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Prioritizing Backyard Poultry Bottlenecks Using Analytic Hierarchy Process in Punjab, India

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HIGHLIGHTS

- Analytic Hierarchy Process identified and prioritized critical bottlenecks constraining backyard poultry value chain.
- Production constraints ranked as the leading challenge with highest priority weight of 0.250.
- Limited access to market information highlighted as a significant marketing constraint (global priority score: 0.037).
- Predator attacks recognized as the most alarming threat to backyard poultry (global priority score: 0.079)

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ABSTRACT

Backyard poultry in rural India symbolizes both opportunity & adversity, offering livelihoods while battling chronic gaps in feed, healthcare & marketing. This study, conducted during 2022-2023, used the Analytic Hierarchy Process (AHP) to prioritize bottlenecks in the backyard poultry value chain. A total of 385 farmers from 11 districts of Punjab were purposively selected using the snowball sampling technique. The study revealed production constraints (priority weight: 0.250) as the leading challenge faced by respondents. Within input supply constraints, lack of access to credit and insurance support was ranked highest (global priority score: 0.109). High feed costs (0.065) and limited market information (0.037) were the most critical production and marketing challenges, respectively. Inadequate transportation (0.050) topped processing and transportation constraints. Predator attacks (0.079) were identified as the most alarming threat. The study highlights major bottlenecks requiring targeted interventions for sustainable rural poultry development.

INTRODUCTION

Backyard poultry farming, a dynamic and resilient sector, sustains millions of households worldwide, providing essential nutrition and income diversification. Its traditional small-scale structure efficiently supports expanding food needs, enhances rural incomes, and contributes to food security, livelihood creation, poverty alleviation, and sustainable ecological management (Aklilu et al., 2008). This decentralized model not only enhances food security but also empowers local communities by fostering self-reliance and economic independence. Despite its significance, challenges such as access to quality feed, healthcare services, and market opportunities persist (Jadoun, 2019; Patel et al., 2022), underscoring the need for innovative solutions to optimize productivity and sustainability. Embracing modern analytical frameworks like the Analytic Hierarchy Process (AHP) promises to unravel complexities and elevate backyard poultry farming to new heights of efficiency and resilience on a global scale.

Backyard poultry farming refers to the small-scale rearing of up to 100 birds, typically managed in outdoor or semi-free-range

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conditions with minimal inputs and limited biosecurity (Guèye, 2000). In rural India, this low-investment, high-return enterprise plays a crucial role in strengthening the socio-economic resilience of resource-poor families (Chakrabarti et al., 2014). Compared to commercial poultry, which has expanded by only 4.50 per cent over the last census, backyard poultry production has evidenced an incredible growth rate of 45.80 per cent (Livestock Census, 2019). Native poultry breeds like Kadaknath, Aseel, Nicobari, Danki, Tellicherry, and Haringhata Black are sturdy, good brooders, have good mothering abilities, adaptive in challenging climatic situations, and are resistant to many diseases. They can survive well on agriculture and domestic wastes by scavenging on the residual feed. Desi breeds of poultry are more heat-tolerant than exotic breeds (Kumar et al., 2017). Due to their rich flavour, health benefits, and low-fat content, as well as rising purchasing power and urban population, desi or indigenous poultry breeds that are raised in backyards are currently experiencing a substantial surge in demand for their meat and eggs in metropolitan areas.

As consumer preference shifts toward desi poultry raised under natural conditions, the backyard poultry sector is evolving into a high-potential enterprise, making value chain strengthening both timely and necessary. Despite its growing market demand and suitability for low-input rural households, the system continues to face multiple constraints related to feed supply, healthcare access, input distribution, and marketing channels. Although earlier studies have identified several of these challenges, most have relied on conventional ranking methods and lack an integrated prioritization of constraints across the entire value chain. This gap underscores the need for a more structured analytical approach capable of determining which issues require urgent intervention. Therefore, the present study employs the Analytic Hierarchy Process (AHP) to systematically identify and rank key bottlenecks in backyard poultry production and marketing, offering deeper insights into where strategic efforts should be focused to enhance efficiency, improve farmer welfare, and strengthen the long-term viability of this emerging rural enterprise.

METHODOLOGY

The present study was conducted from September 2022 to June 2023 in 11 districts of Punjab (Latitude 30°42 N, Longitude 75°52 E), covering approximately 50% of the state. Districts were selected purposively in proportion to their backyard poultry population as reported in the Livestock Census. However, since no district-wise sampling frame of backyard poultry keepers was available, individual respondents were identified using the snowball sampling technique. The sample size was calculated with the help of an online statistical calculator, according to which on supposing that from the population, 50% of the subjects have factor of interest & for estimating the probable proportion with 95% confidence and 5% precision (absolute), the size of sample should not be less than 385 (Dhand & Khatkar, 2014). From each district, 35 backyard poultry farmers (Broilers and layers) having more than 10 backyard poultry birds, willing to participate, of 20 years of age or more and well-versed with Punjabi language, were contacted to collect the information through a set of structured interview schedule. Thus, total 385 backyard poultry farmers were selected for the study.

The constraints analysis was performed by using Analytic Hierarchy Process (AHP) (Saaty, 1980) among backyard poultry farmers in the Punjab. AHP is a structured technique developed by Saaty (2008), for organizing and analysing the complex decision, based on mathematics and psychology. It aids the decision-maker to set priorities and make the best decision. AHP utilizes a pair-wise comparison method to know the overall priority of each factor considered by respondents; which, in turn, determines the constraints situation in backyard poultry farming value chain in India. The AHP helps to capture both subjective and objective aspects of a decision. Saaty (2008), proposed one nine-point scale to have a pair-wise comparison (Eq. 1) of different constraints criteria and factors. In this AHP, the verbal statements are converted into integers from one to nine, based on the intensity of importance of one over the other.

$$M=(a_{ij})=\begin{array}{c} \\ D_1 \\ D_2 \\ \vdots \\ D_n \end{array}\begin{array}{c} \begin{array}{cccc} D_1 & D_2 & \dots & D_n \end{array} \\ \begin{pmatrix} 1 & a_{12} & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & a_{2n} \\ .. & .. & .. & .. \\ 1/a_{1n} & 1/a_{2n} & \dots & 1 \end{pmatrix} \end{array}$$

M= Pair-wise comparison matrix

Eq. 1

Utilizing AHP in constraints analysis yields analytical priorities for the factors included in constraints analysis and makes them commensurable. AHP measures the relative importance of the constraint's factors. Making pairwise comparisons forces the decision–makers to think over the weights of the constraints factors and to analyse the situation more precisely and in more depth.

RESULTS

The bottlenecks in the backyard poultry value chain were assessed by five criteria i.e., Input Supply Constraints (ISC), Production Constraints (PC), Marketing Constraints (MC), Processing and Transportation Constraints (PTC), and Miscellaneous Constraints (MSC). AHP was used to assign a priority weight to each constraint's component in order to ascertain how strongly each constraint was perceived to be affecting the farmers. Statements used for constraints analysis are listed in Table 1.

Priority weights of overall constraints faced by backyard poultry value chain actors

A priority matrix was developed based on the cumulative individual priority rank of each factor after the criteria for each constraint analysis aspect had been determined. Each section of the constraint analysis was assigned a unique set of five criteria, after which the priority scores for each of the 10 groups of those criteria were calculated individually. Using Saaty's (1991) nine-point continuum priority scale, the aggregate individual priority score for each group of each criterion was determined. The individual priority matrix was utilized to calculate the consistency ratio using AHP. According to the AHP thumb rule, each factor's and criterion's consistency ratio value must be smaller than 0.1, indicating that all the factors and criteria used in the constraint analysis are valid at their respective points.

Table 1. Problem modelling for constraints analysis in backyard poultry farming value chain

Factors (F)	Input Supply Constraints (IC)	Production Constraints (PC)	Marketing Constraints (MC)	Processing & Transportation Constraints (PTC)	Miscellaneous Constraints (MSC)
F1	IC1: Lack of accessibility for improved germplasm	PC1: High cost of feed	MC1: Limited access to market information	PTC1: Lack of processing	MSC1: Attack by predators
F2	IC2: Non availability of day-old chicks round the year	PC2: Low production performance of native birds	MC2: Price fluctuation	PTC2: Lack of storage facility	MSC2: Mortality due to extreme weather conditions
F3	IC3: Lower accessibility to veterinary services	PC3: Lack of knowledge about scientific poultry farming practices	MC3: Weak market linkage	PTC3: Lack of value addition skills for meat and egg products	MSC3: High cost of private veterinary services
F4	IC4: Non availability of medicines and vaccines at right time	PC4: Low hatchability	MC4: Poor access to markets and distant markets	PTC4: Lack of proper transportation facilities to access veterinary services	MSC4: Lack of a practice to provide supplementary feed
F5	IC5: Lack of access to credit, subsidy, and insurance support	PC5: Mortality due to higher incidences of disease and outbreaks	MC5: Seasonality in supply and demand of eggs and meat	PTC5: Inadequate transportation from production areas to markets	MSC5: Theft cases

The priority weights (Table 2) of each factor were used to rank the constraints. Production constraints received a priority weight of 0.250, ranking it first. The subsequent ranking was assigned to input supply constraints (0.237). Corresponding to their respective priority weights, miscellaneous constraints (0.195), processing and transportation constraints (0.174), and marketing constraints (0.144), were ranked III, IV, and V, respectively. All the factors utilised for the constraints analysis were consistent at a consistency ratio of 0.061.

Input supply constraints faced by backyard poultry value chain actors

The most significant input supply constraint faced by respondents was the lack of access to credit, subsidy, and insurance (global priority score: 0.109). Limited accessibility to veterinary services (0.039) ranked next, followed by the untimely availability of medicines and vaccines (0.036) and restricted access to improved germplasm (0.027). The unavailability of day-old chicks throughout the year (0.025) was considered the least critical factor (Table 3).

Production and marketing constraints faced by backyard poultry value chain actors

As presented in Table 3, the strongest production constraint experienced by the respondents was the high cost of feed (global priority score: 0.065). Low hatchability (0.053) and insufficient knowledge of scientific poultry practices (0.047) ranked next, while the suboptimal performance of native birds (0.045) and mortality due to frequent disease outbreaks (0.040) also posed notable challenges. For marketing, limited access to market information (0.037) stood out as the primary hurdle, followed closely by seasonal fluctuations in the supply and demand of eggs and meat (0.035). Issues such as price instability (0.027) and weak market linkages (0.025) further constrained marketing efficiency, whereas poor access to distant markets (0.020) was considered less critical."

Processing, transportation and miscellaneous constraints faced by backyard poultry value chain actors

Table 3 revealed that inadequate transportation from production areas to markets (global priority score: 0.050) was the leading challenge in processing and transportation. Lack of storage facilities (0.048), lack of processing infrastructure (0.032), insufficient transport to access veterinary services (0.027), and limited skills for value addition (0.016) followed in significance. With a global priority scale value of 0.079, respondents rated attacks by predators as the greatest challenge, followed by mortality due to extreme weather conditions (0.034). High cost of private veterinary services (0.029) and insufficient practice of providing supplementary feed (0.028) also affected backyard poultry production, while theft (0.024) was considered the least significant factor.

Table 2. Priority weights of overall constraints faced by backyard poultry value chain actors

Factors	Priority Weights	λ (Max)	Consistency Index (CI)	Consistency Ratio (CR)	Rank
Input supply constraints	0.237	5.274	0.068	0.061	II
Production constraints	0.250				I
Marketing constraints	0.144				V
Processing and transportation constraints	0.174				IV
Miscellaneous constraints	0.195				III

Table 3. Local and global priorities of constraints among backyard poultry value chain actors

Factors	Scaling factors	Alternatives	Consistency Ratio (CR)	Priority of the within factors	Globally or overall priority of the criteria	Rank
Input supply constraints	0.237	IC1	0.015	0.114	0.027	IV
		IC2		0.106	0.025	V
		IC3		0.168	0.039	II
		IC4		0.150	0.036	III
		IC5		0.461	0.109	I
		λ(MAX) = 5.066		Consistency Index (CI) = 0.016		
Production constraints	0.250	PC1	0.031	0.260	0.065	I
		PC2		0.179	0.045	IV
		PC3		0.188	0.047	III
		PC4		0.213	0.053	II
		PC5		0.160	0.040	V
		λ(MAX) = 5.138		Consistency Index (CI) = 0.034		
Marketing constraints	0.144	MC1	0.025	0.25839	0.037	I
		MC2		0.18919	0.027	III
		MC3		0.17086	0.025	IV
		MC4		0.13964	0.020	V
		MC5		0.24193	0.035	II
		λ(MAX) = 5.114		Consistency Index (CI) = 0.028		
Processing and transportation constraints	0.174	PTC1	0.070	0.183	0.032	III
		PTC2		0.276	0.048	II
		PTC3		0.094	0.016	V
		PTC4		0.158	0.027	IV
		PTC5		0.288	0.050	I
		λ(MAX) = 5.114		Consistency Index (CI)=0.079		
Miscellaneous constraints	0.195	MSC1	0.045	0.407	0.079	I
		MSC2		0.175	0.034	II
		MSC3		0.147	0.029	III
		MSC4		0.147	0.028	IV
		MSC5		0.124	0.024	V
		λ(MAX) = 5.199		Consistency Index (CI) = 0.049		

DISCUSSION

Smallholders encountered trouble securing loans due to their limited financial resources and a lack of collateral, which in turn impeded their ability to make investments in the production of poultry. In an analogous manner, Kitalyi et al. (2014) highlighted that lack of access to finance, subsidies, and insurance support serves as a significant hurdle for smallholder poultry producers. The difficulty of backyard poultry farmers to receive veterinary care as well as medications and immunizations at the appropriate times was found to be a key barrier (Bwala et al., 2020). In a bid to combat the health concerns prevalent among backyard poultry producers, the present study triggered dire need for more effective veterinary services as well as improved access to medications and immunizations. Smallholders' efforts to boost the efficiency and viability of their poultry businesses were hampered by their limited access to superior breeding stock and the irregular supply of day-old chicks. The current results align with Rizal[a] et al. (2020), who reported limited access to improved germplasm and scarcity of day-old chicks as key challenges for smallholder backyard poultry producers.

Backyard poultry farmers often rely on free-range systems and kitchen waste to feed their birds because high cost of commercial feed limits their ability to purchase balanced rations (Gupta et al., 2014; Akter et al., 2018). While scavenging and using household leftovers, farmers reduce production expenses, it may compromise the birds' balanced nutrition, highlighting the trade-off between cost-saving and optimal growth in low-input backyard poultry systems. Low hatchability underlined the necessity for improved breeding initiatives and hatchery management strategies to conquer this challenge (Kibet et al., 2020). The lack of cognizant awareness concerning scientific poultry production techniques emphasized the stipulation for capacity building and training programmes to augment smallholder producers' knowledge and expertise in poultry management techniques (Sahu & Singh, 2014; Omondi et al., 2019; Jadoun, 2021). To address low productivity and high mortality in native birds, the study stressed the need for stronger biosecurity, disease control, and better access to vaccines and medicines (Bwala et al., 2020).

The respondents stated that inadequate knowledge of market patterns and prices, hampered their potential to decide wisely and

bargain for higher prices (Leksrisompong et al., 2019). The findings suggested that upgraded market intelligence and more potent market ties might be the crucial components that require urgent consideration to prevail over these roadblocks (Bwala et al., 2020). The respondents specified that due to restricted transportation, substandard infrastructure, and a dearth of market knowledge, they often experience trouble reaching formal marketplaces (Das et al., 2014; Sarker et al., 2017).

The poor transport facilities and amenities affected the market accessibility resulting in detrimental effect on their profitability (Yadav et al., 2018; Musyoka et al., 2020). The present findings of the study anticipated that there is dire requirement for better storage infrastructure and processing amenities since restricted access to processing infrastructure and skills mired the capability of smallholders to add value to their poultry products and capture remunerative prices in the market (Bwala et al., 2020; Rizal[b] et al., 2020). Omondi et al. (2019) revealed analogous findings stating that an acute lack of value addition competencies demands regular capacity building programmes to boost smallholder producers' awareness and proficiency.

Since the predator attacks triggered the farmers to suffer considerable losses while rendering it challenging to run a profitable business, some respondents were found to keep their birds in enclosed structures to mitigate the likelihood of predator attacks and more successfully safeguard their poultry. Farmers reported a higher mortality rate during the winters months when temperature is considerably low. Farmers often relied on kitchen waste or scavenging for their poultry, which could lead to insufficient nourishment and reduced efficiency (Singh et al., 2020). (Kumaresan et al., 2008; Islam et al., 2022) reported analogous results indicating the theft was found to be a substantial concern among backyard poultry farmers.

CONCLUSION

The study analyzed and evaluated the constraints in backyard poultry farming value chain. AHP was used to prioritize various constraints confronted by backyard poultry farmers. In context of overall bottlenecks, production constraints were ranked first, followed by input supply constraints, miscellaneous constraints, processing & transportation constraints, and marketing constraints, and. Furthermore, lack of access to credit, subsidy, and insurance support; high cost of concentrate feed; restricted access to market information, inadequate transportation from production areas to markets, attacks by predators, were identified as the topmost waivers among backyard poultry farmers. Addressing these bottlenecks requires a holistic approach involving government support, investment in infrastructure and research, capacity building for farmers, improved market linkages, and policy reforms to create an enabling environment for the backyard poultry farming value chain to thrive.

DECLARATIONS

Ethical approval and informed consent: The institutional Ethical Committee of Dayanand Medical College and Hospital, Ludhiana, has provided ethical clearance (Ethics approval number: DMCH/R&D/2022/120) to conduct this study.

Conflict of interest: The authors declare that research was conducted in the absence of any commercial or financial relationship that could as a potential conflict of interest.

The authors declare that during the preparation of this work, they thoroughly reviewed, revised, and edited the content as needed. The author takes full responsibility for the final content of this publication.

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