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Antibiotics prescription by veterinarians and its use by dairy farmers of Eastern Haryana region of India

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Abstract
This study developed an index for assessing the antibiotic usage by adopting a systematic procedure for index construction; four dimensions under level of decision making regarding the use of antibiotics were selected namely symptom level, animal level, herd level and alternatives perceived. The Normalised Rank Order Method was used for determining the scale values. These dimensions were ranked according to judges‟ perceived significance and proportions were calculated accordingly while determining the values for each, by Guilford table. Based on the rating of judges, mean relevancy and overall mean relevancy scores were calculated. The statements having relevancy weightage (RW) > 0.70 and Mean Relevancy Score (MRS) greater than the Grand Mean Relevancy Score i.e., 1.75 were considered for inclusion in Antibiotic Usage Index (AUII) and finally 19 indicators were included in the index. A correlation of Index value with the socio- economic parameters of farmers were analysed in which it was found that herd size, education and milk sale significantly correlated with the Antibiotic Usage Index values among all the category (small, medium and large) farmers. However, highest correlation values were found for large farmers, followed by medium and small farmers, reveals the socio- economic adherence of farmers affecting the antibiotic usage of different categories of farmers. Among veterinarians it was found that the preference to generic drugs, concern to public health by reduced prescription of antibiotics and consideration to immune- competence while prescribing antibiotics was satisfactory.

Keywords: Antibiotic resistance, correlation, decision- making, Index, Usage.

Introduction

The overuse of antibiotics in animal production can be considered as a factor contributing for increasing bacterial resistance to antibiotics in humans (Oliver *et al*., 2011) [5]. However, studies on antibiotic use at the herd level are rather limited; illustrating that antibiotic use is an emerging topic. Insight into the methods of antibiotic use and use-reduction strategies would be useful in guiding such a trajectory (Kuipers *et al*., 2014). Behaviour of stakeholders toward improving antimicrobial use could be affected by awareness and understanding about antibiotic resistance and its catastrophic consequences. Different approaches may be needed for various stakeholders with intent to convey underlying message about the appropriate antimicrobial use (Chandy *et al*., 2013) [1]. On behalf of various stakeholders, World Health Organization (WHO) on the behalf of the World Health Assembly (WHA) in May 2014 was tasked to develop a plan to tackle the antibiotic resistance issue. As a consequence, several stakeholders meetings and consultations took place, culminating in a resolution on this issue in the WHA in May 2015 and the release of a global action plan (GAP). In India, antibiotic over-use is a major factor accounting for antibiotic resistance. With publication of the Chennai Declaration, it led to changes in Indian law aimed at ending the sale of over-the counter antibiotics (Gavins, 2014).

The key to successful strategies for managing community-based antibiotic resistance is to promote behaviour rmodification besides providing relevant information on proper antibiotic use. Addressing the global challenge of antibiotic resistance requires a “one-health perspective” that takes into account the connections be-tween human and animal health and the environment (Robinson *et al*., 2016) [6]. The One Health approach was validated to address the threat of antibiotic resistance by supranational entities, following the alliance between the

WHO, FAO, and OIE referred as the "Tripartite Alliance." The WHO, in partnership with its Tripartite partners, published the Global Action Plan on Antimicrobial Resistance in 2015, an attempt to offset effectively this worldwide concern (WHO, 2015).

Appropriate biosecurity measures in food and agriculture should further considerably reduce or reduce antibiotic resistance- bacteria from farm-to fork, and thereby, lesser the burden of infectious diseases. Biosecurity refers to a universal concept used to define a set of ongoing measures in order to reduce the risk of the emergence and dissemination of diseases at herd, region and country-levels (FAO, 2003) [3]. "One Health" is used as a framework, and benefits from this integrated approach could encompass various concepts, such as good agricultural practices, good hygiene practices, good veterinary practices, hazard analysis, and critical control points (HACCP)-based procedures and microbiological risk assessment and management (FAO and WHO, 2011).

Materials and Methods: The study was conducted in Eastern region of Haryana state of India. Karnal and Kurukshetra districts of Haryana were purposively selected, and four villages from these districts were randomly selected. From each village, 21 farmers were selected randomly using stratified random samplings by categorizing into small, medium, and large farmers constituting a total of 168 farmers as respondents. The farmers rearing one to four animals were categorized as smallholder dairy farmers, four to 10 animals as medium holder dairy farmers and those with more than 10 animals were considered as large dairy farmers for the purpose of this study following relevant literature (Delgado *et al.* 2003).

Antibiotic Usage pattern and practices: It was operationally defined as the practices that facilitate the farmers to use the antibiotics in order to cure the disease, all though the involvement of various stakeholders and peers affect the decision to adopt related practices. These practices are associated with change in antibiotic seeking behaviour and its use in present and future.

An Antibiotic usage Index (AUI) as an aggregation of sets of variables for the purpose of meaningfully condensing large amounts of information related to antibiotic use practices among the dairy farmers. It was developed to evaluate the use of antibiotic among various categories of farmers (small, medium and large dairy farmers).

Development of Antibiotics Usage Index (AUI): Kerlinger (1983) defined an Index as "number that is composite of two or more other numbers". A composite index can be defined as an aggregation of sets of variables for the purpose of meaningfully condensing large amounts of information. Antibiotic based usage index is developed as under:

Selection of Dimensions: The decision making has multidimensional aspects. A meticulous review of literature and discussion with the experts in relevant field played an important role in the identification of dimensions of decision making. Broadly, these dimensions were grouped into four categories:

(i) symptom level
(ii) animal level
(iii) herd level
(iv) alternatives perceived.

Determination of Scale Values: specific weights (Scale Values) are given to each dimension of the AUI based on their perceived significance. The Normalised Rank Order Method suggested by *Guilford* (1954) was used for determining the scale values of these dimensions.

Rating by experts. Out of 40 judges, 35 judges returned the same set of indicators after judgement of the relevancy of the indicators duly recording their judgements in a stipulated span of 2 months. Out of 35 responses, 5 responses were found unsuitable for item analysis and were eliminated after duly examining their responses. The remaining 30 responses were considered for item analysis. The rankings given by all 30 judges were summarised and presented in table 1.

Table 1: Indicators of Antibiotic Usage Index for dairy farmers

ri	Ri	Indicators of Antibiotic Usage Index				∑	P	C
		Symptom level	Cow level	Herd level	Alternatives perceived			
1	4	12	8	8	2	30	87.50	8
2	3	8	12	7	3	30	62.50	7
3	2	5	6	10	9	30	37.50	6
4	1	5	4	5	16	30	12.50	6
∑f		30	30	30	30	120	200	27
∑fC		212	208	203	201	960		
Mc or Rj or Rc		7.07	6.93	6.77	6.70	M=6.86 σ=0.14 Standard error for Mc=0.05		
ri = Correct rank order, Ri = Reverse rank order, ∑ = Sum, *p*= Proportion, C = C values of respective ranks, Mc = Mean value, Rj = Response value, Rc = Scale Value, σ = Standard Deviation, Standard Error=								

The proportions were worked out for the ranks assigned by all the judges. The ranks assigned by all the judges and proportions were worked out for using the following formulae:

$$p = \frac{(Ri-0.5)*100}{n}$$

Where Ri stands for the rank value of the dimension, 'i' in the reverse order as 4 to 1 and n indicates the number of indicator ranked by the judges (Table 6). The centile value (*p)* indicated the area of the indicator distributed normally. The indicated p valur is the centile value which represents the area of the dimensions present in the normal distribution. The p values for all the ranks were worked out shown in table 1. Thus, p values for the ranks ranged from the lowest 12.50 to 87.50.

Determining the C values: The correct rank order (1 to 4) is given in the column order Ri (Table 1). The second column Ri

(Table 1) is the reverse rank order. (7 to 1). From the table – M, C values were determined for each rank from Gulford table (Guilford 1954, p.557). Values were traced by putting the finger on the column extreme left of the Gilford Table, on the number which indicates the number of stimuli used in the experiment. In the case of this experiment the numbers of dimensions were 4 thus the number of stimuli ranked were 4. While moving the finger from this number 4 towards right direction, stop at the number which indicates the rank (ri, 4).

Determination of C values and calculation of $\sum f_{ji}C$ values: The C values were determined for each rank from the Table-6 (Guilford 1954, p. 577). In the case of this experiment the numbers of Indicator were 4, which were ranked. The C values are ranging from 1 to 9 only. The same procedure may be adapted in finding out the C values for all the ranks (*ri*) from the Table. The next step $\sum f$ C value for each indicator were obtained. Thereafter, the ∑f C values for each dimension was divided by the total number of judges 30 for obtaining the Mc (mean value) or Rj (response value) for each dimension. The Frequencies of Ranks as given by 30 Judges, Proportions (p), C Values and Rc Values for four Indicators of Usage Index by using Normalized Rank Order Method Suggested by Guilford (1954). The mean of the total frequencies, for the whole data of matrix was 6.86 and the standard deviation of the C values was 0.14 (Table 1).

Calculation of scale values of dimensions

The ∑(fjiC) values for each dimension was divided by the total number of judges for obtaining the Mc = Rj values. The accepted Mc values were treated as the scale values. The total value was 27.47 which was also the total sum of the C values, and the mean of the Mc or Rj or Rc values was 6.86. The standard deviation and standard error of the Mc values was 0.14 and 0.05, respectively.

Selection of indicators: Selection of effective indicators is ensures the overall success of any measuring instruments. To measure the indicators under each dimension were selected after preliminary survey of the study area, review of literature, consultation with experts such as scientists and veterinarians working in the area.

Collection and editing of statements: By referring the available literature, a total 75 statements which were edited as per 74 informal criteria suggested by *Edwards (1957)*.

Relevancy test: The scoring of 3, 2, and 1 were used for three point continuums represented as 'Most Relevant, Relevant and Least Relevant'. The Relevancy Weightage (RW) and Mean Relevancy Score (MRS) were worked out for all the selected statements individually by using the following formula

$$\text{Relevancy Weightage (RW)} = \frac{fx_i * 3 + fx_{ii} * 2 + fx_{iii} * 1}{fx * 3}$$

$$\text{Mean Relevancy Score (MRS)} = \frac{fx_i * 3 + fx_{ii} * 2 + fx_{iii} * 1}{fx}$$

fx_i = Number of more relevant response
fx_{ii}=Number of Relevant response
fx_{iii}= Number of Least relevant response
fx = Total Number of Judges
The statements having Relevancy Weightage (RW) > 0.70 and Mean Relevancy Score (MRS) > 2.25 were considered for including in the Usage Index.
Normalization was done to distribute the equal weightage to all the indicators.
Antibiotic Usage Index value for each farmer was obtained by the following formulae:

$$AUI_i = \frac{\sum U_{ij} * S_j}{\text{Sum of scale values}}$$

Where,
AUI_i = Antibiotic Usage Index of i^{th} respondent
U_{ij} = Unit score of the i^{th} respondent on j^{th} component
S_j = Scale value of the j^{th} component
Thus, the score of each dimension range from 0 to 1 i.e. when Y_{ij} is minimum, the score is 0 and when Y_{ij} is maximum the score is 1.

Standardization of an index

The validity was established for standardisation of the index. It ensures that obtained scores as valid, if it measures what it is intended to measure. The content validity of the index was confirmed by judgement of experts. The indicators having relevancy score of >0.70 were retained.

Table 2: The Selected statements of Respective Indicators of Antibiotic Usage Index for farmers with their Relevancy Weightage and Mean Relevancy Score.

Sl No	Indicators and statements	Relevancy Weightage	Mean Relevancy Score
1	**Symptom level**		
a	Frequency of veterinary consultancy is affected by severity of disease, observed symptom and familiarity with disease.	0.90	2.7
b	Treating animals with previous experience, diagnosis slips and based on information from sale counters, training, peers.	0.86	2.57
c	Seeking therapeutic intervention only when milk yield declines and advance stage of disease is observed.	0.79	2.37
d	Increase the dose of antibiotic with severity of disease without veterinary consultation	0.97	2.90
e	Changing the mode of formulation and administration of antibiotics with symptom.	0.79	2.37
2	**Animal level**		
a	Preserving the residual antibiotics for contingent use	0.84	2.53
b	Use of antibiotics routinely to animals after parturition to prevent disease.	0.81	2.43
c	Milk of animal under antibiotic treatment is fed to calf and used for commercial sale.	0.83	2.50

d	Discontinuing the treatment when symptoms disappear and disease seems to be cured.	0.81	2.43
e	Increasing the dose in case of poor response and treatment failure.	0.79	2.37
3	**Herd level**		
a	Antibiotics not used routinely to animals for prophylactic purpose.	0.77	2.30
b	Physically marking the treated animal and keeping records of treatment.	0.78	2.33
c	Separate animal husbandry practices adopted for the sick, antibiotic treated animal and healthy animal.	0.86	2.57
d	Special preference given to high milk yielding animals in relation to milk quota, thus bias toward treatment.	0.79	2.37
e	Use of dry cow therapy	0.77	2.30
4	**Alternatives perceived**		
a	Vaccination is used to reduce antibiotic usage.	0.76	2.27
b	Use of teat sealant during critical time of dry period for escaping dry cow therapy.	0.82	2.47
c	Homeopathy and ITKs used as alternative measure, thus acting locally.	0.90	2.70
d	Use of probiotics/ prebiotics as functional food and optimization of dietary intake.	0.79	2.37

Table 3: Correlation of socio- economic variables with Antibiotic usage Index values

Large farmers Usage Index		
	Socio-economic parameters	**'r' value**
2.	Age	0.046 NS
3.	Gender	0.038 NS
4.	Education	0.481*
5.	Family size	0.038 NS
6.	Land holding	0.316**
7.	Herd size	0.489*
8.	Milk production	0.371**
9.	Milk consumption	0.128 NS
10.	Milk sale	0.263*
11.	Experience in dairy farming	0.071 NS
12.	Training received	0.184 NS
13.	Mass media exposure	0.196 NS
Medium Farmers		
1.	Age	0.059 NS
2.	Gender	0.041 NS
3.	Education	0.306**
4.	Family size	0.002 NS
5.	Land holding	0.301**
6.	Herd size	0.418*
7.	Milk production	0.307**
8.	Milk consumption	0.201**
9.	Milk sale	0.183 NS
10.	Experience in dairy farming	0.061 NS
11.	Training received	0.196 NS
12.	Mass media exposure	0.098 NS
Small farmers		
1.	Age	0.036 NS
2.	Gender	0.028 NS
3.	Education	0.251**
4.	Family size	0.057 NS
5.	Land holding	0.215**
6.	Herd size	0.263*
7.	Milk production	0.204**
8.	Milk consumption	0.093 NS
9.	Milk sale	0.079 NS
10.	Experience in dairy farming	0.082 NS
11.	Training received	0.124 NS
12.	Mass media exposure	0.102 NS

* Significant at 0.05 level **significant at 0.01 level NS: Non Significant

It was found that among large farmers, education, land holding, herd size, and milk production and milk sale variables which were found significantly correlated with the Antibiotic Usage Index score at 0.01 level of significance. However, mass media exposure, experience in dairy farming, age, gender and milk consumption, family size were not found to be directly correlated with the Antibiotic Awareness Index scores. However, similar pattern of correlation were found with remaining categories of farmers (medium and large farmers), but the strength of these independent variables with the Antibiotic Usage Index was lowest for small holder dairy farmer. The association of independent variables and their attributes with dependent variable (Antibiotic Usage Index) was higher than small dairy farmers but lower than large farmers.

It was found that awareness about antibiotic resistance among paravets were highly accounted by correlation value of 0.507 and 0.315 for awareness about antibiotic resistance and experience of paravets during diagnosis.

Sources of obtaining information about antibiotic resistance by veterinarians

It was found that major information about antibiotic resistance was due to the experience obtained during the clinical diagnosis of disease (33.33%), followed by discussion with the fellow colleagues (25.00%) and training/ literature (20.82%) (Table 4). The study revealed that leaflet and official report were not found suitable contribution to increase or update the information of veterinarians about antibiotic resistance.

Table 4: Source of information about awareness related to antibiotic resistance.

Sr. No.	Source	Frequency and percentage
1	Training/ literature	10 (20.82)
2	Experience	16 (33.33)
3	Label/ leaflet	02 (04.15)
4	Antibiogram	00 (0.00)
5	Colleagues	12 (25.00)
6	Drug representatives	03 (6.25)
7	Official reports	01 (02.07)
8	Internet	04 (8.33)

(n=48) (Figures in parenthesis indicates percentage)

Preference to generic drugs in the diagnosis

It was found that 64.59 percent veterinarians preferred the generic drugs in diagnosis very frequently (Table 5), none of the veterinarians revealed that they didn't prefer the generic drugs to decrease the antibiotic over- prescription and miss-use. However, 10.41 percent opted the choice of ease of availability of the generic drugs to substitute and reduce the antibiotic prescription.

Table 5: Preference to generic drugs in diagnosis.

Sr. No.	Decision	Frequency and percentage
1	Never	0 (0.00)
2	Sometimes	12 (25.00)
3	Always	31 (64.59)
4	According to availability	5 (10.41)

(Figures in parenthesis indicates percentage)

Rate of antibiotic prescription affected by wide spread of disease

The situation when particular disease is present on the premises and spread to other animals on the unit is likely, with probability of immune-competence, the decision of veterinarians go favourable to the clinical and diagnostic guidelines. It was found that 75.00 percent veterinarians always consider this aspect of immune- competence while prescribing antibiotics at herd level (Table 6). In higher level meetings of veterinarians of the area, in which they communicate to each other and higher level authorities in case of any significant pattern of resistance or endemicity of disease in the particular area.

Table 6: Antibiotic prescription rate when particular disease is present on the premises and spread to other animals on the unit is likely, with probability of immune-competence.

Sr. No.	Decision	Frequency and percentage
1	Always consider	36 (75.00)
2	Consider some time	10 (20.83)
3	Not consider at all	2 (4.18)

(Figures in parenthesis indicates percentage)

Awareness about antibiotic prescription to antibiotic resistance public health concern

It was found that 87.50 percent of veterinarians were aware that indiscriminate use of antibiotics in animal agriculture develops antibiotic resistance and 82.33 percent were aware that antibiotic resistance may impact treatment of diseases affecting human population that regime antibiotic intervention (Table 7). This high level of awareness was also reported in a study conducted by Economou and Gousia in 2015 [2].

Table 7: Awareness to antibiotic resistance public health concern regarding:

Sl. No.	Response	Frequency	Percentage
1	Indiscriminate use of antibiotics in animal agriculture develops antibiotic resistance	42	87.50
2	Antibiotic resistance may impact treatment of diseases affecting human population that regime antibiotic intervention	40	82.33

Conclusion

Antibiotic Usage Index was objective, exclusive and exhaustive instrument to elicit the desired and intended type and level of response from the farmers. A correlation of Index value with the socio- economic parameters of farmers were analysed in which it was found that herd size, education and milk sale significantly correlated with the Antibiotic Usage Index values among all the category (small, medium and large) farmers. However, highest correlation values were found for large farmers, followed by medium and small farmers, reveals the socio- economic adherence of farmers affecting the antibiotic usage of different categories of farmers. Among veterinarians it was found that the preference to generic drugs, concern to public health by reduced prescription of antibiotics and consideration to immune-competence while prescribing antibiotics was satisfactory.

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