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Economic impact assessment and disease prevalence of coccidiosis in broilers around tarai region

Sachin Pant, Prakash Bhatt and AK Singh

Abstract
Coccidiosis is a cosmopolitan problem caused by apicomplexa protozoa of the genus *Eimeria*. Heavily infected poultry birds that show severe clinical signs and coccidiostat resistance are causing important economic losses. The present study aimed to investigate the economic impact of coccidiosis in Broilers around Tarai region. The Economic impact assessment due to coccidiosis was conducted in commercial broiler farms during the period from June, 2015 to January, 2016. A total of ten commercial poultry farms were screened for the presence of coccidiosis amongst them six broiler farms (B_1, B_2, B_3, B_4, B_5 and B_6) were confirmed to be positive for coccidiosis with the disease prevalence of 60% and it was observed that the prevalence of coccidiosis was higher during the monsoon season particularly during the months of July to September. The prevalence was recorded to be highest during August- September followed by June-July and equal in months of October- November and December- January with 2 outbreaks reported during the month of June-July (33.3%), 3 in August-September (50%) and 1 during December- January (16.6%). The major economic loss was recorded due to reduced body weight gain (49.06% - 95.7%) followed by increased feed conversion ratio (4.87% - 19.2%), mortality (1.33% - 58.72%), chemotherapy (1.45% -32.5%) and chemoprophylaxis (0.05%- 8.72%). However some variation was also observed in 3 farms (B_1, B_2 and B_6), wherein, farm B_1, there was concurrent infection of Infectious Bursal Disease and therefore the loss due to mortality was higher as compared to poor Feed Conversion Ratio (FCR), in farm B_2 loss due to chemotherapy was higher compared to poor FCR, whereas in other farm (B_6) no subclinical form of coccidiosis was recorded.

Keywords: Coccidiosis, *Eimeria*, broiler, disease prevalence, loss assessment

Introduction
Broiler poultry industry can be considered as the predominant meat producer in India reaching 4.2 million tonnes, turning into volume growth of 7% year on year during 2017-18. It is estimated that with poultry population of 729 million [40% broilers at around 480 million and 30% layers at around 215 million] small and medium farmers are the one mostly engaged in the farming system [1].

In India, poultry production exists in both traditional extensive system of backyard farming as well as modern intensive system. Poultry sector also provides employment to over 3 million people and it is estimated that by 2025 this figure will be around 5 million as per CARI. Earning from exports of poultry products in India was around 565 crores rupees and 651.21 crores rupees in 2013-14 and 2014-15, respectively, as per data from Agricultural and Processed Food Products Export Development Authority [2]. However, for ensuring a continuous and high production level of chicken products, diseases management programs are essential. One of the most well-known diseases worldwide is avian coccidiosis [3]. The losses caused by coccidiosis are due to not only mortality but also poor weight gain and feed conversion rate together with the costs of treatment [4]. It is estimated that worldwide losses due to coccidiosis is more than US$ 3 billion per year [5] while the emerging poultry industry of India incurs a huge economic loss of nearly rupees 1.14 billion per annum due to debility and deaths [4] with commercial broiler industry being the major sufferer as compared to layers [6, 7].

Poultry coccidiosis is caused by various species of *Eimeria* of phylum Apicomplexa. It is an obligate intracellular parasite characterized by unique specialized organelles that provide the structural stability required during the host invasion process [8]. Now-a-days, due to higher stocking densities and intensive husbandry practices, there is increased incidence of disease in poultry [9]. Coccidiosis is observed throughout the year [10] with higher prevalence during rainy

season. However, the prevalence can be reduced significantly in commercial poultry production systems by improved housing, hygiene and proper management [11]. The clinical signs in coccidiosis develop due to destruction of gut epithelia, villous atrophy and some species, disrupt sub-epithelial tissues and is characterized by signs like dysentery, enteritis, emaciation, drooping wings, poor growth, low production [12] with high mortality and morbidity [13]. Bad management practices such as wet litter, contaminated drinkers and feeders, bad ventilation and high stocking densities exacerbate the clinical signs [14]. Inspite the fact that coccidiosis is probably the most frequently reported disease in chicken worldwide [15]**,**recent research has focused mainly on the genetics of *Eimeria*, mechanisms of parasite invasion and disease management and not much emphasis is been given on the specific financial losses incurred by the disease. The estimation of economic losses by different countries differs because of the variability in factors included in the study and very few estimates are available for India. Thus there are only occasional reports on the economic losses of poultry due to coccidiosis [16, 17].

Therefore by keeping in the view the large scale prevalence of coccidiosis in poultry as well as the associated economic loss the present study was undertaken to estimate the disease prevalence and assessment of loss due to coccidiosis in tarai region of Uttarakhand.

2. Materials and Methods

2.1 Type of bird considered for the calculation:

Commercial broiler flocks positive for poultry coccidiosis were considered for the assessment of economic loss.

2.2 Data collection

Records of the commercial poultry farms were analysed for the value of major inputs and outputs and were supplemented with questionnaire designed to obtain additional information from poultry farmers.

2.3 Lifespan of birds

Lifespan of commercial broiler birds were considered to be 42 days.

2.4 Disease prevalence

To calculate the prevalence of coccidiosis in Uttarakhand and adjoining state total flock strength were recorded during the period of June 2015 to Jan 2016.

2.5 Overhead cost

Overhead cost of bird was assumed as per prevailing rates. It consisted of electricity, management and labour cost excluding the cost of chick and feed.

2.6 Market value of day old chick (DOC), poultry meat and eggs

The market price of chicks for commercial broiler and poultry meat were taken as per prevailing rates mentioned in farm records and were further supplemented by NECC (National Egg Coordination Committee) and www.Poultrybazaar.com.

2.7 Feed requirement and cost

The feed consumption for a broiler bird was taken. Cost of feed was taken as per prevailing rates mentioned in farm records**.**

2.8 Economic models

The model developed by Williams [18] to estimate the losses due to poultry coccidiosis were used in the study with slight modification as required. (Table 1)

Table 1: Major parameters considered for estimation

S. no.	Parameters for Broilers
1.	Cost of chemoprophylaxis
2.	Cost of chemotherapy
3.	Loss due to mortality
4.	Reduced body weight gain
5.	Increased FCR

2.8.1 For commercial broiler

2.8.2 Chemoprophylaxis

Prophylaxis of coccidiosis is generally done in broiler by means of chemoprophylaxis. The economic model used was

TCCP (total cost of chemoprophylaxis) = N×CFR×MU×CM

N= no. of birds placed

CFR= cumulative feed requirement for each bird (ton)

MU= medicine used, kg /ton of feed

CM= cost of medicine (Rs/kg)

2.8.3 Chemotherapy during outbreak of disease

The model used was

TCCT (total cost of chemotherapy) = NTB×RW×2*(M1+M2) ×CM

NTB= number of treated birds

RW= requirement of water, L/day/bird

M1= medicine mixed with water in first half of treatment, kg/L

M2 = medicine mixed with water in second half of treatment, kg/L

CM= cost of medicine in Rs/kg

*Modified as per the drug used

2.8.4 Mortality due to coccidiosis:

The model used was

LM (loss due to mortality) = BD× (VC+CCF+OC)

BD= no. of birds died

VC= value of day old chick

CCF= cost of cumulative feed consumed by a single bird

OC= overhead cost

2.8.5 Reduced body weight gain

The model used was

TLRBG (total loss due to reduced body weight gain) = {(N×RI) – M} ×RBW×RM

N= no. of birds placed

RI= rate of incidence of subclinical form of coccidiosis

M= no. of commercial broiler birds died due to clinical coccidiosis

RBW= reduced body weight gain, kg

RM= rate of poultry meat

2.8.6 Increased FCR

The feed conversion ratio (FCR) indicates the efficiency of broiler bird to convert feed into live broiler weight. The economic model used was

TLIFCR (total loss due to increased feed conversion ratio) = (No. of sub clinically affected birds – No. of birds died) × LW× DifFCR ×CF

LW= live weight per bird

DifFCR= difference of FCR in affected birds

CF= cost of broiler feed, Rs/kg

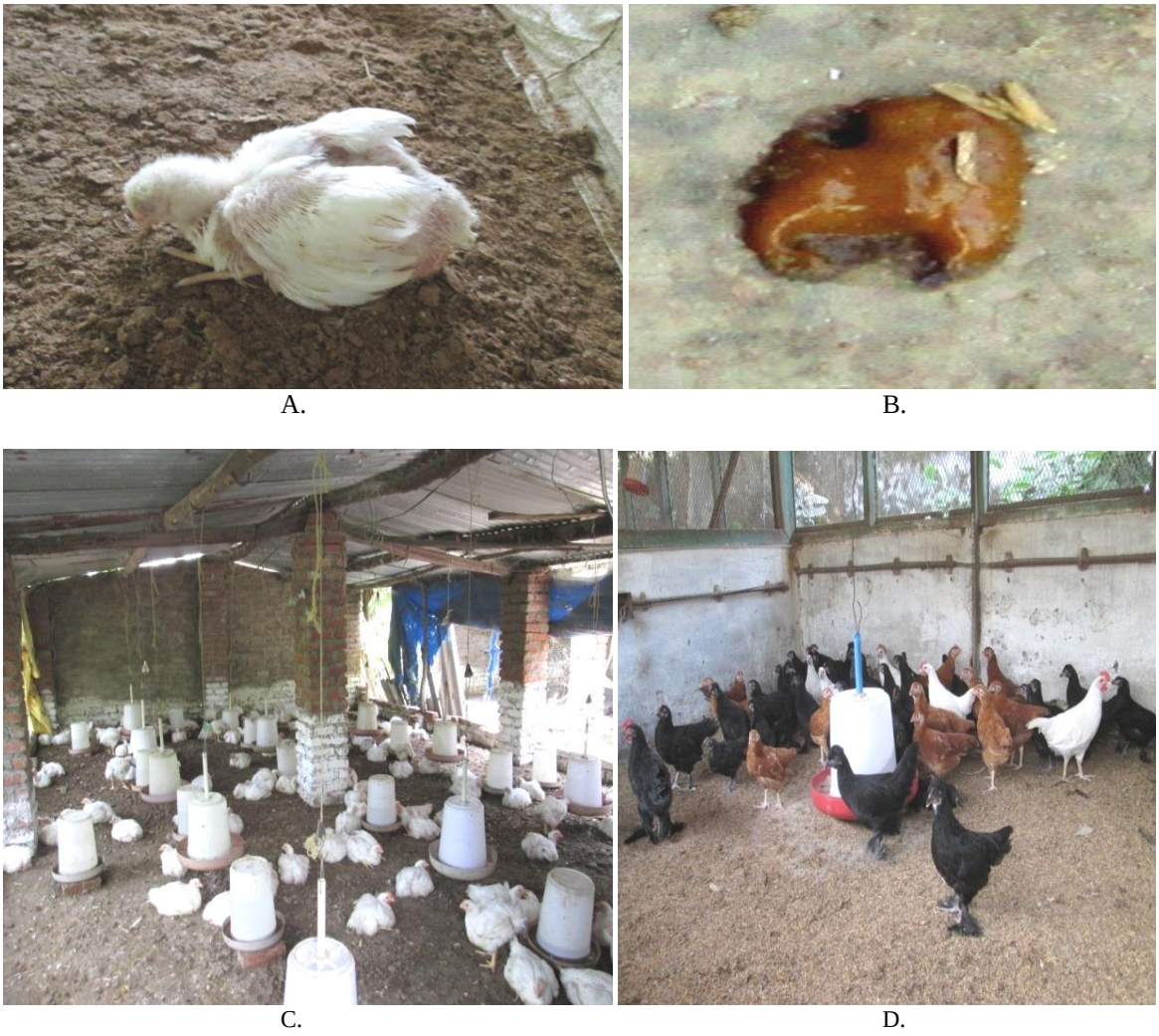
Feed consumption and body weight gain was required to calculate the feed conversion ratio

$$FCR = \frac{\text{Feed consumed (gm)}}{\text{Weight gain (gm)}}$$

3. Results and Discussion

Symptomatology

General clinical signs, being (A) dull and depressed chick, (B) bloody droppings in affected birds, (C) huddling of affected flock together, (D) decreased weight gain in diseased flock (Plate 1) together with anorexia and poor feed utilization, pale combs, and dehydration.



A. B. C. D.

Plate 1: Various symptoms of Poultry coccidiosis

The above clinical signs were in agreement with those observed in previous reports [19, 12, 20, 21].

Disease prevalence

A total of 10 broiler farms were screened during the study period out of which 6 broiler farms were confirmed to be positive for coccidiosis with the prevalence of 60%. The details in this regards are described in Table 2. In the study it was observed that the prevalence of coccidiosis was higher during the monsoon season particularly during the months of July to September. The prevalence was recorded to be highest during August- September followed by June-July and equal in months of October- November and December- January and there were 2 outbreaks reported during the month of June-July (33.3%), 3 in August-September (50%) and 1 during December- January (16.6%). The above finding correlates with the observation made by earlier researchers [22, 23] who also reported higher prevalence of coccidiosis during the monsoon season as compared to other seasons. This is due to the fact that at this time of the year environmental conditions like temperature and humidity are favorable for transmission and sporulation of oocysts therefore resulting in higher cases during this time [24].

Table 2: Disease prevalence in broiler birds

Month	No. of disease outbreak	Age	Causal agent of Infection
June-July	1	21d	*E. tenella*
June-July	1	19d	*E. necatrix*, *E. tenella*
Aug- Sep	1	40d	*E. maxima*, *E. tenella*
Aug- Sep	1	13d	*E. maxima*
Aug- Sep	1	22d	*E. tenella*
Oct-Nov	-	-	-
Dec- Jan	1	37d	-

Economic loss assessment

To evaluate the economic loss in the positive farm, a questionnaire survey was done which was further supplemented with the farm records available. Based on these economic loss occurred in the farm was calculated. The details of the broiler farms are given in Table 3.

Name of the farm: Poultry farm (B_1)

1. TCCP (total cost of chemoprophylaxis) = N×CFR×MU×CM
= 1100 × 0.000960 × 0.5 × 300
= **Rs** 159

2. TCCT (total cost of chemotherapy) = NTB×RW×5× (M1+M2) ×CM
= 1050 × 0.175× 5 × 0.002 × 1460
= **Rs** 2683

3. LM (loss due to mortality) = BD× (VC+CCF+OC)
= 200 × (23.50 + 17.50 + 2.25)
= **Rs** 8650

4. TLRBG (total loss due to reduced body weight gain) = {(N×RI) – M} ×RBW×RM
= {900} × 0.200× 68
= **Rs** 12,240

5. TLIFCR (total loss due to increased feed conversion ratio) = (no. of sub clinically affected birds – no. of birds died) × LW× DifFCR ×CF
=900 × 0.750 × 0.1 × 18
= **Rs** 1215

Total economic loss assessed = 159+ 2683+ 8650+ 12240+ 1215= Rs 24947

Name of the farm: Poultry farm (B_2)

1. TCCP (total cost of chemoprophylaxis) = N×CFR×MU×CM
= 2000 × 0.000955× 0.3× 140
= **Rs** 80

2. TCCT (total cost of chemotherapy) = NTB×RW×5× (M1+M2) ×CM
= 1976× 0.16× 5× 0.001× 1345
= **Rs** 2126

3. LM (loss due to mortality) = BD× (VC+CCF+OC)
= 30 × (22.50+17.25+2.50)
= **Rs** 1268

4. TLRBG (total loss due to reduced body weight gain) = {(N×RI) – M} ×RBW×RM
= {1970} × 0.100× 66
= **Rs** 13,002

5. TLIFCR (total loss due to increased feed conversion ratio) = (no. of sub clinically affected birds – no. of birds died) × LW× DifFCR ×CF
= 1970 × 0.730 × 0.06 × 17.80
= **Rs** 1536

Total economic loss assessed = 80+2126+1268+13002+1536 = Rs 18,012

Name of farm: Poultry farm (B_3)

1. TCCP (total cost of chemoprophylaxis) = N×CFR×MU×CM
= 1500 × 0.0043×0.5×300
= **Rs** 968

2. TCCT (total cost of chemotherapy) = NTB×RW×3× (M1+M2) ×CM
=1475×0.30×3×0.001×1325
= **Rs** 1759

3. LM (loss due to mortality) = BD× (VC+CCF+OC)
= 28× (24+25+3.50)
= **Rs** 1470

4. TLRBG (total loss due to reduced body weight gain) = {(N×RI) – M} ×RBW×RM
= {1472} × 0.5 × 78
= **Rs** 57408

5. TLIFCR (total loss due to increased feed conversion ratio) = (no. of sub clinically affected birds – no. of birds died) × LW× DifFCR ×CF
= 1472 × 1.95 × 0.200 × 25.50
= **Rs** 14639

Total economic loss assessed = 968+1759+1470+57408+14639= Rs 76244

Name of the farm: Poultry farm (B_4)

1. TCCP (total cost of chemoprophylaxis) = N×CFR×MU×CM
= 5000 × 0.000461 × 0.3× 140
= Rs 97

2. TCCT (total cost of chemotherapy) = NTB×RW×3× (M1+M2) ×CM
= 4941 × 0.12 × 3 × 0.001 × 1350
= Rs 2402

3. LM (loss due to mortality) = BD× (VC+CCF+OC)
= 63× (22 + 10.5 + 2.37)
= Rs 2197

4. TLRBG (total loss due to reduced body weight gain) = {(N×RI) – M} ×RBW×RM
={4937} ×0.50 × 64
= Rs 1,57,984

5. TLIFCR (total loss due to increased feed conversion ratio) = (no. of sub clinically affected birds – no. of birds died) × LW× DifFCR ×CF
= 4937 × 0.400 × 0.075 × 15.25
= Rs 2259

Total economic loss assessed = 97+2402+2197+157984+2259= Rs 164939

Name of farm: Poultry farm (B_5)

1. TCCP (total cost of chemoprophylaxis) = N×CFR×MU×CM
= 2000 × 0.000973 × 0.200 × 200
= Rs 78

2. TCCT (total cost of chemotherapy) = NTB×RW×4× (M1+M2) ×CM

= 1970× 0.178 × 4 × 0.001 × 1450
= Rs 2034

3. LM (loss due to mortality) = BD× (VC+CCF+OC)
= 36 × (22.50 + 18.25 + 2.40)
= Rs 1553

4. TLRBG (total loss due to reduced body weight gain) = {(N×RI) – M} ×RBW×RM
= {1964} × 0.20× 70
= Rs 27,496

5. TLIFCR (total loss due to increased feed conversion ratio) = (no. of sub clinically affected birds – no. of birds died) × LW× DifFCR ×CF
= 1964 × 0.775 × 0.150 × 17.75
= Rs 4053

Total economic loss assessed = 78+2034+1553+27496+4053= Rs 35214
Name of farm: Poultry farm (B_6)
1. TCCP (total cost of chemoprophylaxis) = N×CFR×MU×CM
= 500× 0.0030 × 0.5 × 200
= Rs 150

2. TCCT (total cost of chemotherapy) = NTB×RW×3× (M1+M2) ×CM
= 488×0.290 ×3× 0.001 × 1320
= Rs 560

3. LM (loss due to mortality) = BD× (VC+CCF+OC)
= 20 × (23 + 24.50 + 3)
= Rs 1010

Total economic loss assessed = 150+560+1010= Rs 1720
In the study, it was observed that reduced body weight gain was the most severely affected economic factor followed by increased FCR, mortality, chemotherapy and prophylaxis except for farm B_1, B_2 and B_6. In farm B_1, loss due to mortality was higher as compared to increased FCR due to concurrent infection of IBD, in farm B_2 chemotherapeutic cost was higher compared to increased FCR, while in farm B_6 chemotherapeutic loss was lower as compared to mortality and no subclinical form of coccidiosis was observed. The further details are represented in Table 4.

Despite the use of chemoprophylactic drugs in all of the affected farms there was outbreak of coccidiosis probably due to the development of resistance against the currently used drugs. However, the faecal score was recorded to be less in maduramicin treated groups as compared to other drugs in broilers.

These findings co-relate with the observations of earlier researchers [18, 6] who mentioned that broiler industry is the major sufferer of poultry coccidiosis with loss of approximately GB £ 38588795 and 108.9 million in U.K. and India, respectively, with an worldwide economic loss of about $ 2.4 billion including production loss, disease treatment and prevention costs [25-27]. The most important economic parameters that are affected being the reduced body weight gain and increased FCR [28]**.** In case of farm B_6, the observations are in agreement with Kinung' hi *et al.* [29] and the possible explanation could be the presence of more clinical form as compared to other farms.

4. Conclusion

The overall prevalence in broiler farms during the study period was observed to be 60% while the outcome of economic loss assessment was that broiler flocks were the main sufferer in terms of economic losses with maximum loss occurring due to reduced body weight gain followed by increased feed conversion ratio (FCR), mortality, chemotherapy and chemoprophylaxis with exception of 2 farms (B_1 and B_6). In farm B_1 there was concurrent infection of IBD and therefore the loss due to mortality was higher, in farm B_2 loss due to chemotherapy was higher compared to poor FCR, whereas in farm B_6 no subclinical form of coccidiosis was recorded.

Table 3: Data collected from commercial broiler flock

Name of the farm	Poultry Farm (Shantipuri, U.S. Nagar)	Poultry Farm (Haldwani)	Poultry Farm (Almora)	Poultry Farm (Bareilly)	Poultry Farm (Khatima)	Poultry Farm (Moradabad)
Code no.	**Farm B_1**	**Farm B_2**	**Farm B_3**	**Farm B_4**	**Farm B_5**	**Farm B_6**
Flock Strength	1100	2000	1500	5000	2000	500
CFR (Ton/bird)	0.000960	0.000955	0.0043	0.000461	0.000973	0.0030
Chemoprophylactic Drug Used	Nicarbazine+ Maduramicin	Maduramicin	Nicarbazine+ Maduramicin	Maduramicin	Nicarbazine	DOT
Dose (Kg/ton of feed)	0.50	0.30	0.50	0.30	0.20	0.50
Water Requirement (Lit/day/bird)	0.175	0.16	0.30	0.12	0.178	0.29
Cost of Medicine (Rs/Kg)	300	140	300	140	200	200
No. of Treated Birds	1050	1976	1475	4941	1970	488
Total Mortality	200	30	28	63	36	20
Chemotherapeutic Drug Used	Amprolium+sul-faquinoxaline	Amprolium	Amprolium	Amprolium	Amprolium+ sul-faquinoxaline	Amprolium
Dose Rate (Kg/lit)	0.002	0.001	0.001	0.001	0.001	0.001
Cost of Medicine (Rs/kg)	1460	1345	1325	1350	1450	1320
Value of DOC (Rs)	23.50	22.50	24	22	22.50	23
Cost of feed consumed (Rs)	17.50	17.25	25	10.5	18.25	24.50
Overhead Cost (Rs)	2.25	2.50	3.50	2.37	2.40	3.0
Reduced body wt. gain (Kg)	0.20	0.10	0.50	0.50	0.20	-
Rate of Poultry Meat (Rs/kg)	68	66	78	64	70	-
No. of subclinical affected birds	900	1970	1472	4937	1964	-

Live wt. per bird (Kg)	0.75	0.73	1.95	0.40	0.775	-
Difference in FCR (Kg)	0.1	0.06	0.20	0.075	0.15	-
Cost of broiler feed (Rs)	18.00	17.80	25.50	15.25	17.75	-
Concurrent Infection	IBD	-	-	-	-	-

Table 4: Assessment of economic loss in commercial broiler flock

	Farm Code					
Economic Parameters (Rs)	**Farm B_1**	**Farm B_2**	**Farm B_3**	**Farm B_4**	**Farm B_5**	**Farm B_6**
1. Prophylaxis	159 (0.63%)	80 (0.44%)	968 (1.26%)	97 (0.05%)	78 (0.22%)	150 (8.72%)
2. Chemotherapy	2683(10.7%)	2126 (11.80%)	1759 (2.30%)	2402 (1.45%)	2034 (5.77%)	560 (32.55%)
3. Mortality	8650 (34.67%)	1268 (7.03%)	1470 (1.92%)	2197(1.33%)	1553 (4.41%)	1010 (58.72%)
4. Reduced Body wt. gain	12240 (49.06%)	13,002 (72.18%)	57,408 (75.2%)	1, 57,984 (95.7%)	27,496 (78.08%)	-
5. Increased FCR	1215 (4.87%)	1536(8.52%)	14,639(19.20%)	2259(1.36%)	4053 (11.50%)	-
Total loss	24,947	18,012	76,244	1,64,939	35,214	1,720

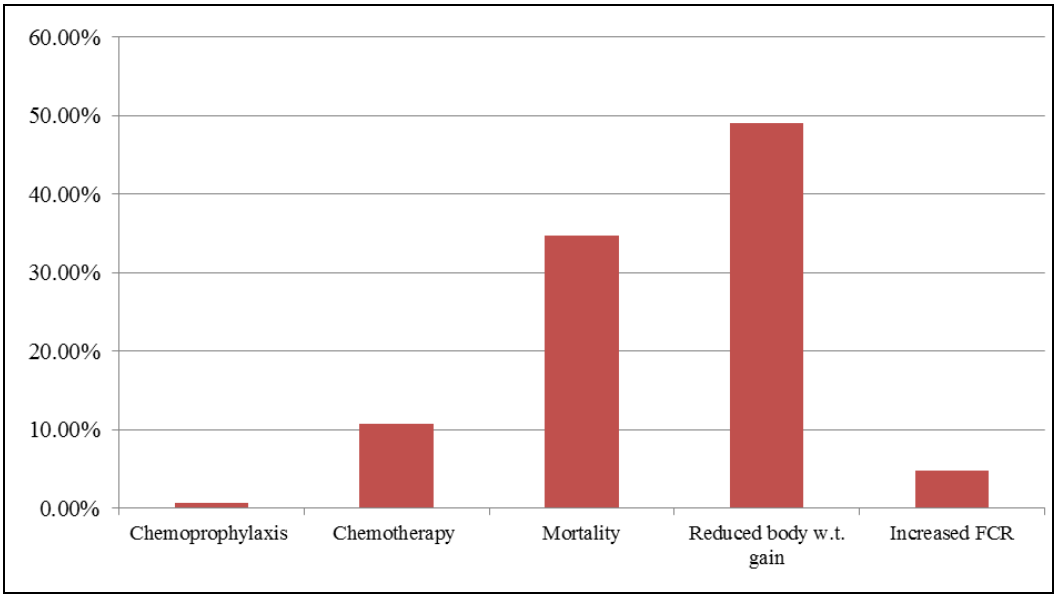


Fig 1: Economic loss in farm B_1 due to poultry coccidiosis

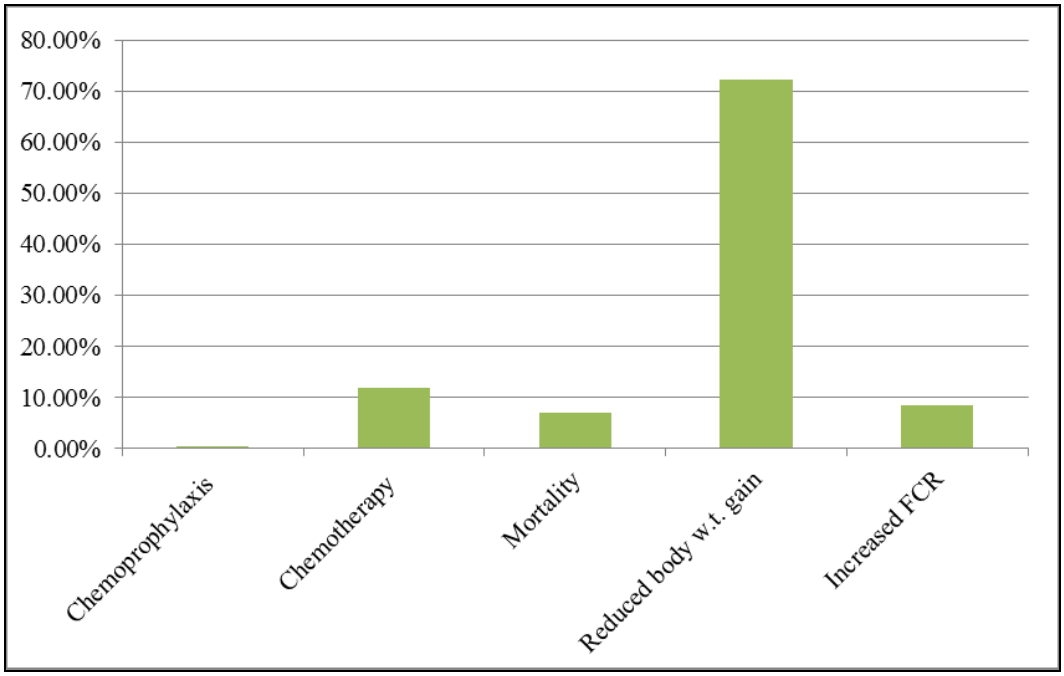


Fig 2: Economic loss in farm B_2 due to poultry coccidiosis

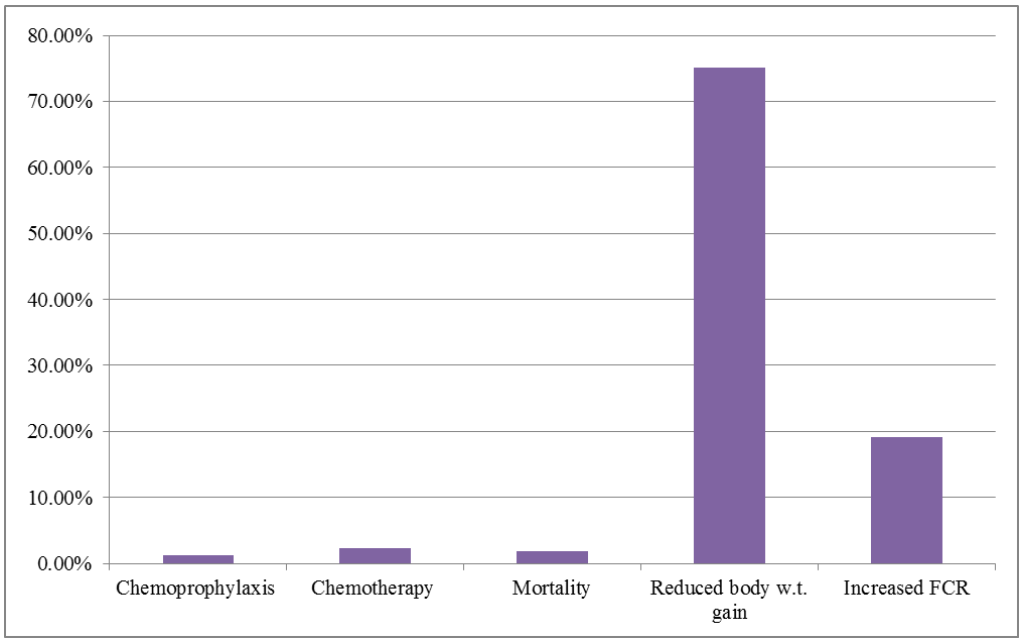


Fig 3: Economic loss in farm B_3 due to poultry coccidiosis

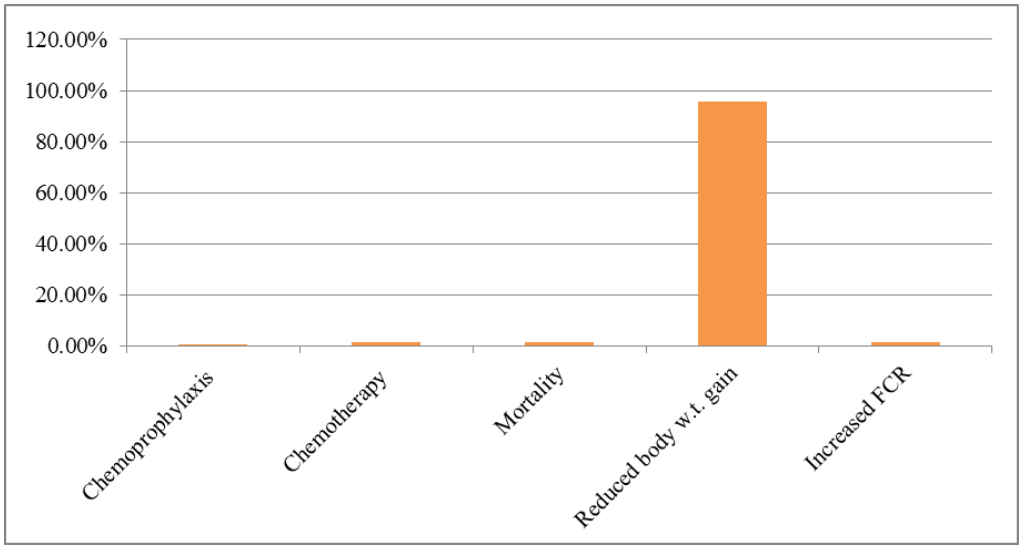


Fig 4: Economic loss in farm B_4 due to poultry coccidiosis

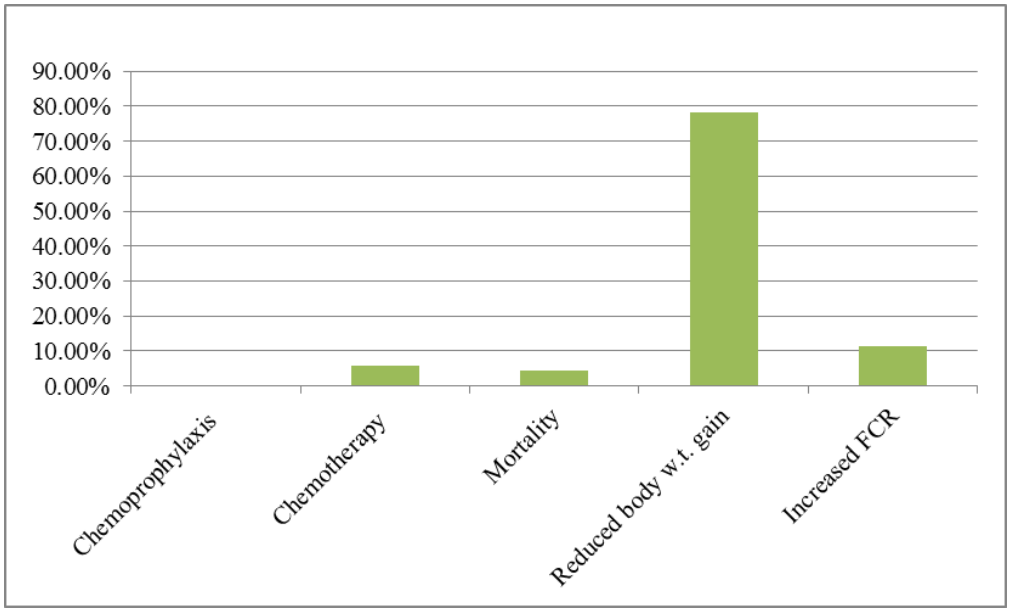


Fig 6: Economic loss in farm B_6 due to poultry coccidiosis

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