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Report Coverage

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Table of Contents

REPORT COVERAGE	III
TABLE OF CONTENTS	IV
LIST OF FIGURES	V
ABBREVIATIONS.....	V
EXECUTIVE SUMMARY	7
1. SPECIFIC TASKS OF THE ASSIGNMENT	9
2. EXPECTED OUTPUTS FOR THE ASSIGNMENT	10
3. BACKGROUND.....	10
3.1 POULTRY SECTOR AND ITS GROWTH:	10
3.2 INDIA MOVING TOWARDS ONE HEALTH APPROACH	12
3.3 POULTRY FARMING AND ITS ASSOCIATED CHALLENGES.....	13
4. STUDY METHODOLOGY AND APPROACH	14
4.1 SECONDARY RESEARCH: AMR IN POULTRY	15
4.2 THEMATIC AREAS.....	18
5. SUCCESS STORIES	23
5.1 NAMAKKAL: EGG PRODUCTION	23
5.2 REGISTRATION OF VACCINES:	24
6. RECOMMENDATIONS	24
6.1 COLLABORATION AND COMMUNICATION AMONG STAKEHOLDERS IN COUNTRY	25
6.2 STRENGTHENING THE DISEASE DETECTION AND REPORTING SYSTEM	25
6.3 ROBUST REGULATORY REGIME	26
6.4 CAPACITY BUILDING: EDUCATE, AWARE AND TRAIN	27
6.5 RESEARCH AND TECHNOLOGICAL ADVANCEMENTS.....	27
7. CONCLUSIONS AND KEY TAKEAWAY	28
7.1 DECISION MAKERS AND IMPLEMENTATION AUTHORITIES	28
7.2 DECISION INFLUENCERS AND RESEARCH ORGANIZATIONS.....	29
7.3 USER GROUP: FARMERS AND PRODUCERS.....	29
7.4 COLLABORATION OPPORTUNITIES BETWEEN NETHERLANDS AND INDIA.....	30
ANNEX 1: LIST OF AGENCIES AND PARTICIPANTS	32
ANNEX 2: LIST OF DUTCH COMPANIES ACROSS POULTRY VALUE CHAIN.....	33
ANNEX 3: SURVEY QUESTIONNAIRE	34
ANNEX 4: 16.10.2019 – ONE HEALTH SESSION (TECHNOLOGY SUMMIT NETHERLANDS- INDIA)	36
ANNEX 5: REFERENCES	40

List of Figures

Figure i: Poultry Value Chain	12
Figure ii: Poultry Farming Challenges.....	14
Figure iii: Study Approach	14
Figure iv: Current Regulatory Regime in India.....	19
Figure v: Poultry Farm Practices.....	20
Figure vi: Nutrition and Feed Chain.....	21
Figure vii: Technology, Research and Exports	22
Figure viii: Stakeholder Collaboration	25
Figure ix: Disease Detection and Reporting System	26
Figure x: Proposed Regulatory Regime	27

Abbreviations

AMR	Anti-Microbial Resistance
AMU	Anti-microbial use
AGP	Antibiotic Growth Promotor
APEDA	Agricultural Processed Food Development Authority
BIS	Bureau of Indian Standards
CPDO & TI	Central Poultry Development Organization & Training Institute
CII	Confederation of Indian Industry
CDDEP	Centre for Disease Dynamics, Economics & Policy
CLFMA	Compound Livestock Feed Manufacturers Association
CDSCO	Central Drugs Standard Control Organization
DBT	Department of Biotechnology
DCGI	Drug Controller General of India
DAHD	Department of Animal Husbandry Dairying
DARPI	Drivers for antimicrobial resistance in poultry in India
DADF	Department of Animal Husbandry Dairying and Fisheries
DPR	Directorate of Poultry Research
EU	European Union
ESBL	Extended spectrum beta – lactamases
FAO	Food and Agricultural Organization
FSSAI	Food Safety and Standards Authority of India
FCR	Feed Conversion Ratio
GDP	Gross Domestic Product
ICRA	Internet Content Rating Association
ILT	Infectious Laryngotracheitis

ICMR	Indian Council of Medical Research
INFAH	Indian Federation of Animal Health
IVRI	Indian Veterinary Research Institute
LIFT	Livestock and Agri Farmer's Trade Association
MRSA	Methicillin-resistant staphylococcus aureus
MoHFW	Ministry of health and family welfare
MMTC	Metals and Minerals Trading Corporation
NAFED	National Agricultural Cooperative Marketing Federation of India
NLP	National Livestock Policy
NADRS	National Animal Disease Reporting System
NECC	National Egg Coordination Committee
NDDB	National Dairy Development Board
NIVEDI	National Institute of Veterinary Epidemiology and Disease informatics
OTC	Over the counter
OIE	Office International de Epizooties
PPP	Public Private Partnership
RDDL	Regional Disease Diagnostic Laboratory
USDA	United States Department of Agriculture
UNSC	UN System Influenza Coordination
UNICEF	United Nations Children Education Fund.
VMP	Veterinary Medicinal Products
WHO	World health organization
WUR	Wageningen University Research

Executive Summary

Poultry has emerged as one of the fastest growing segments of the agriculture sector in India contributing to the nation's overall economic growth and most importantly in alleviating poverty and malnutrition. The transformation from the backyard poultry practices in 1980's into highly intensive integration systems has been achieved by standard & efficient practices on nutrition, housing, management and disease control. Antibiotics are used in poultry farming for maintaining better health of the flock with intentions for prevention, control and treatment of diseases both in commercial and backyard scenarios. Antibiotics are necessary for clinical treatments, but their indiscriminate use is the main causative factor for antimicrobial resistance (AMR). There are studies supporting the resistant microbes in Poultry products both live birds and meat products. The global challenge to fight AMR relates well with the concept of one health approach as increase in antimicrobial usage in animals or humans will impact human health and complications in managing infections due to resistance.

This report makes an effort to understand the present context of Indian poultry value chain specific to AMR by summarizing the published studies on AMR in India which indicates development of antibiotic resistance. The study was developed around focussed interview with decision makers, influencers and business associates, farmers and short questionnaire survey under five broad themes ranging from Government policies & initiatives, farming practices, nutrition, technology & research and the impact on environment. This study methodology also required thorough in-depth study of available published reports and literature. All three approaches were used to summarise the outline recommendations on controlling AMR in Indian conditions and provides suggestions on how the multisectoral collaborations can be established between responsible stakeholders. The experience of Netherlands poultry industry is discussed which led to significant reduction in antibiotic usage in the last decade by combined effort of government and private sector provided the farm management, biosecurity and hygiene is given top priorities. While the approach is quite interesting to address the issue of AMR, depending on their local circumstances and market conditions, it is necessary to understand and devise specific strategies for Indian Poultry Sector where small size farms dominate, backyard poultry still significantly prevalent, logistical & infrastructure challenges very much evident. Given the complex mix of poultry farming practices in India like change in feed raw materials, varied management practices, weather conditions, economic situations of farmers, market fluctuations arriving at a single approach to tackle AMR may not be possible, but instead the way forward should be multifaceted, targeting key issues in achieving the goal for one-health.

This study provides the set of recommendations in the form of best practices and improvement areas in the poultry value chain with specific references to AMR for Government, Researchers, Users and the Poultry sector in general. The recommendations are based on the interactions with different stakeholder's opinions on the five priority areas including the future areas of collaborations. It is highly recommended to share responsibilities between Government and Poultry sector to produce safe, hygienic and affordable poultry products to consumers.

Key recommendations have been summarised below:

I Collaboration and Communication among Stakeholders in Country

Looking into the size and complexity of problem in India, the collaboration within the government bodies; Government and industries; and research institutions for technology transfer, publications will be the best approach. Improved networking and communication system will go a long way in understanding and controlling the AMR.

II Strengthening the Disease Detection and Reporting System

Indian needs a system for disease surveillance, reporting and developing vaccines for their prevention. An initiative to publish repository of disease and registered vaccines for the use of poultry producers should be made in collaboration with Government and industry. The system should be created that farmers, industries and regulators build trust and work together.

III Robust Regulatory Regime

There is a need to develop a robust legislation on feed mill registration, list of unauthorized substances supported by well-coordinated enforcement ecosystem. The regulations need to be understood and implemented especially related to the marketing and sale and distribution of drugs intended for human and animal use. A sustainable ecosystem for poultry industry should include prevention of diseases by adopting hygiene practices at farm and strict biosecurity measures in addition to feed mill registration.

IV Capacity Building: Educate, Aware and Train

Structured initiative for nation-wide awareness campaigns on AMR, diseases like salmonella and E coli control programs, hygienic practices and biosecurity measure at farm level are required. The involvement of private veterinarians, industries and extension people will be imperative. It will be good to bring farmers to the discussion forums to make them better understand.

V Research and Technological advancements

Research should be equally targeted for development of commercial poultry and backyard poultry farms and published for wider accessibility of the work especially in the area of animal diseases, nutrition for alternative resources, vaccine registration.

Conclusion: The study summarises some of the success stories in India in vaccine registration and regionalisation for export of eggs. There is a list of recommendation for decision makers, decision influencers and users' group in section 7.1,7.2,7.3. The study also summarizes the opportunity for collaboration between Netherlands and India in section 7.4. However, key takeaways are as under:

1. Sharing the experience from Netherlands Veterinary medicines Authority and promoting the culture of public-private model. The learnings from Netherlands can be piloted in one of the Indian states for Poultry sector cooperation.
2. Supporting India through exchange of experts, organising technical discussions to formulate poultry farm practices, guidelines, and dissemination of the same along with Indian government and farmers associations.

3. Developing on animal disease and AMR referral laboratories network involving multi sectors such as animal, human, and environmental.
4. Collaborative initiative from disease diagnostics industries, vaccine manufacturers to conduct studies on Indian poultry to develop a disease repository which in turn facilitates the registration of vaccines to prevent disease.
5. Research to work on alternatives to AGP, animal breeding to develop resistant varieties for commercial farming, early detection of sex in embryo and poultry litter management.
6. Facilitating collaboration between Indian research institutes (ICAR, ICMR) and the Dutch WUR for a focussed study to replicate the involvement of key academic institutes across India on one-health approach and the implementation of NAP.

1. Specific tasks of the assignment

Indian Poultry Sector is on a strong upward trajectory posting robust growth in the last two decades. The next five to ten years are highly critical for the poultry sector to maintain its growth and strengthen its competitiveness. The issues of avian influenza (bird-flue) and un-judicious use of veterinary drugs results in impact to animal as well as human health. Most of the time antimicrobials and anti-bacterial drugs are added in the feed additives and premixes to avoid any disease in the broiler and layers. The un judicious use of VMP for prophylaxis or as treatment in poultry chain results in development of antibiotic resistance and impacts human health. The Indian legislative framework for the control and marketing of feed for food producing animal is not well established. Collaboration with international bodies has brought changes in the poultry farming practices and its acceptability as food produce.

In the year 2017, India launched its National action Plan for Anti-microbial resistance (AMR) to support the global initiatives on one health approach wherein collaborative efforts are taken by connecting the human plant and animal and their shared environments. The bacteria are present everywhere and with the interconnected ecosystems are easily transmitted between human animals and environment.

This study will provide an opportunity to explore the gaps in achieving the goal for one health approach towards poultry value chain in India. This study covers the poultry feed, farms, value added product and trade with specific reference to AMR by collating the ongoing and past researches, projects and activities undertaken in the area of one health in poultry sector. The paper will broadly review projects and activities under following five areas:

- Government Policies and Initiatives (focussed on AMR)
- Sustainability and impact on environment (focussed on AMR)
- Infrastructure, technology and alternate practices adoption (focussed on AMR) (e.g. improving biosecurity or changing some zootechnical practices, as poultry density, or type of litter)
- Poultry farm Practices with specific reference to antibiotic usage
- Nutrition and feed chain practices (focussed on AMR)

2. Expected outputs for the assignment

This study provides a set of recommendations in the form of best practices and improvement areas in the poultry value chain with specific reference to AMR for:

- Policy influencers and Ministries
- Decision Makers and implementation authorities
- Users including Framers and producers

The study also provides a list of possible areas for collaboration between the Kingdome of Netherlands and India.

3. Background

3.1 Poultry Sector and its Growth:

3.1.1 Introduction:

Poultry sector is one of the fastest growing segments of the agricultural sector in India contributing over 150 billion to the Indian GDP (ICRA estimate, 2018). India ranks 3rd in egg production and 4th in chicken meat production in the world (Poultry Trends, 2018). About 88 billion table eggs (Statista, 2017) and 4.9 million tons of poultry meat (USDA, 2019) is produced per annum in India. Chicken is the most preferred meat in India due to several factors including price, availability and religious beliefs. There is a high growth and expansion potential in the coming years for poultry products, being a rich source of protein at low cost. The annual per capita availability of chicken in India is estimated at 3.9 kgs in 2019 and projected to reach almost 6 kgs by 2025 (Soundararajan, 2017), exhibiting spectacular growth in spite of several challenges. However, this growth is less than the recommended level of 10.8 kgs poultry meat per person per annum by Indian Council of Medical Research (ICMR) and way below than what an average American is consuming (41 kgs chicken meat / per person / year; Shahbandeh, 2019). The enormous growth of the poultry sector is primarily due to support from the private industries and an enabling policy environment provided by the Government to promote the livelihood and food security. The poultry industry provides a huge employment opportunity for the rural poor either under backyard poultry production system or under small scale commercial broiler farming units. Over 5 million people are engaged in the poultry sector either directly or indirectly. The poultry value chain comprises of three main farming approaches practiced in India:

3.1.2 Commercial Broiler Farming:

Broiler Farming in India has seen a drastic shift with the integrated farming approach being introduced by corporate participants. The large-scale producers (integrators) supplied chicks to the farmers from their parent flocks, feed material, technical & veterinary services support and finally market the birds. The farmers' responsibility is to grow the birds in their farms & give back to the integrators. This concept provided a win-win approach to the integrators and farmers as quick expansion of the business and for the farmers to get livelihood in the form of raising charges, independent from the market fluctuations.

The farm sizes are also highly variable from region to region, state to state and district to district depending on several factors ranging from economic, social and marketing opportunities.

Apart from the integrators expansion approach, introduction of improved, exotic, genetic material in the growth and development of the commercial poultry sector (Chatterjee et al. 2015) in association with nutritious feed, better management and disease control measures has resulted in improved broiler performance (2.0 to 2.2 kgs body weight at 5-6 weeks of age).

There are several popular broiler breeds such as VenCobb (Indigenous), AP 95, Arbor Acre, Indian River, Hubbard; all are developed by German company, Aviagen group, for the Indian market.

3.1.3 Commercial Layer Farming:

65% of the India's layer farms are located in the Southern region, followed by 20% in the West and 15% in the Northern region. Commercial layer farming practices has seen a paradigm shift of the management and operations of farms. There are sizable investments in breeding, rearing, equipment and processing environment. The layer farms of 25,000 to 50,000 birds are more common today. With the sustained development in the high yielding layer in association with better nutrition, farm practices and disease management, average egg production is around 310 - 330 eggs in 52 weeks (Chatterjee et al., 2015). Over 95% of the eggs sold in India are unbranded and sold in terms of numbers. Branded egg market & value-added egg products market is catching up slowly especially in the metro cities. The popular commercial egg type breeds available in India are BV 300 (developed locally), Lohmann (Germany), Hy-line (breed from USA), Bovans (Netherland) are the most popular.

3.1.4 Slow growing / Backyard poultry farming:

Free range and small-scale backyard poultry activities are promoted under rural development programs by central and /or state government with the objective of alleviation of rural poverty, eradication of malnutrition and creation of employment in majority of rural areas. Slow growing local chicken such as Gavran, Aseel, Kadaknath etc., are still popular in rural areas of Maharashtra, West Bengal, Tamil Nadu and Kerala, preferred traditionally by the rural population for their unique taste and texture. It is estimated that about 10-15% of total poultry output in India is still derived from backyard production developed mostly by the Veterinary Universities, Poultry research institutes etc. (Chatterjee et al. 2015). To name a few improved backyard varieties are Giriraja, Girirani, Vanaraja, Gramapriya, Shrinidhi etc; developed to produce both eggs and meat types.

3.1.5 Marketing and Supply Chain

In India, around 90% of the broilers are sold to consumers through live bird market. Live bird market is traditional chicken retail shops where the customers select the live bird, either taken to home live or slaughtered and cleaned in front of them. The mindset of consumers is that such form of poultry produce is fresh and healthy, however, there is a changing trend in metros with increased acceptance for processed chicken in hygienic supermarkets. This type of setup requires infrastructure in terms of cold chain, hygienic chicken shops and distribution network.

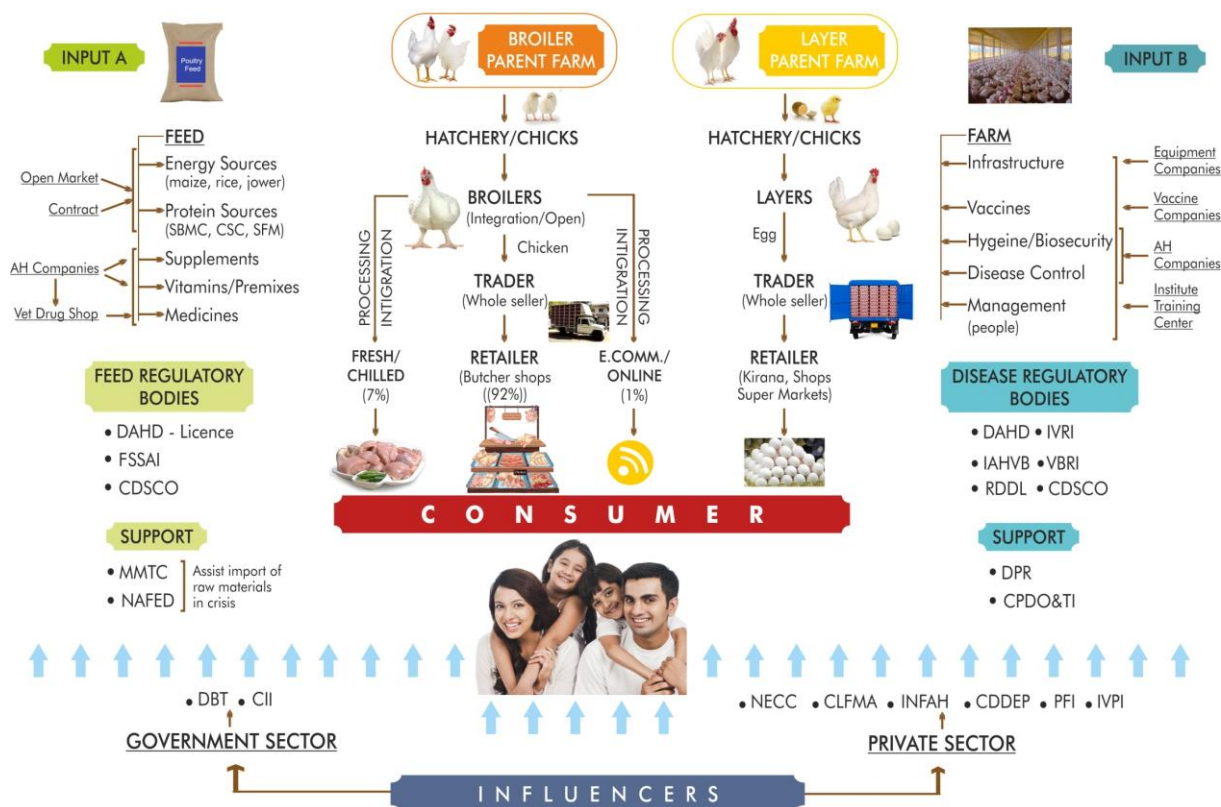


Figure i: Poultry Value Chain

3.2 India moving towards One Health approach

The concept of One Health requires collaboration among Health Science professionals, Academic Institutions, Researchers, Governmental Agencies and Industry towards fighting antimicrobial resistance and manage the consequence of disaster towards public health. FAO, OIE, WHO, UNSIC, UNICEF and the World Bank in their Strategic framework in 2008 defined “One Health” as, “the collaborative efforts of multiple disciplines working locally, nationally and globally to attain optimal health for people, animals and our environment”.

Antibiotics are essential towards the health of humans as well as animals. The non-availability or delayed access to antibiotics can cost human or animal life. At the same time, there is a challenge for restricting inappropriate access and usage. The changing pattern of usage of antibiotics for newer broad-spectrum antibiotics is driven by economic growth, irrational prescriptions, ease of availability over the counter and fragile health care system (McGettigan et al, 2019; Laxminarayan et al, 2016). The injudicious usage of antibiotics in human and animals result in resistance. Antimicrobial resistance has the potential to impact anyone and can be extremely damaging in financial terms but also for trade, health, food security, environmental wellbeing and socio-economic development.

In the year 2017, India launched its National action Plan for AMR to support the global initiatives on one health approach wherein collaborative efforts are taken by connecting the human plant and animal and their shared environments. The bacteria are present everywhere and with the interconnected

ecosystems are easily transmitted between human animals and environment. The Factors contributing to disease emergence are Human factors such as increased population density and mobility, and animal domain factors such as unauthorized trade in animals, Unregulated use of drugs and vaccines, Spatial clustering of livestock farming, Environmental factors and Habitat destruction. Diseases also spread due to Pollution and contamination of environment, Climate Change and Globalization (Dhingra, 2012). As per the National Action Plan on microbial resistance, Government of India. India has objectives of enhancing awareness, strengthening surveillance, improving rational use of antibiotics, strengthening infection prevention and control, research and development, promoting investments, and collaborative activities to control AMR. The state action plans are developed keeping in mind the above objectives. In addition, India aims to support neighbouring countries in collective fight against infectious diseases.

3.3 Poultry Farming and its Associated Challenges

The poultry farming in India has embarked fast expansion since last two decades by introduction of improved genetics due to the high demand for chicken and eggs from growing human population. The new breeds are sensitive and less resistant to endemic diseases compared to backyard local chicken since the commercial varieties were selected for their high production potential (Chatterjee et al. 2015). In addition, the density of commercial farms also increased manifolds due to the integration concept picking up very fast across the country. In some regions especially around metropolitan cities, there are layer, broiler and breeder farms concentrated in the same geographical region due to round the clock demand for supply of chicken & eggs. This necessitates continuous movement of vehicles for supply of feed, equipment, people, birds and eggs sales from place to place posing potential challenges of spreading of diseases. Even though the biosecurity & hygiene levels are higher in intensive production systems, the increase in density of farms in the limited areas increase the probability of infection and the scale of disease outbreaks (FAO, 2008). Increased concentration of poultry farms is also associated with challenges of proper waste disposal especially poultry litter, dead birds, hatchery waste etc. The large integrators and the big farmers in India understand these challenges and most of them are following strict biosecurity measures, standard vaccination programs, providing nutritious feed and comfortable environment to their birds to obtain desired production standards. In case of any disease outbreaks, antibiotics are administered under the supervision of Veterinarians to overcome the disease conditions. However, the real challenge of disease spread lies in the unorganized poultry sector comprising of innumerable number of small individual farmers along with backyard poultry under central and state government's social development schemes since they don't have required knowledge and training to follow strict biosecurity, hygiene and regular vaccine programs.

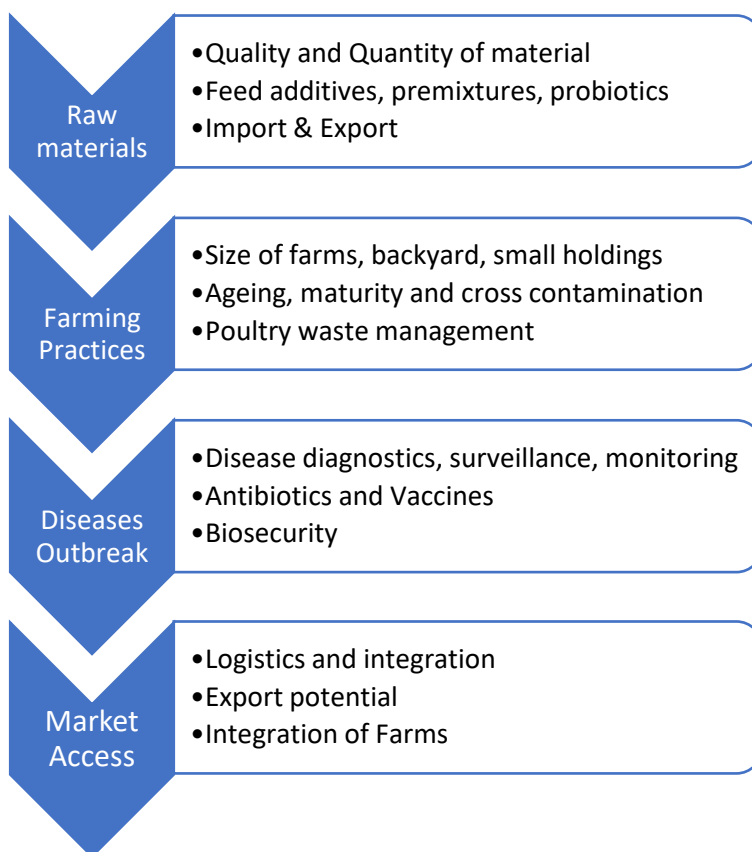


Figure ii: Poultry Farming Challenges

4. Study Methodology and Approach

This short study was undertaken to provide better insights on the challenges of AMR in the Indian poultry value chain and provide a set of recommendations for decision makers, decision influencers and farmers. The study also presents the opportunity for collaboration between India and Netherland in various disciplines in poultry value chain for containment of AMR infection. In order to conduct this study in short span of three months, information gathering was carried out using three sources. The first source was secondary research on the published data related to AMR, Poultry practices, usage of antibiotics in Poultry etc followed by survey around a set theme and discussions and personal interviews. The detailed approach is summarised in figure iii.

Discussions/ Interviews	Secondary Research	Questionnaire Survey
<ul style="list-style-type: none"> •Governmental Authorities (Central and State) •Associations and Farmers •Research Organizations 	<ul style="list-style-type: none"> •Available Reports •Indian Research publications • Netherlands Publications 	<ul style="list-style-type: none"> •Five themes identified •Forwarded to Govt., Industry •Collated

Figure iii: Study Approach

During this pilot study, the Project coordinator along with a local expert developed the focussed interview questionnaire covering the five thematic areas (refer Annex 1)

- Government Policies and Initiatives (focussed on AMR)
- Poultry farm Practices with specific reference to antibiotic usage
- Technology and research initiatives (focussed on AMR) (e.g. improving biosecurity or changing some zootechnical practices, as poultry density, or type of litter)
- Raw material and feed production methods (focussed on AMR)
- Sustainability and impact on environment (focussed on AMR)

The questionnaires were sent to industry personnel who are actively engaged in poultry sector to get their valuable opinions and feedback. There were personnel interviews conducted at central and state level. There was structured interaction with different stakeholders, opinion/ data search on the above mentioned five-priority area including the future areas of collaboration.

Telangana is the leading state in India in terms of egg production and is ranked 3rd among all the states in terms of overall Poultry Population (www.indiaenvironmentportal.org.in). Over 98.7% of Telangana population are Non vegetarians as per the data released by Union Government's Sample Registration System Baseline Survey (Deccan Chronicle, 2016). Hence, the project team selected Hyderabad as the ideal place to conduct this pilot project and decided to visit poultry farms in this region. The project team also interacted with poultry farmers, feed manufacturers, Dept of Animal Husbandry officials and central poultry research organizations in Hyderabad to collect information regarding actual farm management, feed production, disease situations and recent research activities specific to AMR.

The project team covered central ministries, research institutes, industries and State Bodies

- Policy Makers: Government (DAHD, FSSAI, Hyderabad)
- Policy influencers: research institutions (Poultry Research Institute, Hyderabad; CDDEP).
- Farmers and/or associations (Farmers of broiler and layers, Hyderabad; members of INFAH).
- Feed manufacturers or/ and associations (Feed manufacturers).

4.1 Secondary Research: AMR in Poultry

Globally, it has been reported that antimicrobials are used routinely to maintain health and productivity in livestock (Van Boeckel et al., 2019). The usage of antibiotics and development of antimicrobial resistance is equally important in food producing animals due to chances of transmission to human through contact, food and environment (Lander et al., 2012).

4.1.1 Experience from India

Gandra et al. (2017) conducted detailed analysis of AMR studies in India including human, animal and environmental. High levels of antibiotic resistant bacteria were identified in many studies conducted in India. The poultry, livestock and aquaculture has been reported to have antimicrobial resistant strains isolated. They recommended a more structured surveillance approach to make a meaningful output for the control of antibiotics usage for animals. Walia et al (2019) has supported in his reports the usage of antibiotics and its resistance development in poultry production in India by summarizing research in the

area of AMR in Indian poultry sector. Antibiotic resistance and the mode of transmission were investigated in bacteria isolated from poultry litter. Another study indicates that *Staphylococcus* is the predominant bacterial species affecting the poultry, followed by *Streptococcus*, *Micrococcus*, *E. coli*. 50% of these isolates were susceptible to ampicillin, 57% to erythromycin, 75% to streptomycin etc. (Dhanarani et al, 2009). In a study in Coimbatore, 7.7 per cent of total 492 eggs reported *Salmonella* contamination with ampicillin, neomycin, polymyxin-B and tetracycline resistance (Suresh et al 2006).

There are a few studies conducted to examine the presence and antibiotic susceptibility of *Salmonella* species in chicken meat samples, live chickens and their environment. One such study in multiple districts of Chhattisgarh by Naik et al (2015) reported the prevalence of *Salmonella* in raw chicken meat samples contributing to 7% of the total tested samples. The isolates were reported to be highly sensitive to ciprofloxacin (100%), gentamicin (98.6%), erythromycin (98.7%) and oxytetracycline (59.3%). They recommended the need for continued surveillance of zoonotic food borne pathogens including AMR variants throughout food production chain. In another study, the prevalence of *Salmonella* species in chicken meat samples was 23.7% with 100% resistant to ampicillin, moderately sensitive to ciprofloxacin, and highly sensitive to ceftriaxone (Kaushik et al. 2014).

A survey was carried out on 18 poultry farms of Punjab to analyse resistance of 1556 *E. coli* isolates from 530 birds against 11 antimicrobials. The results of this study demonstrated increased prevalence of multidrug resistance (94% compared to 60% in layers) including prevalence of ESBL-producing strains (87% compared to 42% in layers) was observed in broiler farms. A high prevalence of *E. coli* resistant to nalidixic acid (86.1%) and around 45 per cent to other antibiotics such as tetracycline, ciprofloxacin and ampicillin was reported (Brower et al., 2017). Two other studies (Shrivastav et al. 2016; Kar et al. 2015) showed that the proportion of ESBL-producing *E. coli* in poultry was 33.5% and 9.4%, respectively.

A study conducted in Hyderabad on 11 *Helicobacter pullorum* isolates from 100 chicken samples collected from 7 different retail live bird markets. All the isolates reported the resistant profiles against various antibiotics, viz. fluoroquinolones, cephalosporins, sulphonamides and macrolides (Qumar et al., 2017). A similar study to evaluate the prevalence of PVL (panton valentine leukocidin) in methicillin resistant *S. aureus* was conducted in chicken meat marketed in retail outlets in Chennai city. A total of 120 meat samples were collected, out of which 80 samples were positive for *S. aureus*. The results revealed that 54 isolates were positive for presence of mec A gene by PCR indicating that the prevalence of methicillin resistant *S. aureus* (MRSA) was 67.5 per cent. (Ruban et al., 2017).

A study by Samanta et al. (2014) found that the prevalence of *Salmonella* species in healthy chickens and their environment was 6.1%, and they were 100% resistant to ciprofloxacin, gentamicin, and tetracycline. In another study, the prevalence of *Salmonella* species was 3.1%, and they were moderately resistant to various antibiotics (Singh et al., 2013).

A recent study evaluating trends in antimicrobial resistance in animals in low and middle-income countries reported hotspots of resistance in NE China, North Pakistan, North Eastern India, Iran, E Turkey, Brazil, Egypt, Vietnam, Mexico, Johannesburg. The study also indicated highest resistance

rates were observed with antimicrobials; tetracycline, sulphonamides & penicillin's (Van Boeckel et al., 2019). The team of researchers from Mumbai investigated the prevalence of multi-drug resistant *Salmonella* in raw chicken liver and egg yolks. During the study, *Salmonella* Bacteria were tested for susceptibility to 12 antibiotics that are important for treating infections in humans and observed 'multi antibiotic' resistant *salmonella* bacteria (Meenakshi et al.,2019).

Juan et al. (2018) summarized data at global level from 89 scientific studies since 1998 on antimicrobial usage in animal production out of which 17 studies were focussed in low- and middle-income countries. The research reveals maximum usage in chickens with recommendation for comparison with surveillance data from Low- and middle-income countries. There is insufficient data and information on the kind of antimicrobials usage including type, quantity etc and the impact of AMR problem in humans by poultry sector. The available studies are not sufficient to make representation of country's situation. A recent study mapped antimicrobial use and antimicrobial resistance in the entire poultry meat supply chain from farm to table in India and proposed potential solutions (DARPI, 2019).

Since 2007, several initiatives have been taken by different organizations in India like BIS, National policy on containment of AMR, followed by National Action Plan for AMR, DCGI, NLP, DADF, FSSAI etc to address use of antibiotics and antibiotics resistance in livestock, poultry and fisheries sector (Walia et al., 2019). These recommendations require support of legal frame, industry, veterinary practitioners and farmers.

4.1.2 Experience from Netherlands:

A fact-finding mission on the prudent use of antimicrobials in animals in the Netherlands was initiated with objective of gathering information on practical implementation of AMR control measures, usage of veterinary medicines and identification of examples of good practice (EU Commission Report ,2016). It was observed that there is significant reduction in the use of antibiotics in animals in the Netherlands (approximately 58.4% decrease in sales from 2009 to 2015). The judicious use of antibiotic policies has led to direct decrease in levels of antimicrobial resistance in broilers, veal calves and pigs in the Netherlands. The policies were set up as a public-private partnership with the stakeholders in the major livestock production sectors - pigs, broilers, veal and cattle. The Royal Netherlands Veterinary Association took responsibility for effective measures, facilitated and supervised by their national government This public-private cooperation resulted in the establishment of an independent body (the Netherlands Veterinary Medicines Authority) to analyse data on the use of antimicrobials at farm level and to set bench marks (EU Commission Report, 2016). .

A policy paper on Economics of antibiotic usage on Dutch farms indicated Reduction of veterinary antibiotic sales by 63% in the Netherlands from 2009 to 2017 and interestingly showed no evidence of negative effect on average production and economic results on broiler and pig farms. The Dutch livestock industry focused mainly to improve hygiene at farm level, use of pain killers and anti-inflammatory agents or more preventive vaccinations to improve animal health (Wageningen Economic Research 2019).

4.2 Thematic areas

The study was designed to cover the key thematic areas for the poultry value chain. The information captured from various sources is summarised under the five areas described below:

4.2.1 Government Policies and initiatives

AMR is one of the most complex public health threats in the world which requires interdisciplinary collaboration. India being one of highest consumer of antibiotics in the world due to several reasons including climatic conditions pose a serious threat towards AMR. There usage in food producing animals with specific focus on poultry industry is even more challenging. The control of AMR requires a complete collaboration of various ministries controlling the registration, sale and distribution of veterinary drugs, veterinary extension services provided by Animal husbandry, food safety governed by Food Safety and Standards Authority of India (FSSAI) and Department of Science and Technology for a focussed research, vaccine development. In addition to these core Ministries the involvement of Ministry of Environment Forest and climate change cannot be overlooked. Figure iv provides a simplified approach for the various ministries. The need for safe, sustainable poultry production is most urgent and Government is looking for an integrated approach for designing and implementing programs, policies and legislation supported by basic and applied research. There is no specific regulation on feed manufacturing and distribution in India. In some state, the feed manufacturing companies have to obtain valid license number from the DAHD based on advisory. The Indian standards for feed requirements for different categories of birds, lists of different raw materials, feed additives and limits of harmful substances are outlined by Livestock Feeds and Equipment Systems Sectional Committee in Bureau of Indian Standards (BIS) recommended by the Food and Agriculture Division Council. However, BIS standards are voluntary in nature.

There are no specific regulations on the usage of antibiotics in treating animals especially poultry. DAHD has released advisory on judicious usage of antibiotics in poultry production. Further, the feed safety system in India is very primitive and in the constitution of India, it is reported as the sate subject. In such scenario the poultry sector is primarily left to the discretion of the private industries to work on the self-compliance and self-reporting mode. This system seems to be working in the present state as the focus of Indian government is towards doubling farmers income and improving socio-economic conditions. Backyard poultry farming is one of the important approaches to achieve the same.

The intensification of poultry farms in the region is associated with intensification of pathogens in the form of virus, bacteria and fungi. This requires structured research for vaccination programs by the expert community based on the prevalence and frequent outbreak of the diseases. There are certain viral diseases like Bird flu, Infectious Laryngotracheitis (ILT) and Metapneumo virus (APM1) which are considered as “reportable” diseases under OIE. Government of India, the prevention and control of contagious disease Act, 2009 mandates surveillance system and reporting of disease outbreak. In case of an outbreak farmers report the same to local animal husbandry department or take the birds for testing in regional laboratories. In many occasions, there are possibilities of disease outbreaks going unnoticed or not reported by the farmer due to poor compensatory & other support systems from

Government. During such situations, disease spreads very fast and farmers in that region are forced to use lot of medicines to bring disease under control.

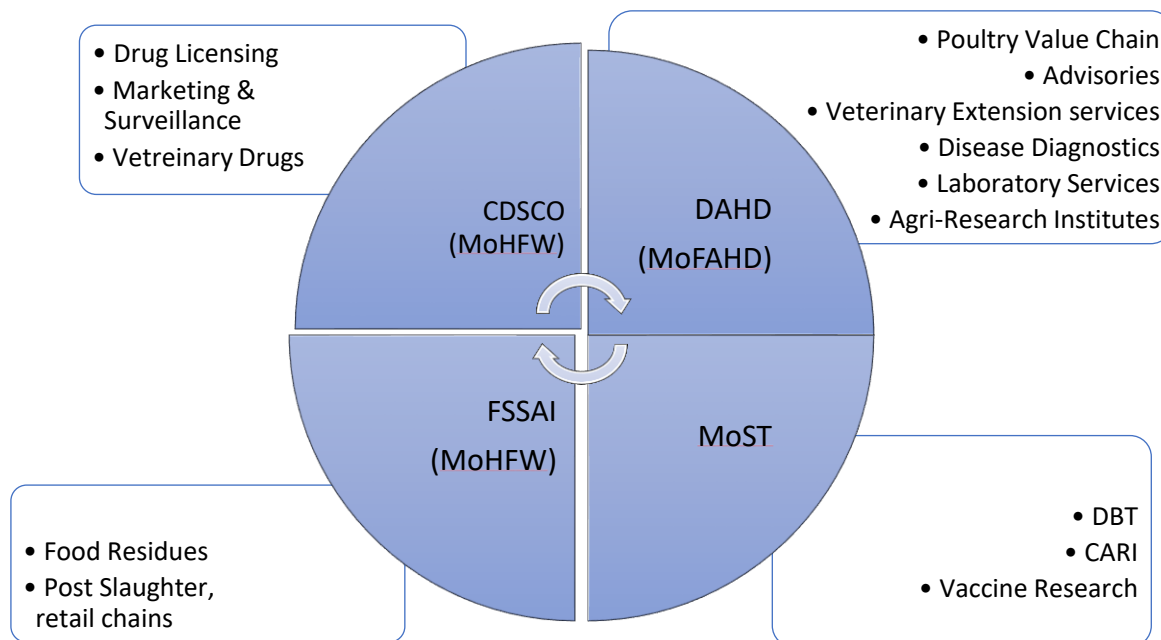


Figure iv: Current Regulatory Regime in India

The regulatory requirements for disease surveillance system implementation in the form of action plan at National and state level is not explicitly available which in turn results in reduced insights on prevalence of diseases in country. Self-reporting system by farmers should be strengthened by providing standardized procedure or system for occasional incidences of diseases and local pattern in region. There are several disease diagnostic laboratories both under central and state governments to service the farming community such as Indian Veterinary Research Institute (IVRI) at Izatnagar (Bareilly), Disease Diagnostic Laboratory of National Dairy Development Board (NDDB) at Anand, National Institute for High Security Animal Diseases (NIHSAD) at Bhopal, National Institute of Veterinary Epidemiology and Disease Informatics (NIVEDI) at Bengaluru playing crucial role in assessing epidemiological profile mapping. However, they are providing critical support to the backyard poultry establishments and livestock sector and less utilized by organized poultry sector. The lack of data on disease due to poor reporting structure and disease surveillance by Government, the vaccines availability becomes a challenge for many farmers. Many viral diseases further complicate the bacterial infections and forces the farmers to use more antibiotics to treat the birds to minimize the losses due to disease. Antibiotics in Poultry sector are dispensed through feed and water for identified period under the guidance of poultry veterinarians for treatment of diseases.

There is large variation in poultry farm sizes in India ranging from 10 birds in the backyard to 500-2000 bird owned individual farmer to highly professional integrated farms managing over lakhs of birds. Accordingly, the farm management also differs in organized integrated setup supervised under qualified veterinarians to unorganized farmer owned management with little knowledge getting inputs from veterinary health officer and the backyard farmer managing on his own. In such scenario, there are chances of misuse of antibiotics either as a growth promotor or for treatment of birds. Unfortunately,

the enforcement of veterinary drugs distributions and sale is not adequate to control sale of OTC drugs making easy availability. Recently, Govt. of India has taken an important initiative by banning the usage of Colestine in Poultry production which has been appreciated by industry and other stakeholders.

4.2.2 Poultry Farm Practices

Livestock production and agriculture are interlinked in an agrarian economy like India and contributes 17% of India's total GDP, out of which, the 27% comes from Animal Husbandry. The animal husbandry not only contributes to GDP of the country but is crucial in providing employment opportunity (ET Bureau, Sept 2017). Poultry sector, in particular, has come a long way from the traditional backyard farming to the highly organized integration model. There has been an increase in the demand of eggs and chicken in recent years along with incentives from Government for backyard poultry farming resulted in the increased farm density across the country. In India, most of the poultry farms are open sided farms with mud flooring resulting in flocks getting in contact with environment including migratory birds.

The broilers, layers and breeding farms are sometime located in the same district or same region resulting in multiple age birds in the same location to meet the cyclical output of the birds round the year. This type of farming model results in uncontrolled movement of various inputs (men, materials, live birds, eggs, feed etc) between farms, between villages, between districts posing challenge to geographical biosecurity and cross contamination. The organized poultry sector comprising of large farmers better understand these obligations and set up farm biosecurity measures, hygiene standards to prevent diseases. In some states like Kerala and West Bengal, composite farming is common increasing the possibility of cross infections between species. The coexistence of multiple ages, multiple species flock creates a serious challenge for effective controls of diseases.

The rural development schemes promoting backyard poultry farming by state governments pose a serious gap in implementation of vaccination programs, appropriate biosecurity and hygiene measures. Some of the integrators and large farmers are moving towards automated air conditioned (controlled) houses with the objective to maintain high levels of biosecurity and hygiene at farming level.

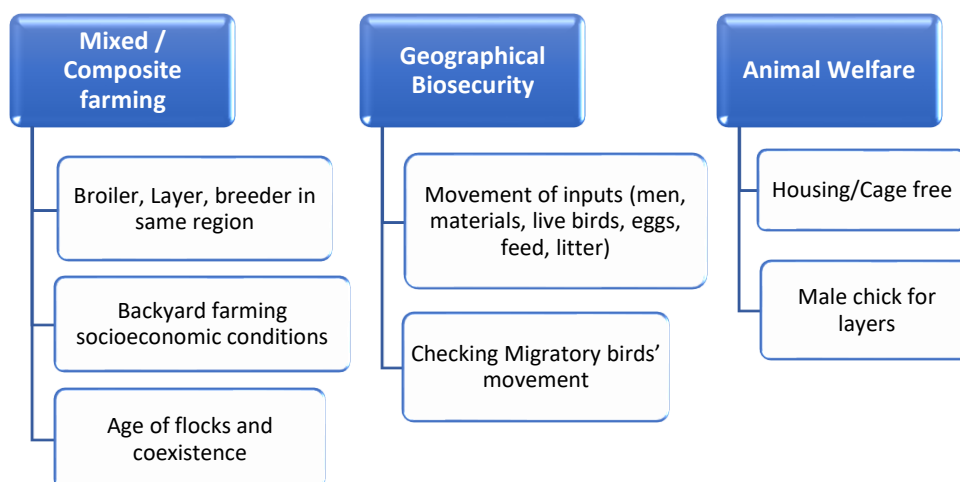


Figure v: Poultry Farm Practices

4.2.3 Nutrition and Feed Chain:

Around 70% of the input cost in Poultry farming is the feed raw materials. Poultry Sector is significantly dependent on the availability, quality and supply of agriculture commodities to be used as feed ingredients. Poultry feed is comprising of raw materials such as maize, broken rice, jowar, bajra, soybean meal, sunflower meal, cotton seed cake, de-oiled rice bran etc., depending on the availability (quality & quantity), season, cost, logistics etc. Along with these raw materials, Vitamins and Mineral premix, other nutritional supplements such as enzymes, organic acids, binders, liver powders are added to improve the performance of the birds. In order to address the disease situations of the birds, medicines and antibiotics are supplied to the farms by the animal health companies directly or through Veterinary medicine shops. As per the poultry feed industry point of view, annually around 26-28 million tons of poultry feed is produced for broiler, layer and breeder segments, out of which over 20 million tons of feed is produced by farmers themselves and the remaining is supplied by compound feed manufacturing companies. In case of scarcity of raw materials, Government provides support to poultry sector for import raw materials such as maize and soybean meal through departments such as MMTC (Metals and minerals trading corporation of India) and NAFED (National Agricultural Marketing Federation of India Limited).

The regulatory bodies which govern the use of Feed and feed additives in poultry sector are the Ministry of Agriculture and Farmers welfare Department of Animal Husbandry (DAHD) and the Bureau of Indian Standards (BIS). The feed regulations & registration procedure is not uniform across in India being identified as state subject. A feed manufacturer in Karnataka has to obtain license number from DAHD for its sale in the region whereas this procedure is not mandatory in Telangana. There is no animal feed regulation act from the government in terms of list of approved raw materials, feed additives and medicines to be used in poultry sector. This implies that the feed companies, integrators and farmers are free to prepare their feed using any raw materials, vitamins and medicines depending on the economics of their farms / organization. Today, most of the feed companies and integrators have stopped using antibiotic growth promotors in their feed due to the challenges of AMR and are trying to use natural alternatives such as probiotics, prebiotics, enzymes, yeast, organic acids, essential oils etc., to improve the performance of their birds.

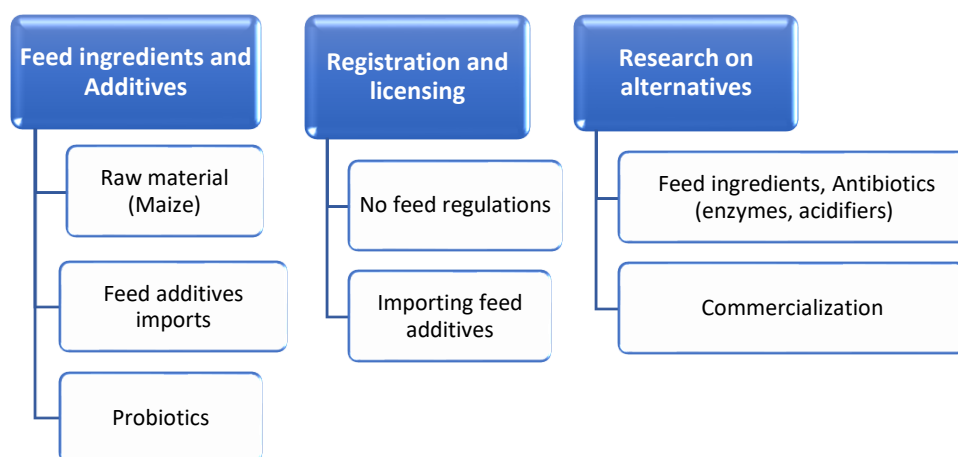


Figure vi: Nutrition and Feed Chain

4.2.4 Technology, Research and Exports:

The Poultry Sector in India is growing in an unprecedented pace due to the increase in demand for animal protein. Hence, it is important to embrace technology hand in hand to produce safe and hygienic poultry products. Currently, the disease diagnosis and subsequent line of treatment in poultry sector is dependent on the clinical symptoms and post-mortem findings at the farm level. The laboratory capacities require fast and accurate diagnosis of the disease situations. The research is required to address the challenges associated with sample collections, test kits and logistic at farm level. The research on surveillance system of exotic, emerging and re-emerging diseases is the need of hours in India to avoid disease outbreaks. The vaccine manufacturers and suppliers are well equipped but needs to strengthen capacity in identification of specific strain to improved accuracy in treatment. The system for data monitoring, linkage with sale and usage of antibiotics involving CDSCO at central and state level will facilitate the improved understanding.

Apart from research and technological upgradation related to diseases, alternate programs and vaccines, there is a pressing need to develop solutions to manage the huge quantities of poultry waste generated at the farm (litter) and slaughterhouses. This is an important area to ensure farm hygiene and environment control.

The poultry research activities at Universities and Regional Poultry Research organizations are restricted to develop the rural poultry with less commercial implications. With more than 85% of the all India poultry output coming from the commercial poultry sector, the PPP (public private partnership) model between poultry sector and Government research institutions in critical areas of importance has to be established.

India is producing over 4.9 million tons of poultry meat (USDA, 2019) and 88 billion table eggs (Statista, 2017) per annum focussed to meet the domestic demand. There is a shift in focus towards export of poultry products which in turn put pressure for effective disease controls. In the year 2018-19, India exported about 95 million USD worth of poultry products to various countries, especially to Oman, Maldives, Japan and Vietnam (APEDA). A good policy initiative to establish multiple disease-free zones under the office International des Epizooties's (World Organization for Animal Health) terrestrial code new guidelines for the purpose of smooth trade will help in boosting exports of poultry products from India.

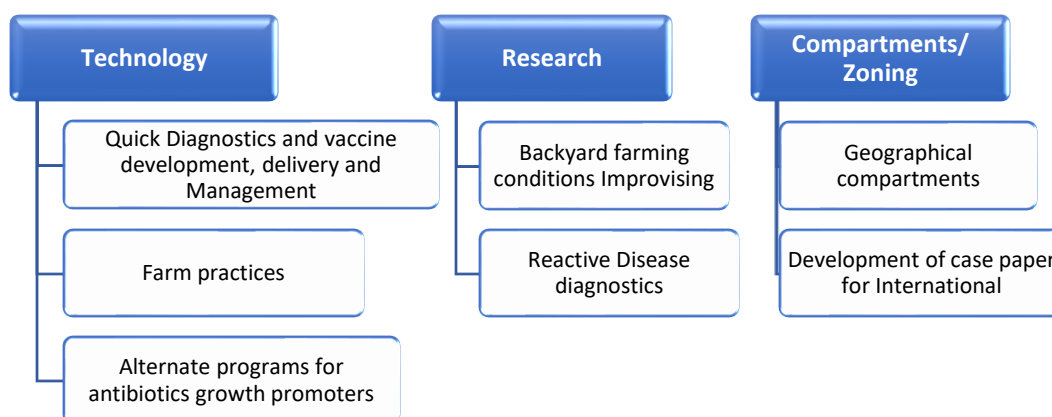


Figure vii: Technology, Research and Exports

4.2.5 Sustainability and impact of Environment:

Poultry farming is poised to grow further in coming years in India which means sustainable growth to have minimum impact on environment. The poultry waste disposal and effective management system plays an important role on the sustainability of the sector. Huge quantities of poultry litter generated at the farm level which is actually a great resource to utilize as organic fertilizer for agriculture. The dead bird disposals at the farm level is well handled by the integrators and large farmers by setting up scientifically designed dead bird pits in the farm vicinity. However, this awareness is still not there at the small farmers and backyard farming practices. The poultry birds are transported through vehicles and hence, monitoring the cleaning and disinfection of live bird transport vehicles is also important in controlling infections. Over 90% of the Indian poultry meat is sold through live bird market and during the process, huge quantities of slaughter waste is generated which has to be properly disposed to avoid the spread of infections. In case of layer farming, male chicks are culled since they are economically unviable to grow and subsequently, proper disposal methods of male chicks need to be adopted.

5. Success Stories

5.1 Namakkal: Egg production

Namakkal, one of the 37 districts from Tamil Nadu, is considered as Egg basket of India. Tamil Nadu produces over 30 Million eggs per day, out of which Namakkal region itself produces 25 Million eggs per day. There are close to 1,100 poultry farms in Namakkal and about 95% of India's egg exports are from Namakkal. Before Bird flu outbreak in India, Namakkal farmers used to export significant quantity of eggs to many countries such as United Arab Emirates, Oman, African countries etc. During 2006-08, Namakkal farmers exported over 10 million eggs per day but, following the bird flu outbreaks in the other parts of the country (North East in 2008, Kerala in 2013), the export of eggs drastically dropped and ended at 0.5 million eggs per day during 2018-19. However, Poultry companies like SKM foods could export egg products to Japan and other European countries by obtaining commercial layer compartmentalization. The present policy from Government to issue commercial compartment certificate is highly expensive to the tune of 140,000 USD per farm and practically not possible to obtain for even large and medium farmers, forget the small farmers as such (Times of India, Sept 2019).

The Livestock and Agri Farmer's Trade Association (LIFT), representing the layer farmers from Namakkal, has made representation to the Center in July 2019 to announce Namakkal district as disease-free zone for trading table eggs. After considering the representation, the Joint Commissioner, Govt. of India has written to Director of Animal Husbandry, Dept of Tamil Nadu on Sept 2019 to send a detailed proposal to the Center in context of current OIE terrestrial code. The Namakkal Farmers Association is upbeat with the Government's move and looking forward for its support to export table eggs which will significantly help to promote the Egg Industry in India to prosper.

5.2 Registration of Vaccines:

Zoetis, an Animal Health Company from USA, has been selling medicines and vaccines in India. Mycoplasma is one of the important bacterial diseases in poultry transmitted both vertically from parents and horizontally through dust, feathers, litter etc. Proper control of mycoplasma in Breeders is must in order to avoid CRD (complex respiratory disease) infections at commercial poultry level. Prevention of Mycoplasma is not practical and therapeutic medication is not effective since we cannot eliminate the infections completely. Hence, vaccination is the long-term solution to reduce the transmission of mycoplasma infections. As part of the registration process, Zoetis had applied for registration of their Mycoplasma vaccines at Central Drug Standard Control Organization (CDSCO). Due lack of available data about the disease prevalence of Mycoplasma infections, CDSCO suggested Zoetis to provide more information about mycoplasma prevalence in Indian conditions. Zoetis put up a proposal to Department of Poultry Research (DPR), Hyderabad for a joint project on surveillance of mycoplasma incidences across India. Further to the execution of project and submission of report about the prevalence of Mycoplasma infections to CDSCO, the regulatory body analysed the results and gave approval for registration of Mycoplasma vaccines in India. After Zoetis, many other vaccine companies have also registered their vaccines against Mycoplasma. Subsequent to the introduction of mycoplasma vaccines in Indian poultry sector, there is significant reduction in the antibiotics usage to treat mycoplasma infections.

6. Recommendations

The poultry sector has a huge potential for growth due to rising demand for eggs and chicken meat and the socio-economic benefits achieved in an agrarian economy. The rapid increase in poultry farms and backyard poultry development programs in rural areas also poses challenges to sector for safe and sustainable production including diseases. The need for round the clock availability of eggs and poultry may result in use of growth promoters and antibiotics to prevent any diseases. Increased antimicrobial resistance due to misuse of antibiotics in poultry farming is a major threat to human and animal health welfare. It is understood that antibiotics are not the choice of the farmers but usage as growth promoters will be based on economics of scale and fear of outbreaks due to hear and say in lack of factual data and information.

This study attempts to develop a case of Indian Poultry value chain and development of AMR due to misuse of antibiotics in the sector. The way ahead is to address these sensitive areas by the coordinated efforts by the Government, poultry sector, research institutes, civic society by working together and devising appropriate strategies. Based on the above information gathered from various sources, a set of recommendations are listed.

6.1 Collaboration and Communication among Stakeholders in Country

It is clearly understood from this study that AMR is a Global issue which needs to be addressed involving all relevant stakeholders. AMR is a crosscutting issue covering health, animal husbandry, food safety, environment, science and technology and our industry comprising of farmer community, pharma companies, feed manufacturers and associations. Figure 4 showcase the communication system to be developed between G2G, G2I, Research to Industry and Government and International Community and at the same time collaboration among all the four key pillars.



Figure viii: Stakeholder Collaboration

Every stakeholder is working hard to achieve this goal of AMR containments; however, we do not have substantial initiatives to showcase our efforts due to the varied factors like country size, community and roles of individual organization and objective. The most important aspect in controlling AMR is to acknowledge and understand the problem and answer the root cause as why a farmer be interested to use antibiotics. The reason is fear of disease outbreak and easy availability of some drugs. Poultry value chain is the best case for Private sector self-compliance regime. It is important to convert this initiative of AMR control to a public private collaboration system.

6.2 Strengthening the Disease Detection and Reporting System

It is extremely important for the Government Authorities in India to start developing a repository of diseases in Indian Poultry sector. The current documented system does not enlist the diseases prevalent in Indian poultry layer and broiler, hence, in spite of the well-developed scientific system for vaccinations many of the poultry disease vaccines are not readily available. The reason is lack of their registration and approval in CDSCO as there is no reported description of the associated disease. Many of the viral infections, coliform (E Coli) diseases and salmonella pathogens could be easily prevented by administering vaccines for the specific strains. It is proposed to strengthen the Early Warning Signals of Diseases through the National Disease Reporting System and instil the confidence among farmers. Strengthen the research around the new diseases and collaboration with Government and Industry for the vaccine research and validation for use in Indian poultry should be encouraged. Figure 5 explains the journey to achieve a systematic disease and vaccine development journey.

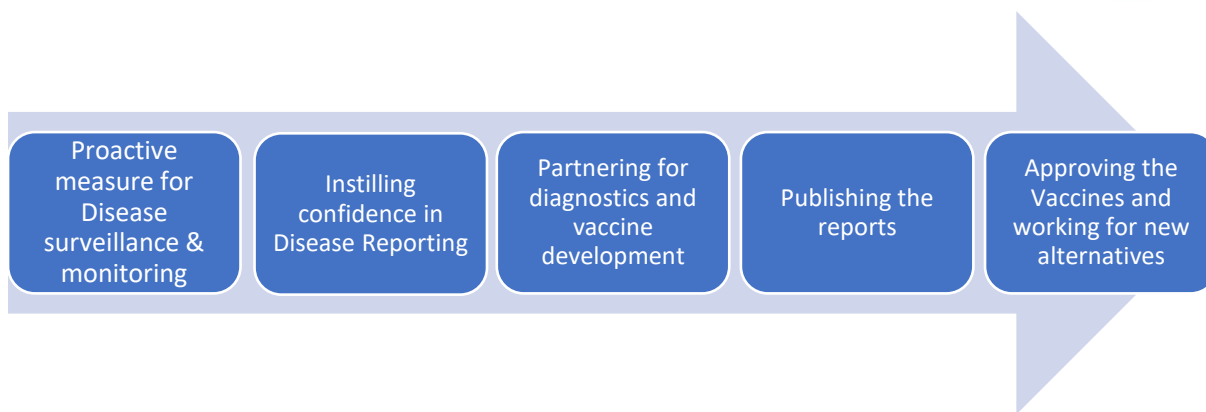


Figure ix: Disease Detection and Reporting System

6.3 Robust Regulatory Regime

The Indian regulatory system for veterinary drug authorization, licensing, manufacturing sales and distribution control should be strictly enforced. A strong system for surveillance of diseases and resistant strain is highest priority as it will provide insights on India's status and what is to be achieved. The surveillance and monitoring system for drug sale and usage needs to be traceable for the high priority medicines. Government should take restrictive measure for import, production, sales and usage of antibiotic growth promotors (AGP's) in food animals which is strongly supported by the organized poultry sector. The sales of antibiotics for animal disease treatment should be made mandatory with prescription from registered Veterinarian only. It is recommended to develop centralized system to track import, production, sale & use of antibiotics for treatment at all levels including Pharma companies, Veterinary Drugs distributors, Integrators & Feed producers. Easy approval and availability of vaccines (active substance) already approved for humans use in animals if suitable. National Animal Disease Reporting System (NADRS) may be considered as nodal point to monitor the trend in use of antibiotics at farm level. A strong support of trained manpower and equipped laboratory network is required.

Improved biosecurity measure combined with hygiene practices at Farm system will result in prevention of disease. A system for registration and renewal of farms is recommended with specific parameters related to farm hygiene and biosecurity to prevent contaminations and spread of diseases. This will help in reducing the antibiotics usage in farms. India is in need of a centralised regulation for feed safety in India including registration and licensing of commercial feed millers and Integrators. This will include a list of approved feed ingredients, premixes and growth promotors. The feed regulations should adequately address the feed hygiene and manufacturing requirements along with the need for traceability.

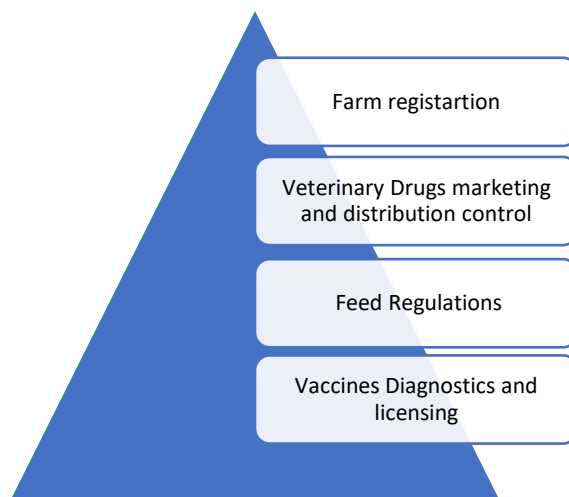


Figure x: Proposed Regulatory Regime

6.4 Capacity Building: Educate, Aware and Train

It is recommended to educate the stakeholders in the poultry value chain about the healthy farming practices and hygiene in farms. It is equally important that farmers should be brought to the discussion table while drafting guidelines and regulations as decision makers. Increased participation from farmers community will result in increased awareness and easy adoption of regulations. Structured awareness and Training programs, especially for small and backyard farmers in conjunction with organized Poultry sector on standard vaccination programs, strict biosecurity measures, proper waste disposal methods etc should be conducted. There is a need for buy in from the practitioners.

There is a need to enhance transfer of technology, knowledge and expertise from researchers to the practitioners in an easy, smooth approach. The commercialization of the breeds, alternative growth promoters and other scientific knowhow on disease should be appropriately shared among public partnership model

It is important to involve veterinary extension officers and private veterinarians in building a robust awareness campaign on AMR. India is a vast country; however, it has a strong team of state veterinarians and private veterinarians working with the integrators which can be developed as community facilitators to create awareness.

Learning from best practices adopted by other countries in handling the AMR issues. The best case is Netherland system for usage and control of antibiotics in Poultry production system by adoption of PPP approach and developing an independent setup.

6.5 Research and Technological advancements

The research should target on fast and accurate diagnosis of diseases and their controls. It will be good to develop such researches in PPP model. Apart from controlling the disease by quick detection there is a need to exploit the science of animal breeding for disease control including genomic and DNA

research. This may help in developing disease resistant species which will in turn result in lower consumption of antibiotics. The technology to identify strain variation to understand the efficacy of vaccine has to be developed to avoid vaccine failures.

Researches should focus on decreasing emissions from poultry value chain including technology to convert poultry litter to biogas and subsequently for other useful initiatives. A technology to identify early detection of sex of embryo to avoid culling of male chicks in egg laying birds. Alternate growth promoters and nutrition for poultry feed is another important area for research. A coordinated research work between poultry sector, veterinary universities & research institutions in the areas of disease management, nutrition, breeding & biosecurity is needed for the benefit of poultry farmers

7. Conclusions and Key Takeaway

India's poultry sector has grown significantly with a transformation from backyard farming into scientific and technology driven integrated model. The intensive farming systems requires considerable use of medications, vaccines and bio-security protocols to be in place to reduce pathogen pressures for profitable production. The indiscriminate use of antibiotics in animal farming creates threat for AMR but there is limited evidence available on the quantity and type of usage of antibiotics consumption within the poultry industry. The policy makers have to work as a team with organized poultry sector and other associated stakeholders to improve awareness on AMR, develop capacities for prevalence studies, strengthening monitor and surveillance systems, tracking usage of antibiotics at farm level, train farmers to adopt good farm practices & promote judicious use of antibiotics. Effective collaborations have to be established across different stakeholders including government and independent organizations from local to international fraternities for reaping virtual benefits on AMR recommendations. It will be imperative to mention here that the time allocated for the study was short and only one location could be covered in India. It was observed during the study that there was resistance from the industry in sharing their practices. The responses to the survey was low, however, face to face interviews with Government, industry professionals and research organizations along with literature study helped in drafting this report. Some of the key take aways are summarised below for the decision makers, influences and users along with future areas of collaborations between India and Netherlands.

7.1 Decision Makers and implementation authorities

In India it is important to ensure the access of antibiotics to avoid mortality and avoid the excess antibiotic usage especially from hearsay, self-medications and availability of medicines over the counter. The usage of antibiotics in livestock, poultry and fisheries for disease prevention and growth promoters is an area to be addressed urgently by policy makers. A strong regulations and stronger enforcement regime are required for any unauthorized usage of antimicrobial products. Single regulatory structure will not be able to control the same in India and there is a need for involvement of workforce in agriculture extension services, veterinary extension services and industries to build trust in government and its regulations. It is important to bring the practitioners, framers, integrators and associations to

participate in campaigns which is only possible if they are aware of the enormity of the problem and its impact on Humans. Government and research institutions should work for Integrated Disease Surveillance Program including standardized Disease Reporting System and strengthening Early Warning Signals of Diseases Outbreaks.

India has developed its National Action plan in 2017 in response to the global action plan on AMR. The success of this umbrella plan (plan of plans) depends on the effective cascading of the same to state level, district level, farms level planning. It is the responsibility of the policy makers not just to make regulations but create the ecosystem for its existence and implementation. This can be achieved by developing strong regulatory structure for veterinary drugs registration, manufacturing, distribution, retail at one hand and farm registration scheme to inculcate the disease prevention approach by improved hygiene, sanitary and biosecurity measures.

7.2 Decision Influencers and Research organizations

The research in agriculture, animal husbandry and health in India is primarily governed by universities and institutions under ICAR, ICMR, AYUSH etc. The public health is a major concern and development of new drugs is important to control the mortality rate. However, there is increasing impact of over usage of drugs in humans as well as animals which creates an opportunity for research in alternative medicine practices. A structured collaborative research involving private sectors, pharmaceutical companies, feed manufacturers and vaccine manufacturers and traders should be promoted. Both these researches at Public and private level contributes significantly for decision making. It is equally important that the research should be published and acknowledged to support one health approach. Recently, ICAR and ICMR has collaborated for agricultural and human health surveillance activity to evaluate impact of AMR.

The associations such as CLAFMA, INFAH and poultry federations etc should be working together with the government machinery to create awareness about judicious usage of antimicrobials and ill effect of overdosage. The possibility of transmission of antibiotics from animals to humans and its ill-effect can be better campaigned by them. It is the responsibility of the associations to act as bridge between Government initiatives and farmers and private industries benefits.

7.3 User group: Farmers and producers

The user group stays at heart of any initiative as poultry sector is not just about providing food and nutrition to the country but its importance in generating employment in rural sector. The farmers are more skilled in their operational areas, it is the effort of government and industries to educate them on the abuses of antibiotics in their animals. Usage of antibiotics is not by choice but the need and fear to lose the entire population with some unknown diseases. The participation and support of producers group is imperative for effectively controlling and managing the supply and distribution chains.

The farmers have to take initiatives to participate in forums and make adequate representations for their needs, problems and related solutions. This is not limited to the vaccines for diseases not reported but also for the farm practices and subsidised veterinary services etc. Disease reporting is the responsibility

of the user groups in proactive manners and the suitable compensations demand is necessary to increase such reporting and avoid high economic losses to the farmer community.

7.4 Collaboration opportunities between Netherlands and India

Netherlands has taken several initiatives towards reduced usage of antimicrobials especially in poultry sectors and has set example for the other countries. In India the climatic conditions, cultural settings, operational environment for poultry value chain and antimicrobials is different, however, there can be a good opportunity for learning and collaboration at various levels. The collaboration between India and Netherlands is proposed to be at three levels:

7.4.1 Government to Government

As the Kingdom of Netherlands has set an example for the entire world in building the public private partnership model to control AMR in poultry sector. It is very important that such models can be taught and developed as pilot with Indian government at state level. India could collaborate with Netherlands by visiting the setup of Netherlands Veterinary Medicines Authority (an independent public-private cooperation) involved in analysis of data on the use of antimicrobials at farm level and to set benchmarks. This will facilitate the implementation of National Action Plan of India on AMR. India needs to develop the requirements for poultry farm practices, hygiene and biosecurity measures to be practiced. Exchange of experts well versed with Indian farm practices and Netherlands farm initiatives can interact in suitable forums to exchange views for development of documents. The referral laboratory networking system for AMR requires multisector like health laboratories, animal husbandry laboratories and food laboratories to share data and information. A networking system could be guided for integration based on expert advice if available in Netherlands or other international bodies.

7.4.2 Industry to Industry

There are several pharma and feed industries from Netherlands having their manufacturing and /or marketing set up in India especially related to poultry value chain. Many of the vaccines are already registered in Netherlands, Germany or other parts of Europe which do not need to be reinvented or researched but required to be registered for their easy availability. Collaborations / Partnership in Vaccines manufacturing and Vaccine related technologies to develop vaccines for emerging and re-emerging diseases. There is an example of collaboration of foreign vaccine industry collaborating a research with the Government lab in India to conduct a surveillance study to showcase the prevalence of disease which lead to registration of mycoplasma vaccine. Alternative technologies and feed alternatives including growth promoters are required to be developed by collaboration between India and Netherlands industries. Indian Poultry sector is looking for alternatives to antibiotic growth promoters (AGP's) to improve the performance of birds which is an opportunity segment for many EU countries.

The facilitation of export trade of table eggs & other value-added egg products the collaboration with association such as International Egg Commission, NECC can connect for inter country buyers which will surely help the Indian layer farmers to expand their business.

7.4.3 Research to research

Launching a collaborative effort on studying the areas such as; the antibiotics usage in farm, trends in industrial and backyard farms practices, supply chain of value chain, disease diagnostics etc. Central research institutes can collaborate with WUR to understand the public private model of university and regulators and industry for developing and implementing NAP in the country. Technological research opportunity in the best practices of litter management in terms of power generation and organic fertilizer is again a great opportunity for collaboration. Embryo sexing technology is the area which has to be explored for early detection of sex in the layer sector so that culling huge number of male chicks can be avoided.

India needs to explore more on the science of Animal breeding as preventive measures for diseases rather than usage of antibiotics. The industry, researchers and government can look for animal breeding as an alternative.

ANNEX 1: List of agencies and participants

S. No.	Contact Point	Medium of Interaction
1	Directorate of Animal Husbandry, Hyderabad	Focussed Interview/ Discussion
2	VN Hatcheries, Hyderabad	Focussed Interview/ Discussion
3	Principal Scientist, Poultry Research on Poultry, Rajendranagar, Hyderabad	Focussed Interview/ Discussion
4	CPF India Pvt Ltd, Bangalore	Focussed Interview/ Discussion
5	Principal Scientist (Nutrition), Directorate of Poultry Research, Rajendranagar, Hyderabad	Focussed Interview/ Discussion
6	Senior Scientist, Animal Health Lab, Directorate of Poultry Research, Rajendranagar, Hyderabad	Focussed Interview/ Discussion
7	CDDEB	Focussed Interview/ Discussion
8	Animal Husbandry Commissioner	Focussed Interview/ Discussion
9	Director and Joint Director, FSSAI on AMR	Focussed Interview/ Discussion
10	Assistant Commissioner Poultry	Focussed Interview/ Discussion
11	INFAH	Focussed Interview/ Discussion
12	Head (Retd), Department of Poultry Science, University of Agricultural Sciences, Bangalore.	Questionnaire Study
13	Zoetis India Limited, Mumbai.	Questionnaire Study
14	HyLine layers Private Limited, Tamil Nadu.	Questionnaire Study
15	Ventri Biologicals.	Questionnaire Study
16	Former Assistant Director, Dept of Animal Husbandry, Karnataka.	Questionnaire Study
17	Lexington Enterprises, Singapore.	Questionnaire Study
18	JAPFA Comfeed India Pvt Ltd.	Questionnaire Study
19	Deputy Director, CPDO & TI, Bangalore.	Questionnaire Study
20	Lifeguard Laboratories, Bangalore	Questionnaire Study
21	Megha Farms, Mysore.	Questionnaire Study
22	Cargill Provimi Animal Nutrition India Pvt Ltd.	Questionnaire Study
23	Trouw Nutrition India Pvt Ltd	Questionnaire Study
24	Chairman, CII National Committee on Allied Sectors in Agriculture	Technology Summit Panel Discussion
25	Wageningen University and Research, Research Leader Global One Health	Technology Summit Panel Discussion
26	Amsterdam Institute for Global Health and Development (AIGHD), CEO:	Technology Summit Panel Discussion
27	Alta Genetics	Technology Summit Panel Discussion
28	Veterinary Officer World Health Organization	Technology Summit Panel Discussion
29	Advisor, Poultry Association of India	Technology Summit Panel Discussion
30	ICMR	Technology Summit Panel Discussion
31	Joint Director, Ministry of Animal Husbandry:	Technology Summit Panel Discussion
32	WHO Representative to India	Technology Summit Panel Discussion
33	Former Secretary, Ministry of Animal Husbandry	Technology Summit Panel Discussion

ANNEX 2: List of Dutch Companies across Poultry Value Chain

Company Name	Logo	Area of Expertise
Aminorich Nutrients BV		Pharmaceutical products
CID Lines		Products, combined with tailored advice to improve hygiene
Daavision		Production and trade of agricultural additives mainly based on organic fatty acids
De Heus		Animal nutrition
DSM Nutrition India Private Limited		Science-based animal nutrition solutions
Fancom		Provides help in improving processes in livestock houses with comprehensive house system called iFarming
Hatchtech BV		Incubation solutions for superior chick quality, health and growth
Hotraco Agri		Supplier of innovative automated systems for poultry and pig farming
Impex		Supplier of drinking systems and accessories for poultry and pig farming
Jansen Poultry Equipments		Wide range of poultry systems
Koudijs		Producer and exporter of complete feed programs, concentrates and premixes with customized feed solutions
Marel India Pvt. Ltd.		Provider of advanced poultry processing systems and services
Mavitec		Designing, manufacturing and worldwide installation of high-quality process systems and equipment
Meyn		Innovative systems for poultry processing equipment
Moba Asia		Manufacturer of machinery for egg grading, packing and processing
Ottevanger		Supplier of production equipment and processing lines for the grain processing and compound feed industry
Palital Feed Additives		Manufacturer of high-quality feed additives
Pas reform		Develops and produces innovative hatching machines
Provimi Animal Nutrition India Pvt. Ltd.		Developer of premixes, concentrates and specialty products (such as additives and milk substitutes)
TwinOxide		Ecological water treatment

ANNEX 3: Survey Questionnaire

Theme 1 - Government Policies and Initiatives to address Anti-microbial resistance (AMR)

1. Are you aware of any initiatives taken by Government of India (GoI) for ONE HEALTH approach in Poultry Production?
2. What are the present regulations from GoI in terms of Antibiotic usage in Poultry?
3. Is there any standard protocol followed at Poultry farm level for disease control?
4. According to you, what are the practical “challenges” farmer is facing to control diseases?
5. Are you involved in any AMR related research initiatives with any organisations / associations? If yes, please elaborate.
6. What is your opinion about “unorganised” poultry or “composite” farming? Is there any link with commercial Poultry in terms of disease control?

Theme - II - Poultry farm practices with specific reference to antibiotic usage.

1. What is the average size of poultry farm in your region?
 - a. Breeder farm -
 - b. Broiler farm -
 - c. Layer farm -
2. What is your opinion about farm management practices in general (at least 2 good and 2 challenges)?
3. What are the standard disease control measures (SOP's) adopted by poultry farmers?
 - At Farm level -
 - At Feed level -
 - At Hatchery level -
4. What are the alternative strategies to control Antibiotic Usage?
5. What are your views about biosecurity measures adoption in farms? Do the farmers are aware of its importance?

Theme III - Antibiotic Status in India

1. Is usage of antibiotics common in farms? Please provide comments.
2. What are the commonly used antibiotics at farm level across India?
3. Are you aware of any banned antibiotics in poultry production?

Theme IV - Nutrition and Feed Chain

1. What are the present Government Regulations for feed producers in India?
2. What are the new research and innovative studies happening in Poultry Nutrition in India?
3. As a Feed formulator, what are the good measures and practices taken to overcome AMR challenges?

Theme V - Sustainability and impact on Environment

1. How do you handle litter material at farm level?
2. What are the “initiatives” by which we could reduce the need for antimicrobials usage in chicken production?
3. When you supply chicken to institutions / fast food brands, what are the SOP’s followed in terms of traceability at farm level?
4. What is the impact of Poultry manure on soil fertility?
5. It’s a known fact that today’s consumers are looking at poultry producers with suspicion. How to combat it or bring back the confidence?
6. Please provide your valued suggestion for improvements at.....
 - Governance level
 - farmer level
 - resources available
 - collaborations

ANNEX 4: 16.10.2019 – One Health Session (Technology Summit Netherlands- India)

Mr. Arabind Das, Chairman, CII National Committee on Allied Sectors in Agriculture:

Mr. Das highlighted the importance of Biosecurity and called for focusing on improvement in biosecurity levels & hygiene at the farm level. He indicated that today's poultry farmer is facing the challenge of "economics" versus "management". He also pointed out the best practices of litter management is the need of the hour to control the spread of diseases. However, he appreciated the growth of Indian poultry farmer from backyard to highly organized sector in spite of lot of challenges.

Mr. Das told that, India is mycoplasma positive which is vertically transmitted from the grandparents to parents, further to the commercial birds and hence, the birds are infected from day one. He insisted for ideal mycoplasma control program at the breeder level so that problems at commercial level can be reduced significantly. He mentioned that, Poultry sector has its task cut to manage the birds through better nutrition and management to achieve average 1.6 FCR (feed conversion ratio) to be economically viable.

Way Ahead: Feed additives – Collaboration opportunities in the area of Vaccine development and market, disease surveillance and monitoring, technologies for gut microbial, alternatives to AGP's. Also creating awareness among all stakeholders on AMR.

Mr. Tarun Sridhar, Former Secretary, Ministry of Animal Husbandry:

Mr. Sridhar mentioned that contribution of poultry industry, both egg and chicken sectors, is immense in providing quality animal protein to Indian growing population. Along with the growth of the industry, he also cautioned about the awareness about the food standards which has to be strict not for only exports but also for local consumption. He mentioned that many reports are indicating 75-80% of all the diseases in humans are coming from animals and hence surveillance has to be given top priority. He pressed hard about the importance of surveillance in the poultry sector which is the key for identification of disease outbreaks and taking appropriate steps to overcome. He called for developing of "integrated disease surveillance program" involving all the stakeholders for better results. He emphasized for general treatment guidelines to be developed in poultry sector which is presently missing.

Way Ahead: Collaboration in paramedical support in poultry sector.

Dr. Rubeena Shaheen, FSSAI:

Dr. Rubeena indicated that only the food products are coming under FSSAI and subsequently the food standards are already in place. She told that, feed is not a part of their mandate and not coming under FSSAI. Efforts are going on to bring the feed also under FSSAI so that all feed related issues can be tackled upon.

Way Ahead: There is a need to develop regulation on feed in India, strengthen food laboratories for sensitivity analysis, to develop market surveillance system for poultry as food in retail.

Dr. Henk Bekedam, WHO Representative to India:

Dr. Henk appreciated the efforts of India as a country for its involvement in One Health approach in general and tackling AMR in particular. However, he expressed his concern about the challenges in India such as small farms scattered across the country and generating the appropriate data about disease incidences. He called for the collaborations between many relevant departments & institutions for inclusive analysis. He also insisted that the Government and Poultry Sector together has to “trust” in surveillance programs and take necessary action to control AMR. He also asked everybody to think how to collaborate in this line and make things happen.

Way Ahead: Developing Common standards for domestic and exports in country, strong Surveillance system, identifying disease free zones in India and working to create such compartments.

Mr. Sujit Dutta, Joint Director, Ministry of Animal Husbandry:

Mr. Dutta outlined the Government’s support in the growth of Indian poultry industry. He also spoke about how successfully our Government handled the bird flu outbreak situations & the efficiency of stamping out policy in India. He outlined the success of Aquaculture industry (Blue economy) in India being the 2nd largest exporter in the world, taking 40% of US market share from South East Asia. In Poultry, he highlighted export of Egg powder to many EU countries, Japan, US etc. He told about the creation of separate ministry for Animal Husbandry recently by the Government which will definitely help in taking care of the growth of the livestock industry.

Way Ahead: Review and strengthening of Indian regulatory structure for improved public private partnership. Collaboration for developing the repository of diseases for vaccination to avoid usage of Antibiotics

Dr. Wim vander Poel, Wageningen University and Research, Research Leader Global One Health

Dr Poel appreciated India's decision to ban the usage of colistin in animal feed as good initiative to control its usage. He shared the experience from Netherland in controlling the usage of antimicrobials in poultry feed. He strongly indicated the fact that containment of AMR can be achieved by improving hygiene in farms, healthy farming practices.

In successful implementation of AMR control programs structured monitoring of diseases such as avian influenza, low pathogenic microorganisms and Gut microflora is required. Industries can work on resilience programs (breeding to control diseases). he also informed about the research in Netherlands to decrease emissions poultry

Dr. Manju Rahl, ICMR:

Dr. Rahl indicated their collaborative studies with ICAR to understand the disease transmission link between animals to humans and how far is the attributable risks to human health. She also indicated that the Government banned colistin subsequently for usage in poultry production. She mentioned about co-ordinated works going on in association with DADF, Drug Controller General of India and ICAR to develop action plan for antibiotics usage in food animals.

Way ahead: A Surveillance system to address the One health approach, Focus on Improved sanitary practices to avoid infections and diseases and usage of Antibiotics.

Mr. Vijay Sardana, Advisor, Poultry Association of India:

Mr. Sardana explained about the success of Indian poultry farming due to improvement and technology in terms of disease management, breed development, housing system and nutritious feed & clean water. According to him, today farmers are getting excellent FCR's (feed conversion ratio) due to scientific and professional poultry production. He highlighted that we cannot follow a single standard for feed raw materials since raw materials availability changes from location to location, climate being highly variable across the country. He mentioned that, developing vaccines is not easy since it needs extreme sensitive technology. He also told that, the field viruses mutate so fast and we cannot introduce vaccines without relevant disease prevalence data. He indicated that, most of the EU countries have their ambient temperatures comfortable for chicken growth whereas in India, the temperatures are highly variable between the regions and seasons. He endorsed Mr. Dutta's remarks that India could successfully handle Bird flu outbreaks through stamping out policy, even appreciated by OIE. He highlighted that Indian poultry industry acted responsibly and requested Government of India to ban colistin sulphate for use in food animals. He invited the audience to accompany him to visit poultry farms where he could demonstrate the scientific and professional rearing practices.

Way Ahead: To indicate the strengths of poultry industry collaborations and initiatives.

Dr. Remko Van Leeuwen, Amsterdam Institute for Global Health and Development (AIGHD), CEO:

Dr. Remko indicated that they developed an excellent example of Surveillance system for AMR global in public private partnerships

Way ahead: Developing the Learning from public private partnership.

Mr Coen Van Rosmeulen, Alta Genetics

Mr Coen highlighted the importance of animal breeding in developing disease resistant species. The animal breeding is a very important area for disease control including genomic and DNA research

Way ahead: Researchers may collaborate in the area of animal breeding for disease resistant species.

Dr Alexandra Vokaty, World Health Organization.

Dr Vokaty shared her experience as a veterinarian and suggested that many problems can be solved by bringing farmers to the tables for discussions for better connects and problem solving. She also shared that involvement of private veterinarians to work towards farmers training and awareness is a good approach to create wider awareness.

Way Ahead: Farmers involvement in decision making and training of private veterinarians as trainers for farmers.

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