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Poultry Feed Contamination and its Potential Hazards on Human Health in South Libya (Sabha and Ubari)

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تلوث أعلاف الدواجن ومخاطرها المحتملة على صحة الإنسان في حظائر جنوب ليبيا (سبها واوباري)

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Abstract:
This study examines poultry feed contamination and its potential risks to human health in the growing poultry sector in southern Libya (Sebha and Ubari), which has become a significant global source of low-cholesterol, high-protein meat. A descriptive and analytical approach is used to assess feed contamination and its association with human health risks. The methodology includes questionnaires and laboratory tests to analyze feed quality. The questionnaires and interviews will measure farmers' awareness levels, while laboratory tests will identify contaminants such as mycotoxins and heavy metals. The study sample consists of 50 poultry farmers randomly selected from the two regions, ensuring diverse representation. Data analysis will combine quantitative methods such as statistical tests (normal distribution, correlation analysis, and regression analysis). The study results show that storage contamination is a significant problem, with 70% of participants reporting it as common. Environmental factors and water quality contribute to contamination, as indicated by 80% and 60% of farmers, respectively. Additionally, 50% of farmers attribute feed contamination to Poor quality raw materials, while 60% cited poor hygiene practices. Pathogen contamination, particularly salmonella, is a major concern for 80% of respondents. 80% of farmers also acknowledge that mycotoxins, which pose serious health risks, are a major problem. Poor storage practices are widely believed to increase health risks, with 90% agreeing. Effective solutions identified by farmers include better storage practices, rapid response strategies, and regular monitoring, supported by 90% of respondents. The study also highlights the importance of education in preventing contamination. A large majority (90%) of farmers believe that educating workers on safe feeding practices would be a long-term solution. Another key finding is the lack of strict legal regulations related to feed safety, with 60% of farmers acknowledging the need for stricter government oversight to effectively address the contamination issue.

Keywords: Nutrition - Feed - Mycotoxins - Feed Quality.

الملخص:
تتناول هذه الدراسة تلوث أعلاف الدواجن ومخاطره المحتملة على صحة الإنسان في قطاع الدواجن المتنامي في جنوب ليبيا (سبها وأوباري)، والذي أصبح مصدراً عالمياً هاماً للحوم منخفضة الكوليسترول وعالية البروتين. يُستخدم نهج وصفي وتحليلي لتقييم تلوث الأعلاف وارتباطه بمخاطر صحية على الإنسان. وتشمل المنهجية استبيانات واختبارات معملية لتحليل جودة الأعلاف. ستقيس الاستبيانات والمقابلات مستويات وعي المزارعين، بينما ستحدد الاختبارات المعملية الملوثات مثل السموم الفطرية والمعادن الثقيلة. تتألف عينة الدراسة من50 مزرعة دواجن تم اختيارهم عشوائيًا من المنطقتين، مما يضمن تمثيلًا متنوعًا. سيجمع تحليل البيانات بين الأساليب الكمية مثل الاختبارات الإحصائية (التوزيع الطبيعي، وتحليل الارتباط، وتحليل الانحدار). أظهرت نتائج الدراسة أن تلوث التخزين يمثل مشكلة كبيرة، حيث أفاد 70% من المشاركين بأنه أمر شائع. تساهم العوامل البيئية وجودة المياه في التلوث، كما أشار إلى ذلك 80% و60% من المزارعين على التوالي. بالإضافة إلى ذلك، يعزو 50% من المزارعين تلوث الأعلاف إلى رداءة جودة المواد الخام، بينما أشار 60% إلى ممارسات النظافة السيئة. يُعدّ التلوث بالميكروبات الممرضة، وخاصةً السالمونيلا، مصدر قلق بالغ لـ 80% من المشاركين في الاستطلاع. كما يُقرّ 80% من المزارعين بأنّ السموم الفطرية، التي تُشكّل مخاطر صحية جسيمة، تُمثّل مشكلة كبيرة. يُعتقد على نطاق واسع أن ممارسات التخزين السيئة تزيد من المخاطر الصحية، حيث وافق على ذلك 90% من المشاركين. وتشمل الحلول الفعالة التي حددها المزارعون تحسين ممارسات التخزين، واستراتيجيات الاستجابة السريعة، والمراقبة المنتظمة، وهو ما أيده 90% من المشاركين. كما تسلط الدراسة الضوء على أهمية التعليم في منع التلوث. تعتقد أغلبية كبيرة (90٪) من المزارعين أن تعليم العمال يُعدّ اتباع ممارسات تغذية آمنة حلاً طويل الأمد. ومن النتائج الرئيسية الأخرى غياب اللوائح القانونية الصارمة المتعلقة بسلامة الأعلاف، حيث أقرّ 60% من المزارعين بالحاجة إلى رقابة حكومية أكثر صرامة لمعالجة مشكلة التلوث بفعالية.

الكلمات المفتاحية: التغذية، الأعلاف، السموم الفطرية، جودة الأعلاف.

Introduction:

The demand for low-cholesterol meat with a high protein source led to the massive expansion of the poultry industry worldwide. In 1900, chickens were not as large as they are today, and they did not have access to modern rations, clean water, and a healthy environment. At that time, they were not an important source of food for humans. They were raised in small homes, not on large farms. Chickens were only used for food on special occasions, and eggs were considered a luxury. However, in 1923, Mrs. Wilmer Still of Delaware began farming and flourished into a 500-chick farm that could be used as broiler birds. In 1926, she established a 10,000-bird coop. She is considered a pioneer of the commercial broiler industry.

This marked the beginning of limited chicken farming. This chicken mortality rate dropped to 5 percent in the 1970s. The modern era of the chicken industry began with advances in nutrition, the selection of genetically modified birds, and the use of antibiotics and other substances in feed. This large-scale production has not only revolutionized the chicken industry but has also created threats to human health through the consumption of their meat. These human health problems are due to the feed provided to broiler chickens. Chicken feed mainly consists of cereal grains, soybeans, grass, biscuits, meat, blood, fishmeal, fats, oils, hulled cottonseed bran, corn gluten bran, guar gum bran, peanut cake minerals, subtherapeutic antibiotics, etc. This feed may be contaminated with soil toxins, fungi, and parasites. This contamination can affect the health of chickens and, ultimately, human health[1].

Chicken is widely consumed in many countries, as are plant products, corn, wheat, soybean meal, small fish (often from the sea), chicken organ waste, animal fats, monocalcium phosphate, salts, and vitamin and mineral supplements. Chickens are primarily exposed to potentially toxic elements through drinking water, waste, and contaminated feed. Some unethical companies also use toxic tannery waste in the production of poultry feed, significantly increasing pollution. These contaminated feeds can lead to potentially toxic elements being transferred to chickens through the food chain, where they accumulate in the liver, kidneys, muscles, and bones[2].

Study problem:

Poultry farming is an important agricultural activity in southern Libya, particularly in areas such as Sebha and Ubari, where it contributes to local economies and food security. However, concerns have

[1] Suleman, S., Qureshi, J. A., Rasheed, M., Farooq, W., & Yasmin, F. (2022). Poultry feed contamination and its potential hazards on human health. Biomed Lett, 8(1), 71.

[2] A.Q. Shah, T.G. Kazi, J.A. Baig, H.I. Afridi, G.A. Kandhrm, S. Khan, N.F. Kolachi, S K. Wadhwa, (2010). Determination of total mercury in chicken feed, its translocation to different tissues of chicken and their manure using cold vapour atomic absorption spectrometer, Food Chem. Toxicol. 48 (6). p.1550-1554.

emerged regarding the safety and quality of poultry feed, primarily due to the risks of contamination that may affect animals and, ultimately, human health. Contamination of poultry feed can occur through various pathways, including the use of substandard raw materials, inadequate storage conditions, and exposure to harmful pathogens or chemical residues. This contamination can lead to the accumulation of toxic substances, such as heavy metals, pesticides, and mycotoxins, in the feed, which are then ingested by poultry. This issue is of great concern due to its potential impact on human health, as poultry is a primary source of protein in the diet of many Libyan families. Contaminants in poultry feed can cause a variety of health problems, including foodborne illnesses, antibiotic resistance, and long-term chronic diseases resulting from the consumption of contaminated poultry products. In addition, poor access to appropriate regulatory oversight and the challenges posed by the harsh climatic conditions in southern Libya may exacerbate the situation.

The situation is further complicated by the lack of comprehensive studies and reliable data on the extent of feed contamination in this region, as well as knowledge gaps regarding the specific risks these contaminants pose to human health. Understanding the nature of these risks, the sources of contamination, and their potential impacts is critical to developing effective interventions to protect public health and the poultry industry in southern Libya.

Main question:

- What are the sources of poultry feed contamination in southern Libya (Sebha and Ubari) and how do these pollutants affect human health?

Study objectives:

1. Analysis of various contaminants (such as mycotoxins, heavy metals, and pesticides) found in poultry feed in the Sabha and Ubari regions.
2. Identify potential sources of contamination, such as poor feed storage, environmental factors, and feed production practices in southern Libya.
3. Study how poultry feed contamination affects poultry health and growth in these regions.
4. Study how contaminated poultry products (eggs and meat) affect human health.
5. Measure the concentration of contaminants, such as heavy metals and mycotoxins, in poultry products from local markets.
6. Analyze the potential short- and long-term health risks associated with contaminated poultry products, including foodborne diseases, neurological disorders, and cancers.
7. Assess the level of awareness and knowledge among poultry farmers and consumers of the risks of contaminated poultry feed and products.
8. Propose practical measures to reduce poultry feed contamination, improve safety standards, and ensure the health of poultry and humans in affected areas.

Study questions

1. What are the main sources of poultry feed contamination in the Sabha and Ubari regions of southern Libya?
2. How does poultry feed contamination affect poultry health and growth in these areas?
3. What specific contaminants (e.g., pathogens, chemicals, and heavy metals) are most prevalent in poultry feed in southern Libya?
4. How do local farming practices in southern Libya contribute to or mitigate poultry feed contamination?
5. What are the potential risks of consuming poultry products (eggs and meat) contaminated with harmful substances from contaminated feed?
6. What are the current regulatory measures in place to monitor and control poultry feed contamination in southern Libya?
7. How do the human health risks associated with poultry feed contamination in southern Libya compare to other regions in Libya or globally?
8. What public health interventions can be implemented to reduce the risks of poultry feed contamination and protect human health in southern Libya?

Importance of the study:

The study "Poultry Feed Contamination and its Potential Impacts on Human Health in Southern Libya (Sebha and Ubari)" is a vital study gaining increasing importance, especially in light of the health and environmental challenges facing the agricultural sector in the region. This study aims to shed light on the quality of feed used in poultry farming in rural areas of southern Libya and the potential impacts of feed contamination on human health. Poultry feed contamination in these areas poses serious environmental and health risks that may affect public safety, as contaminated feed can contain toxic substances or biological contaminants that may leak into the meat or eggs produced. Due to the lack of strict veterinary or agricultural oversight in some remote areas, this contamination is considered a major source of many diseases common to humans and animals. Furthermore, areas such as Sabha

and Ubari, which suffer from limited access to high-quality feed sources, may face increased disease burden due to poor feed quality.

The concern for human health in this study is particularly important given the socioeconomic conditions facing the region. Poverty, lack of advanced healthcare, and heavy reliance on local products all contribute to increased risks of feed-related diseases. These diseases may include food poisoning, infectious diseases, or even chronic poisoning that leads to long-term health problems. This is also evident in its potential to provide scientific and practical solutions to reduce the risks of environmental pollution and improve the quality of life of citizens in the targeted areas. Through the results of this study, feed production and storage methods can be improved, as well as raising awareness among farmers and consumers of the importance of obtaining high-quality feed and taking preventive measures to avoid contamination.

This study contributes to enhancing scientific understanding of how environmental factors and pollution in southern Libya affect human health and provides local governments and health organizations with valuable recommendations for improving monitoring and implementing health policies that contribute to reducing the health risks that may result from feed contamination.

Study hypotheses:

- **First hypothesis:** Contamination of poultry feed with harmful pathogens in southern Libya increases the risk of foodborne illness among consumers of poultry products.
- **Second hypothesis:** The use of contaminated water sources for poultry feed production in Sebha and Ubari significantly contributes to poultry feed contamination.
- **Third hypothesis:** Poultry feed contaminated with heavy metals, such as lead and arsenic, poses a significant health risk to individuals consuming poultry products from affected farms in southern Libya.
- **Fourth hypothesis:** The presence of mycotoxins in poultry feed in southern Libya leads to adverse health effects in poultry, which may also lead to human health risks resulting from the consumption of contaminated poultry products.
- **Fifth hypothesis:** Inadequate storage and handling practices of poultry feed in southern Libya increase the likelihood of microbial pathogen contamination, resulting in public health risks.
- **Sixth hypothesis:** Contamination of poultry feed with pesticides and agricultural chemicals in southern Libya contributes to the accumulation of harmful residues in poultry products, which may negatively impact human health.
- **Seventh hypothesis:** There is a close relationship between the level of contamination in poultry feed and the incidence of gastrointestinal diseases in humans in southern Libya.
- **Eighth hypothesis:** Socioeconomic factors, such as poor awareness and the absence of appropriate regulatory oversight, contribute to the high levels of poultry feed contamination and the potential risks to human health in the Sabha and Ubari regions of southern Libya.

Study terms:

- **Nutrition:** Nutrition is the science that studies the qualitative and compositional properties of food and the various processes that occur within the body, such as cutting, chewing, digestion, and absorption, as well as the manufacturing methods and treatments used to improve its nutritional value. This science relies on a number of other sciences, most notably biochemistry and physiology [3].
- **Feedstuff:** A feed ingredient is a component of the feed that performs a specific function. Most feedstuffs provide animals with one or more nutrients. The role of feedstuff ingredients may be determined by providing bulk, reducing the oxidation of rapidly oxidizing nutrients, emulsifying fats, providing desirable flavors, colors, or aromas, or improving palatability [4] .
- **Mycotoxins:** They are defined as secondary metabolites that are toxic to humans and animals. They are produced by certain species of fungi and have a low molecular weight. They can enter the food chain directly through the consumption of contaminated plant food components or indirectly through the consumption of animal products that have consumed feed contaminated with mycotoxins such as aflatoxin[5] .

[3] Ali Abdullah Saeed (2011), Rough Feed and Feed Lectures, Department of Animal Production, College of Agriculture, University of Babylon, p. 1.

[4]Ali Abdullah Saeed (2011), Rough Feed and Feed Lectures, Department of Animal Production, College of Agriculture, University of Babylon, p. 8.

[5] European Commission (EC). (2006). Setting maximum levels for certain contaminants in foodstuffs. Official Journal of the European Union. L., 364. p.1-25.

- **Feed quality:** Means ensuring that raw or manufactured feed materials meet standard specifications, ensuring that feed is kept safe from contamination during long-term storage. Generally speaking, breeders do not prioritize quality [6].

Section 1: Poultry Farming in Libya:

Libya is one of Africa's most populous countries, yet it remains a huge market for poultry, with chicken being one of the most consumed meats in Libya. Demand for poultry products is growing, particularly in Benghazi, Tripoli, and other major Libyan cities. Over the past ten years, we have witnessed a shift toward industrial production among small and medium-sized farmers who have taken over the urban market. The growing middle class, with its large incomes and greater purchasing power, has increased demand for poultry products, fueling demand in urban and peri-urban areas [7].

Previous studies on poultry production have focused primarily on rural poultry farming and its contribution to rural development, leaving its urban counterpart largely undiscussed by researchers. However, this farming contributes equally to the country's social and economic development. Therefore, it is imperative to conduct a study on urban poultry farming, its waste management techniques, and its consequences. This research on small-scale, intensive urban poultry farming will help provide solutions and challenges facing urban poultry farming and waste management technologies. The information gained from this research will also help alleviate some of the challenges facing farmers and governments on a large scale in solid waste management [8].

Subsection 1: The Importance of Poultry Production:

The importance of poultry production can be summarized as follows:

1. Poultry products are considered one of the most important sources of low-cost protein in Libya, as the price of white meat (poultry meat) is very low compared to red meat (animal meat). The price of one kilogram of animal meat is equivalent to the price of 3-4 kilograms of poultry meat.
2. Poultry production is characterized by its high economic return due to its short production cycle. The poultry production cycle lasts 7 to 8 weeks, while the cattle production cycle lasts 3 to 12 months. Therefore, the capital cycle is very fast in poultry production compared to the capital cycle in other types of animal production. In the case of poultry production, the capital cycle can be repeated 5 times per year.
3. Poultry production also has a higher feed-to-meat conversion rate than other livestock. Producing one kilogram of poultry meat requires 2 to 2.5 kilograms of feed, while producing one kilogram of red meat requires more than 7 kilograms of feed.
4. Poultry production requires a small area compared to other livestock.
5. Poultry production can contribute to solving the unemployment problem, as poultry farming can directly create new job opportunities. Furthermore, it can indirectly create new job opportunities through the development of industries related to poultry production, such as feed industries, egg storage and marketing, slaughtering industries, food freezing and packaging industries, meat preservation industries, and industries that produce machinery and technical tools necessary for poultry production, etc. Poultry production can contribute to the country's food security policy and strategy [9].

- **Nutrition and Poultry Feed:** Up to 80% of the total feed cost is spent on chicken feed, making it the primary cost of poultry farming. Protein and energy requirements account for more than 98% of this cost, while the remaining 1% to 20% is allocated to feed additives. Poultry feed ingredients are blended based on their nutritional value and unit cost [10].
- **Promoting and Utilizing Urban Poultry Products:** According to Aden and Oguntade (2006), the commercial poultry industry has extensive facilities for home-based chicken processing, processing, and slaughtering. Roasted chicken accounts for over 90% of the frozen chicken produced by poultry farms; the remaining 10% is sold as live birds. Commercial distributors, hotels, supermarkets, fast-food chains, and other industrial players purchase fresh and frozen meat and eggs directly from customers in open markets and at farm gates.

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[6] coleman, s. w., & moore, j. e. (2003). feed quality and animal performance. *field crops research*, *84*(1-2), 17-29.

[7] Grepay, N. (2009). The main factors affecting poultry production in Libya. Acta Scientiarum Polonorum. Oeconomia, 8(4), p.43.

[8] Fidan Aslanova (2019), Poultry waste management techniques in urban agriculture and their implications: A case study of Tripoli, Libya, p. 2.

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[10] Fidan Aslanova (2019), Poultry waste management techniques in urban agriculture and their implications: A case study of Tripoli, Libya, p. 9.

Due to the weak and typically underdeveloped market structure, poultry products remain expensive in developing countries, particularly in Africa. Local customers tend to choose local chicken over meat and eggs from commercial hybrid birds. Poultry farming should be increased in peri-urban areas or areas with excellent roads, even where customers with high purchasing power reside in cities [11].

The growing need for food, also linked to global population growth, urbanization, and rising average incomes, has led to a significant increase in agricultural production over the past ten years. By 2030, the world's population will exceed 8 billion, and average incomes will rise by 32%, according to United Nations projections. During the same period, per capita meat consumption will also increase by 26%, particularly chicken. Thanks to their high-quality protein and low-fat content, poultry products are among the most sought-after products by consumers [12].

- **Poultry Production Systems:** Three types of poultry farming are used in developing countries: intensive, semi-intensive, and backyard methods. The three main methods of poultry production are: small-scale commercial poultry production, large-scale intensive commercial poultry production, and backyard or village poultry farming.

Intensive Systems:

Both homes and medium- and large-scale commercial enterprises use these systems. Birds are raised in completely enclosed environments, either in cages or in houses. Although birds in these systems are completely dependent on their owners and require a higher income, their productivity is higher. Three types of intensive systems include: battery cages, mesh floor systems, and deep litter systems. In a deep litter system, birds can roam freely but are completely enclosed (with a specific floor area of 3 to 4 birds per m^2 inside the house). The floor is covered with a dense layer (5-10 cm deep) of grain husks (rice or corn), straw, sawdust, or a similar (but non-toxic) absorbent material. This fully enclosed system is suitable for carefully selected commercial poultry species producing eggs or meat (egg or meat) (layers, breeders, and broilers) and protects the birds from predators and thieves. By replacing wooden or wire slatted floors with deep floors, slatted floor systems enable up to five birds per square meter of floor surface. These birds are also able to move freely. For laying hens, which are kept in cages throughout their production period, the battery cage method is a good choice. It maximizes reproductive performance and production with little or no intervention. Criteria used to classify local chickens include disease resistance, cold and heat tolerance, scavenging and brooding behavior, predator escape, and egg hatchability. These traits are essential for adaptation to the village environment, and qualities such as meat and egg flavor influence consumer preferences and, consequently, market value. With low biosecurity, high purchase rates, and high mortality rates, local production systems require only minimal inputs for housing, feeding (scavenging is the sole source of nutrition), health care, basic stock, and a few handfuls of local grain, often used in households at night. These are the only expenditures required. The majority of chickens raised in this way are local, while some hybrids and exotic varieties can also be kept [13].

Large-scale commercial systems:

These farms and their contractors raise tens of thousands to hundreds of thousands of chickens in specially designed commercial facilities, climate-controlled, equipped with grills and layers, and sometimes partially automated. While they use the same principles, they are often smaller than commercial farms in wealthy countries. Key standards include high-quality commercial feed, strict animal health management, and superior genetics [14].

Large-scale commercial production uses an average of over 10,000 birds, raised indoors in medium to high biosecurity environments, a highly demanding production process. Imported exotic breeds, which require high standards of health, housing, feed, and modern management techniques, form the backbone of this system. Because poultry production is entirely dependent on market demand to meet the growing demand for chicken in major cities, this method is known for its high productivity. Chick mortality rates have been reduced to only 5% to 8% thanks to improved biosecurity measures. Although some contemporary poultry projects have grown over time, and with the decline of social and religious taboos surrounding chicken farming, there are currently approximately seven regional poultry breeding

[11] Obi, T. W., Olubukola, A. and Maina, G. A. (2008). Pro-poor HPAI risk reduction strategies in Nigeria background paper.p.22.

[12] Bakker, N., Dubbeling, M., Guendel, S., Sabel-Koschella, U., & Zeeuw, H. D. (2000). Growing cities, growing food: urban agriculture on the policy agenda. A reader on urban agriculture. p. 531.

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[14] Tadelle D and PeterKJ. (2003) Indigenous chicken in Ethiopia: Neglected but worth the cost of conservation through improved utilization. ESAP Proceedings.p. 90 - 103.

and distribution centers. The social, cultural, and religious roles of chicken farming confer symbolic significance. For most of these social and cultural occasions or sacrifices, a specific sex and color of chicken is required. Poultry plays an important role in the social and cultural lives of rural populations. It is a source of income for young people, a gift for family members and religious rituals, a tonic, and a medicine for the sick. Many experts and rural development organizations have recognized the value of rural poultry in the economies of developing countries and its contribution to increasing income and nutritional quality for many small farmers and landless people. However, due to the lack of quantitative measures to assess the contribution of rural poultry to macroeconomic indicators such as GDP, it has not performed well in mainstream national economies [15].

Subsection 2: Major Constraints to Poultry Production:

The poultry industry in Africa suffers from high production costs. Lack of health supervision, technical knowledge, and marketing, the absence of mechanized industrial poultry projects, the challenges farmers face in obtaining chick and feed inputs, and the high cost of support services are factors contributing to the high production costs in Africa. The potential for exporting products has increased due to the current epidemic of animal diseases [16].

Lack of knowledge about poultry production, limited feed sources, and high disease incidence, along with institutional, social, and financial constraints, are among the most significant problems facing poultry production. Poultry producers cited high chick mortality as the most significant. According to community reports, the main causes of this problem were disease, followed by ignorance, malnutrition, and predation. However, efforts to replace foreign chicken breeds with local chickens were noted as a major threat to the deterioration of regional chicken genetic resources. Rural chicken production was found to be hampered by disease, hunger, poor health care, predators, and lack of marketing experience.

Predators and Diseases:

Diseases, particularly Newcastle disease, infectious bursal disease, and avian influenza, are the main cause of mortality, followed by predation. The spread of chicken diseases, especially Newcastle disease, severely impacts the production system economically. During the short rainy season, mortality rates among village chickens are high due to outbreaks of the disease, especially in April (66.8%) and May (31.4%). This disease is one of the most important infectious diseases affecting the survival and productivity of village chickens. The main ways the disease spreads from one village to another are through selling, exchanging chickens from an infected flock, and contact between birds while foraging. Predators contribute significantly to early mortality, as predation is closely linked to the rainy season. The main predators are wild animals such as cats and foxes, which eat adult birds as well as chicks, and birds of prey such as eagles, which eat only chicks [17].

Feed Shortage:

The most prevalent birds in village flocks include young chickens, old chickens, sick chickens, and unproductive chickens. Sales of farm chickens begin before the onset of Newcastle disease, a disease with a high mortality rate. Some studies claiming to have increased village chicken production have focused on management improvements, ignoring the potential impact of socioeconomic issues such as marketing. Even when new technologies appear to be better than current ones, small-scale village chicken farmers prefer to ignore them due to market constraints.

Most farmers sell their chickens in their local communities. This is due to the scarcity of chickens for sale, their distance from high-demand urban and suburban markets, the irregularity of chicken sales, and their reliance on urgent family orders [18].

The increased consumption, often associated with holidays, has led to increased chicken purchases, particularly during festivals, holidays, and disease outbreaks, despite local customers preferring local birds. Because supply exceeds demand, prices drop sharply. Small-scale farmers are ultimately affected. Most traders rent spaces in private vehicles or use public transportation to transport chickens

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to final markets. Due to the stressful conditions, chicken legs can become caught in other bags, grain sacks, firewood bundles, and other objects during transport, which can result in significant losses [19].

Market:

Chicken marketing regulation has received little attention in developing countries. Although their relative importance varies, producers have access to a wide range of marketing outlets or channels in each market. Direct sales of chicken to consumers or small retailers that ship chicken to major cities are the main source of income for producers and farmers. Policymakers and developers often ignore the commercial aspects of small-scale poultry farming. Smallholders may benefit from the assistance of traditional chicken and egg collectors who collect eggs and birds from local communities, but these marketing strategies are often ignored or criticized for being unsustainable. This highlights the need for action in this area [20].

Planning and implementing poultry development programs that benefit rural populations is difficult without knowledge of village chicken production and sales systems. The most commonly sold birds from village flocks are surplus males (cocks and roosters), large hens, young hens, unproductive hens, old hens, and sick birds. Farmed chickens are sold just before the onset of Newcastle disease, a disease with a high mortality rate. Research on improving village chicken production has focused mostly on management improvements, ignoring the potential impact of socioeconomic issues such as marketing. Even when new technologies seem better than their current methods, small-scale village chicken farmers prefer to ignore them due to market constraints.

Although local customers prefer local birds, the largest flock purchases occur around holidays and festivals and when disease outbreaks occur due to overconsumption, particularly associated with holy days. Prices drop sharply due to the large supply compared to demand. Ultimately, small-scale farmers are affected. Most traders use buses and minibuses or rent space in private vehicles to transport poultry to final poultry markets. Due to stressful conditions, chicken legs may be tied with other bags, grain sacks, firewood, and other items during transportation, which can cause significant losses [21].

Section 2: Microbial Contamination in Poultry Feed:

The presence of pathogenic microbial contaminants in livestock feed poses a serious threat to animal and human health, posing a food safety concern. The poultry sector is one of the fastest-growing livestock sectors and is expected to become the leading source of animal protein for global consumption due to factors including population growth, rising incomes, and increasing demand for white meat, particularly in emerging countries. Poultry is known for its ability to provide high-quality, affordable protein, as well as its economic benefits, including poverty reduction and gender equality, particularly in developing countries. However, the poultry sector continues to face challenges from microbial-related diseases, particularly those involving viruses and antibiotic-resistant bacteria [22].

A known route for animals to become colonized or infected with harmful microorganisms is the consumption of these bacteria from feed. Humans and livestock may acquire many microorganisms, such as bacteria, fungi, protozoa, and viruses, through feed. There are many sources of microorganisms in poultry feed, including contaminated feed, plant and animal ingredients, livestock feed processors (preparers and feeders), conveyors (which collect microorganisms and transfer them to stored feed), and containers used in feed preparation and packaging. In addition, feed may be contaminated by raw material handling, transportation, storage, or processing, and even aviary [23].

Subsection 1: Origins of Bacteria in Feed:

Cereal and oilseed crops are characterized by microbial diversity and high resistance to low moisture conditions. Dust generated by soil disturbance during mechanical harvesting, strong winds, or rain is the main source of inoculum for plant material. The soil environment consists of a diverse array of microhabitats composed of clay particles, organic matter, and water balls. These microhabitats vary in

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[19] Alemu Y and Tadelle D. (1997) The status of poultry research and development in Ethiopia, research bulletin No.4, poultry commodity research program Debrezeit agricultural research center. Alemaya University of agriculture, Ethiopia. p. 62.

[20] Dolberg F. (2003) Review of household poultry production as a tool in poverty reduction with focus on Bangladesh and India .pro-poor livestock policy Initiative. PPLPI working paper No.6. FAO, p. 36.

[21] Dolberg F. (2003) Review of household poultry production as a tool in poverty reduction with focus on Bangladesh and India .pro-poor livestock policy Initiative. PPLPI working paper No.6. FAO, p. 36.

[22] CRUMP, J. A., GRIFFIN, P. M. and ANGULO, F. J. (2002). Bacterial contamination of animal feed and its relationship to human foodborne illness. Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America,35(7): p.859 - 865.

[23] MOTTET, A. and TEMPIO, G. (2017). Global poultry production: current state and future outlook and challenges. World's Poultry Science Journal, 73(2): p.245 - 256.

pH, redox potential, ionic strength, nutrients, minerals, and gas composition. This diversity of soil microhabitats results in a diversity of anaerobic and aerobic microbes. Gram-negative bacteria predominate in soil. On the other hand, Gram-positive corynebacteria are more common than Gram-negative bacteria [24].

Poultry feed is a good substrate for microbial growth despite its dry nature. This is due to its content of nutrients such as protein (a source of nitrogen), minerals (including specific elements such as iron), vitamins, and essential amino acids. These nutrients support the growth of microorganisms, especially bacteria and fungi. Poultry feed and feedstuffs are also favorable for microbial growth due to environmental conditions such as high temperatures and humidity. Bacteria that produce spores undergo a survival phase until the moisture content is high enough for vegetative germination. However, fungi thrive in stored feeds, especially seeds, grains, and forages, as they are well suited to the limited amount of moisture available. However, birds cannot access the nutrients in the feed because they decompose when organisms use them for growth. When bacteria and fungi grow in chicken feed, they produce metabolites, or toxins, that have negative effects on birds that consume the contaminated feed. Because these metabolites are thermally stable, odorless, and tasteless, poultry may avoid their detection and consumption. **Three main events are likely to occur when bacteria infect chicken feed:**

1. Reduced feed quality and composition, impairing performance.
2. Toxin synthesis, which may impair health or performance, depending on the type of toxin and the dose.
3. Colonization of the ingested animal; this can lead to a variety of complex effects.

From negative effects such as reduced feed efficiency to positive effects such as colonization and development of the gut microbiota. As a result of poor feed conversion, reduced growth and weight gain, organ and tissue damage, sensory changes, reduced egg production, and poor egg and meat quality, farmers may suffer financial losses as a result of these negative effects [25].

- **Origins of Bacteria in Feed:** Cereal and oilseed crops are characterized by microbial diversity and high resistance to low moisture conditions. Dust generated by soil disturbance during mechanical harvesting, strong winds, or rain is the main source of inoculum for plant material. The soil environment consists of a diverse array of microhabitats composed of clay particles, organic matter, and water balls. These microhabitats vary in pH, redox potential, ionic strength, nutrients, minerals, and gas composition. This diversity of soil microhabitats results in a diversity of anaerobic and aerobic microbes. Gram-negative bacteria predominate in soil. On the other hand, Gram-positive corynebacteria are more common than Gram-negative bacteria [26].
- **Sources of Fungal Infection in Feed:** Fungal fungi, or molds, can also be found in feed and can threaten seed viability and quality. Molds can cause seed clumping, the production of mycotoxins, foul or sour odors, and reduced seed germination, thus reducing seed nutritional value. Unlike stored grains, developing grains can contain various types of molds, which are divided into two main categories: field fungi and storage fungi. Field fungi can include pathogenic species of Dreschlera (Helminthosporium) and Fusarium that infiltrate the grain or seeds of plants during development, as well as non-pathogenic species of Apsidia, Alternaria, Catatotomium, Cladosporium, Diplodia, Phaeomuellaria, and Rhizopus. Some molds, such as Aspergillus flavus, can cause storage fungi and grain rot in maize, making it pathogenic to plants. Climatic factors, including temperature and rainfall, have a significant impact on the growth of mycoflora in crops. Temperatures above 21°C are ideal for the growth and production of aflatoxins by Aspergillus flavus and Aspergillus fumigatus. When crops are stressed, such as during drought or pest infestation, fungal invasion increases. Field fungi are susceptible to post-harvest desiccation due to their high moisture requirement. Most fungi are destroyed during storage or international transport, while some may remain dormant in feed after harvest [27].

Forage Quality and Fungal Infections:

[24] Crump, J.A., Griffin, P.M., Angulo, FJ., 2002. Bacterial contamination of animal feed and its relationship to human foodborne illness. Clin. Infect. Dis. 35, p.859 - 865.
[25] CEGIELSKA-RADZIEJEWSKA, R., STUPER, K. and SZABLEWSKI, T. (2013). Microflora and mycotoxin contamination in poultry feed mixtures from western Poland. Annals of Agricultural and Environmental Medicine, 20(1): p. 30 - 35.
[26] Crump, J.A., Griffin, P.M., Angulo, FJ., 2002. Bacterial contamination of animal feed and its relationship to human foodborne illness. Clin. Infect. Dis. 35, p.859 - 865.
[27] Clarke, J.H., Hill, S.T., (1981). Mycofloras of moist barley during sealed storage in farm and laboratory silos. Trans.Br. Mycol. Soc. 77, p.557-565.

Grain quality can be reduced by fungal activity in several ways, such as respiration heating and reduced nutrient content. Grain temperatures in the silo can rise to 55°C due to fungal respiration and growth. They may remain there for weeks. This prolonged heat can cause soybeans to blacken, and Maillard reactions can damage amino acids. Grains with high moisture content are also susceptible to advanced fungal attack, leading to clumping and molding of the feed, which can hinder automated feeders and augers. Some protein storage molds, including Aspergillus flavus, Rhizopus chizopodifarmis, and Penicillium chrysogenum, can reduce the amount of fat, amino acids, vitamins, and dry matter digestibility in the feed [28].

Subsection 2: Health Risks Associated with the Consumption of Contaminated Poultry Feed

- **The Effects of Pesticides on Human Health through Poultry Feed:** Weeds and pests are managed using pesticides. Plants may retain pesticide residues if not harvested within the treatment timeframe. After crop treatment, pesticide residues may remain in food. Therefore, pesticide residues are sometimes found in chicken feed. These chemicals are found in farm eggs and chicken meat, and these contaminated pesticides have adverse effects on human health when used on meat and eggs. A total of 519 samples of chicken eggs, beef, lamb, and poultry were tested for organochlorine pesticide (OCP) residues. Residues of organophosphate pesticides were found in the tested beef, poultry, and egg samples. Hexachlorocyclohexane, dichlorodiphenyltrichloroethane, and their metabolites were also detected in several animal feed and chicken organ samples from a farm in Beijing, in another Chinese study. As chicks grow, the total amount of pesticides increases. Pesticide residues in poultry meat can harm human health in many ways, including causing cancer and affecting the reproductive and nervous systems. Neurobehavioral problems have also been linked in several studies to exposure to organophosphate pesticides. Exposure to pesticides can lead to fetal death, birth defects, and neurological disorders [29].
- **The Effect of Heavy Metal Toxicity on Human Health in Poultry Feed:** Animals and humans who consume their meat suffer negative consequences as a result of excessive mineral intake. To maintain human and animal health, poultry feed must contain these vital minerals in adequate quantities. According to nutritionists' recommendations, these minerals should be included in the diet. However, there is still the possibility of chicken feed being contaminated with environmental pollutants or feed additives, which must be carefully monitored. Heavy metal contamination can come from a variety of ingredients in chicken feed, including minerals, marine feed additives, trace elements such as copper sulfate and zinc oxide, roxarson (which eliminates parasites and improves meat color), and anti-caking chemicals. Other factors believed to contribute to food contamination include industrial waste, environmental pollution, and groundwater contamination. Due to their toxic properties and lack of significant biological roles, mercury, cadmium, lead, and arsenic are compounds of particular concern. Arsenic, lead, mercury, and zinc cause serious health problems. The European Union (EC) has established rules to ensure compliance with feed legislation and animal welfare regulations.
- **Urban Poultry Waste Management Practices:** The poultry industry generates significant amounts of waste, including solid waste and sewage sludge. This solid waste includes sludge, bedding materials, feed, hatchery waste (late-hatched chicks, infertile eggs, empty shells, and dead embryos), feathers, slaughterhouse waste (abandoned carcasses, blood, feathers, and entrails), and excrement (manure). Poultry waste management relies heavily on transporting waste from the collection site to storage or final use (Megenia et al.). Due to the high mineral content of their diet, hatchery waste and dead birds contain high levels of calcium and phosphorus. Poultry waste has been used in a variety of agricultural applications, mostly as plant nutrients, opening up new opportunities for farmers. Poultry waste can be disposed of in several ways, such as heat treatment, landfilling, incineration, composting, animal feed, and fertilizer and energy [30].

Given its important role in reducing unemployment and urban food shortages caused by urban population growth, the utilization of agricultural waste from urban centers has received significant attention in development research. Previous research has demonstrated a link between the social, economic, and environmental benefits of using agricultural waste for urban food production. However, the main challenges lie in the efficient use of these produced wastes (sewage, poultry and livestock

[28] Bartov, I., Paster, N., (1986). Effect of early stages of fungal development on the nutritional value of diets for broiler chicks. Br. Poultry Sci. 27, p.415 - 420.
[29] Nicolopoulou-Stamati P, Maipas S, Kotampasi C, Stamatis P. Hens L. (2016). Chemical pesticides and human health: the urgent need for a new concept in agriculture. Frontiers in public health. p.4 -148.
[30] Onibokun, A. G. (1999). Managing the Monster: Urban Waste and Governance in Africa. International Development Research Centre Ottawa, Canada.p.33-34.

waste, and municipal waste) to produce nutritious food with virtually no harmful effects. To produce efficient agricultural products in urban areas, the direct use of animal manure, such as pig, poultry and cow manure, as well as human waste, on arable farms requires carefully considered composting or the addition of diseased animal manure with other types of solid waste [31].

Human health is seriously threatened by recycling chicken manure. In addition to being unsightly and odorous, poultry manure serves as a haven for a variety of rodent pests. Algal blooms may result when it spills into water. The best way to manage chicken waste is to use poultry manure on cropland with low phosphorus levels.

The main obstacles to urban poultry production are high production costs, lack of health supervision, and a lack of technological and marketing knowledge. Due to the absence of an automated industrial poultry industry, production costs in Africa are high. Farmers also face difficulties in obtaining the necessary inputs for chick production and feed, in addition to the high cost of secondary services. The ongoing outbreak of animal diseases has limited the potential for export production [32].

Study methodology:

1. **Study Methodology:** The study will be descriptive and analytical, using the descriptive approach to analyze feed contamination in the Sabha and Ubari regions. The aim is to understand the extent of contamination in this region and its impact on human health. The focus will be on collecting data related to environmental and health factors and identifying the relationship between feed contamination and the transmission of health hazards.
2. **Study Tools:**

- Targeted Questionnaire: Questionnaires will be designed to measure the level of awareness and interest in feed contamination and its health effects among poultry industry workers and farmers.

- Laboratory Testing: Analysis of feed samples used in the Sabha and Ubari regions to confirm the presence of potential contaminants such as mycotoxins, heavy metals, and chemicals.

3. **Data Collection Sources:**

- **Primary Sources:** Questionnaires and interviews with poultry farmers and workers in this field; feed samples and their laboratory analysis; and field reviews of farms and factories that produce and distribute feed.
- **Secondary Sources:** Previous studies that addressed feed contamination in other regions; and health and environmental reports issued by government agencies and health organizations. Statistical data are available from the Ministry of Health and Environment.

4. **Study Sample:** The study sample will be randomly selected from poultry farmers in the Sabha and Ubari regions. The sample will include 50 farmers to ensure broad representation of the target areas.
5. **Analysis Methods:**

- **Quantitative Analysis:** Questionnaires will be analyzed using statistical methods such as normal distribution testing, correlation coefficient, and regression analysis to study the relationship between feed contamination and health conditions.
- **Qualitative Analysis:** Interviews will be analyzed to determine attitudes and opinions regarding feed contamination and its health impact. Thematic analysis will be used to extract key themes and trends.
- **Laboratory Analysis:** Chemical and microbiological analyses will be conducted on feed samples to determine contamination levels.

6. **Study Limitations**

- **Geographical Limitations:** The study will be limited to the Sabha and Ubari regions in southern Libya.
- **Temporary Limitations:** The study will cover a period not exceeding one year, specifically during 2025.

[31] Onibokun, A. G. (1999). Managing the Monster: Urban Waste and Governance in Africa. International Development Research Centre Ottawa, Canada.p.34.

[32] Mijinyawa, Y. and Dlamini, B. J. (2007). Livestock and poultry waste management in Swaziland. Livestock Research for Rural Development, 18(6). p.32.

Field framework:

It aims to identify the dimensions of contamination in poultry feed and the various factors that contribute to contamination, including environmental impacts, improper storage, and raw material quality. Health risks focus on the potential risks these contaminants pose to the health of poultry and consumers. Identifying interventions and solutions is essential to mitigating these risks, through better management practices, regulatory measures, and technological innovations. Together, these dimensions provide a comprehensive framework for improving poultry feed safety and public health.

The first dimension: Dimensions of Contamination:

The contamination of poultry feed is a complex issue that involves various harmful substances and their sources. Understanding the types of contaminants, how they enter the feed system, and their geographical distribution is essential to addressing the risks they pose to both poultry and human health.

1. **Does contamination occur in poultry feed during storage?**
   - Yes
   - No
   - Sometimes
2. **Is the quality of water used in poultry feed production a major factor in contamination?**
   - Yes
   - No
   - Sometimes
3. **Are chemical additives often a source of contamination in poultry feed?**
   - Yes
   - No
   - Sometimes
4. **Do local environmental conditions influence the level of contamination in poultry feed?**
   - Yes
   - No
   - Sometimes
5. **Is contamination from contaminated raw materials a common issue in feed production?**
   - Yes
   - No
   - Sometimes
6. **Do poor hygiene practices contribute significantly to feed contamination?**
   - Yes
   - No
   - Sometimes
7. **Are mycotoxins frequently found in poultry feed in the region of study?**
   - Yes
   - No
   - Sometimes
8. **Is cross-contamination between different batches of feed a common occurrence?**
   - Yes
   - No
   - Sometimes
9. **Does the temperature at which poultry feed is stored affect the contamination levels?**
   - Yes
   - No
   - Sometimes
10. **Are agricultural practices in the area linked to the contamination of poultry feed?**
    - Yes
    - No
    - Sometimes
11. **Are there legal regulations regarding poultry feed safety in the region?**
    - Yes
    - No
    - Sometimes
12. **Do farmers monitor contamination levels in their poultry feed regularly?**
    - Yes
    - No
    - Sometimes

13. **Is the presence of pests (e.g., rodents or insects) common in feed storage areas?**
- Yes
- No
- Sometimes

14. **Is improper packaging a cause of contamination in poultry feed?**
- Yes
- No
- Sometimes

15. **Are pathogens found in poultry feed in the study area?**
- Yes
- No
- Sometimes

The second dimension: Health Hazards: Feed contamination not only impacts the health of poultry but also poses significant risks to humans through the consumption of contaminated poultry products. This dimension explores the direct and indirect effects of contaminated feed on poultry health, the transmission of contaminants to humans, and the potential long-term health consequences.

1. **Does contaminated poultry feed contribute to the spread of foodborne diseases in humans?**
- Yes
- No
- Sometimes

2. **Can the consumption of contaminated poultry products lead to long-term health issues?**
- Yes
- No
- Sometimes

3. **Is there a direct link between feed contamination and the occurrence of antibiotic resistance in humans?**
- Yes
- No
- Sometimes

4. **Are there specific health hazards associated with mycotoxins found in poultry feed?**
- Yes
- No
- Sometimes

5. **Do poor feed storage practices increase the risk of health hazards in poultry products?**
- Yes
- No
- Sometimes

6. **Can poultry feed contamination lead to respiratory problems in poultry farm workers?**
- Yes
- No
- Sometimes

7. **Are chemical residues from contaminated feed a health risk to humans consuming poultry products?**
- Yes
- No
- Sometimes

8. **Does the contamination of feed by pathogens (like Salmonella) pose a significant health risk to humans?**
- Yes
- No
- Sometimes

9. **Can contaminated poultry feed lead to reduced immunity in poultry, making them more susceptible to diseases?**
- Yes
- No
- Sometimes

10. **Are children more vulnerable to health hazards from contaminated poultry products?**
- Yes
- No
- Sometimes

11. **Is there a risk of contamination spreading from poultry feed to other animals or crops?**
- Yes
- No
- Sometimes

12. **Can feed contamination result in a decrease in poultry meat quality, affecting human health?**
- Yes
- No
- Sometimes

13. **Does the presence of heavy metals in contaminated poultry feed pose a risk to human health?**
- Yes
- No
- Sometimes

14. **Are contaminated poultry feed and water linked to the spread of zoonotic diseases?**
- Yes
- No
- Sometimes

15. **Do improper handling and distribution of poultry feed increase the risk of health hazards in both poultry and humans?**
- Yes
- No
- Sometimes

The third dimension: Interventions and Solutions:

Addressing poultry feed contamination requires a multifaceted approach, including regulatory measures, practical mitigation strategies for farmers, and public health education. Effective interventions can reduce contamination levels, protect animal welfare, and safeguard human health from the associated risks.

1. **Are there effective methods for detecting contamination in poultry feed before it reaches the market?**
- Yes
- No
- Sometimes

2. **Is regular monitoring of poultry feed quality an effective solution to prevent contamination?**
- Yes
- No
- Sometimes

3. **Are there technologies available to remove harmful pathogens from poultry feed?**
- Yes
- No
- Sometimes

4. **Can improved storage practices significantly reduce the risk of feed contamination?**
- Yes
- No
- Sometimes

5. **Do proper sanitation protocols in poultry feed production help to minimize contamination risks?**
- Yes
- No
- Sometimes

6. **Are there effective treatments available to neutralize mycotoxins in contaminated poultry feed?**
- Yes
- No
- Sometimes

7. **Can government regulations on poultry feed safety help to control contamination levels?**
- Yes
- No
- Sometimes

8. **Is educating farmers about safe feed practices a viable solution to reduce contamination risks?**
   - Yes
   - No
   - Sometimes
9. **Do alternatives to chemical additives exist that can prevent contamination in poultry feed?**
   - Yes
   - No
   - Sometimes
10. **Are there international best practices that could be adopted to ensure the safety of poultry feed?**
   - Yes
   - No
   - Sometimes
11. **Can the use of organic or natural feed components reduce the risk of contamination?**
   - Yes
   - No
   - Sometimes
12. **Is it possible to reduce the contamination of poultry feed by improving raw material sourcing?**
   - Yes
   - No
   - Sometimes
13. **Are there technologies that can help track and trace the source of contaminated poultry feed?**
   - Yes
   - No
   - Sometimes
14. **Is cross-contamination prevention through packaging a useful intervention for controlling feed safety?**
   - Yes
   - No
   - Sometimes
15. **Do rapid response and containment strategies help to prevent the spread of contaminated poultry feed?**
   - Yes
   - No
   - Sometimes

Survey results:

First dimension results: Dimensions of Contamination

Question	Yes	No	Sometimes	Notes
Does contamination occur in poultry feed during storage?	35 (70%)	5 (10%)	10 (20%)	Contamination is a common issue during storage.
Is the quality of water used in poultry feed production a major factor in contamination?	30 (60%)	10 (20%)	10 (20%)	Water quality is considered an important factor in contamination.
Are chemical additives often a source of contamination in poultry feed?	20 (40%)	15 (30%)	15 (30%)	The role of chemical additives is debated among farmers.
Do local environmental conditions influence the level of contamination in poultry feed?	40 (80%)	5 (10%)	5 (10%)	Environmental factors are strongly believed to influence contamination.
Is contamination from contaminated raw materials a common issue in feed production?	25 (50%)	10 (20%)	15 (30%)	Raw material contamination is a frequent concern.
Do poor hygiene practices contribute significantly to feed contamination?	30 (60%)	10 (20%)	10 (20%)	Hygiene practices are a key factor in feed safety.
Are mycotoxins frequently found in poultry feed in the region of study?	25 (50%)	10 (20%)	15 (30%)	Mycotoxin contamination is a recurring problem.
Is cross-contamination between different batches of feed a common occurrence?	15 (30%)	20 (40%)	15 (30%)	Cross-contamination varies depending on practices.
Does the temperature at which poultry feed is stored affect the contamination levels?	35 (70%)	10 (20%)	5 (10%)	Storage temperature is a critical factor in preventing contamination.
Are agricultural practices in the area linked to the contamination of poultry feed?	30 (60%)	10 (20%)	10 (20%)	Agricultural practices are linked to feed contamination.

Are there legal regulations regarding poultry feed safety in the region?	10 (20%)	30 (60%)	10 (20%)	There is a lack of enforcement of legal regulations.
Do farmers monitor contamination levels in their poultry feed regularly?	15 (30%)	25 (50%)	10 (20%)	Regular monitoring is not widely practiced.
Is the presence of pests (e.g., rodents or insects) common in feed storage areas?	30 (60%)	5 (10%)	15 (30%)	Pests are a common issue in storage areas.
Is improper packaging a cause of contamination in poultry feed?	25 (50%)	10 (20%)	15 (30%)	Packaging plays a role in feed contamination.
Are pathogens found in poultry feed in the study area?	20 (40%)	15 (30%)	15 (30%)	Pathogens are sometimes found in the feed.

Comment on the table:

The survey of 50 poultry farmers in the Sabha and Ubari regions reveals that **70%** of respondents identified contamination during storage as a major issue, while **60%** emphasized the importance of water quality in feed production. **50%** of farmers reported contamination from raw materials, and **60%** pointed to poor hygiene practices as significant contributors. However, only **20%** mentioned the existence of legal regulations on feed safety, and just **30%** regularly monitor contamination levels. The presence of pests in storage areas was noted by **60%**, and **50%** linked improper packaging to contamination. These findings suggest that improving storage conditions, hygiene, and regulatory oversight could significantly reduce contamination risks.

Second dimension results: Health Hazards

Question	Yes	No	Sometimes	Notes
Does contaminated poultry feed contribute to the spread of foodborne diseases in humans?	40 (80%)	5 (10%)	5 (10%)	Contaminated feed is widely believed to contribute to foodborne diseases.
Can the consumption of contaminated poultry products lead to long-term health issues?	35 (70%)	10 (20%)	5 (10%)	Long-term health impacts are a significant concern for many farmers.
Is there a direct link between feed contamination and the occurrence of antibiotic resistance in humans?	30 (60%)	15 (30%)	5 (10%)	Many farmers believe contamination may contribute to antibiotic resistance.
Are there specific health hazards associated with mycotoxins found in poultry feed?	40 (80%)	5 (10%)	5 (10%)	Mycotoxins are considered a major health hazard.
5. Do poor feed storage practices increase the risk of health hazards in poultry products?	45 (90%)	5 (10%)	0 (0%)	Poor storage is seen as a major factor in health risks.
6. Can poultry feed contamination lead to respiratory problems in poultry farm workers?	25 (50%)	15 (30%)	10 (20%)	Respiratory problems are common but not universal.
7. Are chemical residues from contaminated feed a health risk to humans consuming poultry products?	35 (70%)	5 (10%)	10 (20%)	Chemical residues are considered a significant health risk.
8. Does contamination of feed by pathogens (such as Salmonella) pose a significant health risk to humans?	45 (90%)	3 (6%)	2 (4%)	Pathogen contamination is widely recognized as a serious health risk.
9. Can contaminated poultry feed lead to reduced immunity in poultry, making them more susceptible to diseases?	40 (80%)	5 (10%)	5 (10%)	Feed contamination is seen as a risk factor for reduced immunity in poultry.
10. Are children more vulnerable to health risks from contaminated poultry products?	30 (60%)	10 (20%)	10 (20%)	Children are perceived to be more vulnerable to contamination.
11. Is there a risk of contamination spreading from poultry feed to other animals or crops?	25 (50%)	15 (30%)	10 (20%)	Contamination may spread, but the risk is not universally acknowledged.
12. Can feed contamination result in a decrease in poultry meat quality, affecting human health?	40 (80%)	5 (10%)	5 (10%)	Feed contamination is believed to reduce meat quality and affect human health.
13. Does the presence of heavy metals in contaminated poultry feed pose a risk to human health?	35 (70%)	10 (20%)	5 (10%)	Heavy metals in feed are seen as a potential human health risk.
14. Are contaminated poultry feed and water linked to the spread of zoonotic diseases?	45 (90%)	3 (6%)	2 (4%)	Zoonotic diseases are often linked to feed and water contamination.
15. Do improper handling and distribution of poultry feed increase the risk of health hazards in both poultry and humans?	40 (80%)	5 (10%)	5 (10%)	Improper handling is seen as a major contributor to health hazards.

Comment on the table:

The table reveals significant concerns regarding poultry feed contamination and its associated health risks. A large majority of respondents, 90%, highlighted the link between poor feed storage practices and increased health hazards, with 90% also recognizing the threat of pathogen contamination (such as Salmonella). 80% of farmers acknowledged the role of mycotoxins, chemical residues, and contaminated feed in posing serious health risks to both poultry and humans. Concerns about long-

term health issues from contaminated poultry products were raised by 70%, and 80% agreed that contaminated feed could reduce poultry immunity. On the other hand, the spread of contamination to other animals and crops was less universally acknowledged, with only 50% agreeing. The responses emphasize the need for better storage, handling, and monitoring practices to mitigate the significant health hazards posed by feed contamination.

Third dimension results: Interventions and Solutions

Question	Yes	No	Sometimes	Notes
Are there effective methods for detecting contamination in poultry feed before it reaches the market?	30 (60%)	10 (20%)	10 (20%)	Detection methods exist but are not always widely used.
Is regular monitoring of poultry feed quality an effective solution to prevent contamination?	40 (80%)	5 (10%)	5 (10%)	Regular monitoring is seen as a key preventive measure.
Are there technologies available to remove harmful pathogens from poultry feed?	25 (50%)	15 (30%)	10 (20%)	Pathogen removal technologies are available but not universally adopted.
Can improved storage practices significantly reduce the risk of feed contamination?	45 (90%)	5 (10%)	0 (0%)	Improved storage is considered one of the most effective solutions.
Do proper sanitation protocols in poultry feed production help to minimize contamination risks?	40 (80%)	5 (10%)	5 (10%)	Sanitation protocols are seen as crucial in reducing contamination.
Are there effective treatments available to neutralize mycotoxins in contaminated poultry feed?	20 (40%)	15 (30%)	15 (30%)	Mycotoxin treatments exist but are not always effective or accessible.
Can government regulations on poultry feed safety help to control contamination levels?	35 (70%)	10 (20%)	5 (10%)	Many farmers believe stronger regulations could help control contamination.
Is educating farmers about safe feed practices a viable solution to reduce contamination risks?	45 (90%)	3 (6%)	2 (4%)	Education is seen as an effective long-term solution.
Do alternatives to chemical additives exist that can prevent contamination in poultry feed?	30 (60%)	10 (20%)	10 (20%)	Alternatives to chemical additives are available but not widely used.
Are there international best practices that could be adopted to ensure the safety of poultry feed?	40 (80%)	5 (10%)	5 (10%)	International best practices are recognized as valuable but not always implemented.
Can the use of organic or natural feed components reduce the risk of contamination?	35 (70%)	10 (20%)	5 (10%)	Organic feed components are seen as a safer option.
Is it possible to reduce the contamination of poultry feed by improving raw material sourcing?	40 (80%)	5 (10%)	5 (10%)	Sourcing higher-quality raw materials is a key factor in preventing contamination.
Are there technologies that can help track and trace the source of contaminated poultry feed?	25 (50%)	15 (30%)	10 (20%)	Tracking technologies exist but are not yet widely adopted.
Is cross-contamination prevention through packaging a useful intervention for controlling feed safety?	30 (60%)	10 (20%)	10 (20%)	Packaging is seen as a helpful tool but not a complete solution.
Do rapid response and containment strategies help to prevent the spread of contaminated poultry feed?	45 (90%)	5 (10%)	0 (0%)	Rapid response strategies are highly regarded as effective.

Comment on the table:

The table shows that **90%** of respondents view **improved storage practices**, **education**, and **rapid response strategies** as key measures to reduce poultry feed contamination. **80%** believe that **regular monitoring** and **sanitation protocols** are essential for feed safety. However, there are challenges in adopting newer solutions; only **50%** think **pathogen removal technologies** and **tracking systems** are effective, and **40%** find **mycotoxin treatments** useful. **60%** are open to using **alternatives to chemical additives**, while **70%** see **organic feed components** as a safer option, though these are not widely implemented. Overall, the results highlight strong support for prevention methods but indicate gaps in practical adoption.

Study results

1. Storage contamination is a major issue, with 70% of respondents acknowledging it as a common occurrence.
2. Environmental conditions and water quality are significant contributors to feed contamination, reported by 80% and 60% of farmers, respectively.
3. Raw material contamination and poor hygiene practices are frequently cited as causes of contamination by 50% and 60% of respondents.
4. Pathogen contamination, such as Salmonella, is seen as a serious health risk by 80% of respondents.
5. Mycotoxins in feed are recognized as a major health hazard by 80% of farmers.
6. Poor storage practices are widely believed to increase health risks, with 90% agreeing.

7. Regular monitoring and sanitation protocols are considered essential for contamination prevention by 80% of farmers.
8. Rapid response strategies and improved storage practices are seen as the most effective solutions, supported by 90% of respondents.
9. Education on safe feed practices is viewed as a long-term solution to contamination risks by 90% of farmers.
10. There is a lack of legal regulations regarding feed safety, with 60% of farmers acknowledging the need for stronger government oversight.

Study recommendations:

1. Strengthening regulatory frameworks by implementing stricter regulations on the production, storage, and transportation of poultry feed to reduce the risk of contamination. Encouraging local authorities to cooperate with international agencies to ensure proper oversight.
2. Periodic monitoring and inspection by establishing regular and random inspection protocols at poultry farms, feed mills, and distribution points to detect contamination early and ensure compliance with safety standards.
3. Improve public awareness by launching awareness campaigns targeting poultry farmers, feed producers, and consumers in southern Libya about the risks of contaminated feed and the importance of proper feed handling, storage, and disposal.
4. Establishing local laboratories equipped with advanced testing facilities to detect various contaminants in poultry feed and ensure timely results, reducing reliance on international testing.
5. Providing training for poultry farmers on best practices for feed management, pollution prevention, and proper hygiene standards to reduce the risk of contamination.
6. Encouraging research into alternative feed sources and sustainable feed practices to reduce reliance on industrial feed and minimize the risk of contamination from imported materials.
7. Strengthening collaboration with international experts in food safety, animal health, and environmental pollution to enhance local expertise and improve pollution management strategies.
8. Developing and improving data collection systems to track feed contamination sources and their impacts on human health, enabling more effective analysis and response.
9. Conducting long-term population health studies in affected areas to better understand the relationship between poultry feed contamination and its human health outcomes.
10. Building partnerships between government agencies, poultry feed manufacturers, and research institutions to promote innovation in pollution control technologies and knowledge sharing across the sector.

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