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Utilization of Agricultural Wastes & By-Products in Broiler Nutrition: Potential for Sustainable Poultry Feed in Gilgit Baltistan

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ABSTRACT

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The present situation in feeding of poultry industry is more economical than feeding to other livestock. Using unconventional low cost feed ingredients available locally to formulate the least cost feed formulation. Poultry meat is a source of valuable protein and essential amino acids and has a relatively little while quality fat and it is used in a large volume for producing a quality desired meat products in the market. Oil cakes have been in use for feed application to poultry fish and swine industry. Being rich in protein some of these have also been considered ideal for supplementation. With increasing emphasis on cost reduction of industrial processes and value addition to agro industrial residues oil cakes could be ideal source for proteinaceous nutrients and as support matrix for various biotechnological processes. Several oil cakes in particular edible oil cakes offer potential benefits when utilized as substrate for bioprocesses. These have been utilizing for fermentative production of enzymes, antibiotics, mushrooms, etc. Biotechnological applications of oil cake also include their usages for vitamins and antioxidants production. Various applications of oil cakes in fermentation and biotechnological processes, their value addition by implementation in feed and energy sources.

Introduction

The human being reared different types of bird species, including chicken, ostrich, guinea fowl, duck, and turkey, to gain meat sources (Abafogi et al., 2022). Meat has termly common used to refer to the flesh of animals typically mammals and birds that is consumed as food. It is a significant source of protein essential nutrients and flavor in many diets around the world. (Micha, R., Michas, G., & Mozaffarian, D. 2020). Poultry meat is a source of valuable protein and essential amino acids and has a relatively little while quality fat and it is used in a large volume for producing a quality desired meat products in the market (A. Motlak, 2015).

Chicken meat is considered as an easily available source of high quality protein and other nutrients that are necessary for proper body functioning. In order to meet the consumers growing demand for high quality protein the poultry industry focused on selection of fast growing broilers which reach a body mass of about 2.5kg within 6 week intensive fattening. Poultry has now turned into one of the most important division of agriculture throughout the world. Poultry industry is one of the fastest growing segments in agriculture sector and undouble it plays an important role in economy (Burker and Saeed, 2014).

Poultry is basically a source of economical palatable and healthy food protein (Mahasar et al., 2010). Broiler chicken breed and raised specifically for meat production (Kruchten, 2002). The behavior repertoires of broiler chickens are similar to those of other gallinaceous birds since they are the same species as egg laying hens. Most poultry meats are categorized as white meat while the meat of other domesticated animals is classified as red meat. Chicken meat contains the most valuable proteins and amino acids for human health. Several scientific studies conducted in different parts of the world on different food consumption habits with varying taboos of food indicated the relationship between human nutrition and human health (EFSA, 2017; Ambaw et al., 2021).

Meat is defined as all animal tissues and all products resulting from the processing of these tissues are suitable for consumption and do not cause health problems for those who eat them.(Soeparo, 2011). Fresh meat contains enzymes that can break down break down several nutritional components protein fat which eventually cause meat spoilage. Meat is easily damaged because of its high nutritional and water content and contains lots of vitamins and minerals. The appearance included texture, suppleness, tenderness, smell and taste are important elements in meat that can affect the quality assessment of the initial and final consumers. Furthermore the objective properties of meat such as water holding capacity, cooking loss, pH and meat color are needed to provide an assessment of meat products.

Poultry feed is food for farm poultry including chickens, ducks, geese and other domestic birds. Feed for poultry must consist of grain. The quality of feed and the nutritional requirement of feed depend on the weight and the age of the poultry as well as the season. The quality of feed has significant effects on growth and performance of poultry birds. Poultry feed consist of various macro and micro components. Poultry feed industry is closely connected to the primary agricultural production and forms an essential component of the food chain. These components are mostly supplied by different agricultural and industrial by products or wastes (Anjum and Naseem, 2000, Farhat and Mohammed, 2014). In the developing countries it is one of the common trends that the high quality cereals and grains kept stored are exported for human use while the low quality agricultural products are used for manufacturing animal feeds (Sarah et al.,2016).

Review of literature

Broiler Chicken

Broiler chickens are livestock products that have economic characteristics fast growth as a producer of meat harvested in a fast time because of their fast growth generally harvested at the stage 5-6 weeks (Kartsudjana, 2006). Broiler chickens in the economic classification have characteristics with the characteristics of tender meat large body size wide chest shape dense and filled efficient in ration and very fast body weight gain. Broiler chicken is one of the largest contributions of animal protein from livestock and is a superior commodity (Kartsudjana, 2006). Broiler chickens have the ability to produce meat with a relatively short rearing time. The rapid development of broiler chickens is also an effect to balance people's need for chicken meat.

Chicken meat

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needed to provide an assessment of meat products. Wheat bran is a byproduct of milling wheat and is rich in fiber, vitamins, and minerals. It can be used as a source of fiber in poultry feed. Wheat is grown in various parts of Gilgit-Baltistan, making wheat bran a readily available byproduct. Shah, S. A., & Ali, N. (2023).

Local Agricultural byproducts

In regions like Gilgit Baltistan local agricultural byproducts such as wheat bran, barley straw, and buckwheat hulls can be valuable feed resources. These byproducts can often be sourced locally and provide a cost effective solution for poultry nutrition Ahmad, N., & Khan, A. (2023). By combining these various sources, poultry feed can be tailored to meet specific nutritional needs while optimizing costs and sustainability. The poultry industry in Pakistan is a significant sector within the country's agriculture contributing substantially to the economy and food security. Here's an overview of the poultry industry in Pakistan, including its current status, challenges, and opportunities, along with relevant references.

Poultry Industry Overview

Importance and contribution

The poultry sector is one of the largest segments of Pakistan's livestock sector. It contributes about 1.4% to the country's GDP and provides employment to millions of people across various stages of the supply chain. Poultry meat and eggs are critical sources of animal protein for the Pakistani population, addressing nutritional needs Khan, M. A., & Hussain, A. (2021).

Production statistics

Pakistan produces approximately 1.5 million metric tons of poultry meat annually. The country produces around 14 billion eggs per year Pakistan Bureau of Statistics. (2023). Broiler production is highly intensive and concentrated in Punjab with a growing presence in Sindh and Khyber Pakhtunkhwa. Many broiler farms operate under integrated systems where feed breeding and marketing are controlled by large companies Javed, M. T., & Ali, M. (2022).

Poultry Feed Formulation

The poultry feed represents the major cost of poultry production constituting up to 70 percent of the total feed cost about 95 percent is used to meet energy and protein requirements about 3 to 4 percent for major mineral trace mineral and vitamins requirements and 1 to 2 percent for various feed additives. Poultry diets are formulated from a mixture of ingredients including cereal grains cereals by products, fats, plant protein sources animal by products vitamins and mineral supplements, crystalline amino acids and feed additives. These are assembled on a least cost basis taking into consideration their nutrient contents as well as their unit prices (Kellems and Church, 2010). Accurate prediction of energy intake is important to formulate diets for poultry during different stages of growth and production (Berura et al., 2016). Energy sources constitute the largest component of poultry diets followed by plant protein sources and animal protein sources. Globally maize corn is the most commonly used energy source and soybean meal is a common plant protein source. However other grains such as wheat and sorghum and plant protein meals such as canola meal peas and sunflower meal are also widely used in some countries. The main animal protein ingredients are fishmeal and meat meal.

Main Energy Source

The predominant feed grain used in poultry feeds worldwide is maize. This is mainly because its energy source is starch which is highly digestible for poultry. In addition it is highly palatable is a high density source of readily available energy and is free of anti nutritional factors. The metabolizable energy value of maize is generally considered the standard with which other energy sources are compared. The other energy source that meets most of the same criteria as maize is low tannin sorghum. Sorghum can be grown in low rain fall areas and is a popular crop in hot drought prone regions. The high tannin content of many older sorghum varieties limits their use in poultry diets but low tannin varieties are now available and can be used in poultry diets without any limitation. The energy value of low tannin sorghum is 90 to 95 percent that of maize (Kellems and Church, 2010).

Main Sources of Plant Protein

After energy yielding raw materials, protein supplements constitute the largest component of poultry diets. Plant protein sources supply the major portion of dietary protein (or nitrogen) requirements. The plant protein source traditionally used for feed manufacture is soybean meal which is the preferred source for poultry feed. Soybean meal contains 40 to 48 percent crude protein, depending on the amount of hulls removed and the oil extraction procedure. Relative to other oilseed meals, soybean protein has a good balance of essential amino acids, which can complement most cereal based diets. The amino acid availability

in soybean meal is higher than those for other oilseed meals. The metabolizable energy content is also substantially higher than in other oilseed meals (Kellems and Church, 2010).

Fibre content

Fibre is a polymeric plant substance that is resistance to mammalian digestive enzymes and among nutrients constituting poultry feeds the level of fibre inclusion in poultry feed is very low. Increasing the level of fibre may enhance performance (Sklan et. al., 2003). Dietary fibre in poultry feed helps to increase the retention time of the digest in the upper part of the digestive tract i.e. from the crop to gizzard and stimulate proper gizzard production (Hetland et. al., 2005). Fibres helps in the production of hydrochloric acid in the proventriculus, gastrointestinal motility, reducing gizzard PH which will improve the solubility and absorption of mineral salt in gastrointestinal tract benefits the development of the gastrointestinal tract to improve the growth performance of the birds (Matoes et al., 2006, Moran, 2006).

Amino acids

The pure forms of individual amino acids are now commercially available. Currently the limiting amino acids in poultry diets methionine, lysine, threonine and tryptophan in that order can be purchased at reasonable cost and included in poultry diets to balance dietary amino acid levels. Amino acid supplements now play a very important role in improving protein utilization in animal feeding (Kellems and Church, 2010). Iyayi (2014) in his research concluded that reduction of crude protein content supplemented with lysine or methionine in broiler diets resulted in reduced feed intake and suboptimal body weight gain of the broilers. Rushton et al., 2010, indicates that economic models for no and low input family poultry production are extremely complex because of the variety of inputs and often lack of data on output even more so as most no and low input poultry production is multipurpose eggs and meat plus delivering the next generation. Systems with commercial genotypes are in general single purpose either eggs or meat and do not breed the next generation on the production farm. Due to the complex logistics buying feed laying hens or broiler chicks, veterinary care, get products to the market and find a market for the products and introduction of formal quality systems it is difficult for small scale family farms to compete with the industrial farms (Pym, 2010; McLeod and Sutherland, 2012). Industrial poultry production is often highly integrated and controlled by one party while family farms are only one link in the production chain. Arancibia et al., 2015 considered the minimum explicable concentration (MEC) and determine the flame speed of three Pakistani agriculture wastes bagasse straw and rice husk. Agriculture biomass contained higher ash than woody biomass and this factor influenced the MEC. The result shows that silica was the greatest ingredient of ash and it varied between 48 and 87%. This would cause a slagging problem at high temperature. Potassium and other ash constituent may cause corrosion problems in broiler tubes.

Table 1:

No.		Key finding	Reference
1	Wheat bran nutrition	Wheat bran provides fibre, protein, minerals and bioactive compounds, but its nutritional value varies among sources.	Liu et al. (2024)
2	Fibre level	Moderate wheat-bran inclusion can improve nutrient utilization, while excessive fibre may reduce energy and protein retention.	<i>Animals</i> (2024)
3	Inclusion level	Broiler response to wheat bran depends on inclusion level and overall diet formulation.	<i>Livestock Science</i> (2023)
4	Gut health	Dietary fibre can affect gut development, digesta passage, nutrient absorption and gut microbiota.	<i>Animal Nutrition</i> (2024)
5	Particle size	Wheat-bran particle size can influence feed intake, FCR and fibre fermentation in broilers.	<i>Animals</i> (2024); <i>Animal Nutrition</i> (2026)
6	Wheat bran + enzymes	Combining wheat bran with enzymes/stimbiotics may improve nutrient utilization and broiler performance.	<i>Poultry Science</i> (2024–2025)
7	Meat quality	Agricultural by-products are increasingly being evaluated for their effects on carcass and physicochemical meat-quality traits.	<i>Animal Nutrition</i> (2025)
8	Local feed resources	Locally available agricultural by-products have potential to reduce dependence on conventional feed ingredients and improve feed sustainability.	Salahi et al. (2025)
9	Pakistan poultry sector	Poultry remains an important component of Pakistan's livestock sector and a major source of animal protein.	Government of Pakistan (2025–26)

Results & Challenges facing the poultry industry

Disease management

The avian influenza and newcastle disease and other viral and bacterial infections significantly impact poultry health and productivity. There is a need for improved biosecurity measures and vaccination programs Ahmad, M., & Raza, S. H. (2022).

Feed costs and supply

The industry is heavily reliant on imported feed ingredients which affects cost and supply stability. There is potential to utilize local agricultural byproducts to reduce dependency on imports Khan, M. A., & Khan, M. N. (2023).

Market Fluctuation

Fluctuations in poultry prices affect both producers and consumers influenced by factors such as feed costs and disease outbreaks. Tariq, M., & Shahid, M. (2023).

Protein Availability in Specific Regions

South Asia faces significant challenges in protein availability due to high population density low per capita income and reliance on plant based diets. Government and NGO programs focus on improving protein access through subsidized food programs and educational initiatives. Rao, N. S., & Ghosh, S. (2022). Protein deficiency is prevalent often exacerbated by poverty and food insecurity. Efforts include promoting local protein sources like legumes developing aquaculture and enhancing livestock productivity Koffi, N., & Edoh, S. (2023).

Enhancing Local production

Promoting local protein production through community farms and small scale livestock operations can help address protein shortages. Emphasizing sustainable and environmentally friendly protein sources will be crucial for future food security FAO (2023).

Policy and Education

Effective policies and programs are needed to ensure equitable access to protein especially in vulnerable populations. Education on nutrition and protein sources can help communities make informed dietary choices. Berti, P. R., & McDonald, C. (2024).

Poultry farming in recent times (2001 until now)

The poultry industry started to stabilize in the late 1990s by gaining better profit margins on poultry products. The establishment of the University of Veterinary and Animal Sciences in Lahore in 2022 was a further step towards extending support to this fast growing industry in Pakistan by helping solve disease issue and provide trained personnel. Despite showing excellent potential and growth over the years per capita availability of poultry meat in Pakistan is still 5 kg and 51 eggs per year compared to developed countries where these figures are 41 kg meat and 300 eggs (PPA, 2013b). According to the World Health Organization (WHO) the average daily requirement for animal protein is 27 g per person where in Pakistan it is only 17 g (Memon, 2012). Out of this 17 g, the share of protein from poultry is just 5g causing a gap of 10 g per person per day. The poultry industry in Gilgit Baltistan (GB) faces several challenges that hinder its development. The region's unique geographic, climatic, and economic conditions contribute to the complexities of expanding poultry operations. Here's a detailed look at the reasons why the poultry industry has not fully developed in Gilgit-Baltistan.

Geographic & Climatic Challenges

The region experiences severe winter conditions with temperatures dropping below freezing, which can be detrimental to poultry health. Managing these temperatures requires significant investment in heating and insulation. The high altitude can affect poultry health and growth, requiring specialized care and management practices. Ahmad, I., & Saeed, M. (2023).

Infrastructure Limitations

Poor transportation infrastructure can limit access to markets and the supply chain affecting the distribution of poultry products and feed. Inconsistent access to electricity and water can impact poultry farming operations especially for maintaining optimal conditions in poultry houses. Khan, M. N., & Bhat, M. A. (2022).

High Costs of Production

The cost of poultry feed is a major factor and high transportation costs and the need to import feed ingredients increase the overall cost of production. Building and maintaining poultry houses that can withstand extreme weather conditions requires significant capital investment. Iqbal, M., & Malik, A. (2023). Limited access to financial resources and credit facilities hampers the ability of local farmers to invest in poultry operations. There is a lack of targeted government support and subsidies for the poultry sector in Gilgit Baltistan. Akhtar, S., & Khan, N. (2023). There is a shortage of training programs and technical expertise available to local farmers. This affects their ability to implement modern poultry management practices and disease control measures. Limited agricultural extension services mean that farmers do not receive adequate support and guidance on best practices. Baloch, M. S., & Ali, S. (2024).

Market Access and Demand

The local market is small and may not provide sufficient demand to support large-scale poultry operations. Farmers may face competition from larger, more established poultry industries in other regions. Rehman, F., & Ahmad, S. (2022). Despite these challenges, there are opportunities for developing the poultry industry in Gilgit-Baltistan: Government and NGO Support: Enhanced support from government and non-governmental organizations can help address infrastructure and financial constraints. Technological Innovations: Introducing climate-adapted poultry breeds and technologies can improve productivity and resilience. Local Resource Utilization: Leveraging local agricultural byproducts for feed can reduce costs and enhance sustainability. Niazi, S., & Ali, M. (2024). Formulating balanced poultry feed requires a variety of ingredients to provide essential nutrients such as protein, energy, vitamins, and minerals. Here's an overview of common feed ingredients and resources needed for poultry feed, categorized by their nutritional contributions.

The primary energy source in poultry diets, rich in carbohydrates and provides high energy. Wheat Used for its energy and protein content. Wheat byproducts, like wheat bran, also provide fiber. Barley Contains energy and fiber. Often used in combination with other grains. Tzeng, J. Y., & Lin, C. H. (2021). The vegetable Oils Soybean oil, canola oil, and palm oil are used to increase the energy density of the feed. Animal Fats, Rendered fats from poultry, beef, or pork can also be used as energy sources. Jiang, Y., & Zhang, H. (2023). The most common protein source in poultry feed, providing high levels of essential amino acids. Canola Meal is alternative to soybean meal with similar protein content but may contain more fiber. Sunflower meal Provides protein and fiber; often used as a partial replacement for soybean meal. Li, X., & Wang, X. (2022).

The rich in protein and omega-3 fatty acids. Provides high-quality protein and essential nutrients. Meat and Bone Meal: Used in poultry feed to provide protein and minerals, though its use is regulated in some regions. Tacon, A. G. J., & Metian, M. (2021). And adds fiber and supports digestive health. Often used in layer diets to improve gut health. Rice Bran Contains fiber, oil, and some protein O'Connor, C. A., & Fernandez, J. (2022). The forages alfalfa meal Provides fiber and some protein. Used in small amounts in poultry diets Lee, J. H., & Kim, I. H. (2023). Vitamin premixes include vitamins A, D, E, and K, and B vitamins, essential for poultry health and growth. The mineral Premixes Include calcium, phosphorus, salt, and trace minerals like zinc and manganese Coudray, C., & Rémésy, C. (2022).

Alternative & Innovative Ingredients

The black Soldier Fly Larvae has high in protein and fat, increasingly used as a sustainable protein source Van Huis, A., & Oonincx, D. G. A. B. (2023). The spirulina and Chlorella Provide high-quality protein and essential fatty acids. Used in specialized poultry diets. Kloas, W., & Schönfisch, B. (2022). The local Resources and Byproducts Pea and lentil byproducts can be used as protein sources. Crop Residues stalks and leaves from crops can be used as fiber sources or minor ingredients. Ahmad, N., & Khan, A. (2023).

Consumption & imports statistics of poultry by down country

To provide an accurate overview of poultry consumption and imports in Gilgit-Baltistan, specifically focusing on the movement of poultry products from other regions or "down country" to Gilgit-Baltistan, we'll explore general statistics and relevant data available for the region. Since specific data for Gilgit-Baltistan might not be readily available, we'll consider broader trends and available statistics from Pakistan as a whole. Poultry is a significant part of the diet in Pakistan, including Gilgit-Baltistan, though consumption patterns can vary by region. In mountainous and remote areas, access to fresh poultry can be limited, leading to reliance on imported or stored poultry products Pakistan Bureau of Statistics (2023). Consumption data specifically for Gilgit-Baltistan may not be detailed but trends suggest that poultry consumption is increasing as economic conditions improve and access to markets increases. Gilgit-Baltistan Planning and Development Department (2023). Pakistan imports poultry products primarily from countries such as Brazil and the United States. These imports are often distributed to various regions, including remote areas like Gilgit-Baltistan. Pakistan Customs Department (2023). Poultry products imported to

Pakistan are distributed through various channels, including wholesalers and retailers. For remote areas like Gilgit-Baltistan, transportation logistics play a crucial role in the availability of imported poultry products. Pakistan Agricultural Storage and Services Corporation (PASSCO) (2023). Increase in Imports there has been an increase in poultry imports in recent years to meet domestic demand including for areas like Gilgit-Baltistan. Trade Development Authority of Pakistan (TDAP) (2023). Price Fluctuations Imported poultry can influence local prices. In remote areas, higher transportation costs can lead to higher prices for poultry products. Pakistan Economic Survey (2023). Gilgit-Baltistan Specific Local government and agricultural reports may provide insights into the specific import and consumption patterns of poultry in Gilgit-Baltistan. These reports can include data on supply chain challenges and local market dynamics. Gilgit-Baltistan Chamber of Commerce and Industry (2023). The research studies focusing on poultry supply chains and consumption in mountainous and remote regions like Gilgit-Baltistan can offer detailed insights. Iqbal, M., & Aslam, M. (2023). The mountainous terrain and remote location of Gilgit-Baltistan pose logistical challenges for the distribution of imported poultry products. Ensuring a reliable supply chain is critical. There is potential to develop local poultry production to reduce reliance on imports and improve food security Ahmad, N., & Khan, A. (2024). Overall while detailed data specific to Gilgit-Baltistan may be limited, broader national trends and reports provide useful insights into poultry consumption and imports. Addressing logistical challenges and exploring local production opportunities can help improve poultry availability in the region.

Requirement of Chicken meat for Gilgit-Baltistan

The total population of Gilgit-Baltistan affects the overall demand. As of recent estimates the population is around 2.5 million people. Understanding local dietary preferences and consumption habits is crucial. For instance, the average per capita consumption of chicken meat in Pakistan might be a useful reference. Assess the current chicken meat production in Gilgit-Baltistan. This includes local poultry farms and any import sources. Determine the amount of chicken meat imported into Gilgit-Baltistan, if applicable. This can help gauge the shortfall between local production and consumption. Income levels and purchasing power can influence how much chicken meat people buy. Consumption might vary seasonally, so accounting for any fluctuations in demand throughout the year is important. Press cake is rich in protein, which is essential for the growth and development of poultry. Depending on the type of seed, press cakes can have varying levels of protein content, often ranging from 30% to 50%. It contains residual fats that contribute to the energy content of the feed. The fiber in press cake can aid in digestion and improve gut health in poultry. Press cakes often contain important minerals such as calcium, phosphorus, and magnesium, which are necessary for bone development and overall health. High in protein and often used in poultry feed. Canola Press Cake Also rich in protein but has lower fat content compared to soybean press cake. Sunflower Press Cake Contains less protein than soybean but still a useful feed ingredient. Cottonseed Press Cake Contains gossypol, which can be toxic in high amounts, so it's used cautiously. The inclusion of press cake in poultry feed must be balanced with other feed ingredients to ensure a complete and nutritionally adequate diet. Some press cakes may contain anti-nutritional factors such as gossypol (in cottonseed cake) or glucosinolates in canola cake that can affect poultry health if not properly managed. The quality of press cake can vary, so it's important to source it from reliable suppliers and ensure it's free from contaminants. Press cake is often a cost-effective feed ingredient, especially when compared to other protein sources like fish meal or soybean meal. Press cake can be a valuable component of poultry feed due to its protein content and other nutrients. However its inclusion should be managed carefully to ensure it meets the nutritional needs of poultry and does not introduce harmful substances.

Conclusion

The agricultural wastes and byproducts are there with great potential to be used as cheap feed ingredients for broiler production in GIB. Wheat bran, barley by product buckwheat hulls, crop residues and oilseed press cakes are all locally available sources of nutrients essential for the growth and development of poultry. If they are used then this can help reduce the high cost of commercial poultry feed and reduce dependence on poultry feed ingredients transported from other regions. Oilseed press cakes are especially valuable as they contain residual fats, protein, energy and minerals. Their use in broiler diets should be added with caution, however, as certain by-products may have a high fibre or anti nutritional content. Thus appropriate processing, drying, storage and nutritional assessment is essential before they can be used in poultry feed. Using locally available agricultural byproducts can also minimize the agricultural waste and help in the promotion of eco-friendly poultry production in Gilgit Baltistan. Balanced feed formulations based on these local resources could enhance the growth performance of the broilers feed efficiency and profitability of local farmers. Proximate analysis, digestibility studies and feeding trials should be conducted to establish proper levels of inclusion of various agricultural byproducts. In conclusion the proper management of agricultural wastes and byproducts can help to make the broiler poultry industry in Gilgit Baltistan more profitable, sustainable, and environmentally friendly.

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