EFFECT OF COVID-19 AND SOYBEAN UNAVAILABILITY SITUATTIONS ON THE POULTRY INDUSTRY OF PAKISTAN: A COMPREHENSIVE ANALYSIS OF PROBLEMS FACED BY THE INDUSTRY AND ITS SOLUTION FOR SUSTAINABLE ANIMAL PRODUCTION

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ABSTRACT: The COVID-19 pandemic, caused by the novel coronavirus SARS-CoV-2, has had a profound impact on various production sectors worldwide, including agriculture. Poultry production, a critical component of the global food supply chain, is also not spared from the effects of pandemic. Soybean, a versatile and widely consumed crop, plays a crucial role in global food security and is a key player of feed and food industries, however, in recent years, soybean unavailability has become a growing concern. This review article aims to examine the reasons behind the limited availability of soybean and its effects on different stakeholders, including farmers, consumers, and industries. Through a comprehensive analysis of the factors contributing to soybean unavailability and the consequences of COVID-19 and soybean shortage on poultry production, this article provides insights into the implications for agricultural systems, exploring potential genes, sustainable marketing, and sustainable development of poultry products. Additionally, it provides insights into the future adaptation strategies implemented by farmers and stakeholders to mitigate such negative impacts to ensure sustainable production.

Keywords: COVID-19, soybean import, ban, poultry industry, Pakistan.

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INTRODUCTION

The COVID-19 pandemic disrupted the global poultry industry, leading to significant challenges throughout the production chain (Attia *et al*., 2022) during the last few years. The infection had seriously affected animal production, especially poultry production throughout the world (Sharun *et al*. 2021) due to the misconception of the involvement of chicken meat and eggs in the spread of COVID-19. This rumor deteriorated the poultry production economics in all aspects (Das and Samanta 2021). Moreover, lack of labor, an increase in table egg consumption and its prices, decreased chick production, an increase in the retail price of meat, decreased global demand for poultry products, and less availability of poultry feed ingredients affected the industry during the pandemic. Soybean imports and utilization had already decreased by up to 15% over the past three years (Karlsson *et al*., 2021) due to several factors including the COVID-19 pandemic, which has disrupted global supply chains and reduced demand for soybean products (Hashem *et al*., 2020).

Table 1: Showing the decreasing trend of soybean import and utilization in Pakistan due to COVID-19.

Year	Soybean Imports (tonnes)	Soybean Utilization (tonnes)	Reference
2019-20	2.2 million	2.0 million	Accessed on https://www.world-grain.com/articles/16662-pakistans-total-oilseed-use-to-hold-steady-in-2022-23
2020-21	1.9 million	1.8 million	
2021-22	1.7 million	1.6 million	

Pakistan's poultry industry is on the threshold of serious downfall, as 50% of the poultry farms have shut down due to a huge increase in poultry feed prices. The industry was working smoothly, and playing a pivotal role in supplying eggs and chicken to the country's people at affordable prices; however, the sudden increase in the price of soybean (an increment from Rs165/kg to Rs465/kg on average) due to unwise ban on soybean import has led to a huge increase in the prices of chicken eggs and meat (poultry meat selling @Rs700-750/kg) as the feed mills owners have increased the price of feed bag from Rs2,400 to Rs7,500 per bag (on an average) during the last few months which is expected to go further higher.

Due to the soybean unavailability and shortage of quality feed ingredients, a broiler that usually reaches market age within 32 days is now taking 50 days to reach market weight causing losses to farmers. The bad decision of the government has crushed the poultry industry and now the existence is based on the prompt permission for soybean meal import. Additionally, Pakistan's poultry industry has been struggling to recover from the pandemic, which has further decreased demand for soybean meal (Kabir *et al*., 2021). The significance of soybean as a key agricultural commodity highlights its diverse applications and importance in the global food and feed industries (Oliveira *et al*., 2016). This article aims to provide an overview of the current devastating situation the industry faced due to the COVID-19 pandemic and soybean unavailability, exploring factors contributing to soybean unavailability and the future endeavors to support the industry to avoid such hurtful circumstances to ensure sustainable poultry production.

FACTORS CONTRIBUTING TO SOYBEAN UNAVAILABILITY:

Soybean Production Challenges During COVID-19 and thereafter: The primary challenges faced during soybean production includes unfavorable weather conditions, pests and diseases, limited access to quality seeds, and inadequate agricultural practices (Dogbe et al., 2013). Soybean is cultivated worldwide including Brazil, China, Japan, Korea, USA, and many South and Midwest countries are major producers. It is used vastly in poultry feed and agriculture subdue however, changes in climate due to green house gases and diseases have affected its production in recent years (Conner *et al*., 2011). Moreover, the COVID-19 pandemic affected soybean production at a challenging level and contributes to its unavailability as during COVID-19, concerns about disease risks of influenza and import restriction reduced the utilization of the soybean that resulted in lowered production. Inadequate agricultural practices, seeding not at the proper time, and having improper knowledge about environment requirement for Soybean has also led to a decline in production (Nair *et al*., 2023). Poor management of the crop, cutting not at the proper time, and chemicals used as a spray have led to a great crop loss. The lack of quality agricultural medicines and fertilizers are also one of the main cause of the low yield of the crop (Bhagat *et al*., 2015). The uncontrolled growth of pests and herbs make a competition for water and nutrients from the soil Soybean needs paved soil for their growth (Vencill *et al*., 2012). The quality of seeds is not proper which resulted in limited growth of the crop (Hartman *et al*., 2011). Diseases challanges on the other hand also serve as a hindrance to production (Nget *et al*., 2021). There is a need for implications of reduced surveillance and disease control focusing the enhanced biosecurity measures and plant protection and precise poultry diet formulation (Stull *et al*., 2018; Obuene *et al*., 2021).

Avaialability of Land, Market Volatility and Consumer Demand: The increasing competition for arable land, particularly for other crops and biofuel production, has resulted in reduced soybean acreage (Martin *et al*., 2010). The dynamics between soybean cultivation and competing land uses have also affected soybean availability. The unavailability of fertile land and other important crop cultivation has led to a decline in soybean production (Rathmann *et al*., 2010) and this has affected the poultry and agriculture industry both at the same time (Boyd *et al*., 2001). Uanavaialability of separate lands for soybean cultivation and mall-scale cultivation of Soyabean led to failure to meet the market demands (Gras, 2009). However, use of proper fertile land without mixed cultivation may enhance the yield of the soybean crop (Wesz *et al*., 2022) that may led to economical poultry feed production. Currently, poultry industry experienced shifts in its product demand patterns due to changing preferences, reduced purchasing power, and disruptions in food service sectors (Nkukwana *et al*., 2018) that has resulted to decreased poultry product demand causing losses to farmers and retailers. Farmers were compelled to sell chicken at a lower rates (Sohel *et al*., 2022). The poultry meat and egg market bore great loss because of the lockdown situation (Agius *et al*., 2021)

and the ban on social gatherings places like marriage halls, fast-food hubs like KFC and Mcdonalds etc. (Crothers *et al*., 2021) resulting in reduced soybean production worldwide.

Trade, Market Factors, and Economy: Global trade policies, export restrictions, and market dynamics had greatly influenced the availability of soybean during and after COVID-19 which disturbed the supply chain and negatively affect trade policies, prices, and market volatility on soybean availability. The recent Russian-Ukrainian war further harmed the trade policies of many countries. Export restrictions to developing countries led to an increase in feed prices and many farmers have shut down their farms now (Foyer *et al*., 2019). Market dynamics have changed to an extent that now farmers have started to use low-quality protein sources as replacements for soybean meal in poultry diets wherever affordability of Soyabean meal is a question. Pakistan had imported 2.5 million tonnes of soybean in 2021 which cost $ 1 billion in foreign exchange. Market uncertainty due to shortage of soybean meal is now a big risk affecting the seasonal profit of the farmers and due to this poultry farmers had faced numerous challenges, such as increased production costs, reduced prices, and market uncertainties. For example, if the cost of production is 360 PKR per kg and the farm rate is RS. 315 then the farmer is having a loss of 45 rupees per kg.

GMO Soybeans Facts: Soybean meal is an important feed ingredient obtained from soybean seeds GMOs (Genetically modified organisms) during oil extraction process. During the last year customs department hold 9 vessels without NOCs from the MCC (Ministry of Climate Change) making it difficult to allow the seeds. It is reported that an importing company had given an undertaking that 3000 MT Soybean seed loaded on the vessel (MV Cl DAYANG HE) is non-GMO and is fit for consumption.

Minister for national food security and Research Mr. Tariq Bashir Cheema raised serious objections on GMO based soybean and said that it contains carcinogens substances, and that its use may cause antibiotic resistance, toxicity, and allergenicity. It is said that GMO's also contain glycophosate and AMPA, both are toxic and cause digestive upsets (Domingo *et al*., 2007; Miyazaki *et al*., 2019) and that Pakistan biosafety rules require the registration of GMOs with National Biosafety council (NBC) and detailed scrutiny is required for these products (Tiwari *et al*., 2023).

Other GMO crops: GMO-modified soybean is widely being used throughout the world and the decision of banning GMO soybean is not right. Several other crops are also genetically modified like wheat maize and cotton and are being used to fulfill human demand. Moreover, GMO soybean has been used for many years, and there is not a single evidence of its side effects, therefore, there was no need to impose a ban on its import (Hansen *et al*., 2023). Most of the crops are GMO modified now to improve growth/yield with desired characteristics (Rana *et al*., 2022) to fulfill the demand of huge human population. Soybean is not easily replaceable, it is a great protein source and is used for a long time, however, addressing the problem is a big issue. Trade-associated problems can create a big gap, leading to the disruption of the food chain, closure of the market, and ban on imports.

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Agricultural Systems and Food Security: Although, the pandemic also affected the availability of skilled labor, leading to workforce shortages for agriculture and poultry operations. Currently, limited availability of soybean has affects agricultural systems, crop rotation practices, and overall food security severly (Islam *et al*., 2022) that led to exploring ways implications for crop diversification, soil fertility, and nutrition in both developed and developing countries. The feed and food industry affected abruptly being soybean a significant part and shortage of soybean in the market created a severe loss to feed and food industry. Pakistan must promote soybean cultivation in the country to bridge the gap through public campaign and training of the farmers (Hussain *et al*., 2021) preparing them using technology helping the country to be independent in soybean production and uplifiting the country by reducing the import of soybean and its products. Labor unavailability for soybean production also remained a main issue during COVID-19 as people were not contacting and were frightened to work in the fields and farms, not going out and avoiding people which led to the recruitment of unskillful labor that caused a decrease in soybean and poultry production globally. The pandemic caused disruptions in the in soybean and poultry supply chain, including difficulties in procuring inputs, reduced availability of labor, and logistic challenges (Raj *et al*., 2022). Training and teaching of the labor may helpful for sustainable working conditions (Holmemo *et al*., 2020), also there is need of adopting sound strategies to avoid such situations in future.

Livestock and Poultry Industry: The livestock and poultry industries heavily rely on soybean as a primary source of protein in animal feed (Govoni *et al*., 2021). The impact of soybean unavailability on feed costs, livestock production, and prices of animal products was influential and the poultry industry was badly hit by the situation. Soybean is a major source of protein in animal and poultry feed. Necessary for proper weight gain. Due to unavailability the demand was increased but there is less supply which raised rate of poultry feed (Fukase *et*

al., 2016). In Pakistan, the feed bag is now going at 9000 PKR. This poses a serious effect on small farmers. For e.g farm containing 15000 birds will just close its farm due to increased feed prices. Meat prices have increased tremendously as farmer seeks to earn more than the cost of production (Kosgey *et al*., 2003). Also, shopkeepers having poultry meat increase their prices to earn profit. The industry is finding a source of protein to use as a substitute for soybean, increased feed rates and farm rate being low keeps farmer irritating (Galecki *et al*., 2021; Nierenberg *et al*., 2005). Feed conversion ratio of poutry production without soybean mixed rations remained between 20-27 at farm level (personal survey when visiting poultry farms). Hence unavailability of quality feed has led to shutdown of farms (50%) that may cause big vhallange for food chain (Kusi *et al*., 2015) and collapse of the poultry industry. Therefore, there is a dire need to provide insentives to the poultry producers to manage losses.

Consumer Choices and Health: Soybean and its products are widely used in the food and feed industry. The unavailability of soybean will affect consumer choices, dietary patterns, and nutritional outcomes (Yoza *et al*., 2021; Adegbusi *et al*., 2023). Dietary patterns can be affected such that soy-based food products being used now may not be available in the future. To minimize risks and compensate for market uncertainties, farmers should explore alternatives to soybean, diversify their operations, and focus on value addition through product diversification, direct marketing, and local collaborations (Barbieri *et al*., 2009). Processed and packed poultry products (Chicken cubes, nuggets, sausages, wings, rolls, etc.) have been proven delicious and value additive (Abdel *et al*., 2022) as these products provided a lot of diversity, making it easier for the consumer to have choices and can support the industry through foreign exchange and improved prices of poultry products.

Sustainable solutions and future perspective to enhance soybean production and sustainable poultry production in the country: Agricultural Research Institutes in the country should explore innovative agricultural practices, including precision farming, improved seed varieties, and sustainable cultivation techniques, that can enhance soybean yield (Shaikh *et al*., 2022). Seed quality affects crop yield and viability to combat diseases. Farmers must be aware to use separate fertile and arable lands to grow soybean (McFadden *et al*., 2023) and poultry farmers need to adopt good production practices to enhance sustainable poultry production (Blacksell *et al*., 2023). Efficient trade policies and market interventions, such as promoting fair trade practices, reducing export restrictions, and ensuring market transparency, can help mitigate the challenges of soybean unavailability (Fischer *et al*., 2020). Policymakers should consider the problems of the farmers and relevant stakeholders when considering such decisions as GMO Soyabean. Promoting trade will lead to good diplomacy between different countries and if we meet their demands, we can overcome the political issues to a great extent. Governments and international organizations should implement various policy interventions and support measures to mitigate the impact of COVID-19 on poultry production (Sattar *et al*., 2021). Farmers should be trained to implement artificial intelligence tools and technology (Abbas *et al*., 2023) for efficient poultry production.

Exploring the diversity of protein sources and precise formulations for maximum protein utilization for better environmental health: To reduce reliance on soybean, diversification of protein sources in animal feed and alternative plant protein crops can be explored (Jahanshiri *et al*., 2022). Synthetic/crystalline amino acids along with probiotics, feed additives, organic acids and enzymes etc. are essential parts of diets to boost the ideal amino acid profile and gut health (Afzal *et al*., 2023; Abbas *et al*., 2021; Abbas *et al*., 2022; Han and Lee, 2000; Cmiljanić *et al*., 2003). Supplementation of poultry diets with synthetic amino acids (0.1–0.3%) could help to spare 2–3% of dietary protein and thus may be helpful for better environmental health (Han and Lee, 2000).

Plants are the primary protein source of the ecosystem (Abbas, 2020), however, Plant proteins contain some anti-nutrient factors that naturally exist within their structures, which can adversely affect the quality of the protein and limit its value in animal nutrition (Abbas, 2020; Akande *et al*., 2010). The most common plant protein source in animal/poultry nutrition is soybean although, other cereal grains i.e. canola meal, sunflower meal, peas meal, corn gluten meal, maize, azolla meal, algae meal, fungi meal, wheat, sorghum, and some plant protein meals such as are also extensively used. In poultry nutrition, soybeans are used as soybean meal. various varieties of soybeans having high protein contents and a lower oligosaccharide level have also been developed (Baker *et al*., 2011), moreover, processed soybean products (soybean protein concentrates, soybean protein isolates), are also being added to poultry diets (Peisker, 2001). Replacing soybean meal with processed soybean products in poultry diets is reported to better production performance in broilers and turkeys (Philpotts and Norton 2003; Saki *et al*., 2012; Van der Eijk, 2015).

Animals and animal by-product (good quality protein and energy, reasonable EAA profile etc.) which are part of a slaughtered animal obtained from rendering operations (Meat and bone offal, blood, bones, intestines, rumen content, rejected carcasses of animals/poultry, milk and dairy processing wastes, fish and fish processing waste, earthworm meal, black soldier fly larvae meal, snail meal, poultry litter, hatchery wastes meal, locusts meal, dung beetle meal, single cell proteins,

insect meal, meal worm scales, fungi meal, algae meal etc. are potentially used in poultry nutrition (Hazarika, 1994;Konwar and Barman, 2005; Denton *et al*., 2005; Abbas *et al*., 2020a; Abbas *et al*., 2020b; Abbas *et al*., 2020c; Khan *et al*., 2022; Arshad *et al*., 2022; Arshad *et al*., 2022a). Blood meal has been reported to be included in poultry feeds up to 25% level (Hazarika, 1994). Whilst Anang *et al*. (2001) and Nuarautelli *et al*. (1987) reported that 1–4% dietary inclusion of blood meal can improve production performance of poultry birds. Further its higher inclusion levels did not report adverse effect broiler performance (Khawaja *et al*., 2007; Donkoh *et al*., 2002). Various processing technologies has been introduced to the blood forthe production of various blood-derived products i.e. spray-dried plasma protein (SDPP) and spray-dried blood cells (Stein, 1996). SDPP is produced by separating whole blood into plasma and cell fractions (Stein, 1996). SDPP are highly digestible protein sources with good amino acid profiles (Castelló *et al*., 2004, Torrallardona, 2010) and has been reported positive influences on immunity and intestinal wall functions non-ruminant animals (Shahidi *et al*., 1984; De Rodas *et al*., 1995; Godfredson-Kisic and Johnson, 1997; Quigley and Drew, 2000; Coffey and Cromwell, 2001; Campbell *et al*., 2003, Campbell *et al*., 2004a; Campbell *et al*., 2004b; Nofrarias *et al*., 2006; Rodriguez *et al*., 2007; Moretó and Pérez-Bosque, 2009; Campbell *et al*., 2009; Jamroz *et al*., 2011; Jamroz *et al*., 2012). Since the late 1980s, these products have been used in North America and Asia (Gatnau and Zimmerman, 1990) and their use into European animal rations is being re-considered (Castelló *et al*., 2004**).**

Conclusions and Recommendations: The unavailability of soybean poses significant challenges for various stakeholders, including farmers, the feed industry, and consumers. Understanding the underlying factors and their effects is crucial for developing sustainable solutions. By implementing innovative agricultural practices, promoting fair trade policies for soybean and other feed ingredients, and diversifying protein sources, the challenges of soybean unavailability can be addressed, ensuring a more resilient and sustainable food production system. Farmers needs to be trained through efficient media channels, workshops and seminars to search for methods for better production using advanced technology and consistent production strategies. Government must devise a policy to solve the problems of farmers at the root level like its role in the past to promote poultry production in the country. Incentives should be provided to all stakeholders of poultry farmers to maintain the equilibrium. Government should also make efforts to support the backyard industry to support sustainable eggs and meat production in the country like the EX-Prime Minister Imran Khan's past initiative of promoting backyard Poultry production under the National Agricultural Emergency Program aimed at the economic development of villagers, especially women, and children to raise backyard poultry using kitchen residue (It will help to cut down use of soybean). Efforts should be made to keep the prices of poultry and its by-products uniform, and the import/export subsidies of poultry and the related facilitating items. Based on the findings and analysis it is concluded that potential strategies and recommendations are needed for the resilient and sustainable poultry production in the country. As the poultry industry is the largest industry in the country therefore government is requested to play a positive role to prevent the industry from being crushed by unwise decisions. The government should also focus on indigenous breed improvement because if the supply of grandparent stock disturbs then how to provide cheap poultry products to the 240 million population of Pakistan?

REFERENCES

Abbas, G. 2020. An Augmented Review about Anti-Nutrients and Toxins of Feed Stuff and their Control Strategies, a Step toward Sustainable Resource Utilization. International Journal of Agriculture Innovations and Research. 8(4): 2319-1473.

Abbas, **G.,** A.M. Jabbar, andA. Razia . S. Qureshi. 2020a. Control Cum Exploitation of Locusts Attack to Enhance Productivity. EC Veterinary Science 5.4: 30-34.

Abbas, **G**., A. Iqbal, M.Asif and M. Arshad Javid. 2020b. Use of Fly(Musca Domestica) Larva Meal in Poultry Diet. Biomed J Sci & Tech Res 30(3): 23444-23445. BJSTR. MS.ID.004960.

Abbas, G., M. Abduljabbar 1 and M. Arshad Javid. 2020c. Dietary Inclusion of Azolla (Azolla pinnata) Meal as a Protein Source in Poultry Feed. International Journal of Animal Husbandry and Veterinary Science. Volume 5 (3): 2455-8567

Abbas, G., M. Arshad, A. J. Tanveer , M. A. Jabbar, M. Arshad, D. K. A. AL-Taey, A. Mahmood, M. A. Khan, A. A. Khan, Y. Konca, Z. Sultan, R. A. M. Qureshi, A. Iqbal, F. Amad, M. Ashraf, M. Asif1, R. Mahmood, H. Abbas, S. G. mohyuddin, M. Y. jiang (2021). Combating heat stress in laying hens a review. Pak. J. Sci. 73 (4): 633-655.

Abbas, **G.,** M. Arshad, M. Saeed, Imran S, Kamboh AA, Al-Taey DK, Aslam MA, Imran MS, Ashraf M, Asif M, Tanveer AJ, Qureshi RAM, Arshad M, Niazi HAK, Tariq M, Abbas S. 2022. An Update on the Promising Role of Organic Acids in Broiler and Layer Production. Journal of Animal Health Production. 10 3: 273-286.

Abbas, G., S. Jaffrery, A. H. Hashmi, M.Arshad, S. J. Usmani, M.S.Imran, A. J.Tanveer, M. Tariq, M.Saleem, Q. Amin, A. A. Khan, M. A. Alvi, S. B. Shabbir, R. A. M. Qureshi, A. Mustafa, T. A. Iqbal, A. Iqbal, M. Hassan, S. Abbas, W. Abbas, H. Abbas, S. G. Mohyyuddin, W. Ismail, D. K. A. AL-Taey, & B. Shaukat. 2023. Current prospects of nanotechnology use in animal production and its future scenario. Pakistan Journal of Science, 74 (3), 203–222. https://doi.org/10.57041/pjs.v74i3.789.

Afzal, S. A., U. Farooq, M. F. Khalid, S. L. Butt, & G. Abbas. 2023. Effect of xylo-oligosaccharide and xylanase supplementation on growth performance, carcass characteristics, nutrient digestibility, and intestinal histology of broilers. Pakistan Journal of Science, 74(4). https://doi.org/10.57041/pjs.v74i4.800

Agius, Karl, Francesco Sindico, Giulia Sajeva, and Godfrey Baldacchino. "'Splendid isolation': Embracing islandness in a global pandemic." Island Studies Journal (2021).

Akande, K., U. Doma, H. Agu, H. Adamu. 2010. Major antinutrients found in plant protein sources: their effect on nutrition. Pak J Nutr, 9: 827-832.

Arshad, M., G. Abbas, S. Jeffery, A. H. Hashmi, I. Hussain, A. Mustafa, M. Arshad, A. Rehman, A. Iqbal, S. Aslam, R. Khan, M. Ashraf, F. Mahmood, T. Mahmood, S. Javed, R. O. Simon, T. J. Shad, M. A. Alvi, A. U. Haq, M. H. Ali, M. S. Rehman, T. A. Iqbal, S. Khan, M. M. Saleem, S. E.Hassan, H. Munir, S. H. Qamar, A. Mahmood, U. Mehboob, and R. A. M. Qureshi. 2022. Towards efficient control of locusts to avoid the plagues on humans: evolving and applying advanced control strategies. Pak. J. Sci. 74 (4): 366-376.

Arshad, M., G. Abbas, M. A. Jabbar, S. Jaffery, A. H. Hashmi, I. Hussain, A. Mustafa, M. Arshad, A. Rehman, A. Iqbal, R. Khan, A. Mahmood, T. Mahmood, S. Javed, R. Mahmood, M. A. Alvi, A. U. Haq, M. H. Ali, M. S. Rehman, T. A. Iqbal, U. Mehboob, S. Khan, M. M. Saleem, S. E. Hassan and .assnainMunir1and R. A. M. Quresh. 2022a. Earthworm meal: a novel non-conventional feed ingredient for sustainable poultry production. Pak. J. Sci. 74 (4): 383-391.

Attia, Youssef A., Md Tanvir Rahman, Md Jannat Hossain, Shereen Basiouni, Asmaa F. Khafaga, Awad A. Shehata, and Hafez M. Hafez. "Poultry production and sustainability in developing countries under the COVID-19 crisis: Lessons learned." Animals 12, no. 5 (2022): 644.

Baker, K., P. Utterback, C. Parsons, H. Stein. 2011.Nutritional value of soybean meal produced from conventional, high-protein, or low-oligosaccharide varieties of soybeans and fed to broiler chicks. Poult Sci, 90: 390-395.

Barbieri, Carla, and Edward Mahoney. "Why is diversification an attractive farm adjustment strategy? Insights from Texas farmers and ranchers." Journal of rural studies 25, no. 1 (2009): 58-66.

Bhagat, Yogesh, K. Gangadhara, Chidanand Rabinal, Gaurav Chaudhari, and Padmabhushan Ugale. "Nanotechnology in agriculture: a review." Journal of Pure and Applied Microbiology 9, no. 1 (2015): 737-747.

Blacksell, Stuart D., Sandhya Dhawan, Marina Kusumoto, Kim Khanh Le, Kathrin Summermatter, Joseph O'Keefe, Joseph Kozlovac *et al.* "The Biosafety Research Road Map: The search for evidence to support practices in human and veterinary laboratories." Applied biosafety 28, no. 2 (2023): 64-71.

Boyd, William. "Making meat: Science, technology, and American poultry production." Technology and Culture 42, no. 4 (2001): 631-664.

Campbell, J., J. Quigley, L. Russell, L. Koehnk. 2004. Efficacy of spray-dried bovine serum on health and performance of turkeys challenged with *Pasteurella multocida*. J Appl Poult Res, 13: 388-393.

Campbell, J., J. Quigley, L. Russell, M. Kidd. 2003. Effect of spray-dried bovine serum on intake, health, and growth of broilers housed in different environments. J Anim Sci, 81: 2776-2782.

Campbell, J., J. Quigley, L. Russell. 2004. Impact of spray-dried bovine serum and environment on turkey performance. Poult Sci, 83:1683-1687.

Campbell, J.M., J.D. Crenshaw, L.E. Russel, S.K. Hayes. 2009. Management of the inflammatory response using plasma as an immune modulator and its impact on swine production. Paper presented at the proceeding of 16th international conference, Krmiva, Opatija, Croatia, p. 43.

Campbell. J. 2003. The use of plasma in swine feeds. acesso em 26: 2005. www.americanprotein.com/discoveres/summer98/plasma.html.

Campbell. J.M., 2011. Application of new technologies in functional proteins for feeding calves. APC Inc., Ankeny, IA. Oral presentation by: H.D. Tyler Iowa State University, Ames, IA.

Castelló, A., O. Francino, B. Cabrera, J. Polo, A. Sánchez. 2004. Identification of bovine material in porcine spray-dried blood derivatives using the polymerase chain reaction. Biotechnol Agron Soc Environ, 8: 267-273.

Cmiljanić, R., Z. Pavlovski, S. Trenkovski, M. Lukic. 2003. New additives in poultry nutrition. 7th

International symposium 'modern trends in livestock production' in Belgrade. Biotechnol Anim Husb, 19: 357-362.

Coffey, R.D., G.L. Cromwell. 2001. Reviews-Use of spray-dried animal plasma in diets for weanling pigs. Pig News Inf, 22: 39-48.

Connor, David J., Robert S. Loomis, and Kenneth G. Cassman. Crop ecology: productivity and management in agricultural systems. Cambridge University Press, 2011.

Crothers, Lane. Globalization and American popular culture. Rowman & Littlefield Publishers, 2021.

Das PK, Samanta I (2021) Role of backyard poultry in south-east Asian countries: post COVID-19 perspective. World's Poult Sci J:1–12.

De Rodas, B., K. Sohn, C. Maxwell, L. Spicer. 1995. Plasma protein for pigs weaned at 19 to 24 days of age: effect on performance and plasma insulin-like growth factor I, growth hormone, insulin, and glucose concentrations. J Anim Sci, 73 (1995), pp. 3657-3665.

Denton, J., C. Coon, J. Pettigrew, C. Parsons. 2005. Historical and scientific perspectives of same species feeding of animal by-products. J Appl Poult Res, 14 (2005), pp. 352-36Donkoh, A., D. Anang, C. Atuahene, M. Hagan. 2002. Influence of processing temperature on chemical composition of solar-dried blood meal and on performance of broiler chickens. J Anim Feed Sci, p. 11.

Dogbe, Wilson, Prince M. Etwire, J. C. Etwire, I. I. Y. Baba, and A. Siise. "Economics of Soybean Production Evidence from Saboba and Chereponi Districts of Northern Region of Ghana." (2013).

Domingo, José L. "Toxicity studies of genetically modified plants: a review of the published literature." Critical reviews in food science and nutrition 47, no. 8 (2007): 721-733.

Fischer, Carolyn, and Timothy Meyer. "Baptists and Bootleggers in the Biodiesel Trade: EU–Biodiesel (Indonesia)." World Trade Review 19, no. 2 (2020): 297-315.

Foyer, Christine H., Kadambot HM Siddique, Amos PK Tai, Sven Anders, Nándor Fodor, Fuk-Ling Wong, Ndiko Ludidi *et al*. "Modelling predicts that soybean is poised to dominate crop production across A frica." Plant, Cell & Environment 42, no. 1 (2019): 373-385.

Fukase, Emiko, and Will Martin. "Who will feed China in the 21st century? Income growth and food demand and supply in China." Journal of Agricultural Economics 67, no. 1 (2016): 3-23.

G. Abbas, S. Jaffrery, A. H. Hashmi, M.Arshad, S. J. Usmani, M.S.Imran, A. J.Tanveer, M. Tariq, M.Saleem, Q. Amin, A. A. Khan, M. A. Alvi, S. B. Shabbir, R. A. M. Qureshi, A. Mustafa, T. A. Iqbal, A. Iqbal, M. Hassan, S. Abbas, W. Abbas, H. Abbas, S. G. Mohyyuddin, W. Ismail, D. K. A. AL-Taey, & B. Shaukat. 2023. Current prospects of nanotechnology use in animal production and its future scenario. Pakistan Journal of Science, 74 (3), 203–222.

Gałęcki, Remigiusz, Łukasz Zielonka, Magdalena Zasępa, Joanna Gołębiowska, and Tadeusz Bakuła. "Potential utilization of edible insects as an alternative source of protein in animal diets in Poland." Frontiers in Sustainable Food Systems 5 (2021): 675796.

Gatnau, R., D. Zimmerman. 1990. Spray dried porcine plasma (SDPP) as a source of protein for weanling pigs. J Anim Sci, 68 (1990), p. 374.

Godfredson-Kisic, J., D. Johnson. 1997. A bioassay used to identify the active fraction of spray-dried porcine plasma. J Anim Sci, 75 (1997), p. 195.

Govoni, Camilla, Davide Danilo Chiarelli, Alice Luciano, Matteo Ottoboni, Simge Nur Perpelek, Luciano Pinotti, and Maria Cristina Rulli. "Global assessment of natural resources for chicken production." Advances in Water Resources 154 (2021): 103987.

Gras, Carla. "Changing patterns in family farming: the case of the pampa region, Argentina." Journal of Agrarian Change 9, no. 3 (2009): 345-364.

Han, K., J. Lee.2000. The role of synthetic amino acids in monogastric animal production. Asian-Australas J Anim Sci, 13: 543-560.

Hansen, Casper Worm, and Asger Mose Wingender. "National and Global Impacts of Genetically Modified Crops." American Economic Review: Insights 5, no. 2 (2023): 224-240.

Hartman, Glen L., Ellen D. West, and Theresa K. Herman. "Crops that feed the World 2. Soybean—worldwide production, use, and constraints caused by pathogens and pests." Food Security 3 (2011): 5-17.

Hashem, Nesrein M., Antonio González-Bulnes, and Alfonso J. Rodriguez-Morales. "Animal welfare and livestock supply chain sustainability under the COVID-19 outbreak: An overview." Frontiers in veterinary science 7 (2020): 582528.

Hazarika. M., 1994.Utilization of animal by-products as animal feed. Livest Advis, 19: p. 14

Holmemo, Camilla, Pablo Acosta, Tina George, Robert J. Palacios, Juul Pinxten, Shonali Sen, and Sailesh Tiwari. "Investing In People." (2020).

Islam, Mohammad Sohidul, Imam Muhyidiyn, Md Rafiqul Islam, Md Kamrul Hasan, ASM Golam Hafeez, Md Moaz Hosen, Hirofumi Saneoka *et al*. "Soybean and sustainable agriculture for food security." In Soybean-Recent Advances in Research and Applications. IntechOpen, 2022.

Jahanshiri, Ebrahim, Ee Von Goh, Eranga M. Wimalasiri, Sayed Azam-Ali, Sean Mayes, Tengku Adhwa Syaherah Tengku Mohd Suhairi, Nur Marahaini Mohd Nizar, and Siti Sarah Mohd Sinin. "The potential of Bambara groundnut: An analysis for the People's Republic of China." Food and Energy Security 11, no. 2 (2022): e358.

Jamroz, D., A. Wiliczkiewicz, J. Orda, J. Skorupińska, M. Słupczyńska, J. Kuryszko. 2011. Chemical composition and biological value of spray dried porcine blood by-products and bone protein hydrolysate for young chickens. Br Poult Sci, 52 pp. 589-605

Kabir, A., M. Rasheed, H. A. Kaleri, D. K. Bhuptani, M. Kumar, R. A. Mangi, A. W. Solangi *et al*. "Effect of COVID-19 outbreaks on the livestock industry." Journal of Innovative Sciences 8, no. 2 (2021): 263-270.

Karlsson, Johan O., Alejandro Parodi, Hannah HE Van Zanten, Per-Anders Hansson, and Elin Röös. "Halting European Union soybean feed imports favours ruminants over pigs and poultry." Nature Food 2, no. 1 (2021): 38-46.

S. Khan, A. J. Tanweer, Rafiullah, Ibrahimullah, G Abbas, J. Khan, M.S. Imran, A. A. Kamboh 2022. Effect of supplementation of mealworm scales (Tenebrio molitor) on growth performance, carcass traits and histomorphology of Japanese quails. J. Anim. Health Prod. 10 3: 381-389. DOI http://dx.doi.org/10.17582/journal.jahp/2022/10.3.381.389

Khawaja, T., S.H. Khan, N.N. Ansari. 2007. Effect of different levels of blood meal on broiler performance during two phases of growth. Int J Poult Sci, 6: 860-865

Konwar, D., K. Barman. 2005. Potential of utilization of animal by-products in animal feed. North East Vet, 5: 28-31.

Kosgey, I. S., Johan AM van Arendonk, and R. L. Baker. "Economic values for traits of meat sheep in medium to high production potential areas of the tropics." Small Ruminant Research 50, no. 1-2 (2003): 187-202.

Kosgey, I. S., Johan AM van Arendonk, and R. L. Baker. "Economic values for traits of meat sheep in medium to high production potential areas of the tropics." Small Ruminant Research 50, no. 1-2 (2003): 187-202.

Kusi, Lawrence Yaw, Senyo Agbeblewu, Isaac Kwadwo Anim, and Kwamina Minta Nyarku. "The challenges and prospects of the commercial poultry industry in Ghana: a synthesis of literature." (2015).

Martin, Marshall A. "First generation biofuels compete." New biotechnology 27, no. 5 (2010): 596-608.

McFadden, Jonathan, Eric Njuki, and Terry Griffin. "Precision Agriculture in the Digital Era: Recent Adoption on US Farms." (2023).

Miyazaki, Juliana, Andreas Bauer-Panskus, Thomas Bøhn, Wolfram Reichenbecher, and Christoph Then. "Insufficient risk assessment of herbicide-tolerant genetically engineered soybeans intended for import into the EU." Environmental Sciences Europe 31, no. 1 (2019): 1-21.

Moretó, M., A. Pérez-Bosque. 2009. Dietary plasma proteins, the intestinal immune system, and the barrier functions of the intestinal mucosa. J Anim Sci, 87: E92-E100.

Nair, Ramakrishnan M., Venkata Naresh Boddepalli, Miao-Rong Yan, Vineet Kumar, Balwinder Gill, Rabi S. Pan, Chansen Wang, Glen L. Hartman, Renan Silva e Souza, and Prakit Somta. "Global status of vegetable soybean." Plants 12, no. 3 (2023): 609.

Nget, Raby, Edna A. Aguilar, Pompe C. Sta Cruz, Consorcia E. Reaño, Pearl B. Sanchez, Manuel R. Reyes, and PV Vara Prasad. "Overview of farmers' perceptions of current status and constraints to soybean production in Ratanakiri province of Cambodia." Sustainability 13, no. 8 (2021): 4433.

Nierenberg, Danielle, and Lisa Mastny. Happier meals: rethinking the global meat industry. Vol. 171. Worldwatch Institute, 2005.

Nkukwana, T. T. "Global poultry production: Current impact and future outlook on the South African poultry industry." South African Journal of Animal Science 48, no. 5 (2018): 869-884.

Nofrarias, M., E. Manzanilla, J. Pujols, X. Gibert, N. Majo, J. Segalés, *et al.* 2006. Effects of spray-dried porcine plasma and plant extracts on intestinal morphology and on leukocyte cell subsets of weaned pigs. J Anim Sci, 84: 2735-2742.

Nuarautelli, A., A. Anghinelli, A. Blanco. 1987. Use of spray dried blood meal in broilers diet. Medicina Veterinaria, Universita di Parma, Italy, pp. 333-353.

Obuene, Henry U. "Hospitality industry and impacts of the coronavirus disease pandemic in Ibadan, Nigeria." Journal of African Transformation Revue des mutations en Afrique (2021): 1.

Oliveira, Gustavo de LT, and Mindi Schneider. "The politics of flexing soybeans: China, Brazil and global agroindustrial restructuring." The Journal of Peasant Studies 43, no. 1 (2016): 167-194.

Peisker, M. 2001. Manufacturing of soy protein concentrate for animal nutrition. Cah Options Mediterr, 54: 103-107.

Philpotts, A., C. Norton. 2003. A comparison of Hamlet protein HP 300 to skim milk powder and

fishmeal in commercial diets for newly weaned pigs. Hamlet protein feeding trial report no. P 29.

Quigley, J.,T. Wolfe. 2003. Effects of spray-dried animal plasma in calf milk replacer on health and growth of dairy calves. J Dairy Sci, 86: 586-592.

Raj, Alok, Abheek Anjan Mukherjee, Ana Beatriz Lopes de Sousa Jabbour, and Samir K. Srivastava. "Supply chain management during and post-COVID-19 pandemic: Mitigation strategies and practical lessons learned." Journal of business research 142 (2022): 1125-1139.

Rana, Abdul Wajid, Sitara Gill, and Iqra Akram. "Seed system of Pakistan: Policy challenges and prospects." (2022).

Rathmann, Régis, Alexandre Szklo, and Roberto Schaeffer. "Land use competition for production of food and liquid biofuels: An analysis of the arguments in the current debate." Renewable energy 35, no. 1 (2010): 14-22.

Rodriguez, C., F. Blanch, V. Romano, N. Saborido, J. Rodenas, J. Polo. 2007. Porcine immunoglobulins survival in the intestinal tract of adult dogs and cats fed dry food kibbles containing spray-dried porcine plasma (SDPP) or porcine immunoglobulin concentrate (PIC). Anim Feed Sci Technol, 139: 201-211.

Saki, A., M. Abbasinezhad, S. Ghazi, M. Tabatabai, A. Ahamdi, K. Zaboli. 2012. Intestinal characteristics, alkaline phosphatase and broilers performance in response to extracted and mechanical soybean meal replaced by fish meal. J Agric Sci Technol, 14: 105-114.

Sattar, Abdullah Al, Rashed Mahmud, Md Abu Shoieb Mohsin, Nurun Nahar Chisty, Md Helal Uddin, Nusrat Irin, Tony Barnett, Guillaume Fournie, Eve Houghton, and Md Ahasanul Hoque. "COVID-19 impact on poultry production and distribution networks in Bangladesh." Frontiers in Sustainable Food Systems 5 (2021): 714649.

Shahidi, F., M. Naczk, L. Rubin, L. Diosady. 1984. Functional properties of blood globulins. J Food Sci, 49: 370-372.

Shaikh, Tawseef Ayoub, Waseem Ahmad Mir, Tabasum Rasool, and Shabir Sofi. "Machine learning for smart agriculture and precision farming: towards making the fields talk." Archives of Computational Methods in Engineering 29, no. 7 (2022): 4557-4597.

Sharun K, Dhama K, Pawde AM, Gortázarc C, Ruchi T, Katterine B-AD, Rodriguez-Morales AJ, de la Fuente J, Michalak I, Attia YA. SARS-CoV-2 in animals: potential for unknown reservoir hosts and public health implications. *Vet Q.* 2021;41(1):181–201. doi: 10.1080/01652176.2021.1921311.

Sohel, Md Salman, Babul Hossain, Md Nazirul Islam Sarker, Gazi Abu Horaira, Md Khaled Sifullah, and Md Abadur Rahman. "Impacts of COVID-19 induced food insecurity among informal migrants: insight from Dhaka, Bangladesh." Journal of Public Affairs 22 (2022): e2770.

Stein, H. 1996. The effects of adding spray dried plasma protein and spray dried blood cells to starter diets for pigs. Simposlo Latino-Americano de nutricao de suinos e aves, pp. 70-86.

Stull, Jason W., Erin Bjorvik, Joshua Bub, Glenda Dvorak, Christine Petersen, and Heather L. Troyer. "2018 AAHA infection control, prevention, and biosecurity guidelines." Journal of the American Animal Hospital Association 54, no. 6 (2018): 297-326.

Tiwari, Aparna, Surinder K. Tikoo, Sharan P. Angadi, Suresh B. Kadaru, Sadananda R. Ajanahalli, and M. J. Vasudeva Rao. "Regulatory Aspects of the Seed Business in Relation to Plant Breeding." In Market-Driven Plant Breeding for Practicing Breeders, pp. 323-387. Singapore: Springer Nature Singapore, 2023.

Torrallardona, D., M. Conde, I. Badiola, J. Polo, J. Brufau. 2003. Effect of fishmeal replacement with spray-dried animal plasma and colistin on intestinal structure, intestinal microbiology, and performance of weanling pigs challenged with *Escherichia coli* K99. J Anim Sci, 81 (2003), pp. 1220-1226.

Van der Eijk, C. 2015. Reducing anti-nutritional factors in prestarter feeds. Asian Feed Mag, 6–9.

Vencill, William K., Robert L. Nichols, Theodore M. Webster, John K. Soteres, Carol Mallory-Smith, Nilda R. Burgos, William G. Johnson, and Marilyn R. McClelland. "Herbicide resistance: toward an understanding of resistance development and the impact of herbicide-resistant crops." Weed Science 60, no. SP1 (2012): 2-30.

Wesz Junior, Valdemar João. "Soybean production in Paraguay: Agribusiness, economic change and agrarian transformations." Journal of Agrarian Change 22, no. 2 (2022): 317-340.

World Grain. (2023, March 8). Pakistan's total oilseed use to hold steady in 2022-23. Retrieved from https://www.world-grain.com/articles/16662-pakistans-total-oilseed-use-to-hold-steady-in-2022-23

Yoza, Letícia, Érika de Oliveira Cabral de Carli, Filipe Quevedo-Silva, Dario de Oliveira Lima-Filho, and Maria Augusta Gonçalves Maia da Silveira. "INFLUENCING FACTORS FOR THE CONSUMPTION OF SOY AND DERIVATIVES." Pensamento & Realidade 36, no. 01 (2021): 01-13.