented in the chart below:

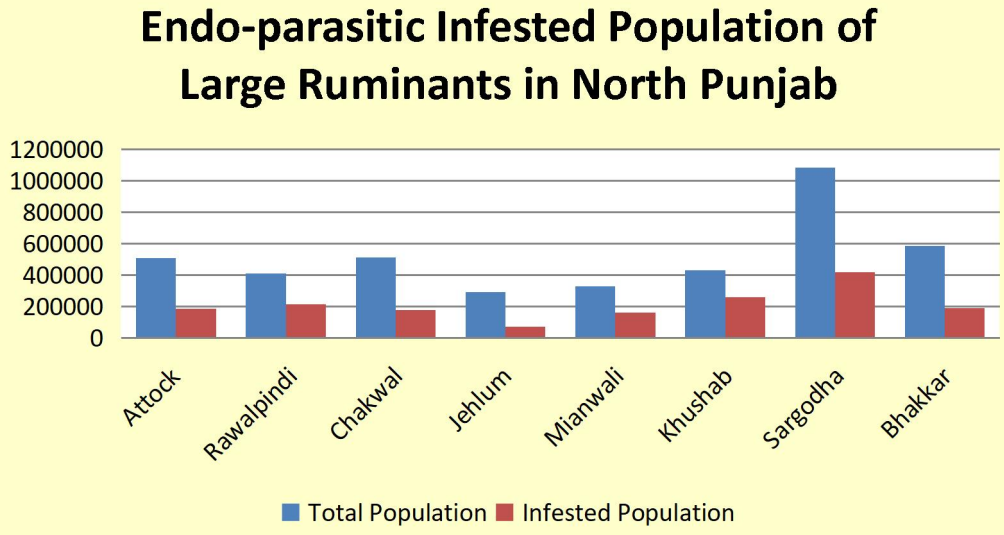


Chart 5: Endo-parasitic Infested Population of Large Ruminants in North Punjab

This chart indicates that 24.93% of the endo-parasitic infested population of large ruminants of North Punjab is in Sargodha followed by Khushab (15.46%) and

Rawalpindi (12.72%). The point prevalence of endo-parasites in large ruminants of North Punjab is given in the chart below:

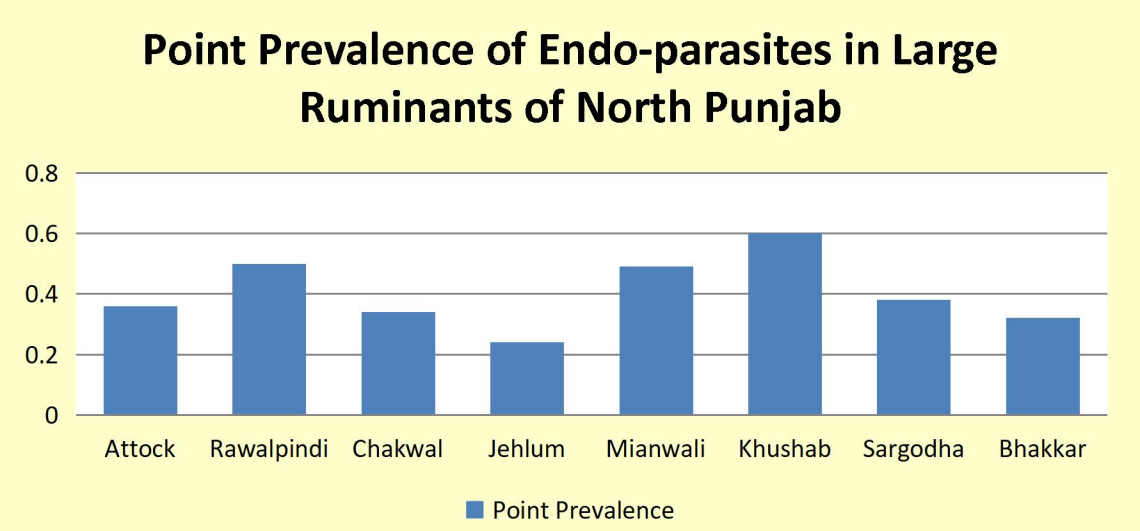


Chart 6: Point Prevalence of Endo-parasites in Large Ruminants of North Punjab

This data indicates that in North Punjab highest prevalence of endo-parasites are recorded in the Khushab (60%) followed by Rawalpindi (50%) and Mianwali (49%).

The magnitude of loss in beef production due to endo-parasitic infestation in North Punjab is given in the chart below:

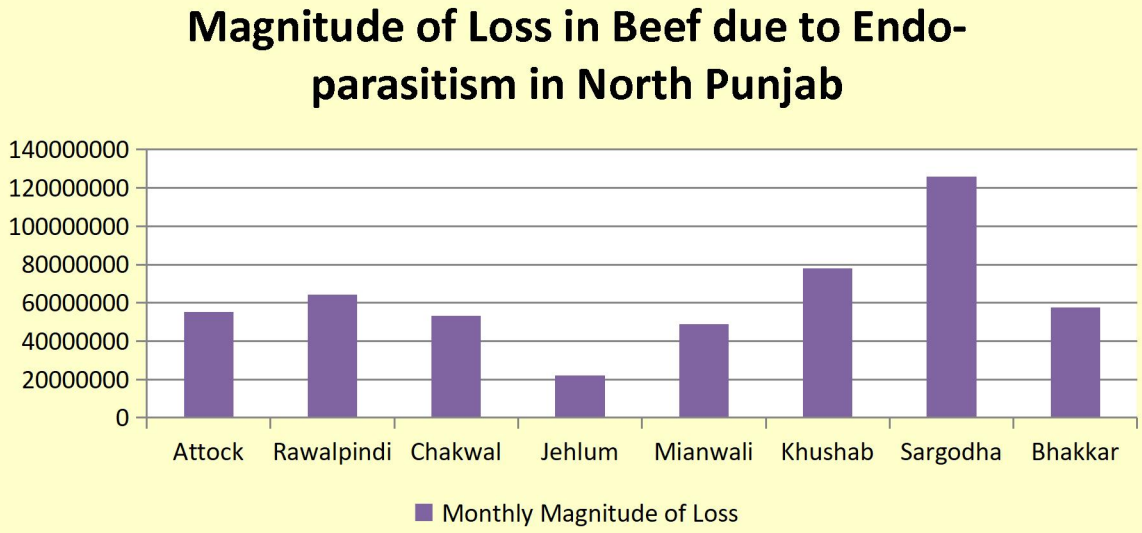


Chart 7: Magnitude of Loss in Beef due to Endo-parasitism in North Punjab

Maximum loss in beef production due to endo-parasitic infestation in North Punjab is observed in Sargodha (Rs. 126,023,489 / month) followed by Khushab (Rs. 78,171,750 / month) and Rawalpindi (Rs. 64,311,891 / month).
The magnitude of loss in milk production due to endo-parasitism in North Punjab is given in the chart below:

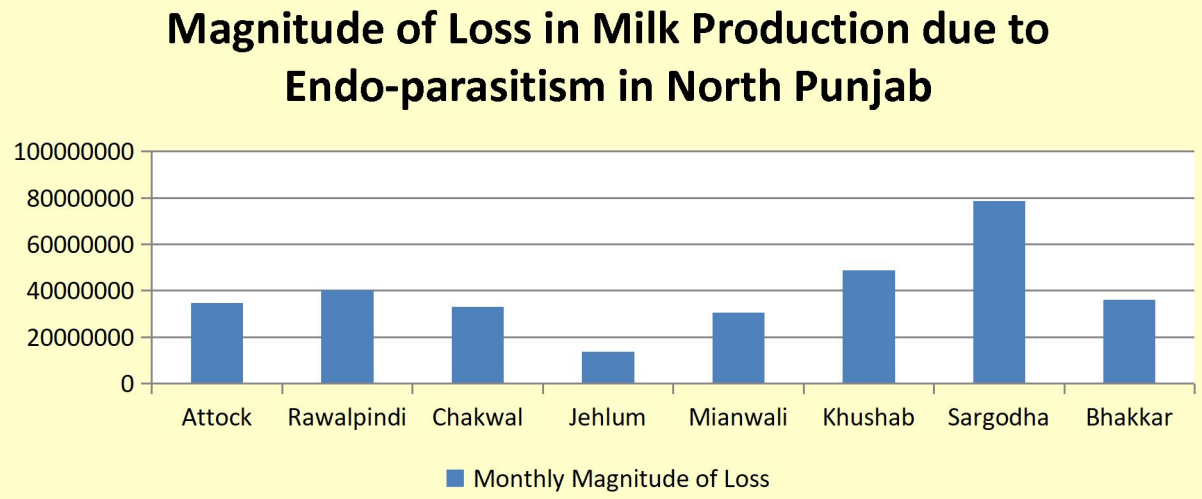


Chart 8: Magnitude of Loss in Milk Production due to Endo-parasitism in North Punjab

This chart indicates that the highest loss in milk production due to endo-parasitic infestation is in Sargodha (Rs. 78,764,680 / month) followed by Khushab (Rs. 48,857,343 / month) and Rawalpindi (Rs. 40,194,933 / month).
In North Punjab the endo-parasitic infested population of small-ruminants is presented in the chart below:

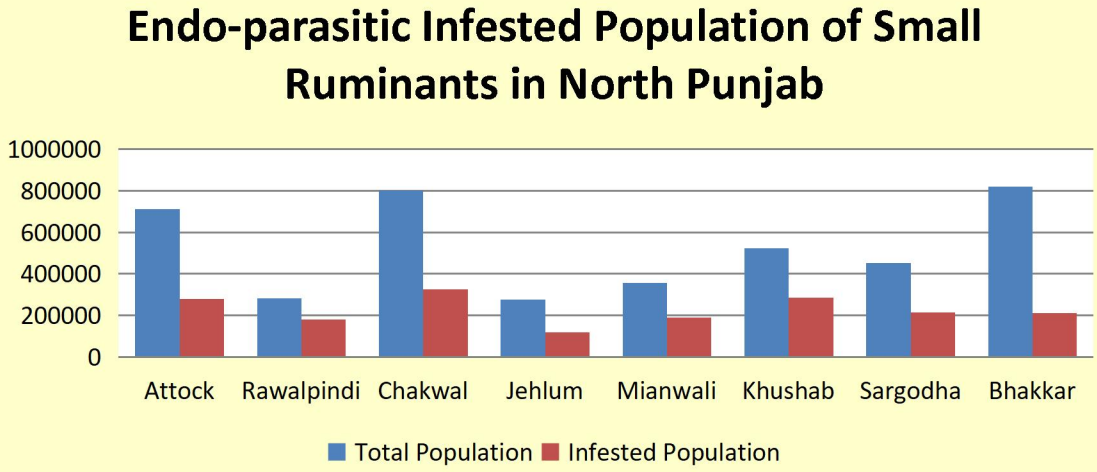


Chart 9: Endo-parasitic Infested Population of Small Ruminants in North Punjab

This chart indicates that 18% of the endo-parasitic infested population of small ruminants of North Punjab is in Chakwal followed by Khushab (15.74%) and Attock (15.5%).

The point prevalence of endo-parasites in small-ruminants of North Punjab is given in the chart below:

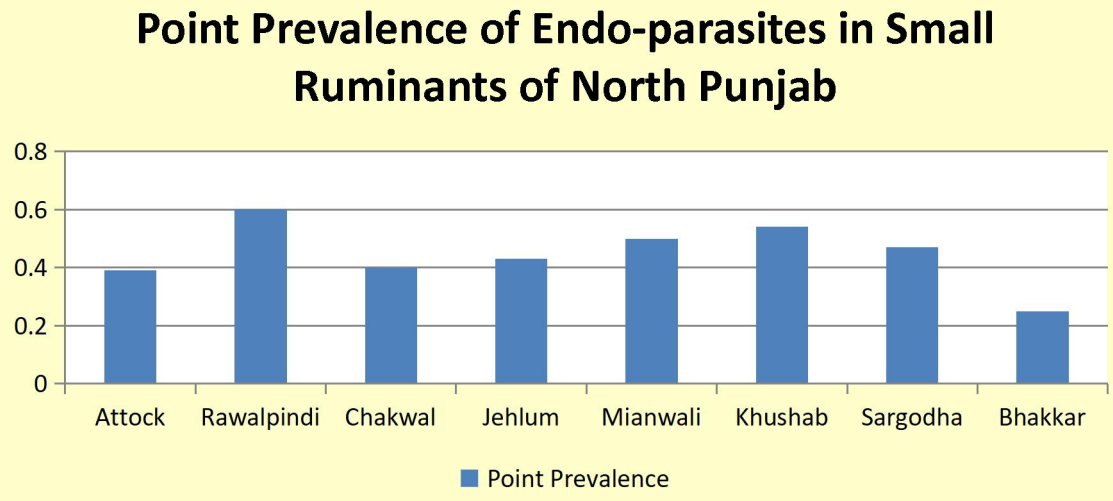


Chart 10: Point Prevalence of Endo-parasites in Small Ruminants of North Punjab.

This data indicates that in North Punjab highest prevalence of endo-parasites in small-ruminants is recorded in the Rawalpindi (60%) followed by Khushab (54%) and Mianwali (50%).

The magnitude of loss in mutton production due to endo-parasitic infestation in North Punjab is given in the chart below:

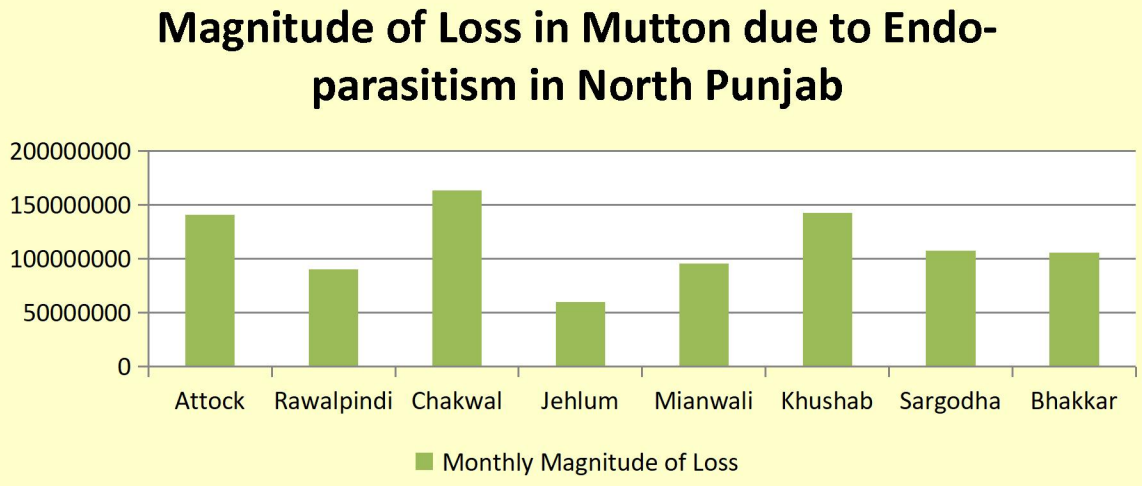


Chart 11: Magnitude of Loss in Mutton due to Endo-parasitism in North Punjab.

This chart indicates that highest loss in mutton production due to endo-parasitic infestation in North Punjab is in Chakwal (Rs. 163,074,655 / month) followed by Khushab (Rs. 142,622,312 / month) and Attock (Rs. 140,448,705 / month).
In Central Punjab the endo-parasitic infested population of large-ruminants is presented in the chart below:

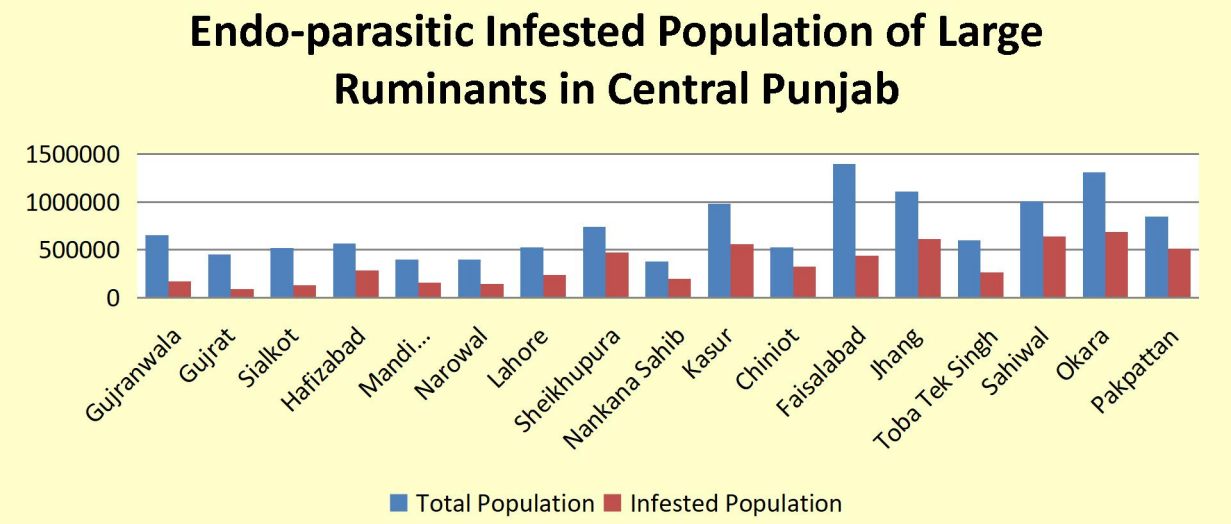


Chart 12: Endo-parasitic Infested Population of Large Ruminants in Central Punjab.

This chart indicates that 11.64% of the endo-parasitic infested population of large ruminants of Central Punjab is in Okara followed by Sahiwal (10.78%) and Jhang (10.33%).
The point prevalence of endo-parasites in large ruminants of Central Punjab is given in the chart below:

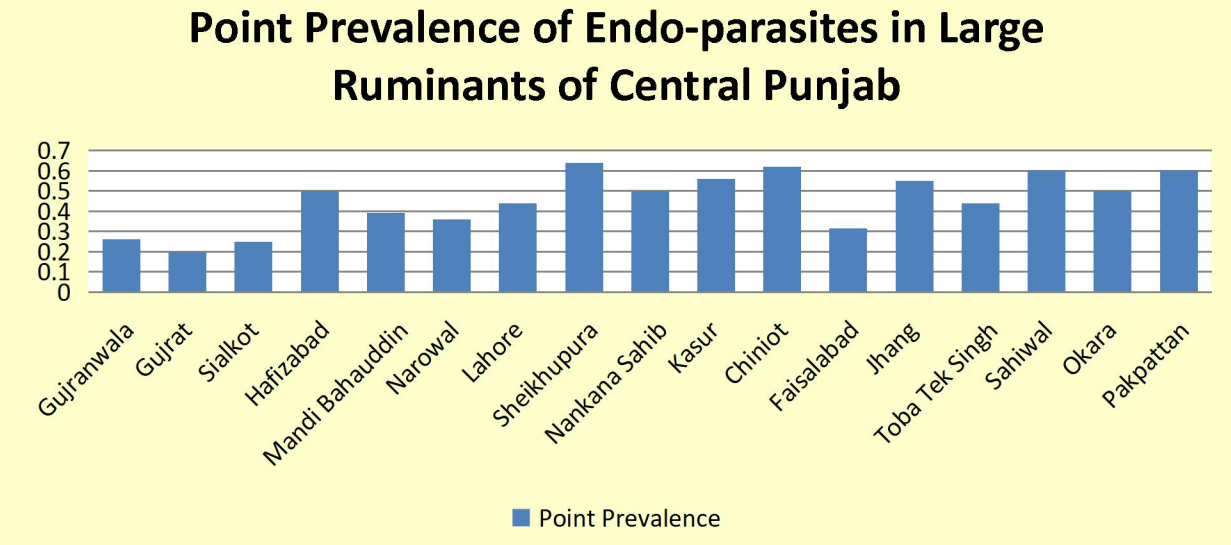


Chart 13: Point Prevalence of Endo-parasites in Large Ruminants of Central Punjab.

This data indicates that in Central Punjab highest prevalence of endo-parasites in large-ruminants is recorded in the Sheikhupura (64%) followed by Chiniot (62%) and Sahiwal (60%).

The magnitude of loss in beef production due to endo-parasitic infestation in Central Punjab is given in the chart below:

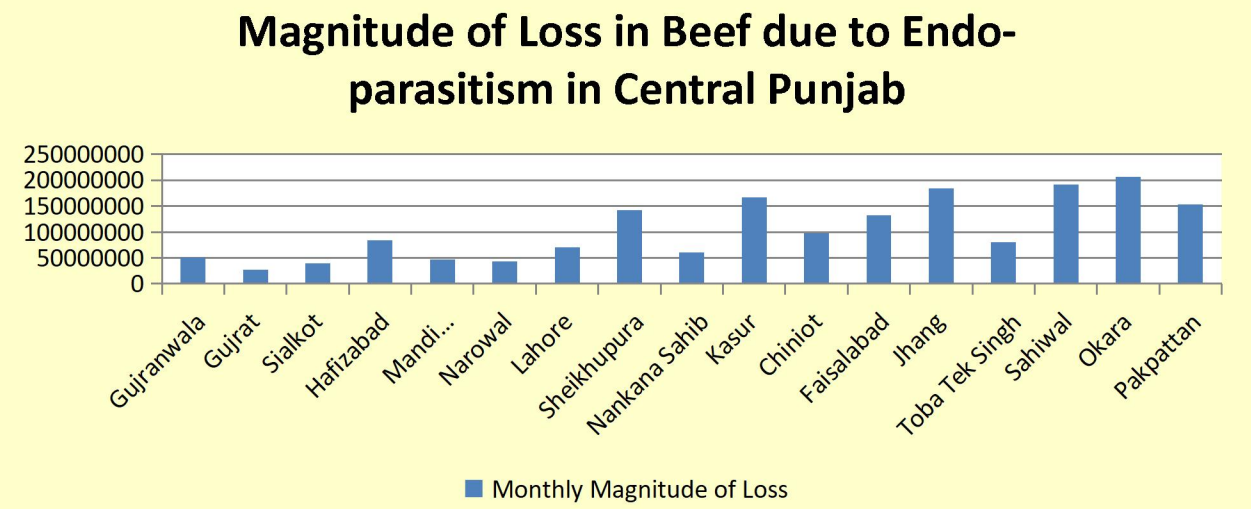


Chart 14: Magnitude of Loss in Beef due to Endo-parasitism in Central Punjab.

Maximum loss in beef production due to endo-parasitic infestation in Central Punjab is observed in Okara (Rs. 206,803,658 / month) followed by Sahiwal (Rs. 191,492,885 / month) and Jhang (Rs. 183,596,871 / month).

The magnitude of loss in milk production due to endo-parasitism in Central Punjab is given in the chart below:

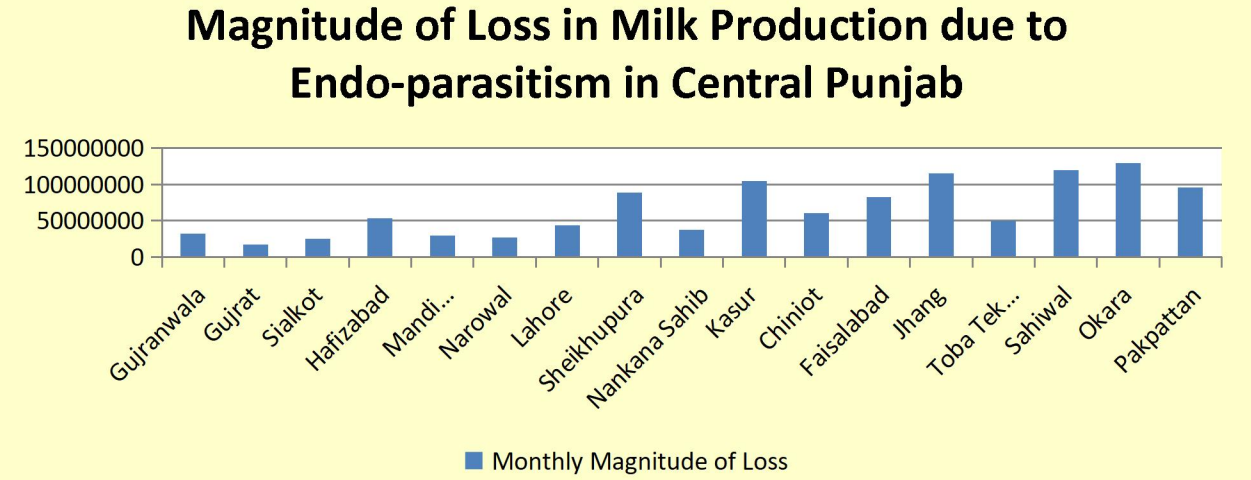


Chart 15: Magnitude of Loss in Milk Production due to Endo-parasitism in Central Punjab.

This chart indicates that highest loss in milk production due to endo-parasitism in Central Punjab is in Okara (Rs. 129,252,286 / month) followed by Sahiwal (Rs. 119,683,053 / month) and Jhang (Rs. 114,748,044 / month).
In Central Punjab the endo-parasitic infested population of small-ruminants is presented in the chart below:

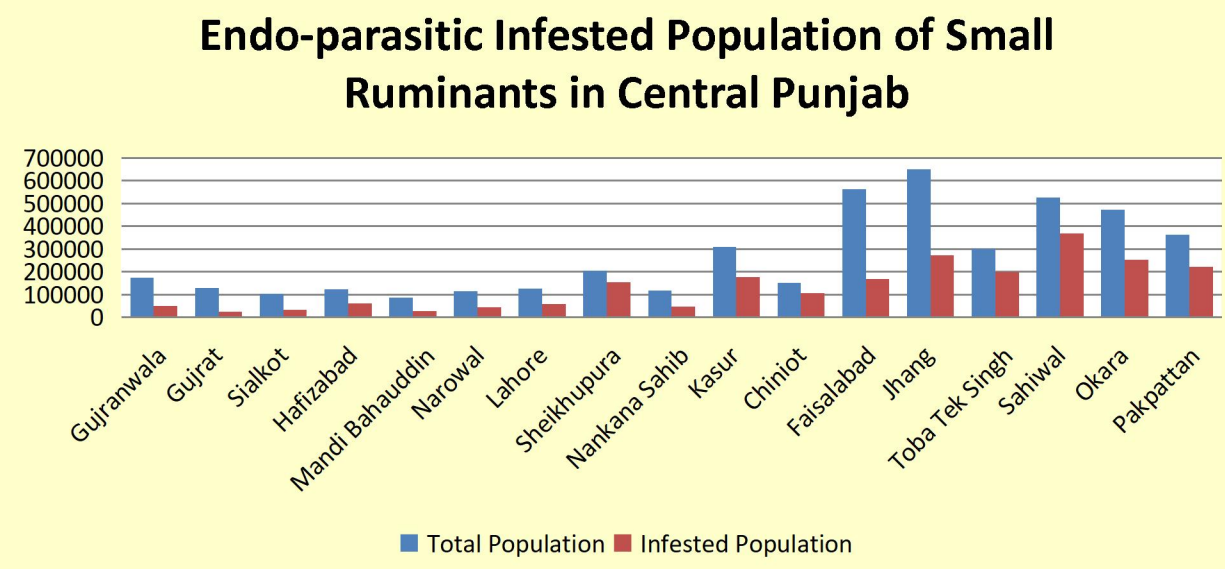


Chart 16: Endo-parasitic Infested Population of Small Ruminants in Central Punjab.

This chart indicates that 16.21% of the endo-parasitic infested population of small ruminants of Central Punjab is in Sahiwal followed by Jhang (12%) and Okara (11.13%).
The point prevalence of endo-parasites in small ruminants of Central Punjab is given in the chart below:

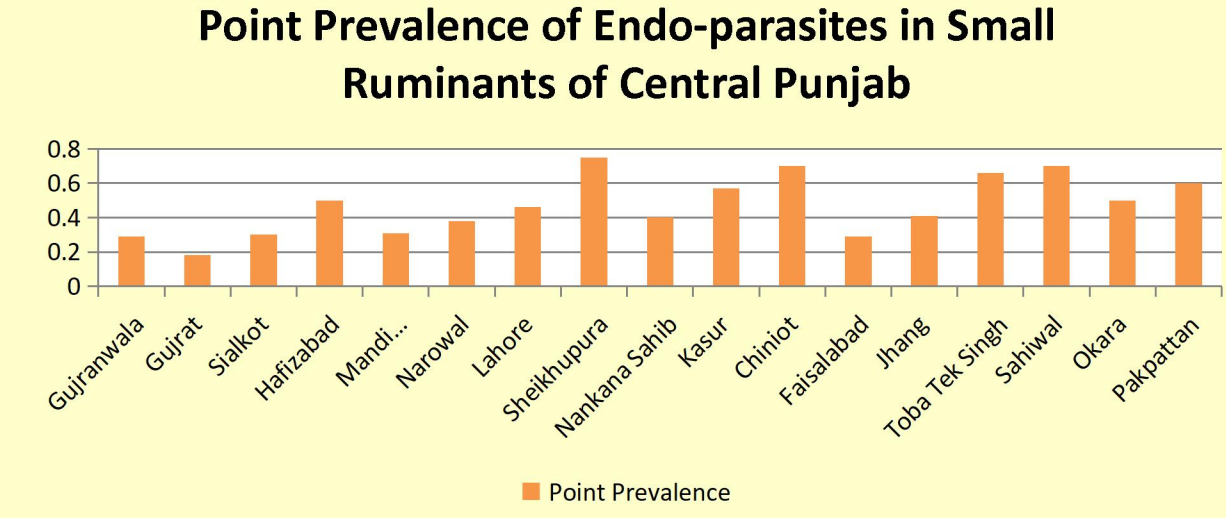


Chart 17: Point Prevalence of Endo-parasites in Small Ruminants of Central Punjab.

This data indicates that in Central Punjab highest prevalence of endo-parasites in small-ruminants is recorded in the Sheikhupura (75%) followed by Chiniot and Sahiwal (70% each).
The magnitude of loss in mutton production due to endo-parasitic infestation in Central Punjab is given in the chart below:

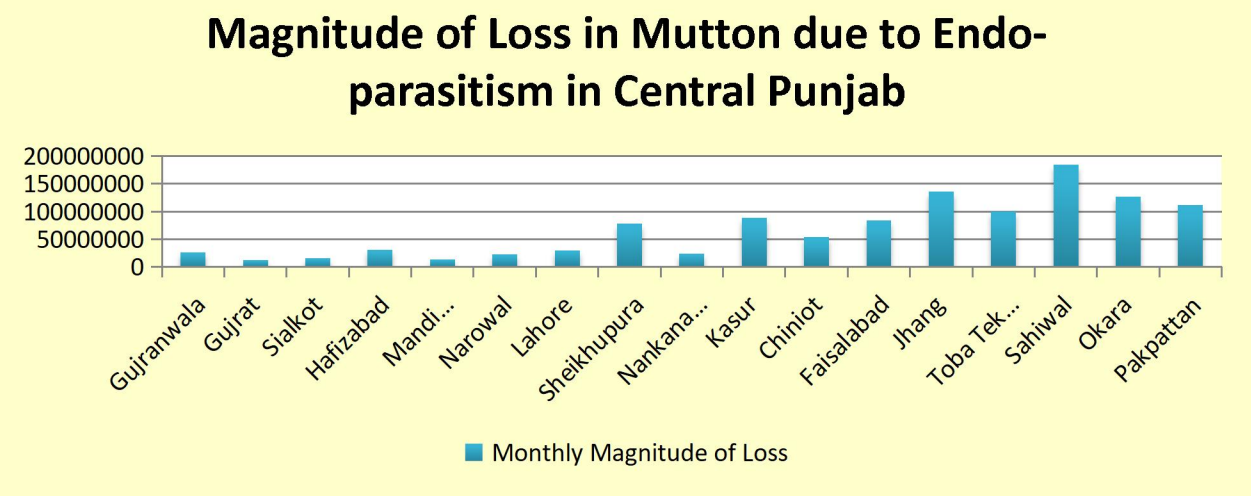


Chart 18: Magnitude of Loss in Mutton due to Endo-parasitism in Central Punjab.

This chart indicates that highest loss in mutton production due to endo-parasitic infestation is in Sahiwal (Rs. 184,250,318 / month) followed by Jhang (Rs. 136,516,880 / month) and Okara (Rs. 126,504,153 / month).

In South Punjab the endo-parasitic infested population of large-ruminants is presented in the chart below:

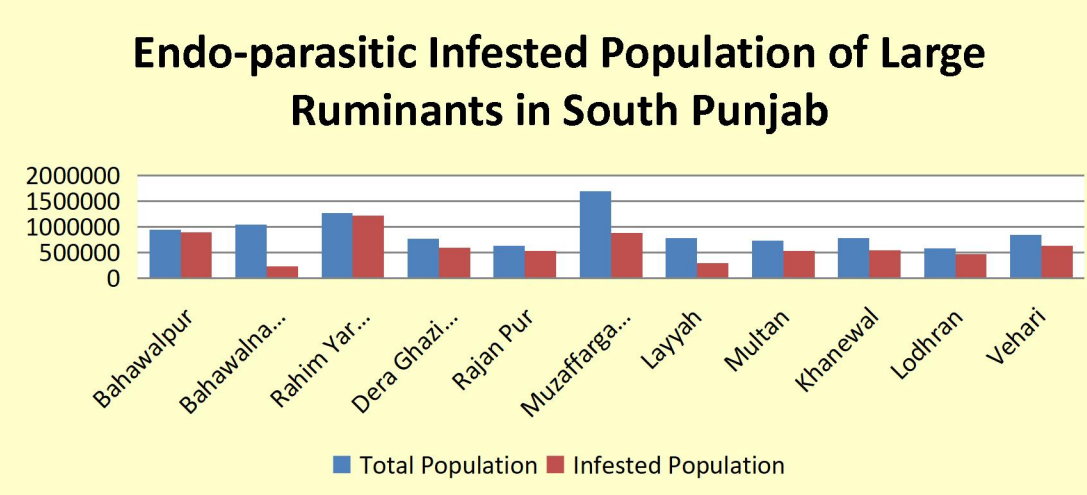


Chart 19: Endo-parasitic Infested Population of Large Ruminants in South Punjab.

This chart indicates that 17.76% of the endo-parasitic infested population of large ruminants of South Punjab is in Rahim Yar Khan followed by Bahawalpur (13.03%) and Muzaffargarh (12.87%).
The point prevalence of endo-parasites in large ruminants of South Punjab is given in the chart below:

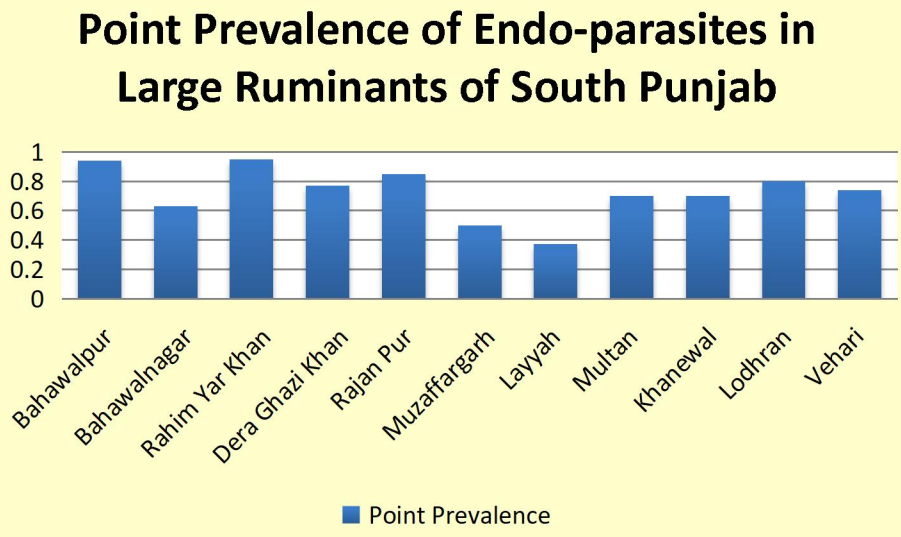


Chart 20: Point Prevalence of Endo-parasites in Large Ruminants of South Punjab.

This data indicates that in South Punjab highest prevalence of endo-parasites in large-ruminants is recorded in the Rahim Yar Khan (95%) followed by Bahawalpur (94%) and Rajanpur (85%).
The magnitude of loss in beef production due to endo-parasitic infestation in South Punjab is given in the chart below:

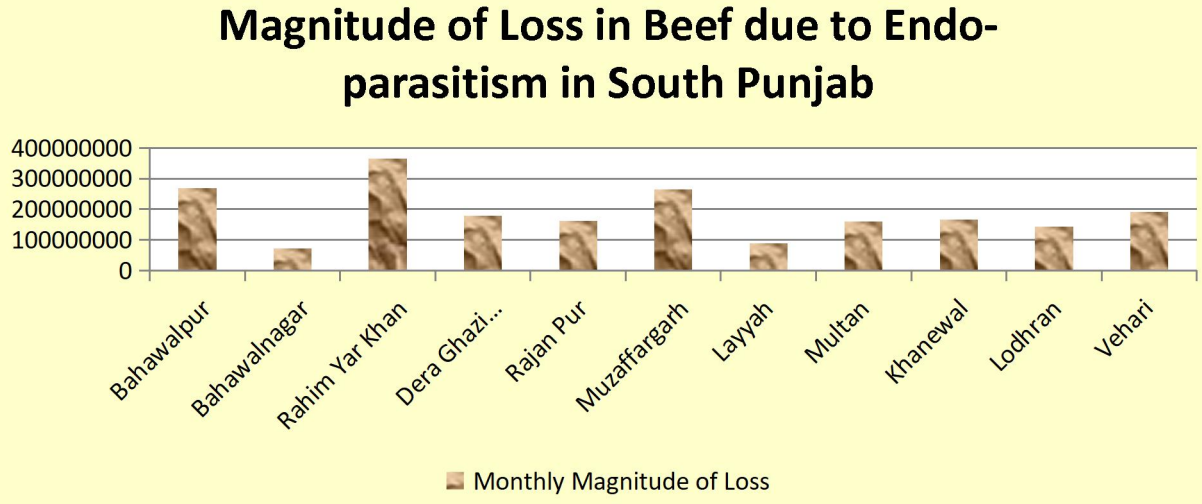


Chart 21: Magnitude of Loss in Beef due to Endo-parasitism in South Punjab.

Maximum loss in beef production due to endo-parasitic infestation in South Punjab is observed in Rahim Yar Khan (Rs. 365,148,953 / month) followed by Bahawalpur (Rs. 267,811,264 / month) and Muzaffargarh (Rs. 264,657,283 / month).
The magnitude of loss in milk production due to endo-parasitism in South Punjab is given in the chart below:

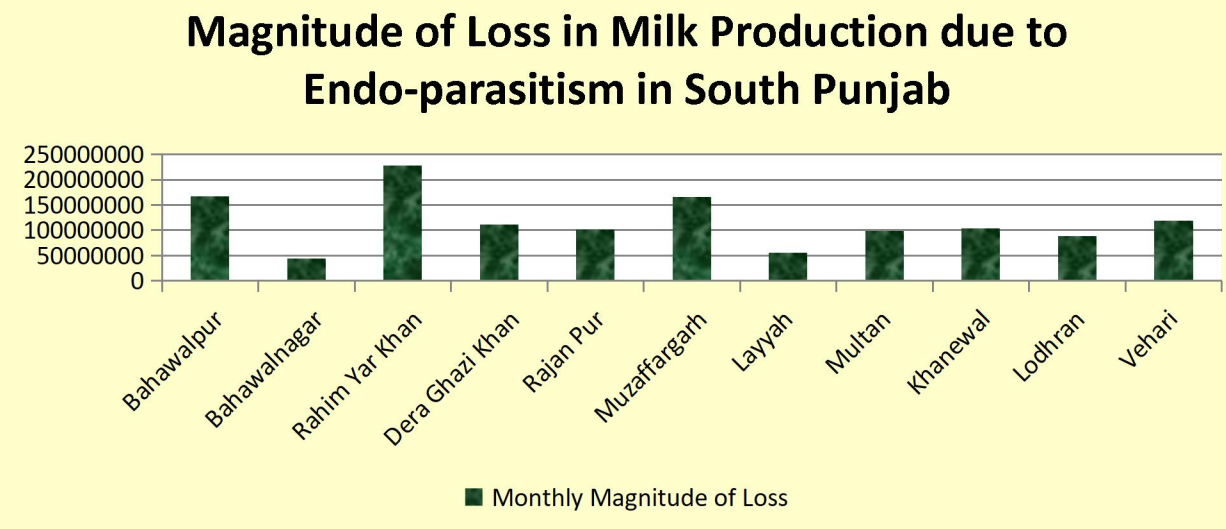


Chart 22: Magnitude of Loss in Milk Production due to Endo-parasitism in South Punjab.

This chart indicates that highest loss in milk production due to endo-parasitic infestation in South Punjab is in Rahim Yar Khan (Rs. 228,218,095 / month) followed by Bahawalpur (Rs. 167,382,040 / month) and Muzaffargarh (Rs. 165,410,801 / month).
In South Punjab the endo-parasitic infested population of small-ruminants is presented in the chart below:

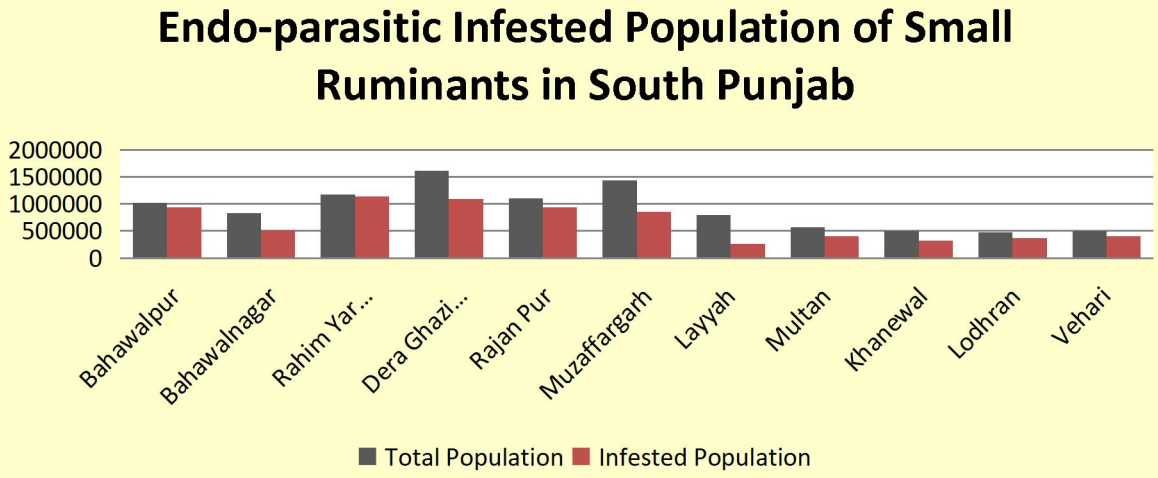


Chart 23: Endo-parasitic Infested Population of Small Ruminants in South Punjab.

This chart indicates that 15.74% of the endo-parasitic infested population of small ruminants of South Punjab is in Rahim Yar Khan followed by Dera Ghazi Khan (15.13%) and Bahawalpur (13.03%).
The point prevalence of endo-parasites in small-ruminants of South Punjab is given in the chart below:

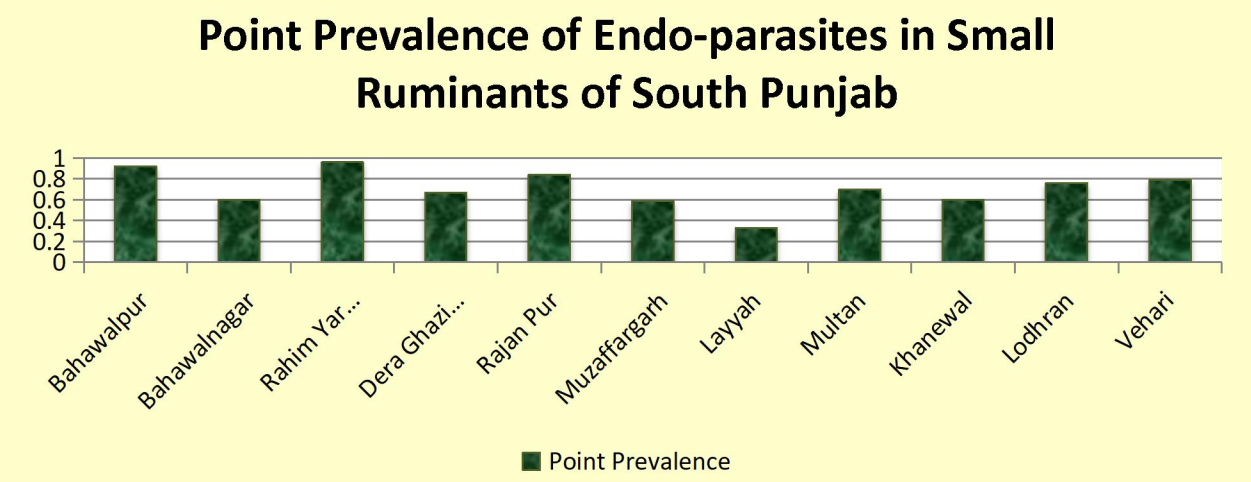


Chart 24: Point Prevalence of Endo-parasites in Small Ruminants of South Punjab.

This data indicates that in South Punjab highest prevalence of endo-parasites in small-ruminants is recorded in the Rahim Yar Khan (96%) followed by Bahawalpur (92%) and Rajan Pur (84%).
The magnitude of loss in mutton production due to endo-parasitic infestation in South Punjab is given in the chart below:

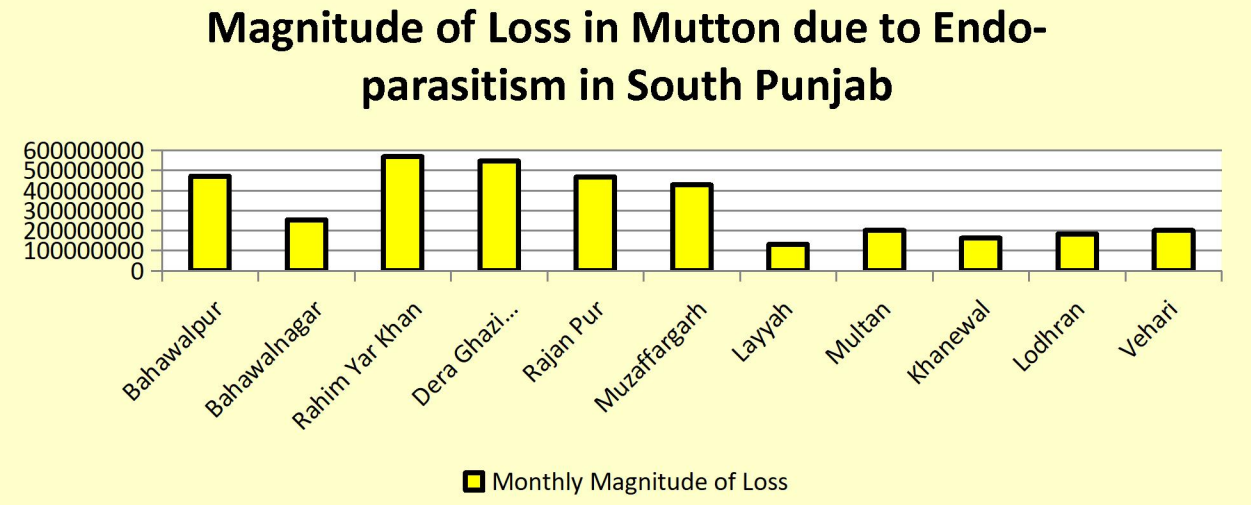


Chart 25: Magnitude of Loss in Mutton due to Endo-parasitism in South Punjab.

This chart indicates that highest loss in mutton production due to endo-parasitic infestation in South Punjab is in Rahim Yar Khan (Rs. 568,823,334 / month) followed by Dera Ghazi Khan (Rs. 546,818,291 / month) and Bahawalpur (Rs. 470,956,516 / month).
The endo-parasitic prevalence in rural poultry, in three regions of the Punjab, is given in the chart below:

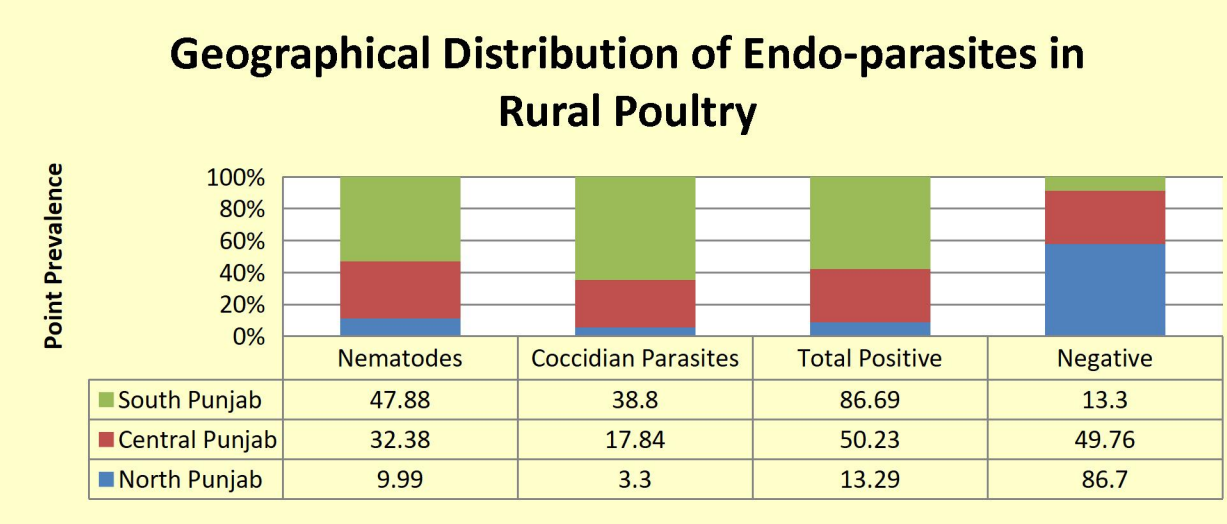


Chart 26: Geographical Distribution of Endo-parasites in Rural Poultry.

The endo-parasitic infested population of rural poultry of North Punjab is given in the chart below:

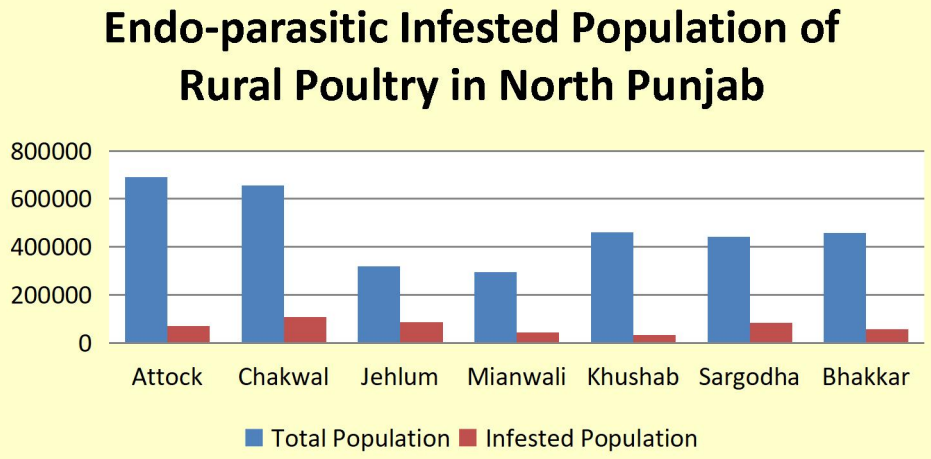


Chart 27: Endo-parasitic Infested Population of Rural Poultry in North Punjab.

This chart indicates that 22.29 % of the endo-parasitic infested population of rural poultry of North Punjab is in Chakwal followed by Jehlum (18.19%) and Sargodha (17.22%).

The endo-parasitic point prevalence in rural poultry of North Punjab is given in the chart below:

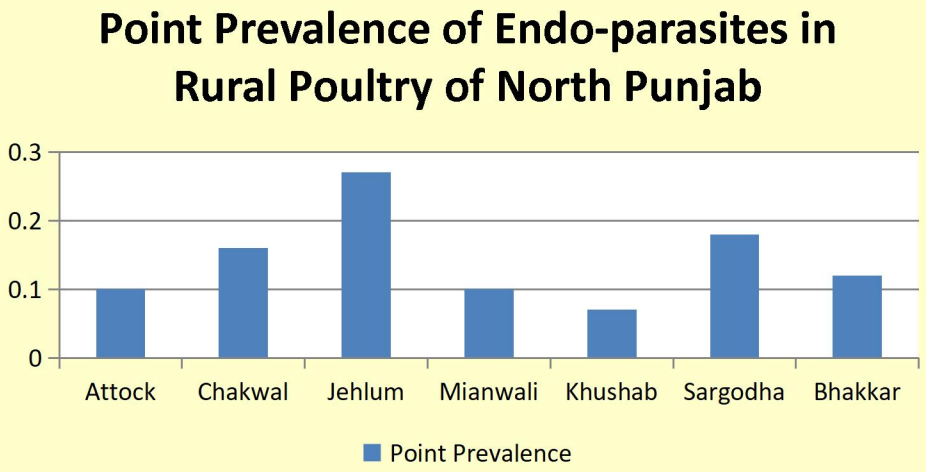


Chart 28: Point Prevalence of Endo-parasites in Rural Poultry of North Punjab.

This chart indicates that highest point prevalence of endo-parasites in rural poultry of North Punjab is recorded in Jehlum (27%) followed by Sargodha (18%) and Chakwal (16%).

The endo-parasitic infested population of rural poultry of Central Punjab is given in the chart below:

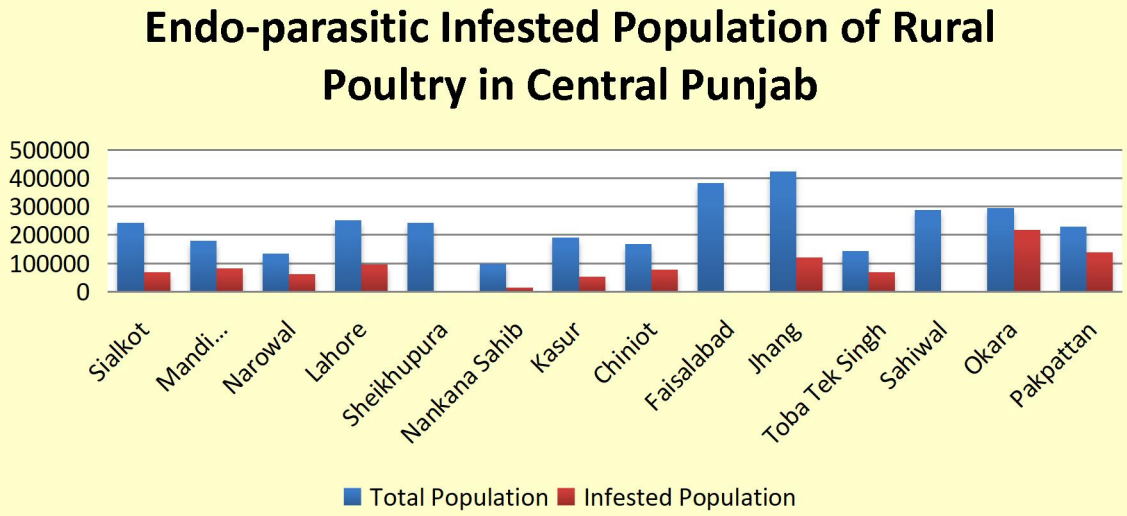


Chart 29: Endo-parasitic Infested Population of Rural Poultry in Central Punjab.

This chart indicates that 21.86 % of the endo-parasitic infested population of rural poultry of Central Punjab is in Okara followed by Pakpattan (13.91%) and Jhang (12.02%).

The endo-parasitic point prevalence in rural poultry of Central Punjab is given in the chart below:

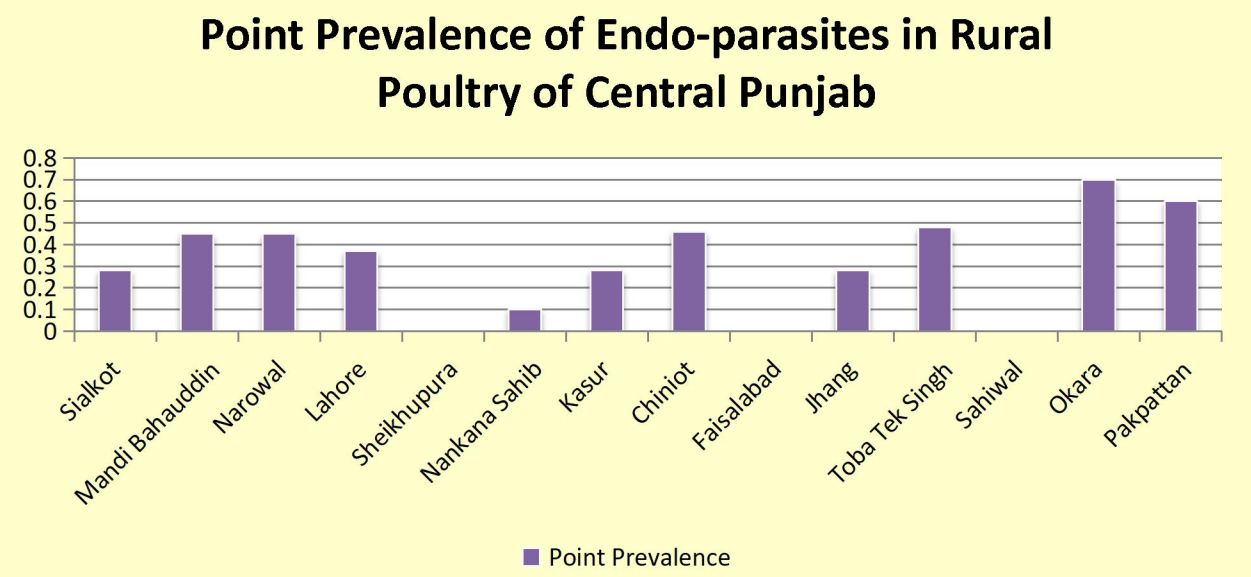


Chart 30: Point Prevalence of Endo-parasites in Rural Poultry of Central Punjab.

This chart indicates that highest point prevalence of endo-parasites in rural poultry of Central Punjab is recorded in Okara (70%) followed by Pakpattan (60%) and Chiniot (46%).

The endo-parasitic infested population of rural poultry of South Punjab is given in the chart below:

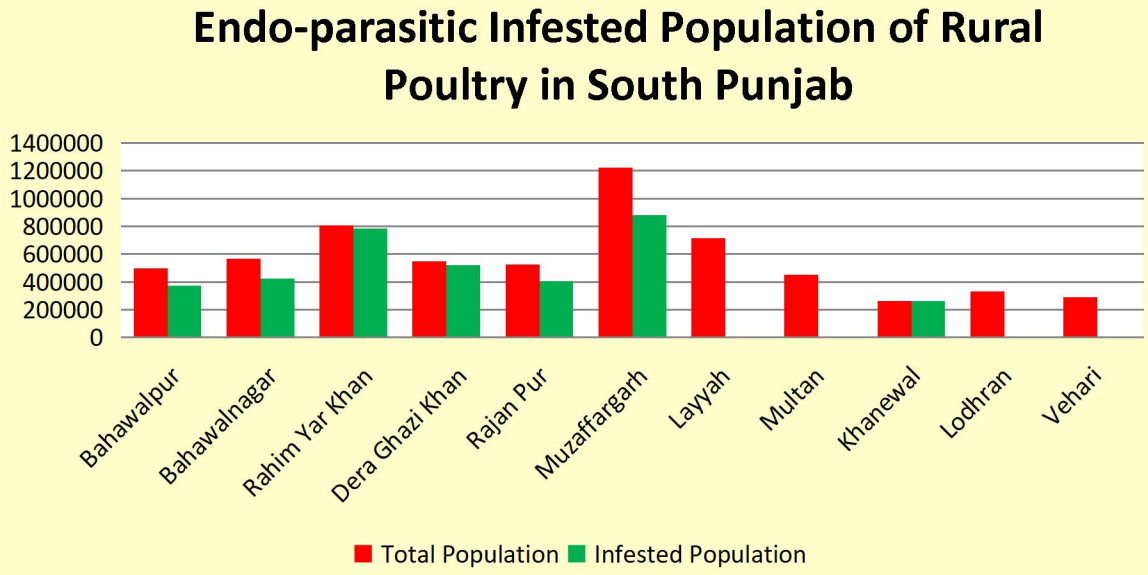


Chart 31: Endo-parasitic Infested Population of Rural Poultry in South Punjab.

This chart indicates that 24% of the endo-parasitic infested population of rural poultry of South Punjab is in Muzaffargarh followed by Rahim Yar Khan (21.46%) and Jhang (14.27%).

The endo-parasitic point prevalence in rural poultry of South Punjab is given in the chart below:

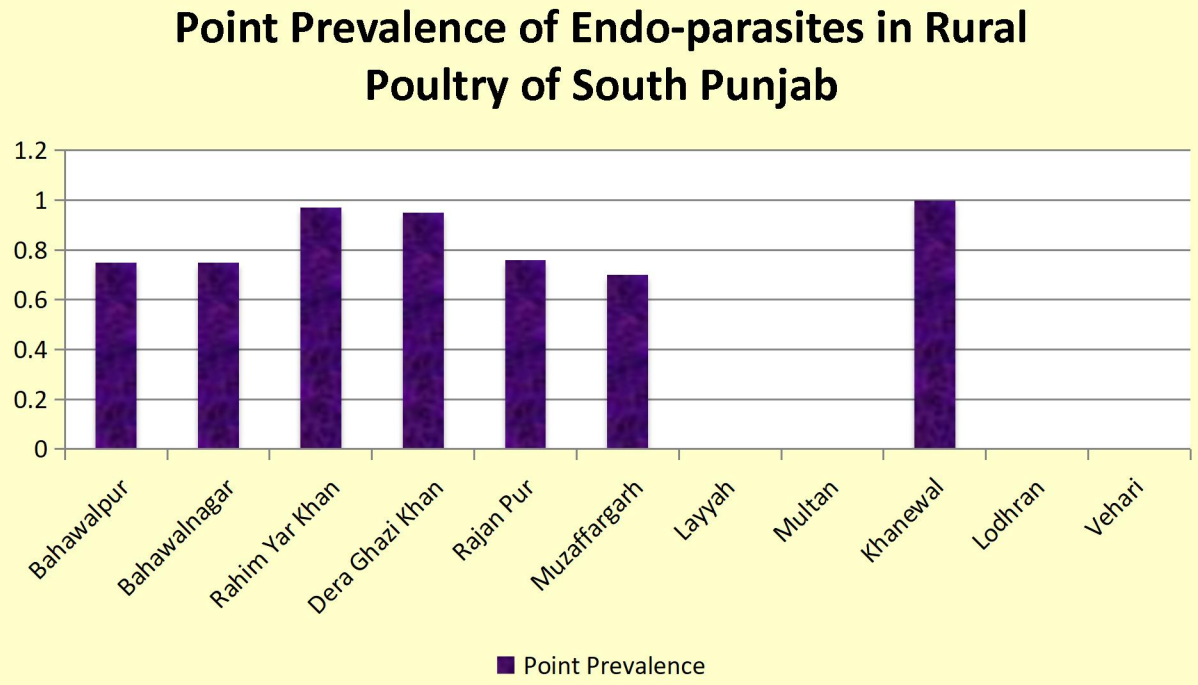


Chart 32: Point Prevalence of Endo-parasites in Rural Poultry of South Punjab.

This chart indicates that highest point prevalence of endo-parasites in rural poultry of South Punjab is recorded in Khanewal (100%) followed by Rahim Yar Khan (97%) and Dera Ghazi Khan (95%).

Haemo-parasites

The examination of blood samples from livestock populations of the Punjab revealed the point prevalence of Babesia, Therileria and Anaplasma.

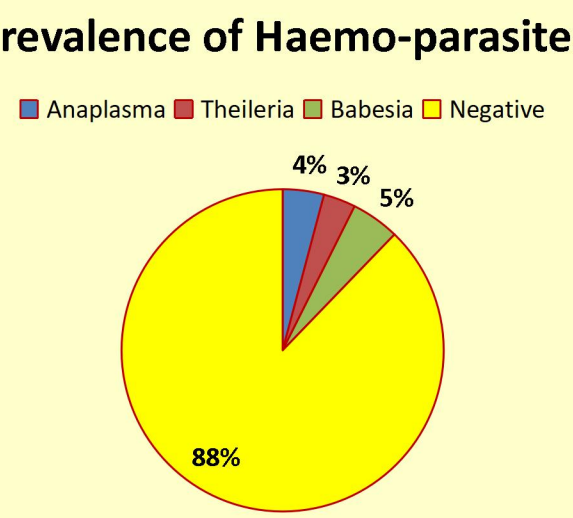
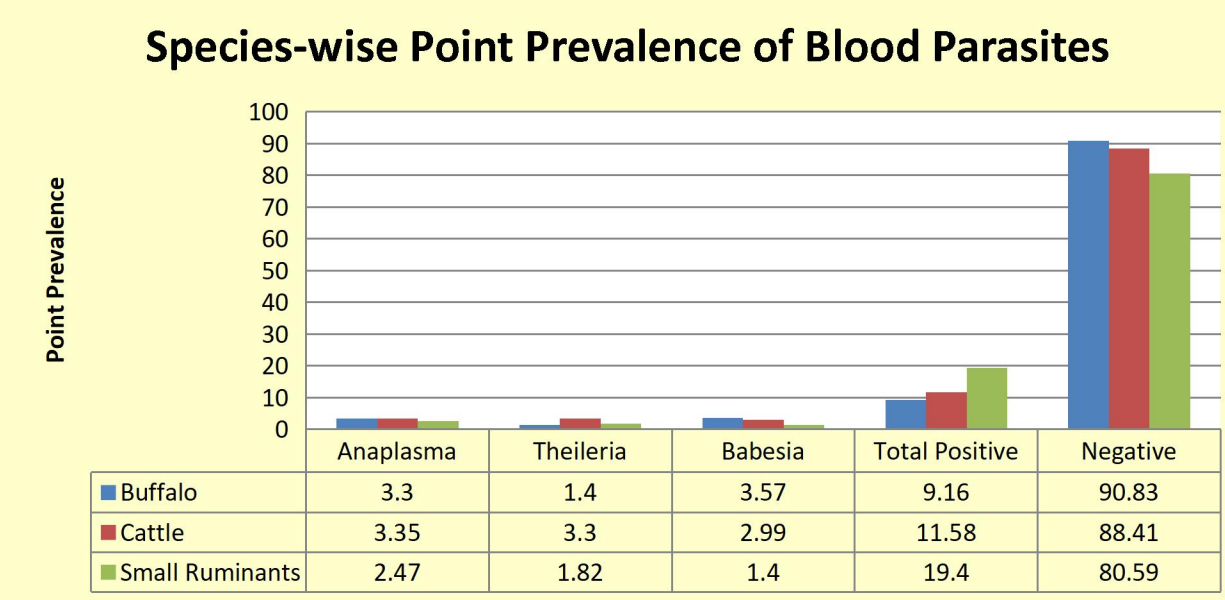


Chart 33: Prevalence of Haemo-parasites in the Punjab.

The species-wise distribution of blood parasites is given in the chart below:



	Anaplasma	Theileria	Babesia	Total Positive	Negative
Buffalo	3.3	1.4	3.57	9.16	90.83
Cattle	3.35	3.3	2.99	11.58	88.41
Small Ruminants	2.47	1.82	1.4	19.4	80.59

Chart 34: Species-wise Point Prevalence of Blood Parasites.

The point prevalence of haemo-parasites in the livestock populations of the three regions of the Punjab is given in the chart below:

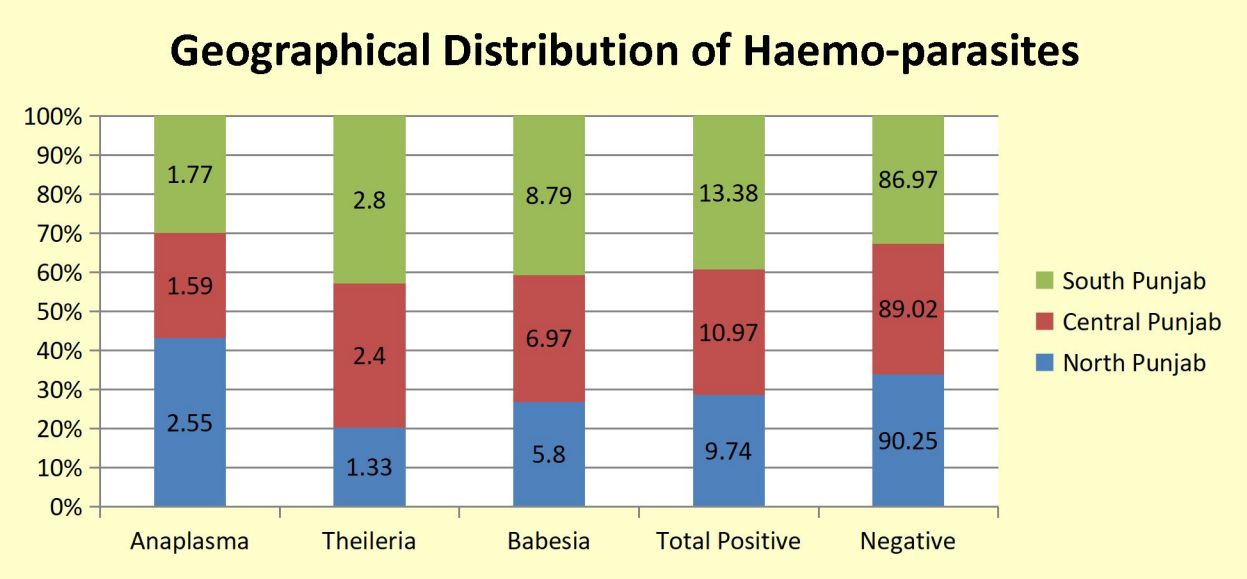


Chart 35: Geographical Distribution of Haemo-parasites.

The prevalence of blood parasites in buffalo population of North Punjab is given in the chart below:

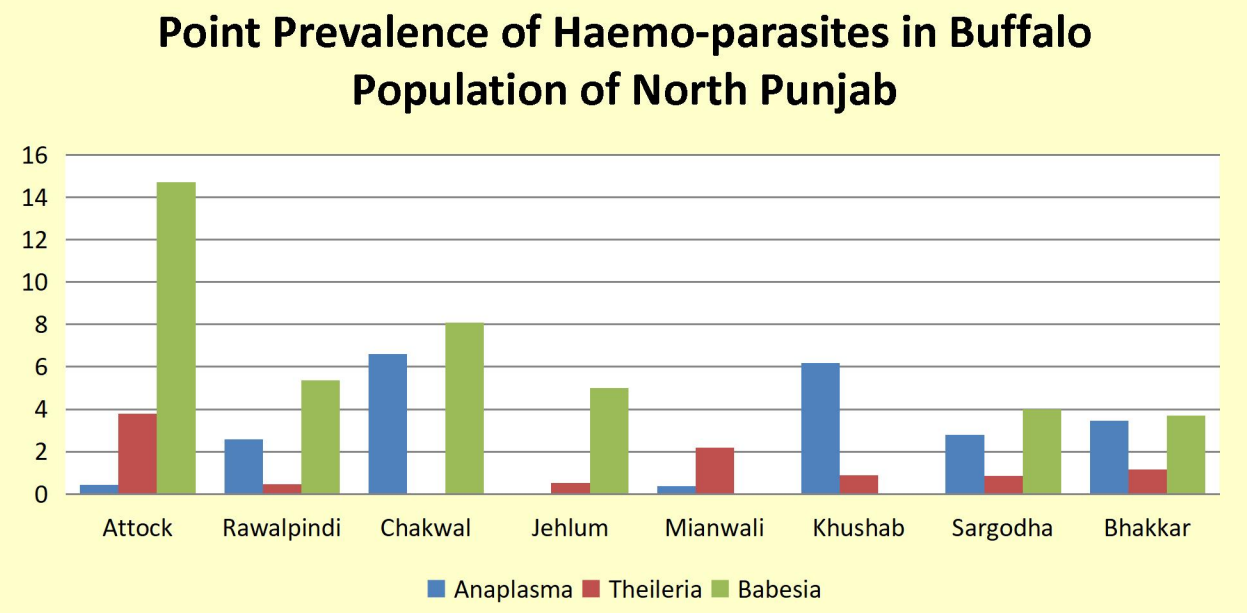


Chart 36: Point Prevalence of Haemo-parasites in Buffalo Population of North Punjab.

This chart indicates that highest prevalence of anaplasmosis is in buffalo population of North Punjab is in Chakwal (6.6%) followed by Khushab (6.19%). The highest prevalence of theileriosis is recorded in Attock (3.78%) followed by Mianwali (2.2%). The highest prevalence risk of babesiosis is recorded in buffalo population at Attock (14.7%) followed by Chakwal (8.1%).

The prevalence of haemo-parasites in the cattle population of North Punjab is as under:

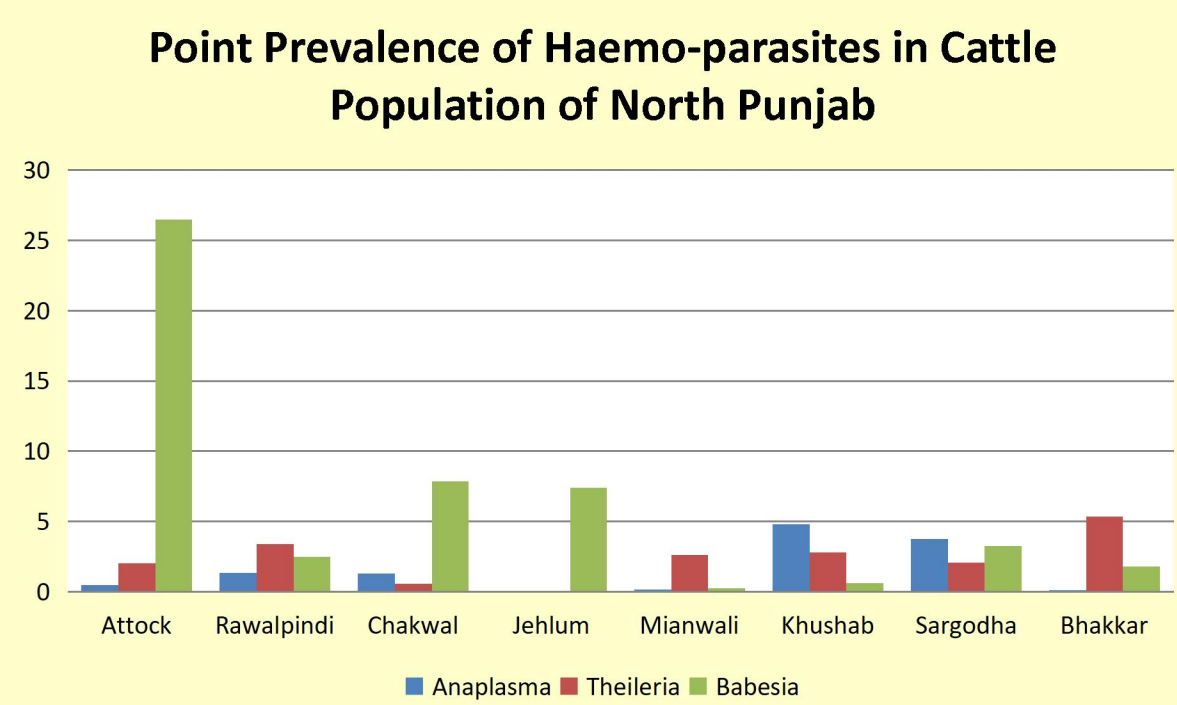


Chart 37: Point Prevalence of Haemo-parasites in Cattle Population of North Punjab.

This chart indicates that the highest prevalence of babesiosis in cattle population of North Punjab is in Attock (26.47%) followed by Chakwal (7.86%) and Jehlum (7.4%). The point prevalence of theileriosis is at the highest in Bhakkar (5.33%) followed by Rawalpindi (3.39%) and Khushab (2.8%). The highest prevalence of anaplasmosis is recorded at Khushab (4.78%) followed by Sargodha (3.76%).

The prevalence of haemo-parasites in the small ruminant population of North Punjab is as under:

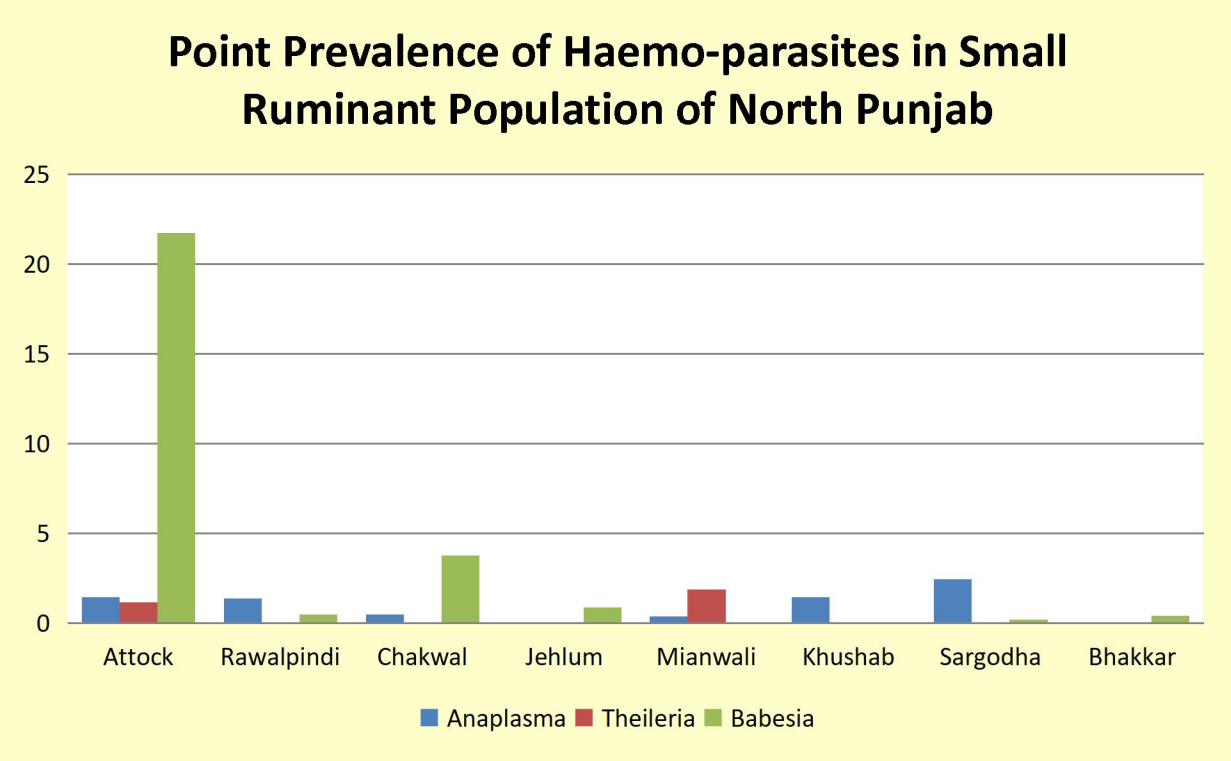


Chart 38: Point Prevalence of Haemo-parasites in Small Ruminants Population of North Punjab.

The chart indicates that the highest prevalence of anaplasmosis (2.42%), theileriosis (1.87%) and babesiosis (21.73%) in small ruminant population of North Punjab is recorded in Sargodha, Mianwali and Attock, respectively.

The following chart indicates that the highest prevalence of babesiosis in the buffalo population of Central Punjab is in Faisalabad (7.3%) followed by Mandi Bahauddin (6.1%), Kasur (5.89%) and Nankana (5.88%). The highest prevalence of theileriosis is recorded in the buffalo population of Sheikhupura (6.75%) followed by Narowal (2.23%). The highest prevalence of anaplasmosis is recorded in buffalo population of Narowal (4.29%) followed by Jhang (3.57%).

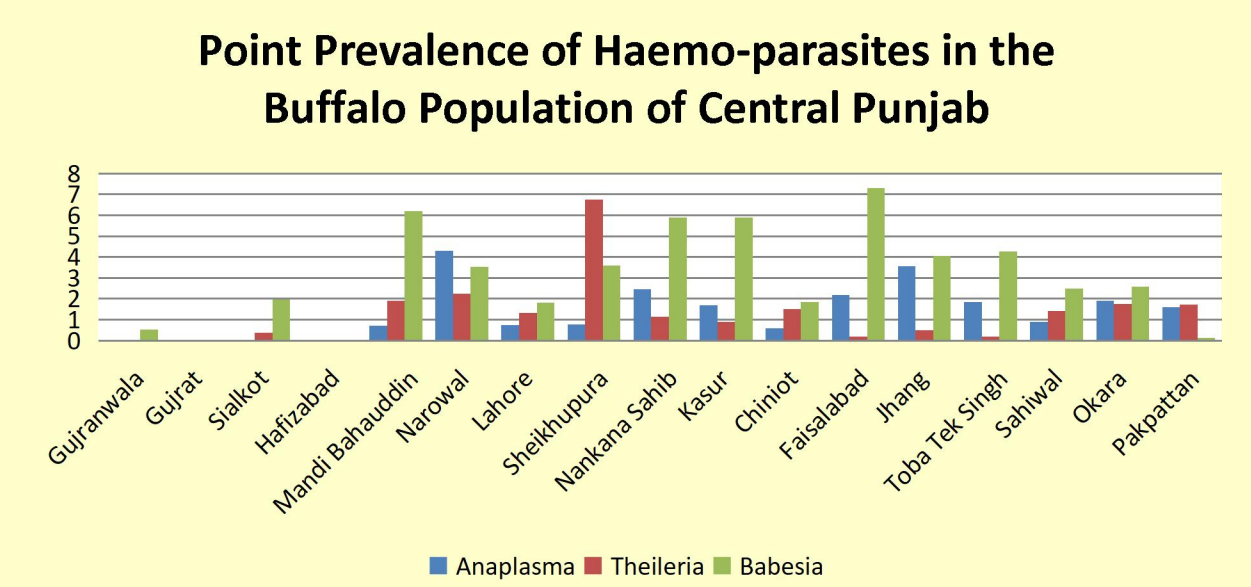


Chart 39: Point Prevalence of Haemo-parasites in the Buffalo Population of Central Punjab.

The prevalence of blood parasites in cattle population of Central Punjab is presented in the chart below:

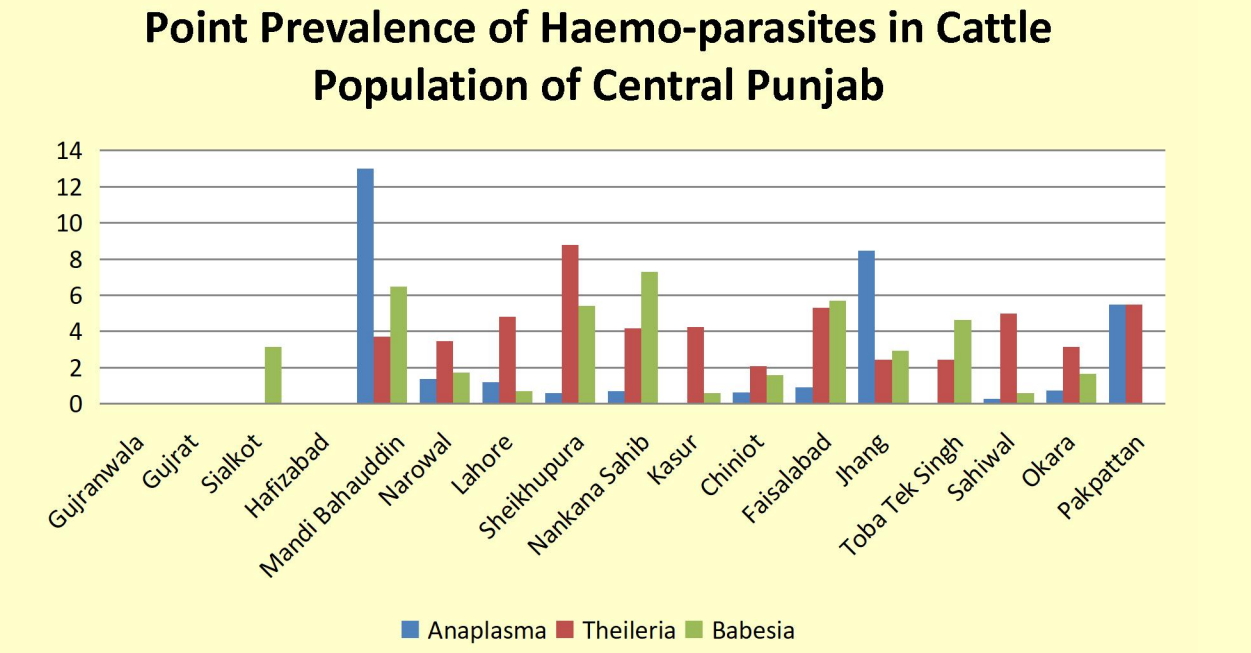


Chart 40: Point Prevalence of Haemo-parasites in Cattle Population of Central Punjab.

This chart indicates that the highest prevalence of anaplasmosis in the cattle population of Central Punjab is in the Mandi Bahauddin (12.99%) followed by Jhang (8.47%) and Pakpattan (5.47%). The highest prevalence of theileriosis is recorded in the cattle population of Sheikhupura (8.79%) followed by Mandi Bahauddin (5.47%). In Nankana, the highest prevalence (7.29%) of babesiosis is recorded in cattle population.

The point prevalence of blood parasites in the small ruminants population of Central Punjab is given in the chart below:

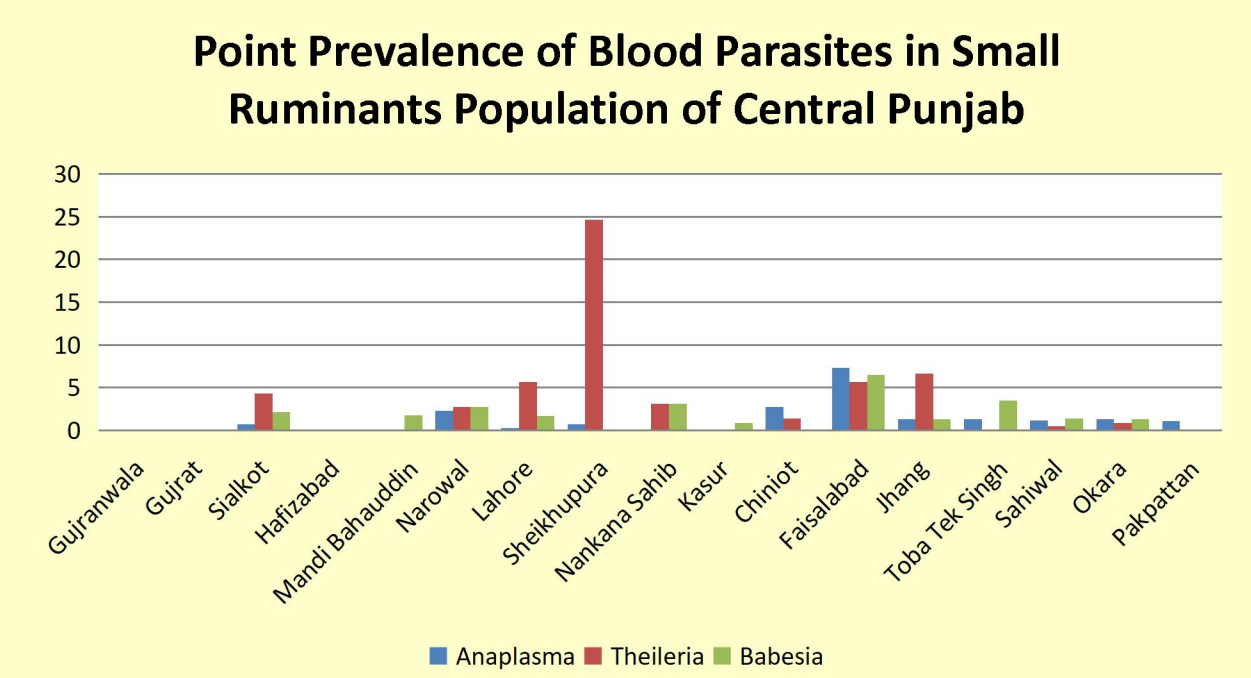


Chart 41: Point Prevalence of Blood Parasites in Small Ruminants Population of Central Punjab.

This chart indicates that the highest prevalence (24.65%) of theileriosis in the small ruminants population of Central Punjab is recorded in the Sheikhupura.

The point prevalence of blood parasites in buffalo population of South Punjab is given in the chart below:

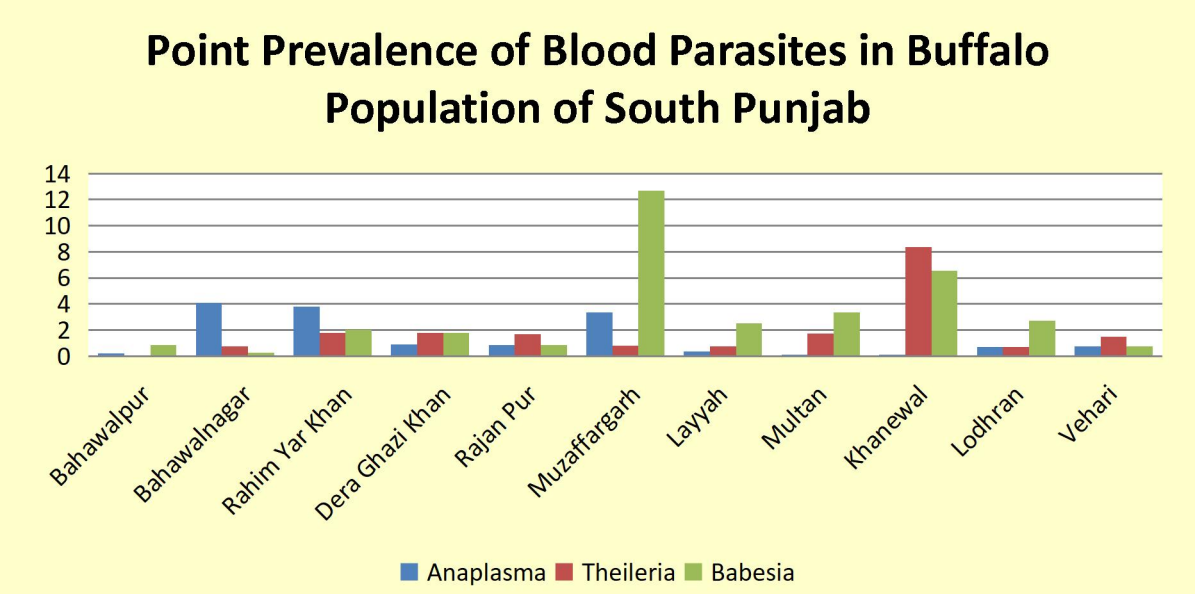


Chart 42: Point Prevalence of Blood Parasites in Buffalo Population of South Punjab.

This chart indicates that the highest prevalence of babesiosis, theileriosis and anaplasmosis in buffalo population of South Punjab is recorded in Muzaffargarh (12.7%), Khanewal (8.38%) and Bahawalnagar (4.06%), respectively.

The following chart indicates that the highest prevalence of theileriosis in the cattle population of South Punjab is in Khanewal (11.95%) followed by Muzaffargarh (9.7%). In the cattle population of South Punjab the highest prevalence of babesiosis and anaplasmosis is in Khanewal (4%) and Muzaffargarh (5.48%), respectively.

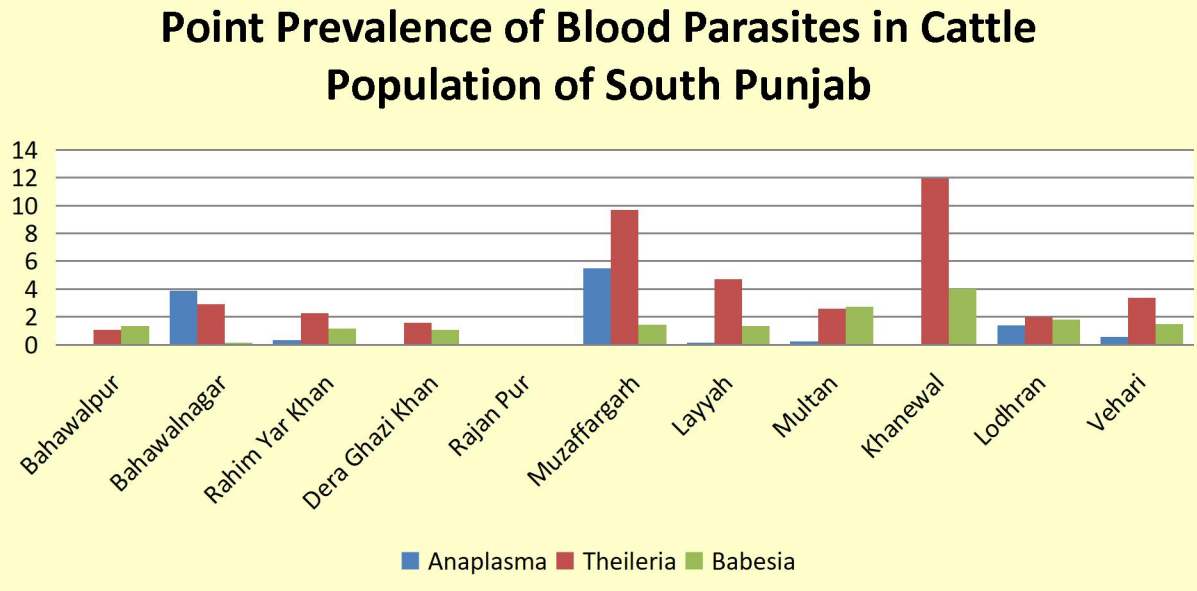


Chart 43: Point Prevalence of Blood Parasites in Cattle Population of South Punjab.

The prevalence risk of blood parasites in small ruminants of South Punjab is presented in the chart below:

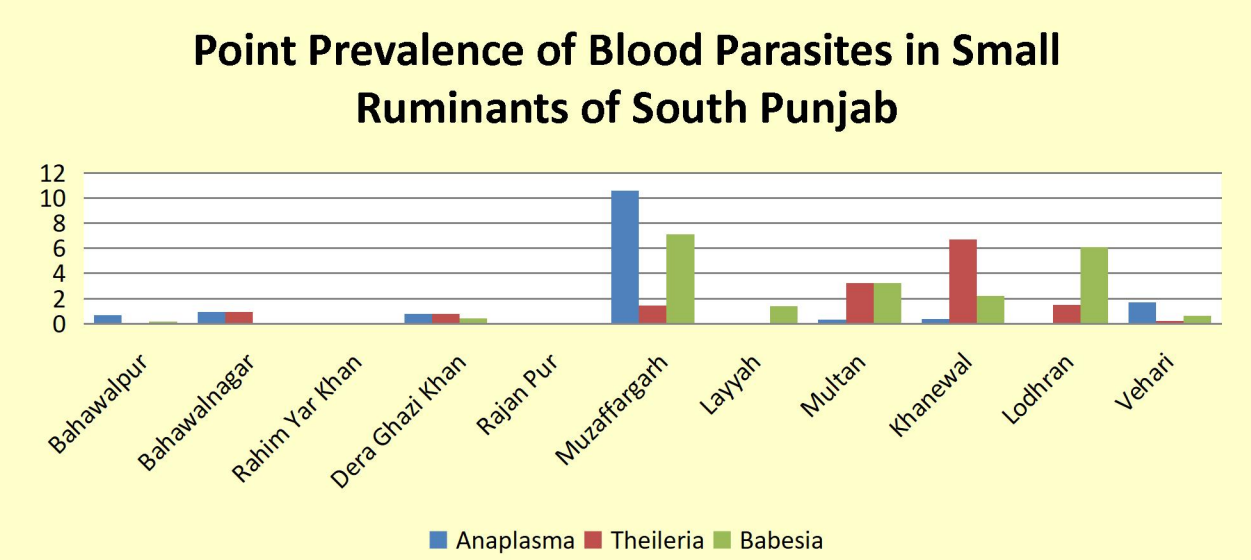


Chart 44: Point Prevalence of Blood Parasites in Small Ruminants of South Punjab.

The highest prevalence of anaplasmosis and theileriosis in the small ruminants of South Punjab is in the Muzaffargarh (10.6%) and Khanewal (6.69%), respectively. The highest prevalence risk of babesiosis is recorded in the Muzaffargarh (7.11%) followed by Lodhran (6.09%).

Brucellosis

The overall prevalence of brucellosis in the livestock populations of the Punjab is given in the chart below:

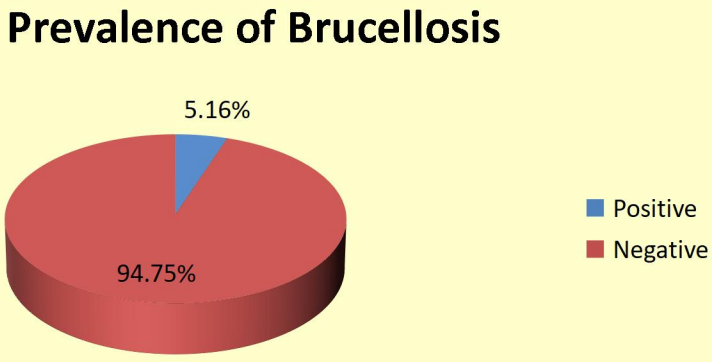


Chart 45: Prevalence of Brucellosis in the Livestock Populations of the Punjab.

The species-wise point prevalence of brucellosis is given in the chart below:

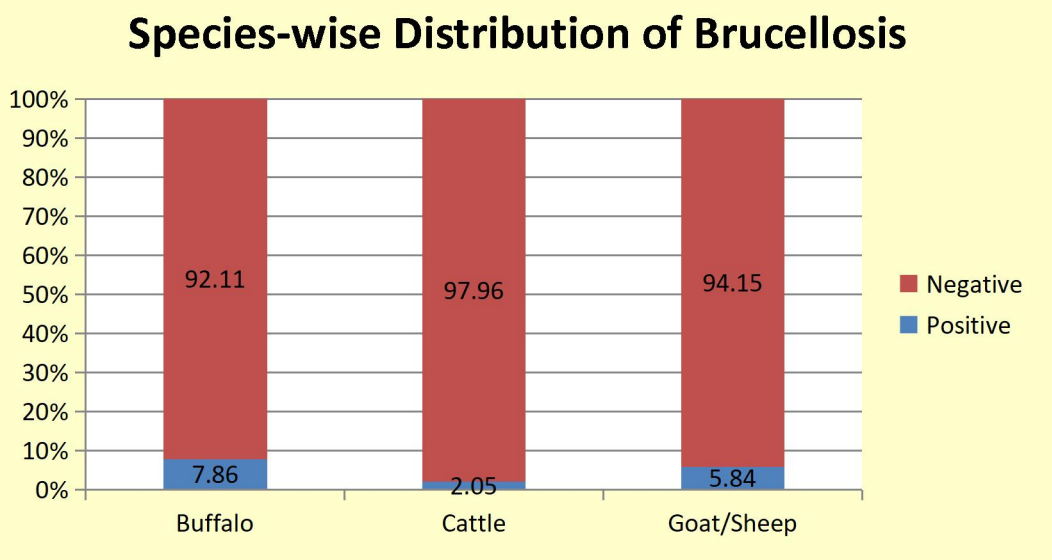


Chart 46: Species-wise Distribution of Brucellosis

The chart below indicates the geographical variation in the point prevalence of brucellosis among three regions of the Punjab.

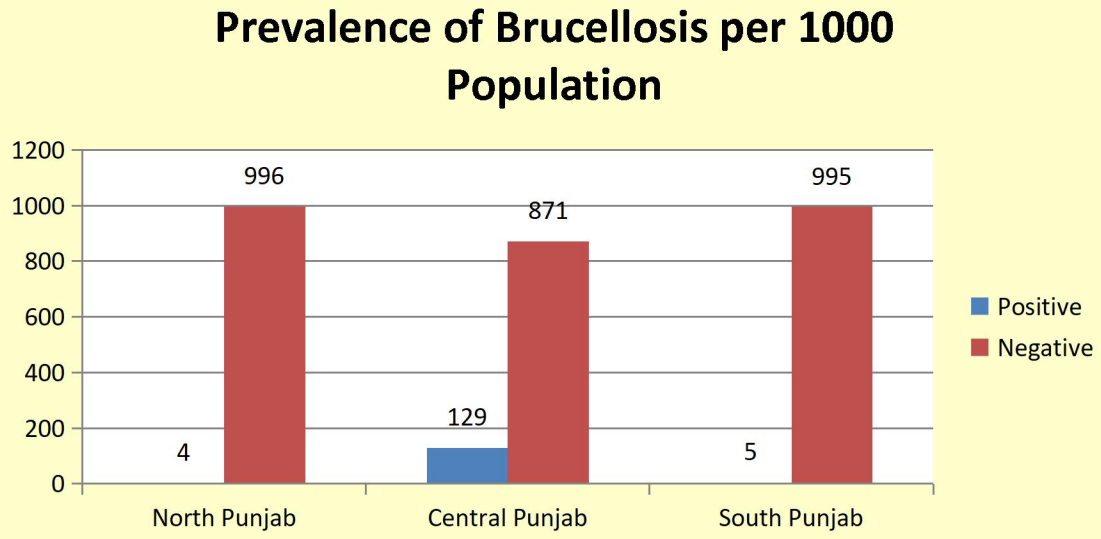


Chart 47: Prevalence of Brucellosis per 1000 Population

In North Punjab positive cases of brucellosis were recorded in Rawalpindi only with point prevalence of 1.13%, 3.15% and 1.85% in buffalo, cattle and small ruminants, respectively. In Central Punjab cases of brucellosis were recorded from Sheikhupura, Gujranwala, Sialkot, Narowal, Kasur, Lahore, Sahiwal, Okara and

Pakpattan. In buffalo, cattle and small ruminants populations of Central Punjab the highest prevalence of brucellosis was recorded in Sheikhupura (36.77%, 37.6% and 25%, respectively).

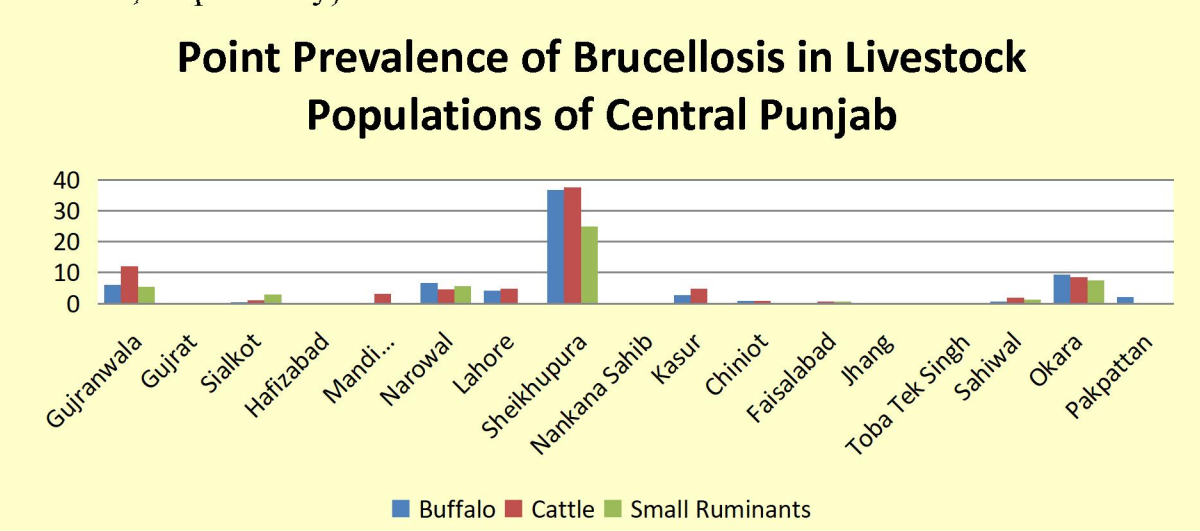


Chart 48: Point Prevalence of Brucellosis in Livestock Populations of Central Punjab

In South Punjab the highest prevalence of brucellosis in buffalo, cattle and small-ruminants populations was recorded in Multan (0.59%), Lodhran (0.79%) and Vehari (2.94%), respectively

Sub-clinical Mastitis

The overall prevalence of sub-clinical mastitis in lactating small and large ruminants is given below:

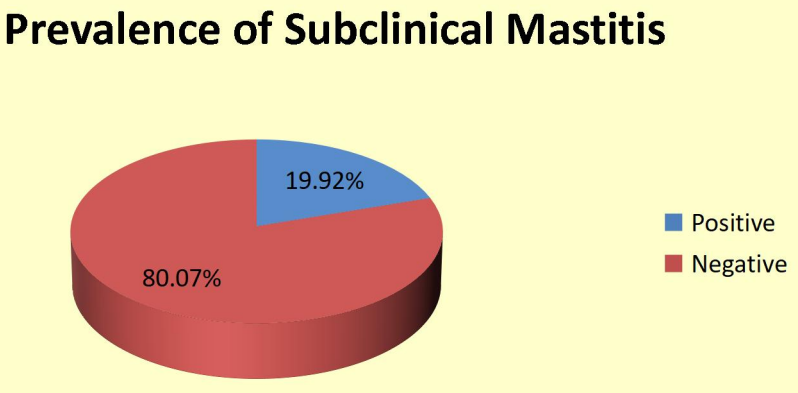


Chart 49: Prevalence of Sub-clinical Mastitis

Species-wise distribution of sub-clinical mastitis is given in the chart below:

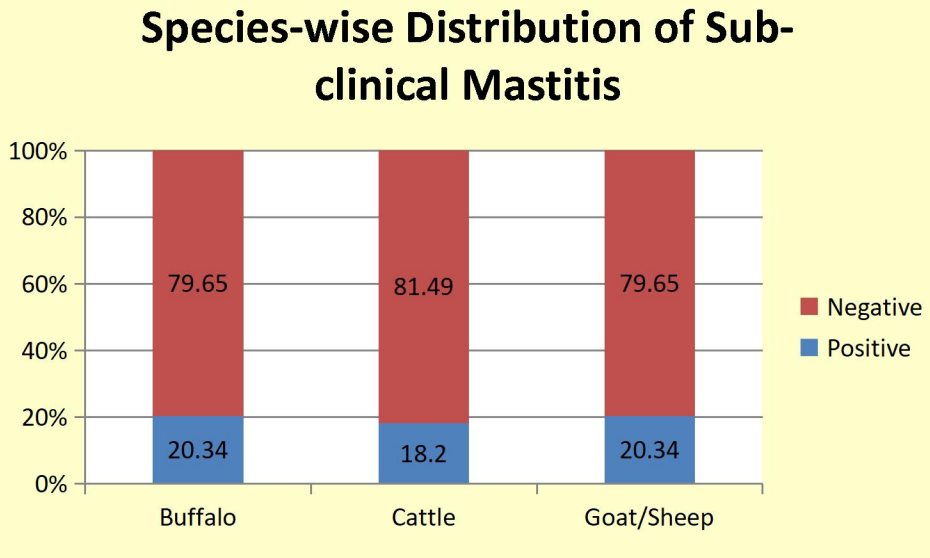


Chart 50: Species-wise Distribution of Sub-clinical Mastitis

The chart below indicates the point prevalence of sub-clinical mastitis in the three regions of the Punjab.

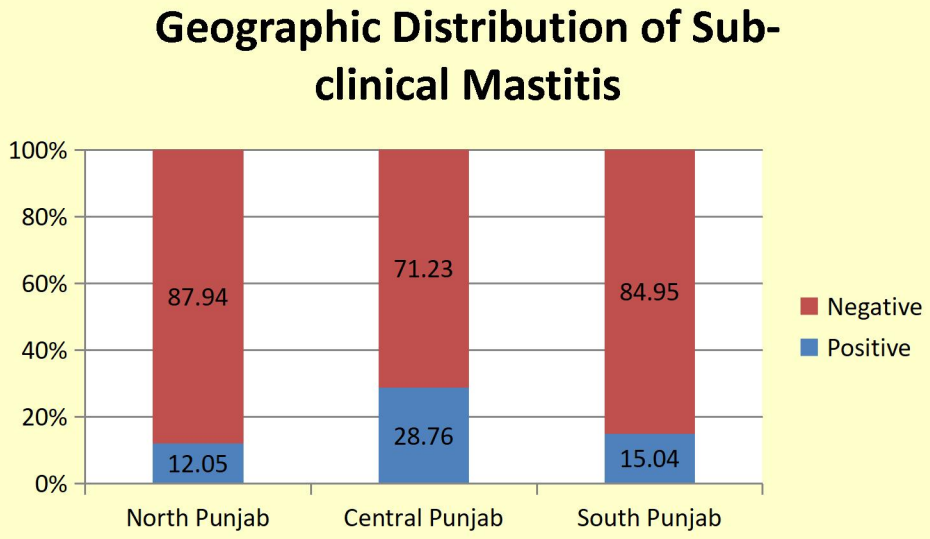


Chart 51: Geographic Distribution of Sub-clinical Mastitis

This chart indicates that the prevalence of sub-clinical mastitis is highest in Central Punjab.

The magnitude of loss in milk production due to sub-clinical mastitis in Punjab is given in the chart below:

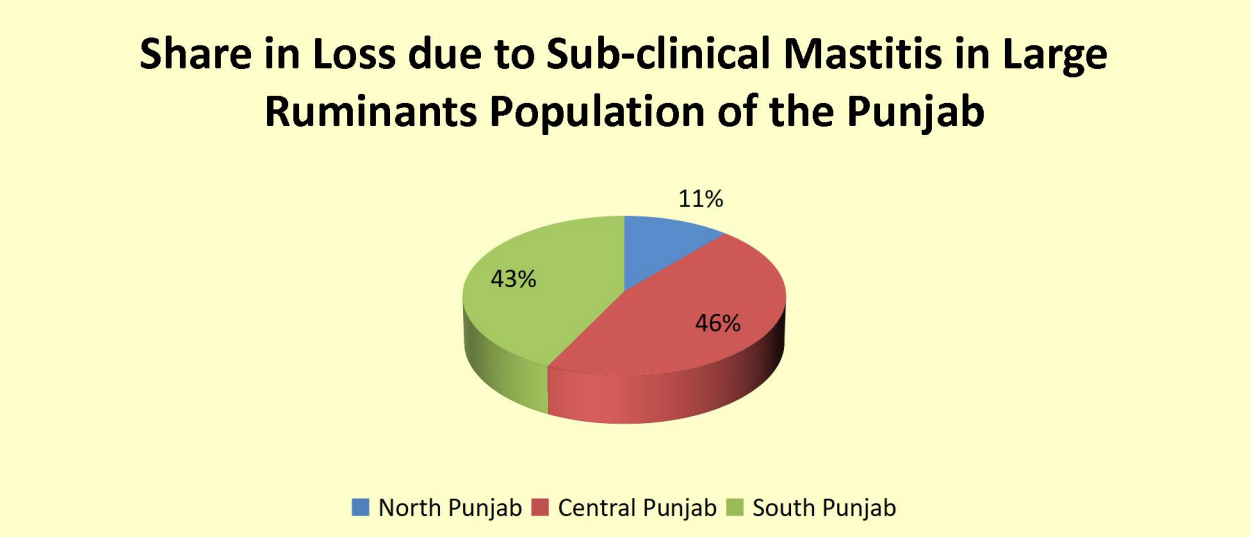


Chart 52: Share in Loss due to Sub-clinical Mastitis in Large Ruminants Population of the Punjab

The highest loss due to sub-clinical mastitis in large-ruminants is recorded in Central Punjab (Rs. 287,727,819 / month) followed by South Punjab (Rs. 265,628,871 / month) and North Punjab (Rs. 70,520,761 / month).
Point prevalence of sub-clinical mastitis in buffalo population of North Punjab is given in the chart below:

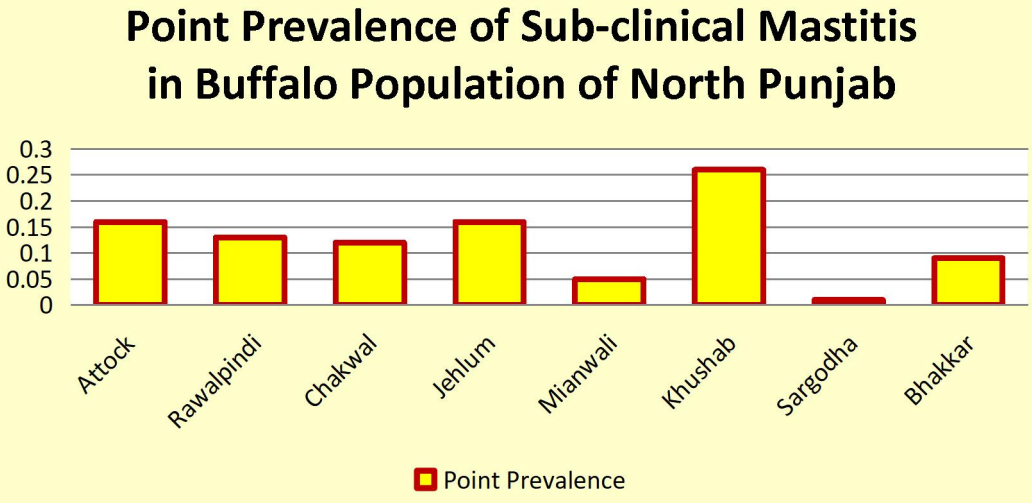


Chart 53: Point Prevalence of Sub-clinical Mastitis in Buffalo Population of North Punjab

This chart indicates that highest prevalence of sub-clinical mastitis in buffalo population of North Punjab is recorded in Khushab (26%) followed by Attock and Jehlum (16% each).
The point prevalence of sub-clinical mastitis in cattle population of North Punjab is given in the chart below:

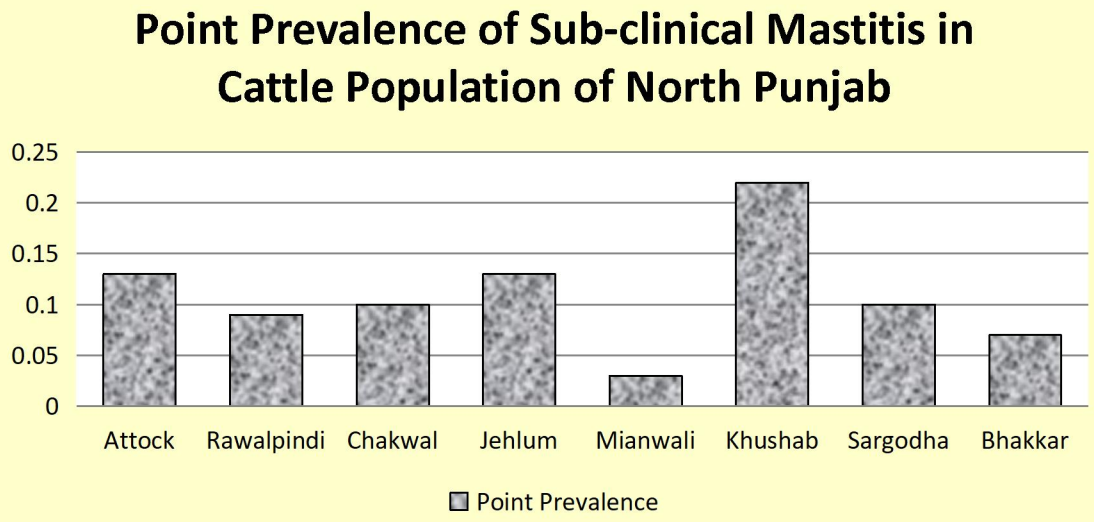


Chart 54: Point Prevalence of Sub-clinical Mastitis in Cattle Population of North Punjab

This chart indicates that the highest prevalence of sub-clinical mastitis in cattle population of North Punjab is in Khushab (22%) followed by Attock and Jehlum (13% each).
The magnitude of loss in milk production due to sub-clinical mastitis is in North Punjab is given in the chart below:

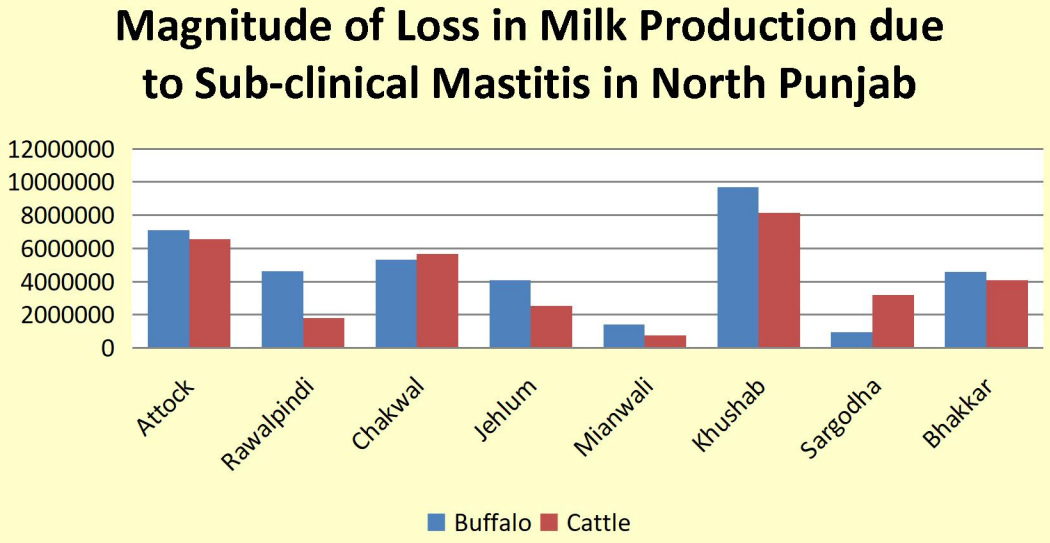


Chart 55: Magnitude of Loss in Milk Production due to Sub-clinical Mastitis in North Punjab

This chart indicates that the highest loss in milk production due to sub-clinical mastitis in large-ruminants population of North Punjab is recorded in Khushab (Rs. 17,842,261 / month) followed by Attock (Rs. 13,645,571 / month) and Chakwal (Rs. 11,001,460 / month)

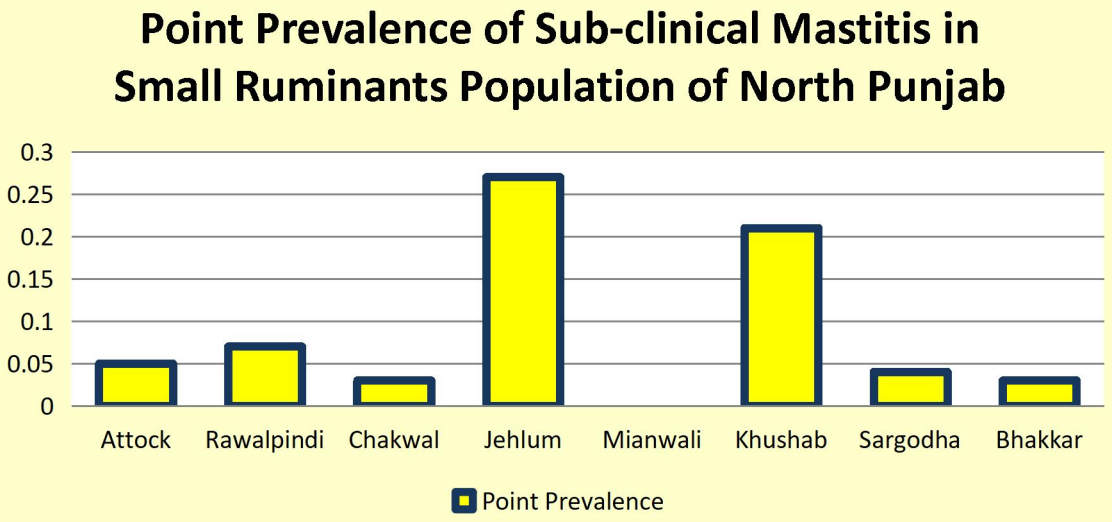


Chart 56: Point Prevalence of Sub-clinical Mastitis in Small-Ruminants Population of North Punjab

This chart indicates that the highest prevalence of sub-clinical mastitis in small-ruminants population of North Punjab is recorded in Jehlum (27%) followed by Khushab (21%).

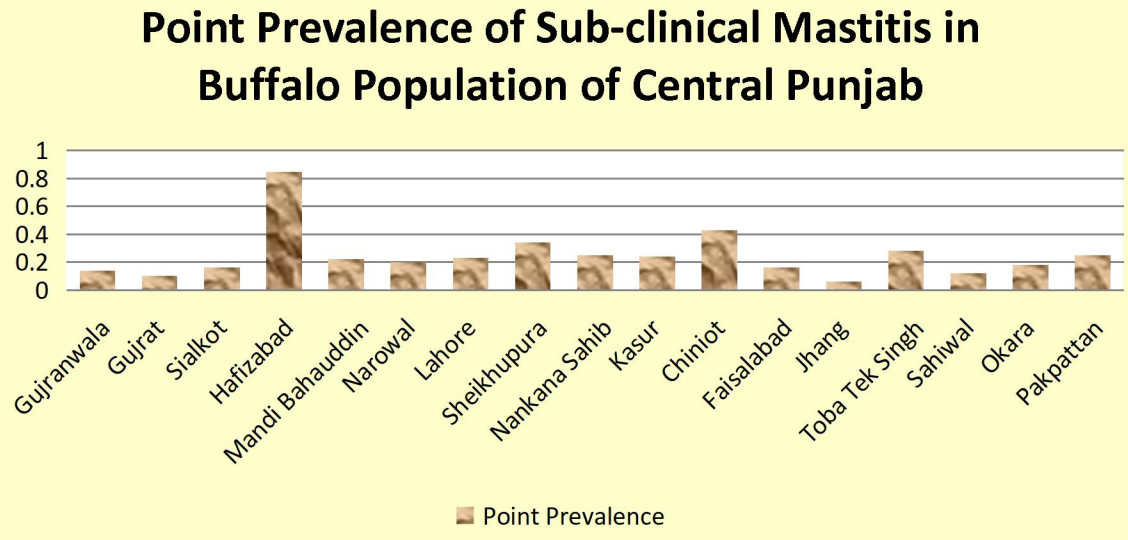


Chart 57: Point Prevalence of Sub-clinical Mastitis in Buffalo Population of Central Punjab

This chart indicates that highest prevalence of sub-clinical mastitis in buffalo population of Central Punjab is recorded in Hafizabad (85%) followed by Chiniot (43%) and Sheikhupura (34%).

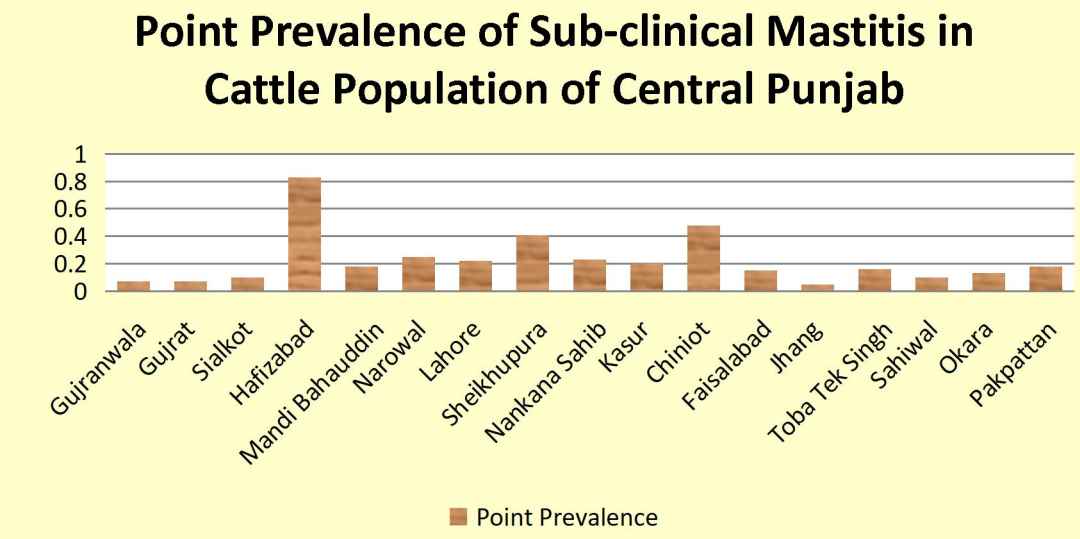


Chart 58: Point Prevalence of Sub-clinical Mastitis in Cattle Population of Central Punjab

This chart shows that the highest prevalence of sub-clinical mastitis in cattle population of Central Punjab is found in Hafizabad (83%) followed by Chiniot (48%) and Sheikhupura (41%).

The magnitude of loss in milk production due to sub-clinical mastitis in Central Punjab is given in the chart below:

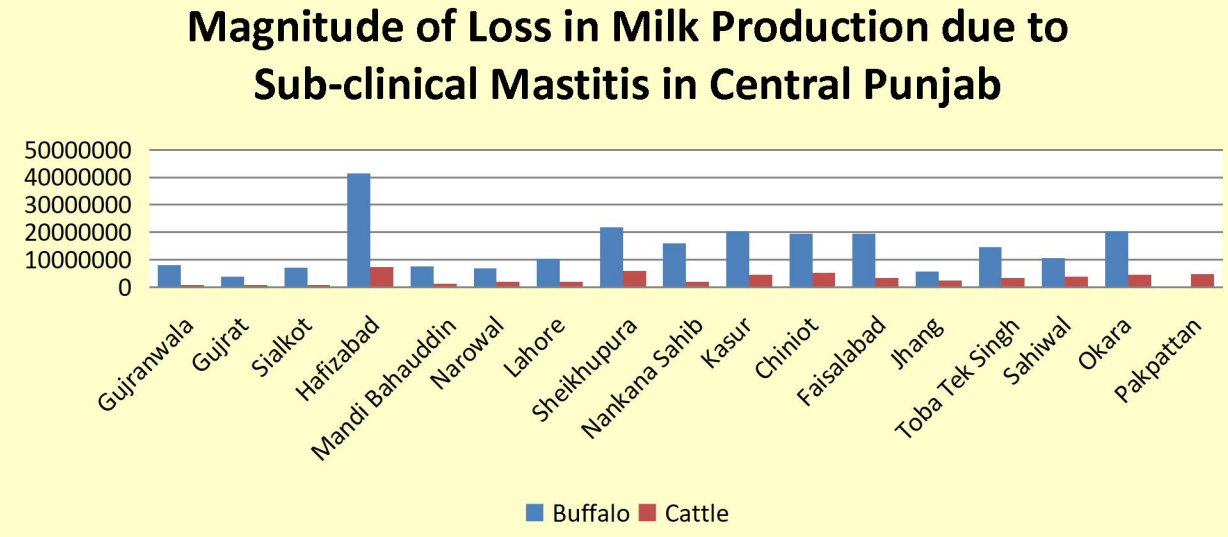


Chart 59: Magnitude of Loss in Milk Production due to Sub-clinical Mastitis in Central Punjab

This chart indicates that the highest loss in milk production due to sub-clinical mastitis in large-ruminants population of Central Punjab is recorded in Hafizabad (Rs. 48,709,786 / month) followed by Sheikhupura (Rs. 27,682,526 / month).
The highest point prevalence of sub-clinical mastitis in small-ruminants population of Central Punjab is in Pakpattan (100%) followed by Sheikhupura (84%) and Hafizabad (83%) as given in the chart below:

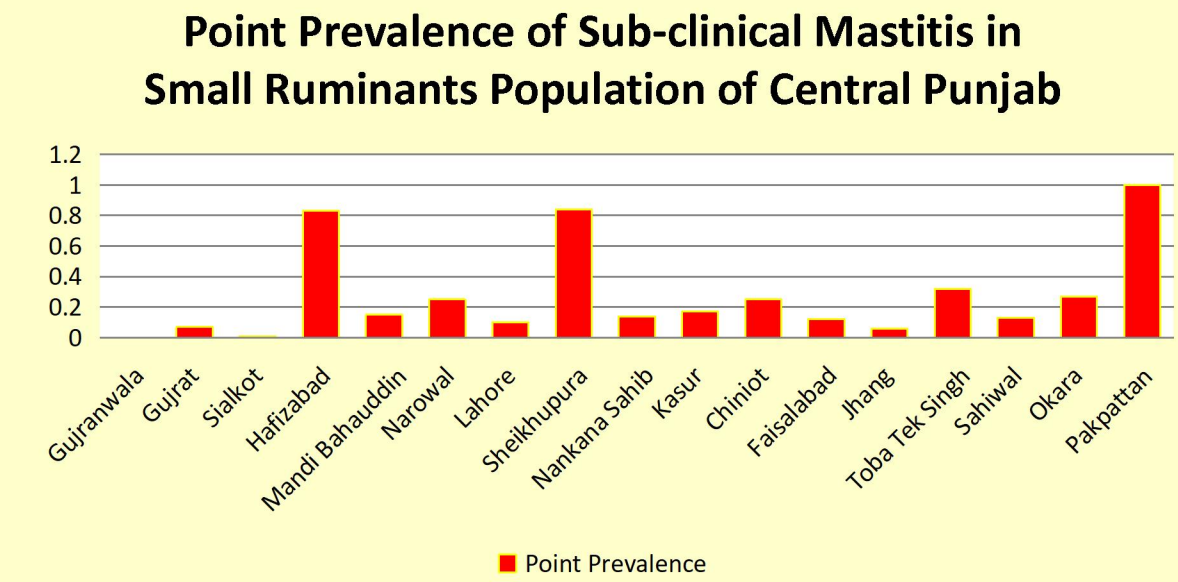


Chart 60: Point Prevalence of Sub-clinical Mastitis in Small Ruminants Population of Central Punjab

The point prevalence of sub-clinical mastitis in buffalo population of South Punjab is presented in the form of a chart below:

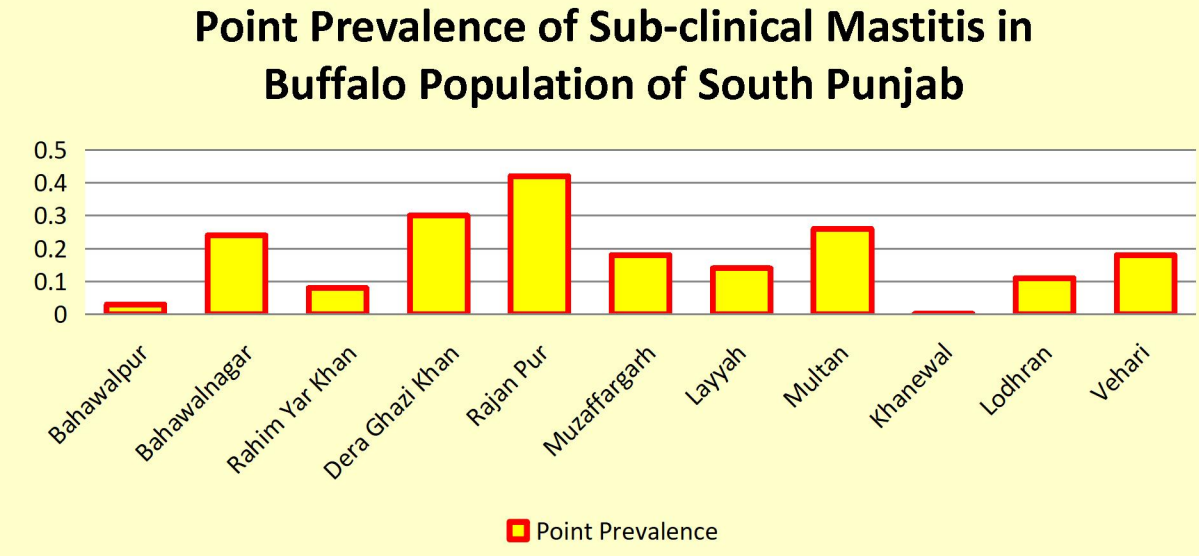


Chart 61: Point Prevalence of Sub-clinical Mastitis in Buffalo Population of South Punjab

This chart shows that the highest prevalence of sub-clinical mastitis in buffalo populations of South Punjab is in Rajan Pur (42%) followed by Dera Ghazi Khan (30%) and Multan (26%).
The following chart indicates the prevalence of sub-clinical mastitis in cattle population of South Punjab.

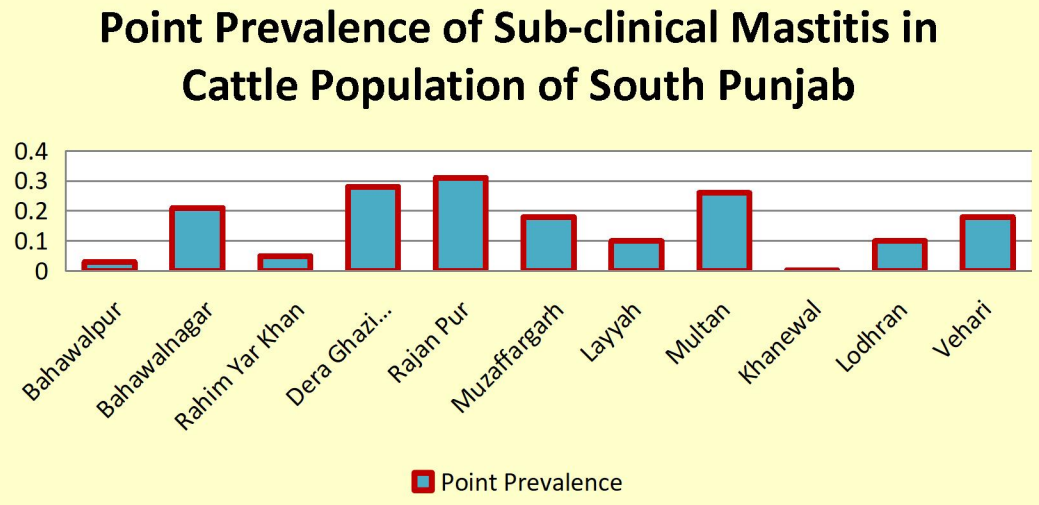


Chart 62: Point Prevalence of Sub-clinical Mastitis in Cattle Population of South Punjab

This chart indicates that the highest point prevalence of sub-clinical mastitis in cattle population of South Punjab is recorded in Rajanpur (31%) followed by Dera Ghazi Khan (28%) and Multan (26%).

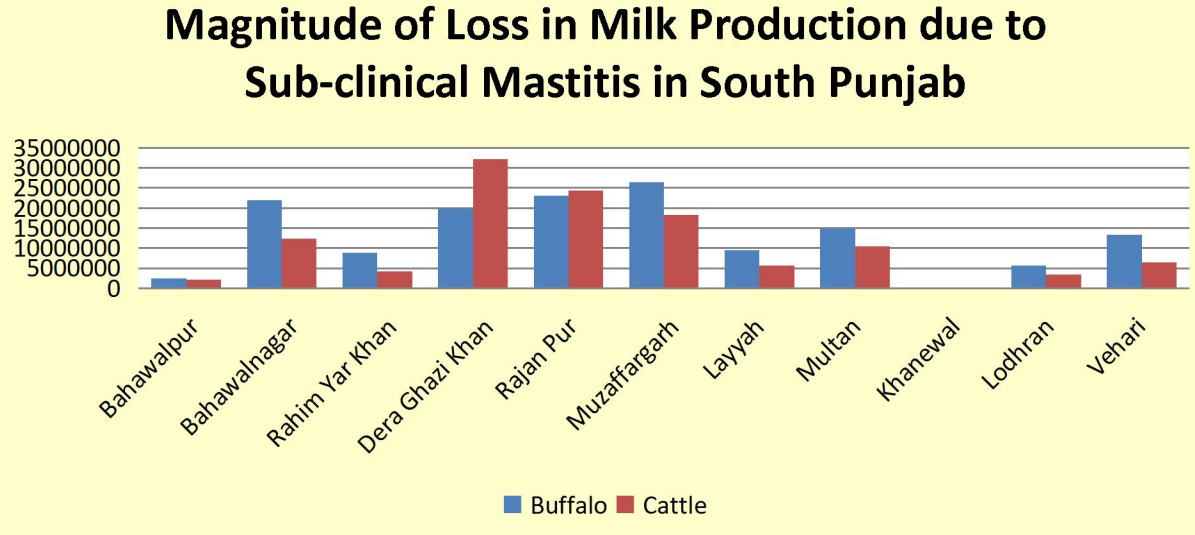


Chart 63: Magnitude of Loss in Milk Production due to Sub-clinical Mastitis in South Punjab

This chart indicates that the highest loss in milk production due to sub-clinical mastitis in large-ruminants populations of South Punjab is in Dera Ghazi Khan (Rs. 52,042,313 / month) followed by Rajanpur (Rs. 47,378,735 / month) and Muzaffargarh (Rs. 44,713,593 / month).

The highest prevalence of sub-clinical mastitis in the small-ruminants populations of South Punjab is recorded in Rajanpur (36%) followed by Multan (30%) and Muzaffargarh (24%).

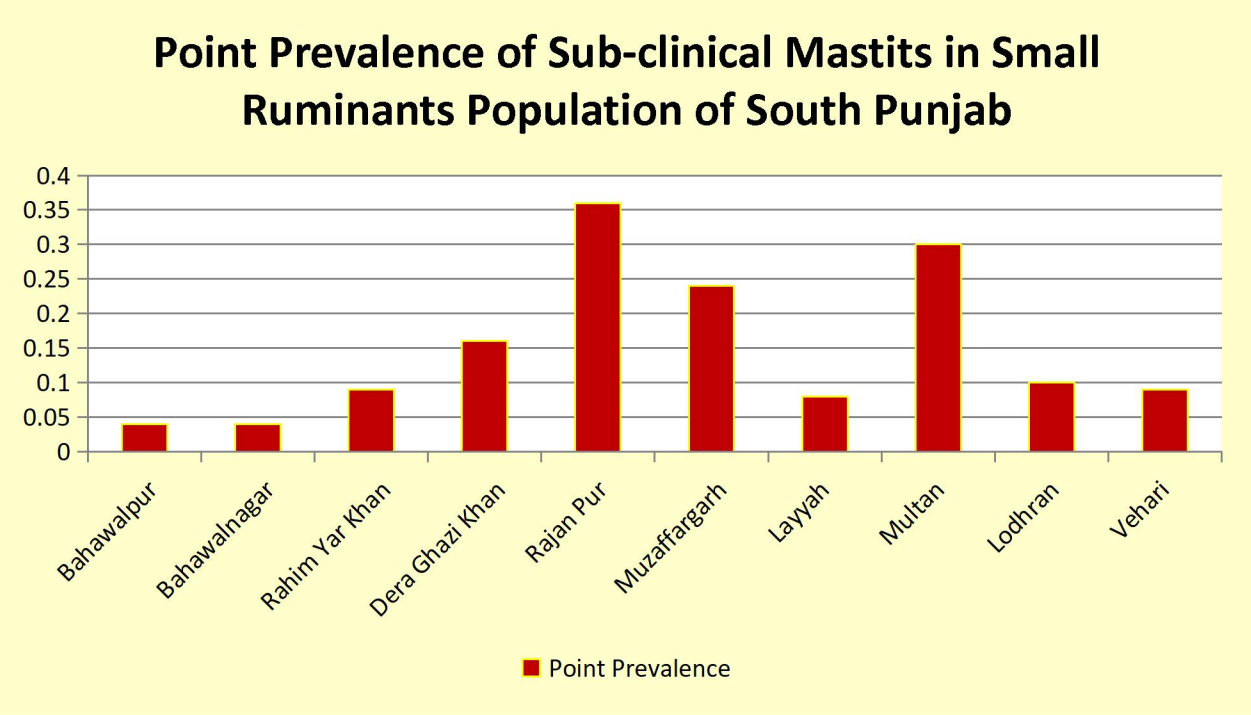
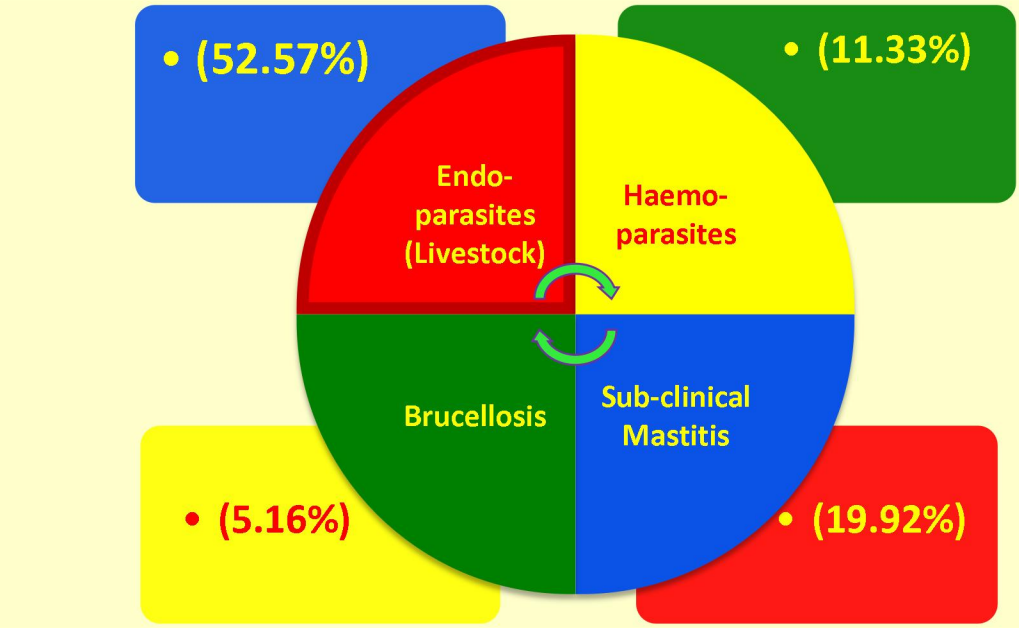


Chart 64: Point Prevalence of Sub-clinical Mastitis in Small Ruminants Population of South Punjab

DISCUSSION

A cross- sectional study, also called prevalence study, is a type of observational study that involves the analysis of data collected from a population, or a representative subset, at one specific point in time. In cross-sectional study, the measurement of exposure and effect are made at the same time. The study is descriptive, often in the form of survey. Usually there is no hypothesis as such, but the aim is to describe, a population or a subgroup within the population with respect to an outcome and a set of risk factors. The purpose of study is to find the prevalence of the outcome of interest, for the population or subgroups within the population at a given time point. The sample used in a large cross-sectional study is often taken from the whole population. This is the optimum situation: if the sample is selected using a random technique, it is likely that it will be highly representative (Beaglehole *et al*., 2006: Levin, 2006).

Sample for present study was selected using simple random sampling technique. Number of positive samples for endo-parasites of large and small ruminants (127289/52.57%), rural poultry (10789/53.93%), haemo-parasites (6762/11.33%), brucellosis (1906/5.16%) and sub-clinical mastitis (17442/19.92%) is more than the desired sample size estimated for each mentioned parameter of present study. This increased number of positive cases indicates that results are more precise and are truly reflecting the disease status of respective population.



Considering the equivalency requirements of World Organization for Animal Health (OIE), which demand all countries of the world to ensure transparency in global animal health situation, the Secretary Livestock, Government of the Punjab envisioned to conduct a cross-sectional survey throughout the Punjab province to identify hotspots and to gauge the magnitude and impact of endo-parasites, haemo-parasites, brucellosis and sub-clinical mastitis among populations of livestock and rural poultry of the locale. The intelligence gleaned though this study would be the basis for the right positioning of all available resources (material and human) available with the L&DD Punjab to institutionalize the requisite sanitary and phyto-sanitary measures with the aim to achieve following well defined objectives:

- To partake in international trade of livestock and livestock based commodities
- To uplift the socio-economic condition of the poor and marginalized segments of the Punjabi society, i.e., landless and rural womenfolk whose

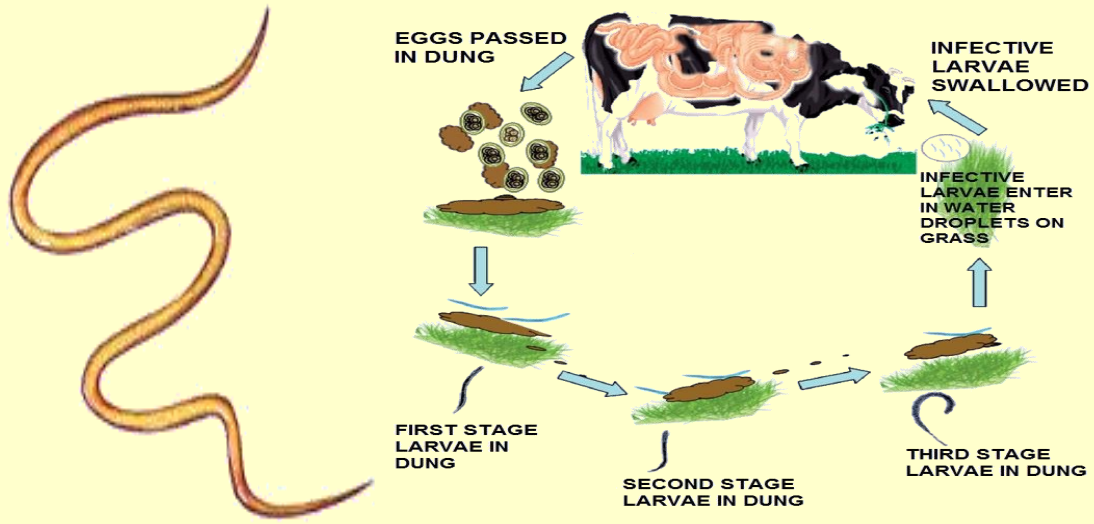
subsistence is directly linked with the health and productivity of livestock and rural poultry.

ENDO-PARASITOSIS

The point prevalence of endo-parasites is 57.02% among livestock and poultry populations of Punjab. Highest prevalence is recorded among cattle (57.15%) followed by in buffaloes (54.43%) and small ruminants (52.06%). Clear cut difference is seen in the prevalence pattern among the regions of the Punjab. Region-wise highest prevalence of endo-parasites was recorded in South Punjab (75.8%) followed by North Punjab (41.3%) and Central Punjab (35.37%).

NEMATODOSIS

Infection with round worms (nematodes) is called nematodosis. Nematodes are cylindrical un-segmented worms, covered with a tough cuticle and possessing a complete gut. The sexes are usually separate. Many nematode species inhabit the stomach and intestines of animals, which may not show clinical signs, if relatively few worms are present. Gastro-intestinal nematodes, depending upon the prevalent species and degree of infestation, can cause enteritis, anaemia, severe un-thriftiness and even death in ruminants (Urquhart *et al*., 1996).



Anaemia

Bottle Jaw

Emaciation

The results of the present study indicate that 26.94% of livestock populations of the Punjab are infested with nematodes of various types. The prevalence of nematodes is higher among small ruminants (31.08%) than cattle (25.46%) and buffaloes (23.87%). This scenario indicates that small ruminants are neglected ones as regard de-worming is concerned. This data also indicates that people at large are not aware of the good husbandry practices of small ruminants. Directorate of Small Ruminants, L&DD Department may revise its strategy taking breeders of small ruminants on board and apprising them about good husbandry practices. The data also indicates that the point prevalence of nematodes is higher (35.61%) in South Punjab than North Punjab (20.02%) and Central Punjab (20.02%).

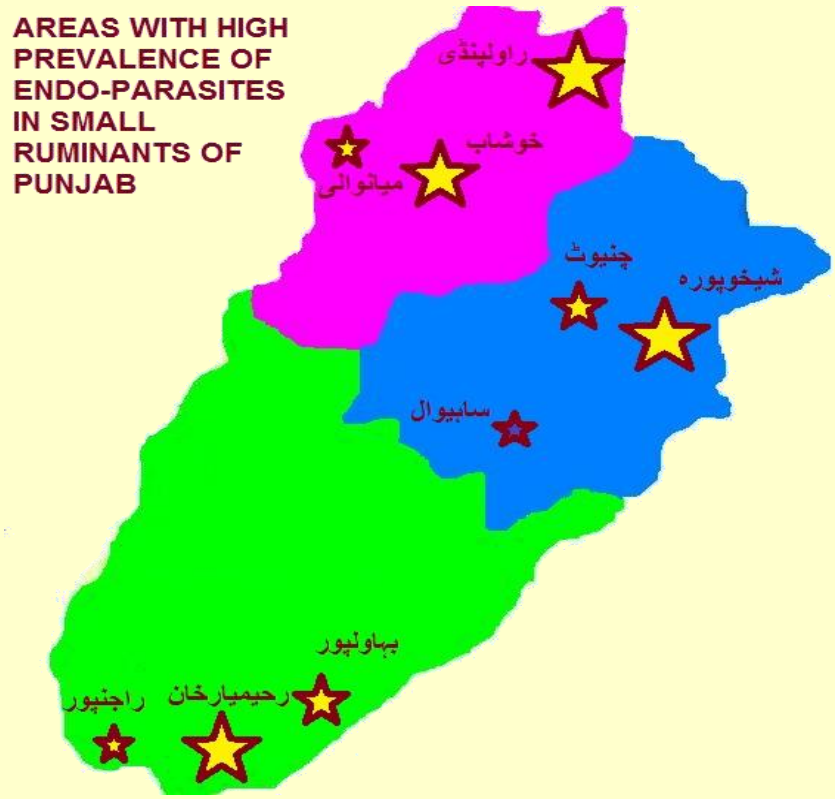


Figure 3: Areas with High Prevalence of Endo-parasites in Small Ruminants of the Punjab

Figure 4: Areas with High Prevalence of Endo-parasites in Large Ruminants of the Punjab

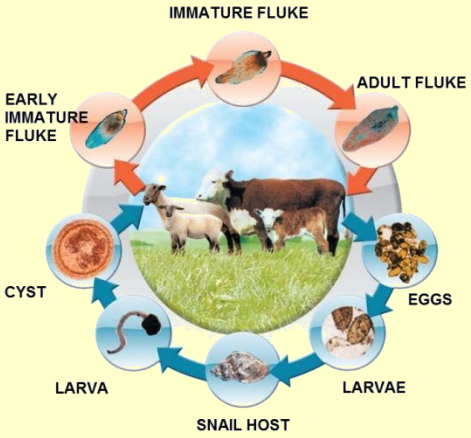
The factors associated with this high prevalence may be solicited and remedial approaches may be chalked out for the uplift of rural economics of South Punjab. There is a large selection of modern anthelmintics which are available in the market for treating nematode infections and many have a wide spectrum of activity which may extend to tape worms and flukes.

Table 1: Recommended Anthelmintics against Gastro-intestinal Nematodes in Ruminants

Dewormer	Efficiency against			Ovicidal Effect	Extended Spectrum
	Adult	Larvae	Arrested Larvae		
Albendazole	>90%	>90%	>90%	Yes	Lung worms, cestodes, flukes (1.3 × normal dose)
Oxfendazole	>90%	>90%	>90%	Yes	Lung worms and cestodes
Levamisole	>90%	50-90%	<50%	No	Lung worm; (toxic signs may appear if over-dosed)
Ivermectin	>90%	>90%	>90%	No	Lung worm and several ecto-parasites

TREMATODOSIS

Infections with flukes are called trematodosis. Flukes have mostly a flat body, with an oval or worm-like form, have no external signs of segmentation and are relatively short (max. about 10 cm). All of the trematode species (estimated to be more than 20,000 worldwide) are obligate parasites of either snails or vertebrates, including livestock and other domestic animals, as well as humans. As a general rule, flukes can be seriously harmful to grazing livestock, especially sheep, but also cattle and buffalo, particularly in humid regions that offer an adequate environment for the intermediate hosts (snails).



Anaemia

Emaciation

Chronic Diarrhoea

The results of the present study indicate that 7.95% of the livestock populations of the Punjab are infested with flukes (mostly Liver Fluke). The prevalence of trematodes is higher among large ruminants (9% for both cattle and buffalo) than small ruminants (7%). The data also indicates higher prevalence of trematodes in South Punjab (12.06%) followed by North Punjab (9.01%) and Central Punjab (4.82%). The geo-medical aspects of this distribution demand an earnest epidemiological study in this regard. The distribution of parasites is seldom homogeneous and tends to be found in foci in local areas where conditions favor

their dissemination and survival. The location of the disease foci may also depend upon host behavior factors. Liver Fluke (Fasciola) is a leaf-like trematode which is capable of infecting the liver of ruminants as well as of humans. It is endemic in wet regions and causes considerable damage to the liver parenchyma before migration to bile duct. Snails of the genus Lymnaea are the intermediate host (Kahn and Line, 2005; Urquhart *et al*., 1996).

Anthelmintics of choice recommended for different stages of fluke infestation in small and large ruminants are presented in table 2.

Table 2: Recommended Anthelmintics against Liver Fluke in Ruminants

Species	Severity of Liver Fluke Infestation	Wormer of Choice
Goats	Acute, Sub-acute, Chronic	Oxyclozanide
Sheep	Acute	Triclabendazole
	Sub-acute	Triclabendazole, Nitroxynil, Rafoxanide
	Chronic	Oxyclozanide, Rafoxanide, Nitroxynil, Triclabendazole, Albendazole (at an increased dose rate)
Cattle / Buffalo	Acute, Sub-acute, Chronic	Triclabendazole

Other measures to control liver fluke infestation include a reduction in the population of the snails by the use of molluscicides (e.g., Copper Sulphate) and / or the removal of snail habitat. For the biological control of snails in the hotspots of Fasciola, keeping of ducks as a rural poultry may be promoted.

CESTODOSIS

Cestodes (tapeworms) are parasitic worms that have a flat ribbon-like body and live in the digestive system of their livestock, poultry and human being. A few tapeworm species are harmful for the livestock and human being. As a general rule, most tapeworm species are less of a problem for livestock. Tapeworms are often

less harmful for their final hosts than for intermediate hosts. Whereas adult tapeworms in the gut of the final host compete for nutrients and weaken the host, immature tapeworms (cysticercoids) in the intermediate host can be life threatening because they affect vital organs (e.g. the brain, the lungs, the liver etc.).

Physical Weakness

Depressed Immune System

Cyst Formation in Intermediate Host

The overall prevalence of cestodes is 6.08% in livestock populations of the Punjab. The prevalence of cestodes is more among small ruminants (7.28%) and cattle (7.17%) than in buffaloes (5.63%). The highest prevalence of cestodes is recorded in South Punjab (11.28%) followed by Central Punjab (5%) and North Punjab (1.25%). Generally cestode infestation in ruminants is regarded as a minor problem as some anthelmintics (like oxfendazole, fenbendazole and albendazole) which are used to treat nematode infections are also effective against tape worms.

MIXED INFESTATION

Mixed type of infestation is also recorded in the present study. The point prevalence of mixed infestation is 11-12% in small and large ruminants and 11-13% in different regions of the Punjab.

COCCIDIAN PARASITE

A large number of Eimeria and Isospora species can infect rural poultry and ruminants. The organisms mostly infect the epithelial cells of the gastro-intestinal tract. Coccidiosis is more commonly present in young animals kept in unhygienic and overcrowded houses. Affected animals usually develop a strong immunity with increasing age. The high mortality rate and lowered productivity due to poor growth, together with costs of anticoccidials and disinfection, are all factors causing losses by coccidiosis in domestic animals. Prevention of losses and reduced productivity from coccidiosis in young animals depends upon management to reduce the level of environmental contamination by infective oocysts and to minimize stress and avoid overcrowding (Rehman *et al*., 2011).

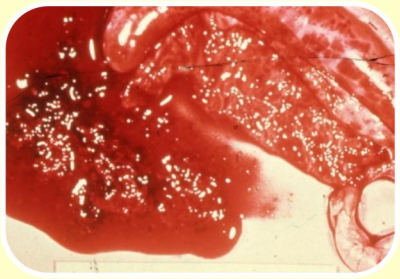
Prevalence of coccidian parasite is about 2% among livestock species. The highest prevalence of 3.77% was recorded in South Punjab. This demands the provision of drugs to the field hospitals of South Punjab. Amprolium is effective in large ruminants while Toltrazuril holds good in small ruminants. All refractory cases of diarrhea may be referred to concerned District Disease Diagnostic Laboratory and

after confirmation that coccidian parasite is the cause of the condition, proper treatment may be given to poor livestock farmers.

RURAL POULTRY

In livestock sector the poultry production has its own impact and value on the overall livestock market and in the GDP. Poultry production is one of the most efficient and economic system for production of animal protein. In Pakistan, poultry is playing vital role in bridging the gap between demand and supply of animal protein. Our poultry production is mostly dependent on exotic/commercial lines but still our rural poultry, at small scale level, contributes 32% share to our national requirement of eggs and 15% share to meat production. Our rural poultry possesses bright prospects for future development due to easy and abundant availability of all the requisite inputs such as land, labor, feed resources and lower cost of production. The indigenous chickens have also the advantage of being well adapted to the local environmental conditions (hot, cold, humid, dry & rainy weather) and can live as a scavenger bird and can be reared at a low cost of production as compared to commercial poultry (Anonymous, 2014).

In our conventional system, women keep indigenous breeds in backyard poultry rearing system and earn money for them through sale of eggs in the village. They earn better with limited resources. Development of rural poultry will significantly enhance the women empowerment.



Severe Enteritis

Ruffled Feathers

Bloody Diarrhea

Among rural poultry 53.93% of the faecal samples were found positive for nematodes and coccidian parasites. Highest parasitic prevalence is found in South Punjab (86.69%) followed by in Central Punjab (50.23%) and North Punjab (13.29%). In South Punjab the prevalence of nematodes is 47.88% followed by 32.38% and 9.99% in Central Punjab and North Punjab, respectively. Highest prevalence of coccidian parasite is found in South Punjab (38.8%) followed by Central Punjab (17.84%) and North Punjab (9.99%). This scenario demands the attention should be given to rural poultry in South Punjab and Central Punjab. Subordinate offices of Directorate of Poultry Research Institute in these regions may be activated to chalk out a doable action plan to curb the impact of endo-parasites and coccidiosis on rural poultry.

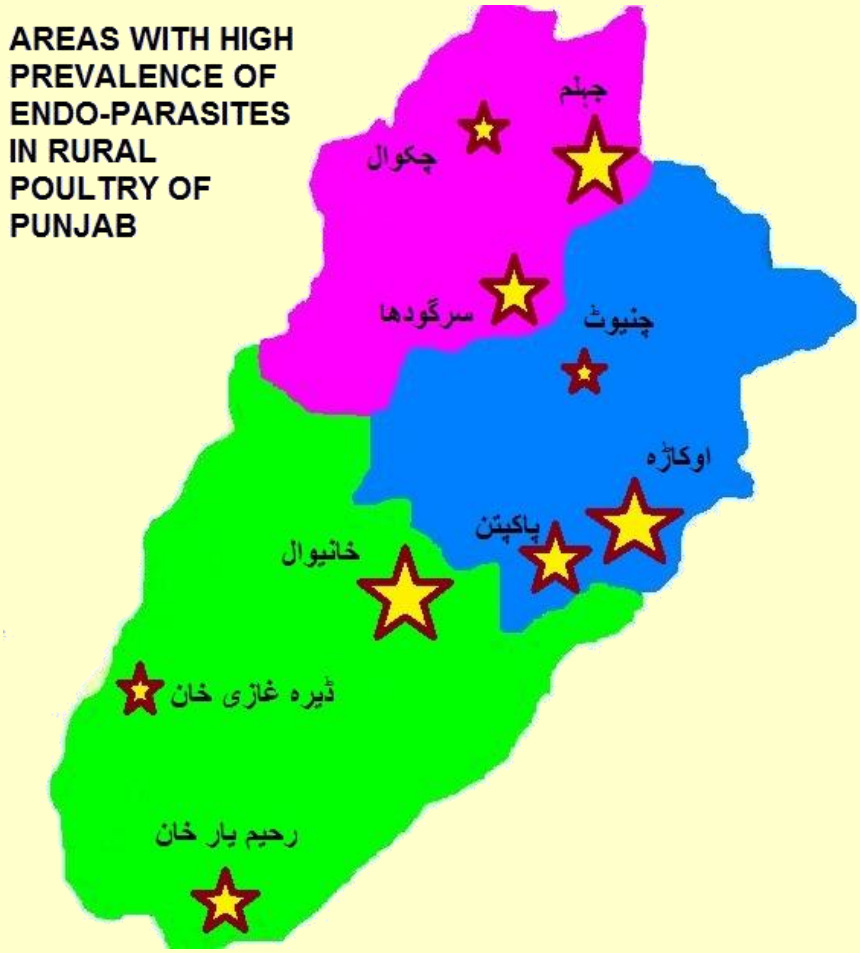


Figure 5: Areas with High Prevalence of Endo-parasites in Rural Poultry of the Punjab

TICK-BORNE DISEASES

Livestock contributes to natural, financial, human, physical and social capital in different ways and to different degrees within livestock-dependent rural economy. In addition to endo-parasites, ticks and tick-borne diseases reduce the productivity of livestock or cause mortality. Loss of an animal or reduction of its productivity can, in turn, affect more than one type of capital asset (Okorafor and Nzeako, 2014). In the present study three groups of tick-borne diseases were recorded in livestock populations: Anaplasmosis, babesiosis and theileriosis. In the Punjab,

these diseases pose a threat to livestock production. The costs associated with tick-borne diseases include direct losses (from mortality and reduced production) and the costs associated with control and treatment. In the present study estimation of actual cost associated with tick-borne diseases is not justified to be carried out. This is because of the fact that incidence of tick-borne diseases is variable from season to season and during the winter season the prevalence of ticks was almost negligible.

Babesiosis	• Anaemia, Haemoglobinuria • Abortion, Temporary Infertility
Theileriosis	• Fever, Diarrhoea, Emaciation • Neurological & Reproductive Signs
Anaplasmosis	• Anaemia, Weight Loss • Abortion, Death

Anaplasmosis

Babesiosis

Theileriasis

ANAPLASMOSIS

In the present study the overall prevalence of anaplasma was recorded as 4.14%. The highest prevalence is recorded in the North Punjab (2.55%) followed by South Punjab (1.77%) and Central Punjab (1.59%). Among livestock species, the highest prevalence is recorded in cattle (3.43%) followed by buffalo (3.26%) and small ruminants (2.65%). Anaplasma is a rickettsial agent that causes anaemia and jaundice in ruminants. Anaplasma species are transmitted either mechanically or biologically by arthropod vectors. Male ticks of Boophilus species and Dermacentor species are important vectors under field conditions. They can become persistently infected and serve as a reservoir for infection. Intrastadial (or transstadial) transmission is the usual mode. *Anaplasma marginale* is readily transmitted during vaccination against other diseases. So a fresh or sterilized needle should be used for injecting each animal in endemic regions (Anonymous, 2012). Sufficient availability of needles to field staff with awareness regarding sterilization will minimize the incidence.

Vaccine consisting of live *Anaplasma centrale* is most widely used in calves. This vaccine confers partial protection against challenge with virulent *Anaplasma marginale*. Immunity develops in 6-8 weeks and lasts for several years after a single vaccination (Anonymous, 2012). Anaplasmosis is not zoonotic.

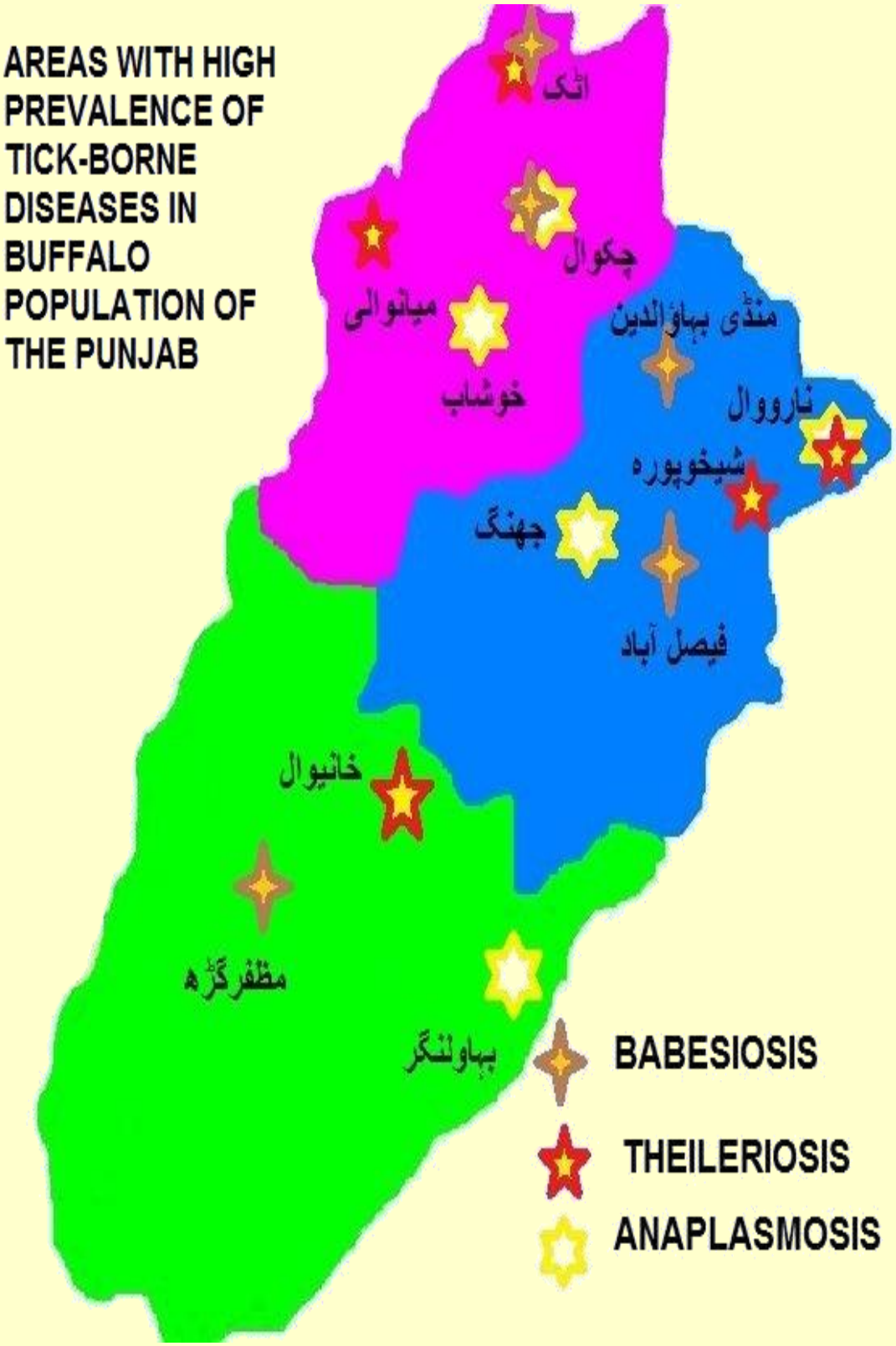


Figure 6: Areas with High Prevalence of Tick-borne Diseases in Buffalo Population of the Punjab

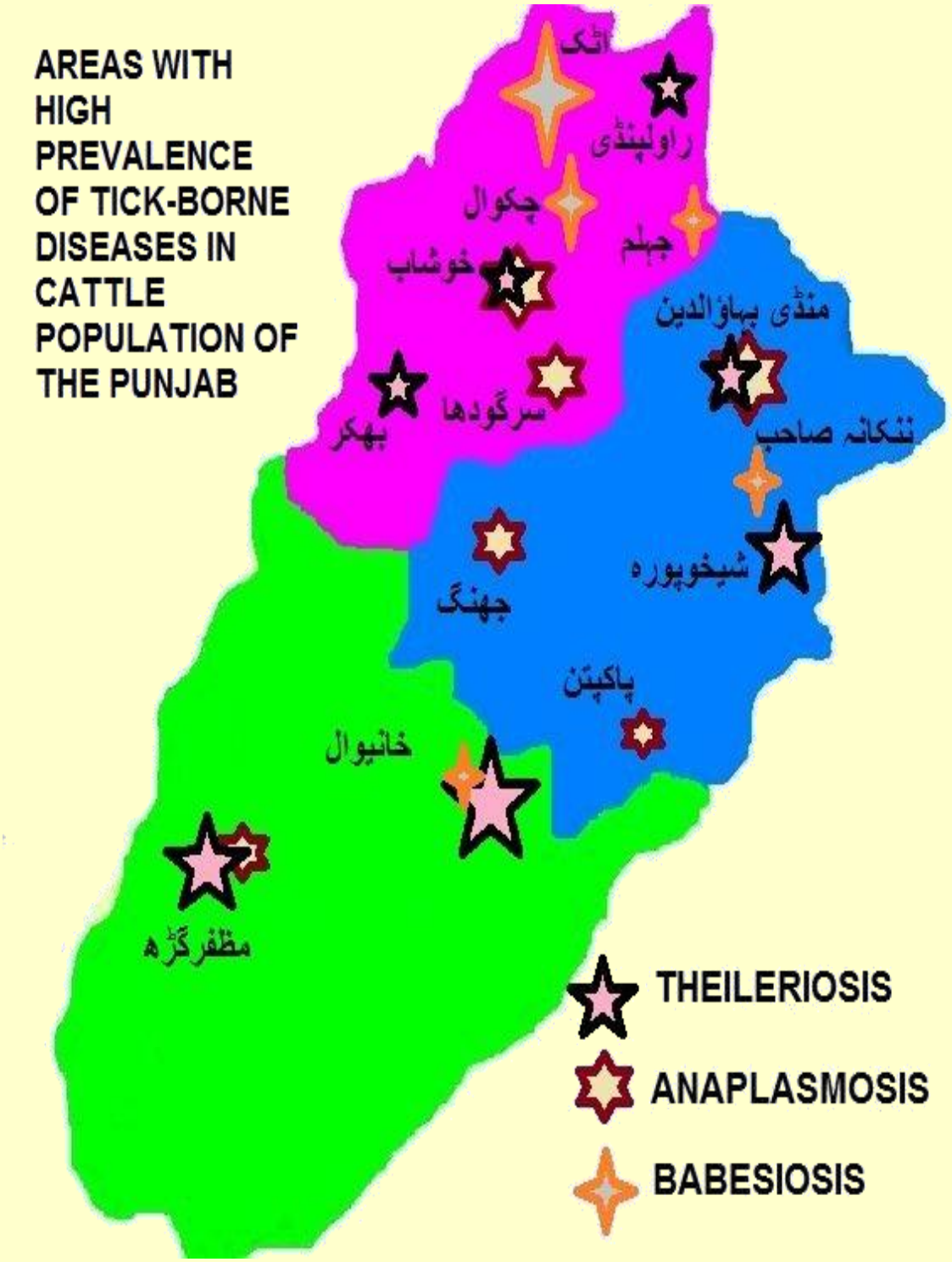


Figure 7: Areas with High Prevalence of Tick-borne Diseases in Cattle Population of the Punjab

THEILERIOSIS

The overall point prevalence of theileriosis is 3.23%. Highest prevalence is recorded in cattle (3.3%) followed by small ruminants (1.82%) and buffalo (1.4%). The point prevalence of theileriosis is highest in South Punjab (2.8%) followed by Central Punjab (2.4%) and North Punjab (1.33%). Theileria are obligate intracellular protozoan parasites of small and large ruminants that are transmitted by ticks of genus Hyalomma. Animals recovered of theileriosis are mostly carriers. Carrier animals are a source of infection that can be transmitted naturally by ticks in the field. The most widely used method for the control of theileriosis is the chemical control of ticks with acaricides; despite their ecological disadvantages. More effective and sustainable integrated control methods should be developed which should include greater exploitation of genetic resistance and the use of vaccines against tick borne diseases. Vaccination (using attenuated schizont-infected cell lines) and infection and treatment (simultaneous sub-cutaneous dose of tick-derived sporozoites and treatment with a long-acting tetracycline formulation) are also used for the control of theileriosis. Recovered animals demonstrate a robust lifelong immunity. Chemotherapeutic agents (parvaquone, buparvaquone and halofuginone), available to treat theileriosis in ruminants, do not completely eradicate theilerial infections leading to the development of carrier states in their hosts (Anonymous, 2014).

Important information gleaned through the present study is the presence of theileriosis among small ruminants. The presence of the organism was detected in the small-ruminants population of 17 districts of the Punjab. The highest point prevalence was recorded in Sheikhupura (24.65%) followed by Jhang (6.66%),

Lahore (5.7%) and Faisalabad (5.7%). As no study of such type was conducted in the past, it is difficult to cast a verdict whether it is an emerging disease or a re-emerging one. Further studies, using advance techniques like Polymerase Chain Reaction (PCR), may be conducted to ascertain the taxonomy of the organism up to species level.

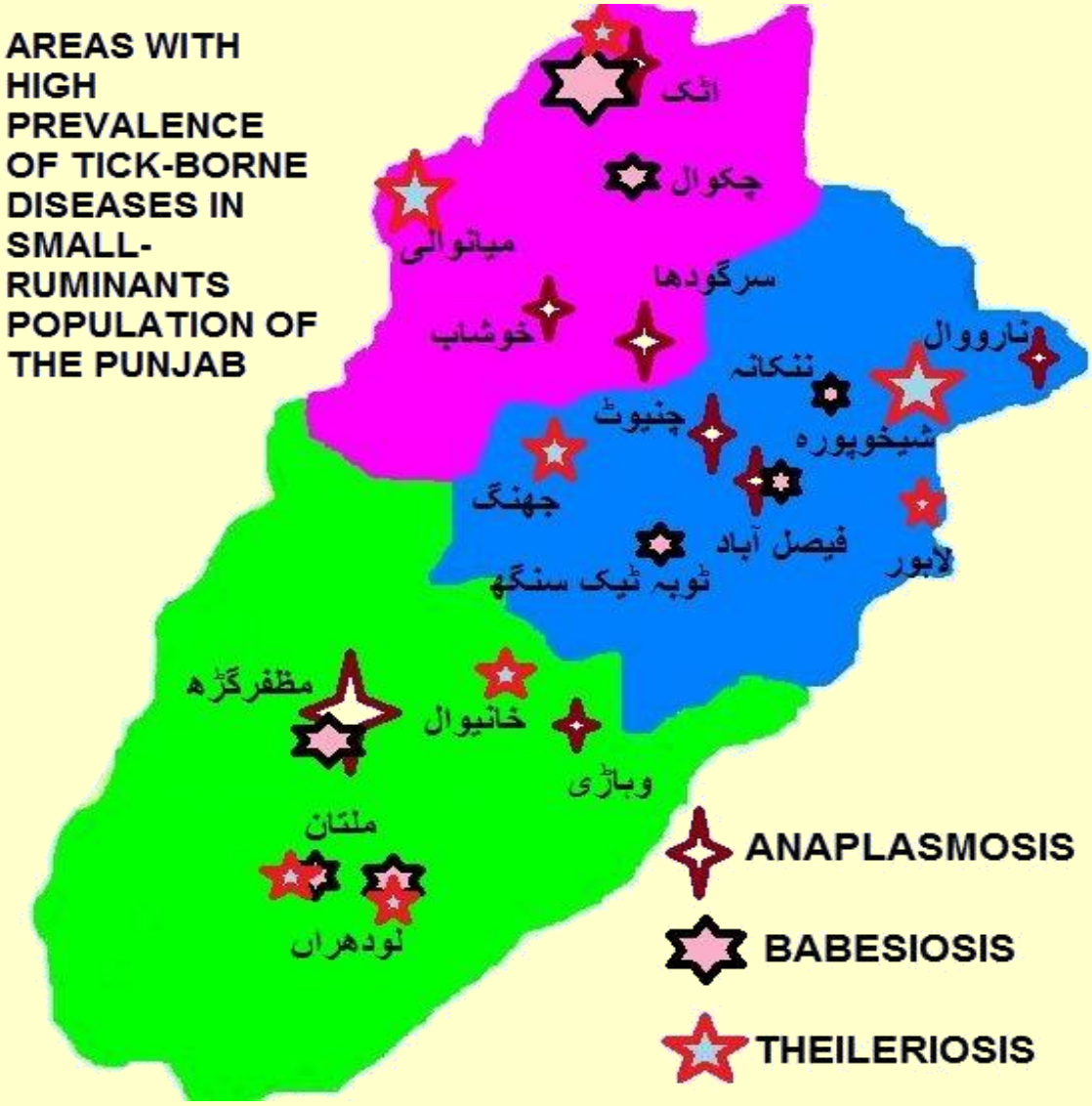


Figure 8: Areas with High Prevalence of Tick-borne Diseases in Small-Ruminants of the Punjab

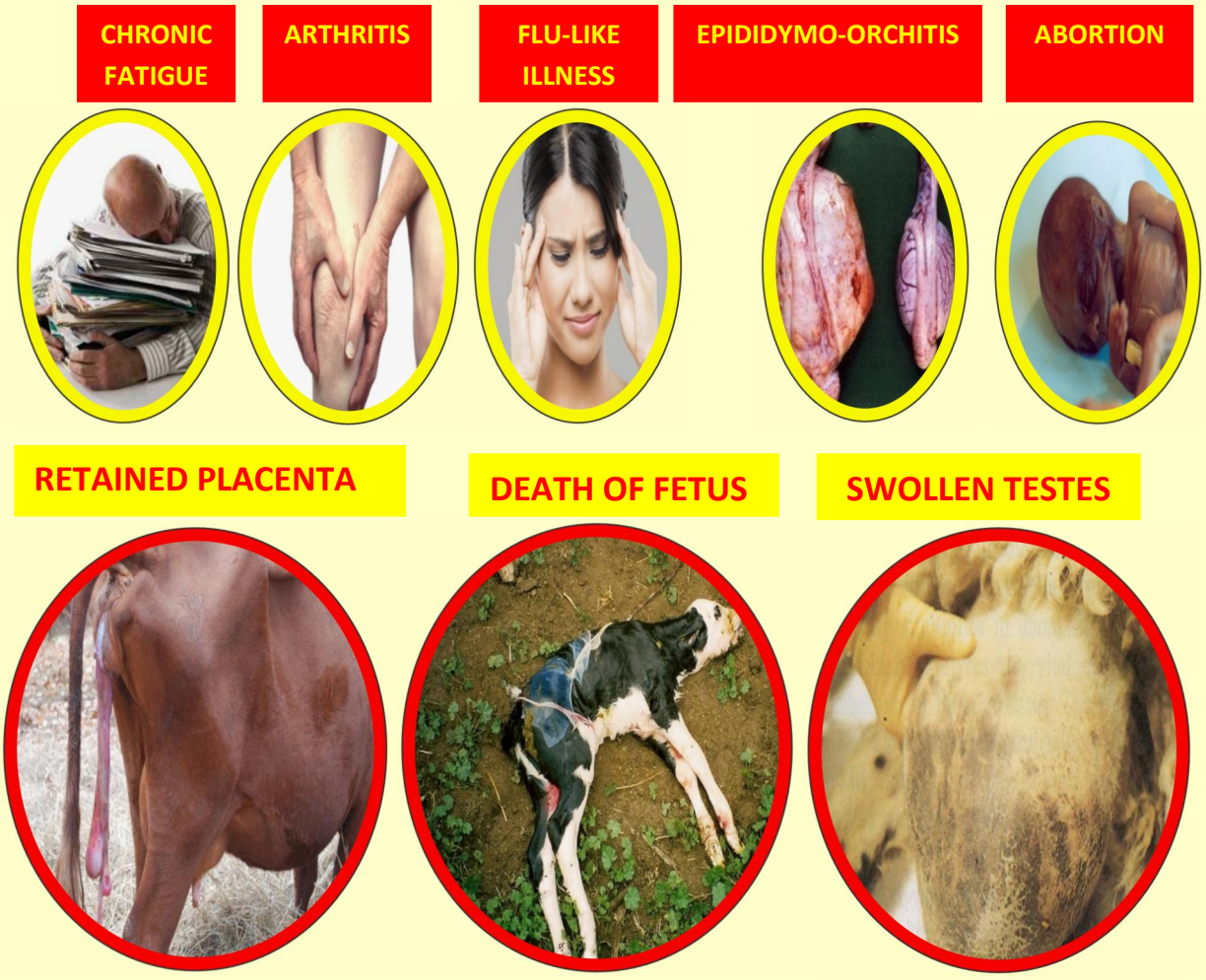
BABESIOSIS

The point prevalence of babesiosis is 4.84%. Highest prevalence is recorded in buffaloes (3.57%) followed by cattle (2.99%) and small ruminants (1.4%). The prevalence of babesiosis is highest in South Punjab (8.79%) followed by Central Punjab (6.97%) and North Punjab (5.8%). Babesiosis is a tick-borne disease caused by the protozoan parasites called Babesia. Ticks (of genus Rhipicephalus, Boophilus, Ixodes and Haemaphysalis) are the vectors of Babesia. Babesiosis is characterized by fever, haemoglobinuria and anaemia. Calves rarely show clinical signs of disease after infection. Recovered animals become life-long carriers for life and can develop the disease if subjected to stress. Vaccines consisting of live, attenuated prevalent strains of Babesia, produced from the blood of infected donor animals or from *in-vitro* culture, may be used in calves less than 1 year of age. Protective lifelong immunity develops within 3-4 weeks of single vaccination. Imidocarb dipropionate and diminazine is used in the treatment of babesiosis (Zahid *et al*., 2005; Todorovic, 1974).

BRUCELLOSIS

Zoonosis is defined as "diseases and infections that are naturally transmitted between vertebrate hosts and man" (Palmer *et al*., 1998). Emerging and re-emerging zoonotic diseases are responsible for profound political, social and economic impacts on society. Around 60% of all human diseases and around 75% of emerging diseases are zoonotic (Woolhouse & Gowtage-Sequeria, 2005); thus the veterinary and medical professionals are faced with immense challenges and opportunities. Brucellosis fall in the category of obligate zoonoses i.e. it requires continued re-introduction from animal reservoirs and has never taken off in the human population as self-sustaining epidemics (Cleaveland *et al*., 2007). Brucellosis is caused by a bacterium Brucella (very small gram negative, aerobic

rods; *Brucella abortus* in cattle and *Brucella melitensis* in small-ruminants). Clinically the disease is characterized by abortion, retained placenta, orchitis, epididymitis and arthritis. The infected animals excrete the organism in uterine discharges and in milk. Brucella is highly pathogenic for humans and causes an acute febrile illness (Malta Fever / Undulant Fever) in humans (Tortora *et al*., 2008). Rose Bengal Plate Test, Milk Ring Test and Enzyme Linked Immuno-sorbent Assay (ELISA) are suitable tests for screening herds and individual animals. Brucellin Skin Test can be used as a confirmatory herd test to rule out false positive cases in unvaccinated herds. As all infected animals do not react to Brucellin Skin Test; so it is neither recommended as a sole diagnostic test nor for the purpose of international trade.



In the present study the overall point prevalence of brucellosis was 5.16%. The highest prevalence was recorded in buffaloes (7.86%) followed by small-ruminants (5.84%) and cattle (2.05%). Region-wise the highest prevalence of brucellosis is recorded in Central Punjab (14.81% / 14.81 cases per 1000 population) followed by South Punjab (0.5% / 5 cases per 1000 population) and North Punjab (0.4% / 4 cases per 1000 population).

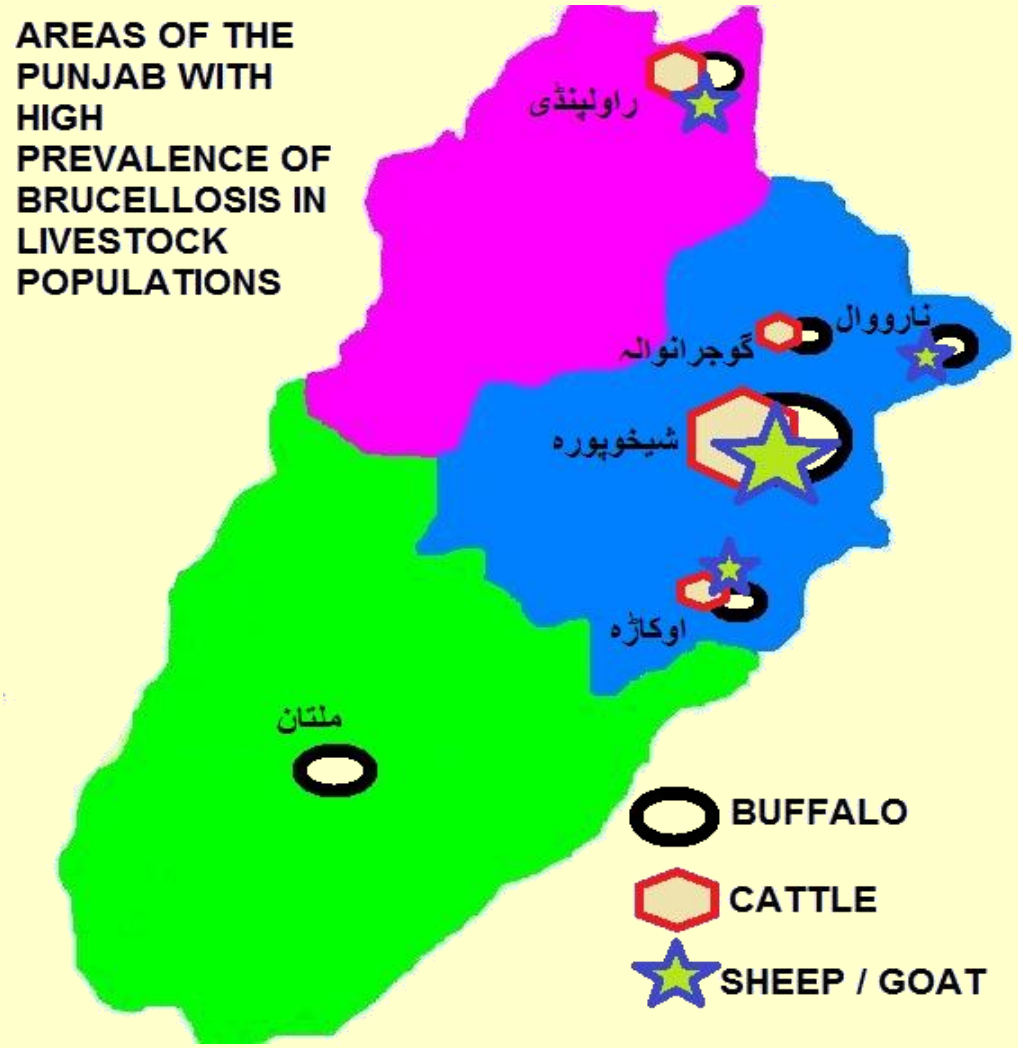


Figure 9: Areas with High Prevalence of Brucellosis in Livestock Populations of the Punjab

Brucella abortus strain RB51 vaccine has become the official vaccine for prevention of brucellosis in cattle in some countries. For best results, female calves

should be vaccinated when they are 4 to 6 months old. RB51 is infectious to humans. Basic approach for the eradication of brucellosis includes:

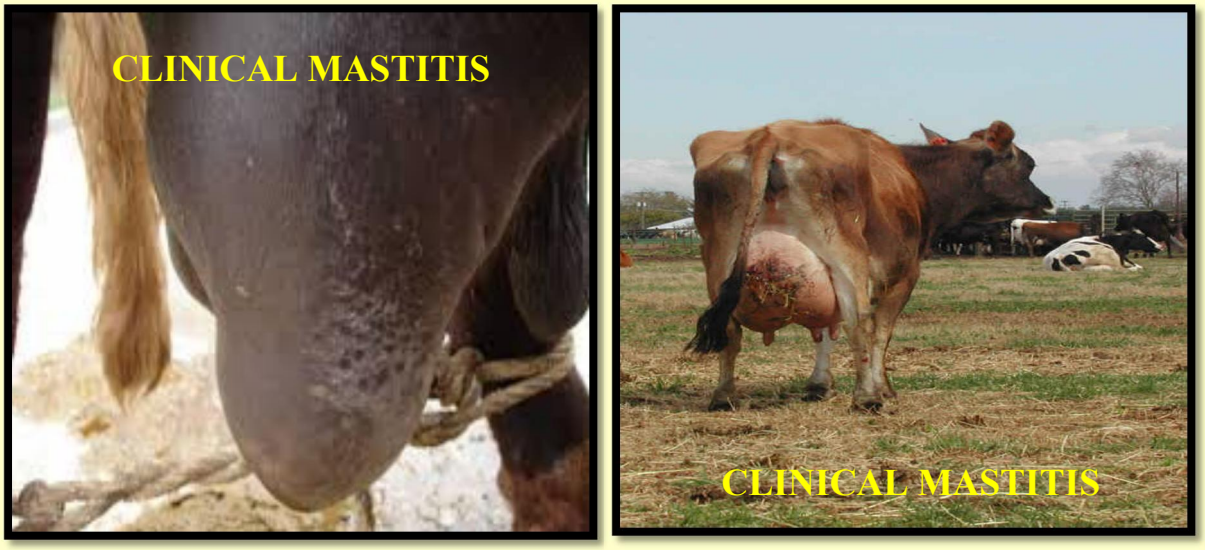
- Identification of market animals for tracing
- Surveillance to find infected animals
- Periodic testing of bulk milk samples
- Condemnation / slaughter of infected animals and compensation to owner
- Investigation of affected herds
- Vaccination of replacement calves

The high prevalence of brucellosis in Central Punjab is alarming. The Directorate of Breed Improvement, L&DD Department may be given the task to screen out all the animals with history of abortion or retained placenta or orchitis or epididymitis in collaboration with District Disease Diagnostic Laboratories.

SUB-CLINICAL MASTITIS

Mastitis is an inflammation in the mammary gland which is generally classified as clinical or sub-clinical depending on the degree of inflammation. Clinical mastitis is characterized by visible abnormalities in the milk or the udder. Sub-clinical mastitis does not create visible changes in the milk or the udder. Although the milk appears normal, sub-clinically infected animals produce less milk, of sub-standard quality. In addition, infected animals can be a source of infection to other animals in the herd. Since there are no visible abnormalities in the milk, sub-clinical mastitis requires special diagnostic tests for detection. Several causative agents and predisposing factors have been implicated in mastitis in dairy cows including bacterial, mycoplasmal and yeast pathogens (Egwu *et al*., 1994). Predisposing factors such as poor management and hygiene, teat injuries and faulty milking

machines are known to hasten the entry of infectious agents and the course of the disease (Majic *et al*., 1993). It is now a well known fact that the subclinical mastitis (SCM) is more serious and is responsible for much greater loss to the dairy industry (Kader *et al*., 2002).



The overall point prevalence of sub-clinical mastitis is 19.92%. The highest prevalence is recorded among buffaloes and small ruminants (20.34% each) than in cattle (18.2%). Another important observation is the highest prevalence in Central Punjab (28.76%) followed by South Punjab (15.04%) and North Punjab (12.05%). As sub-clinical mastitis is a managemental problem. The Departmental functionaries may be entrusted the task to chalk out a doable action plan to create awareness among small farmers (both male and female) regarding good husbandry and milking practices.

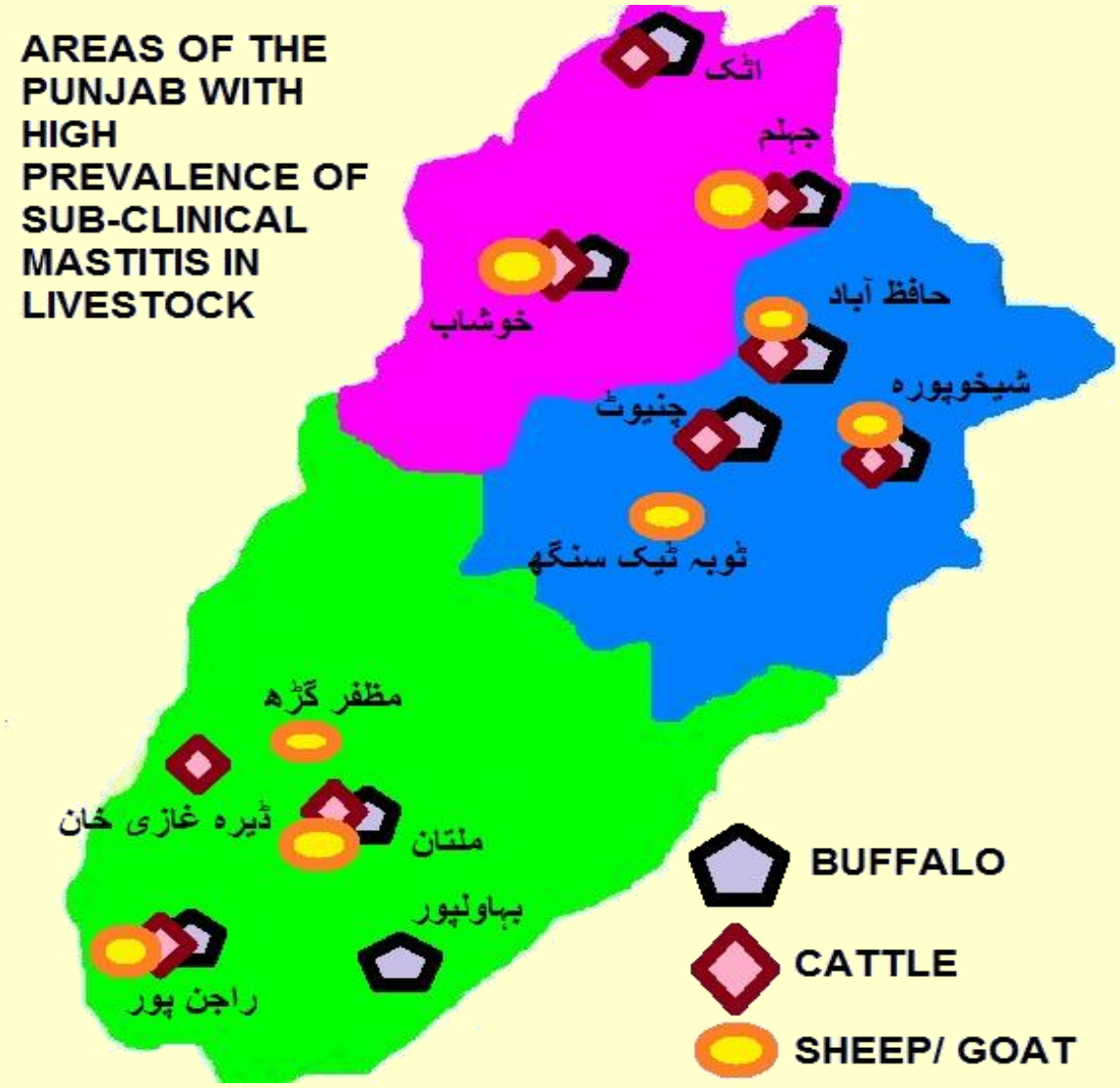
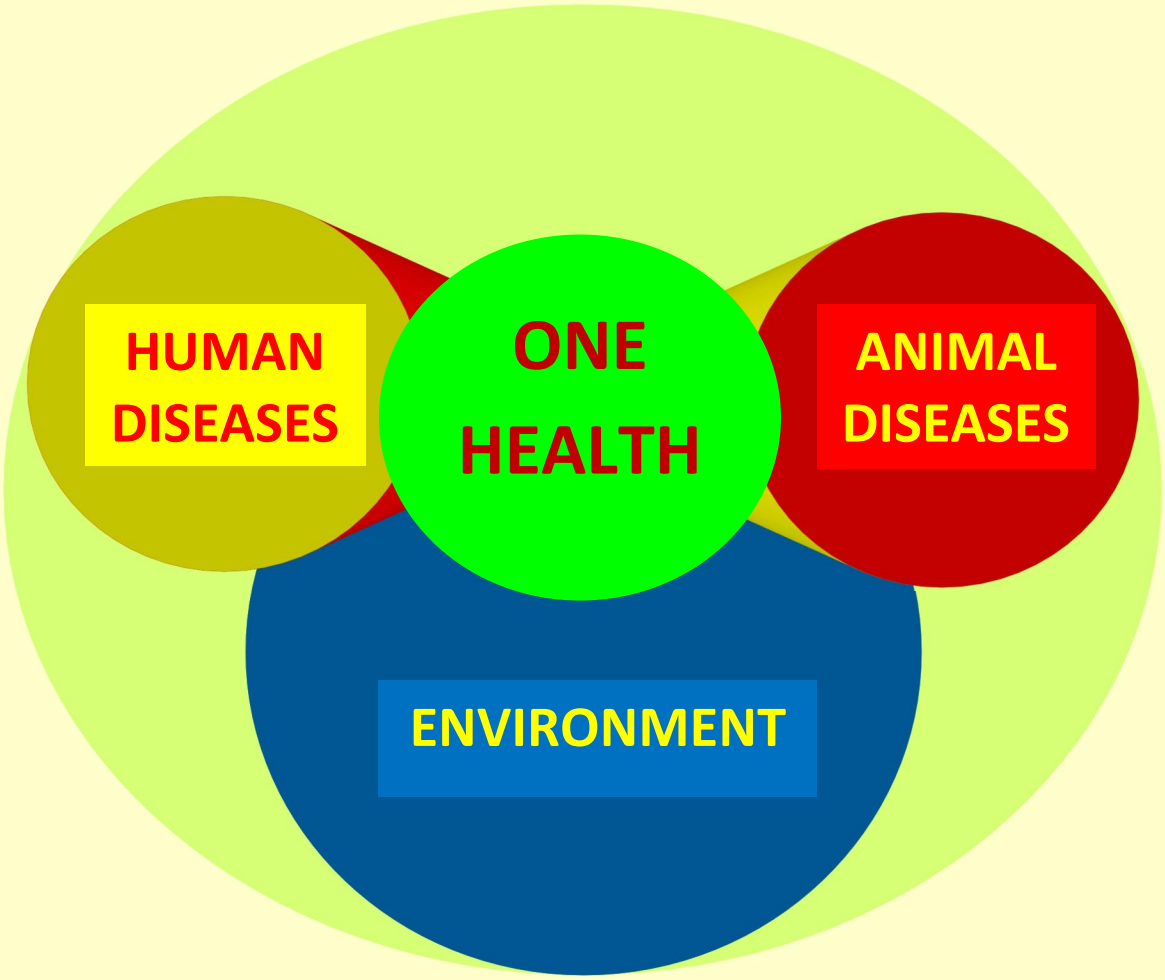


Figure 10: Areas of the Punjab with High Prevalence of Sub-clinical Mastitis in Livestock

Livestock are vital to the lives and livelihood of rural poor. Chronic endemic diseases and zoonoses lower livestock productivity and endanger human health, thereby contributing to the perpetuation of poverty. Bringing together veterinary, medical and social scientists, we can achieve better control over these diseases. A theme that human and animal health is inextricably linked is called "One Health".

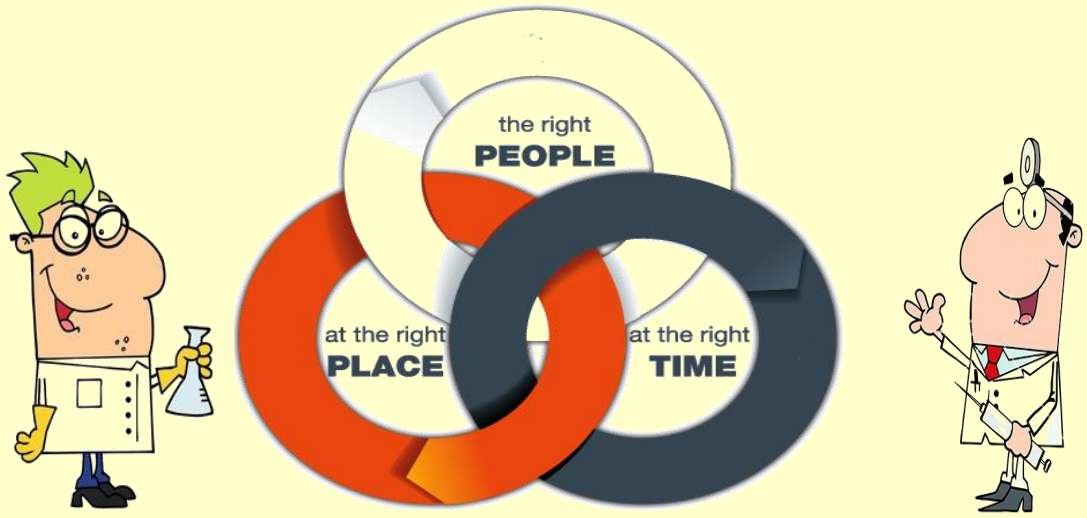
Man has altered the ecology of areas in which other animals and their pathogens interplay with each other. The result of this ecological change is the emergence of zoonotic diseases. If human activity can cause the generation of new / emerging diseases, then changes in human behavior may be a step towards their prevention, control and eradication.



THE WAY FORWARD

There is a strong association between poverty, hunger, poor livestock husbandry and emerging zoonoses. Globally, around two thirds of the rural poor and one third of the urban poor depend on livestock for their livelihood. Livestock provides one fifth to one half of household income for the poor. In developing countries, livestock provides from 6 to 36% of animal protein: food of high biological value. Livestock production is increasing rapidly in response to growing population, increase in income, urbanization and varying diets: the so-called "Livestock Revolution". Over the next 40 years, absolute growth in consumption will be greatest in South Asia, South East Asia and sub-Saharan Africa. In the Punjab high livestock populations and strong rising demand for livestock products offer opportunities for livestock to be a pathway out of poverty. This demand is largely driven by urbanization, demographic growth and increasing wealth. At the very outset if Government of the Punjab sets its focus to use livestock as a pathway out of poverty, it has to rationally use its resources in areas of high priority. "What cannot be measured cannot be managed" is a universal principle. Assessing, mapping and prioritizing diseases of economic and zoonotic importance are bedrocks to decision-makers and implementers to plan and manage disease control. Decision makers and implementers using unstructured prioritization often focus on those livestock-related problems that are irrelevant to pro-poor economy. This scenario demanded to launch a cross-sectional survey of the whole Province to gather valuable intelligence to gauge the magnitude, distribution and impact of diseases of livestock having economic and zoonotic importance. The information gleaned though this survey indicates the following potential areas to work on and achieve the goals:

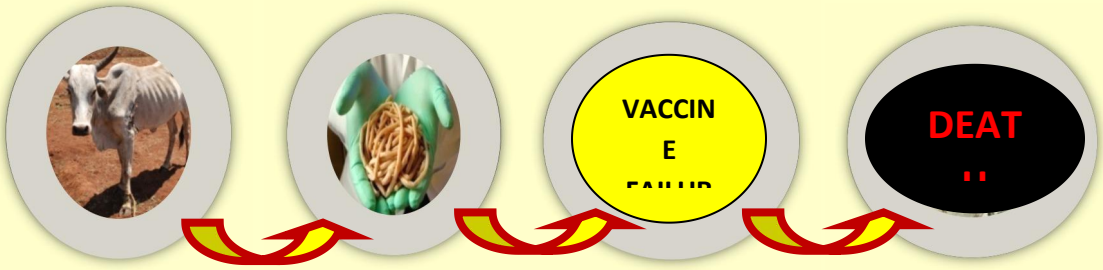
- Disease surveillance is of paramount importance to assess the health status of a population. Provision of staff and resources to diagnostic laboratories is prerequisite for strengthening of disease surveillance system. A surveillance unit may be established at each district level under the supervision of ADIO which will work in close collaboration with the field formations. The surveillance unit will generate its reports on regular basis.
- Under-reporting of diseases is a major impediment to understand patterns, trends and impact of disease for planning of appropriate control strategy. Being District Disease Reporting Officer and Commander of field force, DLOs may be directed regarding their obligation in this connection.
- Capacity building of laboratory staff is the need of time. The post of ADIO demands more technical capabilities than the administrative ones because they are involved in generation of basic data for strategy development regarding future planning and allocation of resources. Authenticity of their information demands excellent professional and technical skills with knowledge of newly developed and advanced techniques. In order to update their knowledge about scientific advancements and most modern techniques, their periodic training is recommended at University level. Provision of special incentive in the form of allowance will enhance their interest and efficiency.
- To yield full benefit out of District Disease Diagnostic Laboratories, only capable professionals having aptitude for laboratory work may be deputed.



- A team of Trainers may be built. These trainers will trail the laboratory staff (Veterinary Officers and Laboratory Assistants) in the art of prompt and correct laboratory diagnosis, maintenance of good laboratory practices and the economical use of available resources.

- Parasitism is associated with decreased immune response of effected animals leading to impaired immunity after vaccination. Improved extension services and anthelmintics coverage on mass scale before vaccination would minimize the parasitic load; enhance vaccine efficacy and its resultant benefits. Instead of irrational de-worming, the concept of strategic

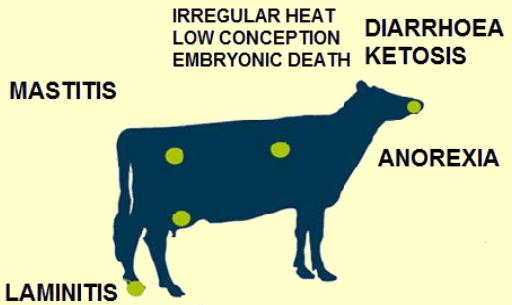
de-worming prior to vaccination may be instituted. Before the purchase of de-wormers, extensive field trials may be conducted at district level to select the de-wormer of choice for different ecological territories. This strategic de-worming will prevent a lot of Government Exchequer from going down the drain. Village livestock breeders may be apprised of the deleterious effects of endo-parasitism through audio-visual aids during farmer meetings.



- Keeping in view the prevalence of coccidian parasites throughout Punjab, supply of anticoccidial drugs (amprolium or toltrazuril) should be ensured to all veterinary hospitals.
- Biological control of liver fluke may be achieved by introduction of large number of ducks into the areas having prevalence of liver fluke, which may be used to reduce the snail population. The ducks eat the snails and the fluke species specific to the ducks compete with the fluke species of ruminants in the infection of snails. It is reported that snails infected with duck flukes will not become infected with flukes of livestock. Similarly separating young ones from adults as early as possible reduces the incidence of nematode infestation as older animals are source. Provision of drinking water in troughs is recommended to avoid the use of fluke-contaminated temporary water bodies in low lying areas of the Punjab.


- Significantly high prevalence of sub-clinical mastitis indicates lack of awareness regarding necessary managemental and milking practices required for prevention and control of this hidden infection. Prevention of this disease is based on early detection and prompt treatment. Capacity building of the livestock owners for detection of sub-clinical mastitis through Surf Field Mastitis Test and apprising them about good husbandry practices will minimize its incidence among lactating animals. For this purpose farmer meetings may be arranged at village level at least twice in a month.


- Cotton seed cake is an integral part of animal feed in the Province. The ingestion of aflatoxin contaminated cotton seed cake may be one of the factors for high prevalence of sub-clinical mastitis throughout the Punjab. In areas with high prevalence of mastitis, analytical epidemiological studies may be designed and conducted for quantification of risk factors associated with subclinical mastitis and livestock breeders may be apprised accordingly through farmer meetings.



EFFECT OF AFLATOXIN IN LIVESTOCK

- In Punjab, care and milking of livestock is mostly carried out by the women. Teams of lady extension workers may be built to apprise female livestock breeders about good husbandry practices regarding prevention of endo-parasitism, tick infestation, haemo-parasitism, sub-clinical mastitis, brucellosis and important zoonotic infections such as Crimean Congo Haemorrhagic Fever (CCHF) through farmer meetings. Honorarium may be given to these female extension workers.

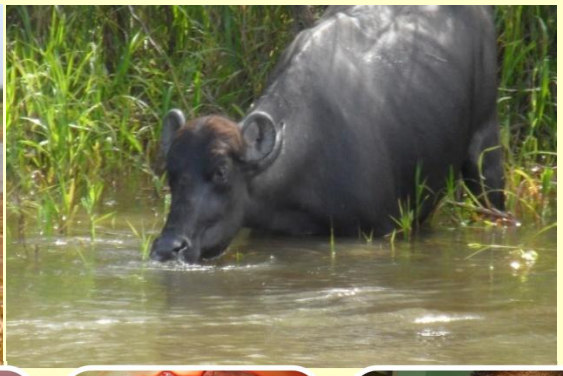


- Print and electronic media may be used for the promotion of Surf Field Mastitis Test.
- For the rational purchase of antibiotics at district level the results of antibiotic susceptibility testing conducted at District Disease Diagnostic Laboratories may be considered.
- Sixty percent of the pathogens that cause diseases in humans are of animal origin. These diseases, known as zoonoses, can be transmitted by domestic

and wild animals. Animal diseases that are transmissible to humans such as avian influenza, rabies and brucellosis present a public health risk worldwide and it is imperative to combat them at every level. The most effective and economical solution to protect humans is to combat all zoonotic pathogens by controlling them at their animal source. This requires a new approach focusing on specific investment in governance, particularly with regard to the allocation of resources (Anonymous, 2013). Millions of people worldwide are at risk of bacterial, viral and parasitic zoonotic infections such as brucellosis, avian influenza and fasciolosis especially in developing countries where the infections in animals have not been brought under control. Consumption of unpasteurized milk, unhygienic and undercooked food and lack of awareness are potential risk factors for transmission of zoonotic infections to human populations. Allocation of sufficient resources for effective disease reporting and surveillance with collaboration of environmental, human and veterinary health professionals is need of time.

- Domestic poultry has significant impact on rural economy and women empowerment. Genetic improvement, better management and prophylactic health coverage are pathways to enhance the potential of this sector. Directorate of Poultry Research Institute may be facilitated for planning and execution of necessary steps in this connection.

- Use of unsterilized needles for vaccination and treatment is a potential risk factor for spread of infectious diseases among livestock populations. Sufficient supply of needles to field staff with awareness regarding sterilization will minimize the incidence of said diseases such as Anaplasmosis.
- Approximately 35 million people are infected with liver flukes throughout the world and the very high incidence of cancer of the bile ducts (cholangiocarcinoma) in some countries is associated with a high prevalence of liver fluke infection. So it is important to have a high awareness of this insidious and destructive liver disease. In order to prevent human infestation with liver fluke, health education and activities to raise awareness about the mode of transmission may be initiated.


Extreme Abdominal Pain


Skin Rashes


Swollen Liver


Jaundice


Anaemia


Liver Cirrhosis

- Mobile squads equipped with audio-visual gadgets may be constituted at tehsil level. Female Veterinary Officers and Veterinary Assistants may be the part of this squad. These teams will arrange meetings with rural womenfolk and educate them about best husbandry practices. Role of endo-parasites and sub-clinical mastitis in lowering the profitability may be highlighted to them. Demonstrations of Surf Field Mastitis Test and Post-Milking Teat Dip may be given to them.

- Millions of people in the Punjab are at high risk for brucellosis, especially in the rural settings where the infection in animals has not been brought under control, heat treatment procedures of milk are not routinely applied, and food habits such as consumption of raw milk and poor hygienic conditions favor human infection. Mass awareness campaign may be launched to apprise people about this insidious pestilence.

- The mass vaccination campaign, coupled with a strategic deworming campaign may be made as a paramount and perpetual feature of the Department. This right positioning will be the driver for the paradigm shift from curative to preventive approach.

FINALE

The development of livestock, rural poultry & dairy leading to pro-poor growth is a journey of many small steps. Cognizance must be taken of the present condition of the sector. It is not possible to turn over a new leaf overnight – the basics must be focused on first, and then a logical progression followed. It should also be recognized that identified grey areas and the remedial approaches thereof are built upon and overlap each other. Therefore, no single initiative would provide a permanent and effective solution. Rather in the thematic strategy (Livestock Policy of the Punjab), endeavors should be multifaceted and progression must be spread over a broad front. A combination of programmes addressing different fronts would drive the development of this sector. Present study not only highlights the bottlenecks to the pace of development of this sector but also it's untapped potential of being a pathway out of poverty. Successful pro-poor growth strategies would enable the rural poor, particularly the most marginalized segments of our society *i.e.* womenfolk and landless livestock breeders, to participate in, and benefit from, the growth process.

This study was conducted under the meager resources (human and material) available with the L&DD Punjab. It was due to the zeal and dedication of the Secretary Livestock and his whole team at Civil Secretariat Lahore, Directors,

L&DD, Monitoring & Co-coordinating Officers of L&DD, District Livestock Officers, Assistant Disease Investigation Officers and their field force that this novel venture became a success story. Above all, the continuous *de facto* support and encouragement of the Chief Minister Punjab was available, at all levels, throughout the course of this survey. It was a team effort and everybody engaged in it was imbibed with the spirit of *datum perficiemus munus*. Being novel in the history of Pakistan, this survey does have some deficiencies in it. But, *data venia*, if we consider the resources available with the L&DD Punjab, the short time frame for execution of this mission, the harsh weather, logistics management, the difficult terrains and high personal risk zones / hostile environments particularly for lady veterinarians then its true worth is revealed. This survey was one of its first kinds and would *Deo volente* be a perpetual and regular feature of the Department. With the passage of time it would get momentum and improvement in all respects.

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APPENDICES

Appendix A: Sample size for Endo-parasites of Large and Small Ruminants

Sample Size for Frequency in a Population

Population size(for finite population correction factor or fpc)(*N*):	74421687
Hypothesized % frequency of outcome factor in the population (*p*):	50%+/-1
Confidence limits as % of 100(absolute +/- %)(*d*):	1%
Design effect (for cluster surveys-*DEFF*):	1

Sample Size(*n*) for Various Confidence Levels

Confidence Level (%)	Sample Size
95%	9603
80%	4106
90%	6764
97%	11772
99%	16584
99.9%	27059
99.99%	37836

Equation

Sample size n = **[DEFF*Np(1-p)]/ [($d^2/Z^2_{1-\alpha/2}$*(N-1)+p*(1-p)]**

Results from OpenEpi, Version 3, open source calculator--SSPropor

Appendix B: Sample size for Haemo-parasites of Large and Small Ruminants

Sample Size for Frequency in a Population

Population size(for finite population correction factor or fpc)(*N*):	74421687
Hypothesized % frequency of outcome factor in the population (*p*):	10%+/-1
Confidence limits as % of 100(absolute +/- %)(*d*):	1%
Design effect (for cluster surveys-*DEFF*):	1

Sample Size(*n*) for Various Confidence Levels

ConfidenceLevel(%)	Sample Size
95%	3458
80%	1479
90%	2435
97%	4239
99%	5971
99.9%	9744
99.99%	13626

Equation

Sample size $\boldsymbol{n}$ **= [DEFF*Np(1-p)]/ [($d^2/Z^2_{1-\alpha/2}$*(N-1)+p*(1-p)]**

Results from OpenEpi, Version 3, open source calculator--SSPropor

Appendix C: Sample size for Brucellosis in Large and Small Ruminants

Sample Size for Frequency in a Population

Population size(for finite population correction factor or fpc)(*N*):	74421687
Hypothesized % frequency of outcome factor in the population (*p*):	5%+/-1
Confidence limits as % of 100(absolute +/- %)(*d*):	1%
Design effect (for cluster surveys-*DEFF*):	1

Sample Size(*n*) for Various Confidence Levels

ConfidenceLevel(%)	Sample Size
95%	1825
80%	781
90%	1286
97%	2237
99%	3152
99.9%	5143
99.99%	7192

Equation

Sample size $n = [DEFF*Np(1-p)]/ [(d^2/Z^2_{1-\alpha/2}*(N-1)+p*(1-p)]$

Results from OpenEpi, Version 3, open source calculator--SSPropor

Appendix D: Sample size for Sub-clinical Mastitis in Large and Small Ruminants

Sample Size for Frequency in a Population

Population size(for finite population correction factor or fpc)(*N*):	74421687
Hypothesized % frequency of outcome factor in the population (*p*):	20%+/-1
Confidence limits as % of 100(absolute +/- %)(*d*):	1%
Design effect (for cluster surveys-*DEFF*):	1

Sample Size(*n*) for Various Confidence Levels

ConfidenceLevel (%)	Sample Size
95%	6146
80%	2628
90%	4329
97%	7535
99%	10615
99.9%	17320
99.99%	24220

Equation

Sample size $n = [DEFF*Np(1-p)]/ [(d^2/Z^2_{1-\alpha/2}*(N-1)+p*(1-p)]$

Results from OpenEpi, Version 3, open source calculator--SSPropor

Appendix E: Sample size for Endo-parasites of Rural Poultry

Sample Size for Frequency in a Population

Population size(for finite population correction factor or fpc)(*N*):	39300000
Hypothesized % frequency of outcome factor in the population (*p*):	60%+/-1
Confidence limits as % of 100(absolute +/- %)(*d*):	1%
Design effect (for cluster surveys-*DEFF*):	1

Sample Size(*n*) for Various Confidence Levels

Confidence Level (%)	Sample Size
95%	9218
80%	3942
90%	6493
97%	11300
99%	15917
99.9%	25969
99.99%	36307

Equation

Sample size $\boldsymbol{n = [DEFF*Np(1-p)]/ [(d^2/Z^2_{1-\alpha/2}*(N-1)+p*(1-p)]}$

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Although this report is generated meticulously yet we acknowledge our shortcomings and are ready for improvements.

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