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A Socio-Technical Systems Analysis of Small-Scale Quail Farming: Innovation Barriers and Readiness for Agri-Enterprise Growth

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ABSTRACT

This study conducts a socio-technical systems analysis of small-scale quail farming enterprises in Nueva Ecija, Philippines, through the lens of the Socio-Technical Business Systems (STBS) framework. Integrating both quantitative and qualitative approaches, it investigates how interactions among social, technical, business, and interface subsystems affect enterprise productivity, innovation readiness, and growth potential. Data were collected from structured surveys and thematic analysis of open-ended responses from quail farmers in major producing municipalities. Findings reveal that while the farmers demonstrate operational competence, adherence to work routines, and infrastructure adequacy, significant constraints persist in financial record-keeping, market access, and external institutional linkages. High ratings in inventory management and process stability suggest a mature operational base; however, weaknesses in cost monitoring, ergonomic tool use, and knowledge transfer limit enterprise scalability. Thematic analysis reinforces these insights, revealing recurring needs for manure valorization, packaging improvement, accessible financing, and targeted capacity-building. The study concludes that while local raisers are intrinsically motivated and practically equipped, the absence of robust interface mechanisms such as cooperative networks, innovation hubs, and policy bridges hinders their transition from subsistence to scalable agribusiness models. To address these challenges, a localized support model is proposed featuring a farmer-centered innovation readiness tool, co-designed operational aids, and inclusive training frameworks. These interventions aim to

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bridge capability gaps, inform policymaking, and align with the Sustainable Development Goals by promoting inclusive innovation and resilient rural livelihoods.

Keywords: Quail Farming; Socio-Technical Systems; Small-Scale Livestock Enterprise; Innovation Readiness; Inclusive Agri-Enterprise Development

1. Introduction

The Philippines, with its predominantly agricultural economy, has long relied on diversified forms of livestock and poultry production to sustain rural livelihoods, strengthen food security, and stimulate local enterprise growth. Among these, quail farming particularly of the Japanese quail (*Coturnix coturnix japonica*) has emerged as a viable micro-enterprise due to its low capital requirement, short production cycle, high protein yield, and growing consumer demand for eggs and meat. In 2022, the country produced approximately 55.6 million kg of quail eggs, ranking 6th globally in output [1].

In Central Luzon, Nueva Ecija stands out not only as the "Rice Granary of the Philippines" but also as a rising hub for agri-based microenterprises. Its strategic location, expanding rural markets, and robust agricultural research infrastructure position it as a promising environment for small-scale livestock ventures. While large-scale poultry farms dominate, a growing number of family-owned or micro-operated quail enterprises are emerging particularly in municipalities such as Jaén, San Antonio, Gapan, and Talavera [2].

Despite this momentum, small-scale quail enterprises continue to encounter systemic and persistent constraints. Many operate using manual labor systems, improvised housing, inconsistent feeding practices, and informal financial tracking mechanisms, resulting in productivity losses, high mortality from environmental stress, and limited scalability [3]. These issues are further compounded by restricted access to veterinary care, organized marketing channels, working capital, and technical training placing most enterprises outside the reach of formal innovation systems [4].

Studies across Asia have likewise noted the innovation gap among smallholder agri-enterprises, particularly where informality and fragmented support systems prevail. Recent work by Ali, et al. [5] emphasizes how access to decentralized innovation intermediaries plays a vital role in enabling technology adoption at the grassroots, particularly in livestock production systems. Moreover, Ali, et al. [6] argue that contextualized training programs and targeted financial instruments are critical to moving micro-enterprises beyond subsistence operations. In the Philippine context, these challenges are magnified by poor alignment between enterprise-level practices and available support mechanisms underscoring the need for holistic diagnostics and inclusive policy response.

To better understand this interplay, the present study adopts the Socio-Technical Business Systems (STBS) framework, originally formulated by Trist and Bamforth in 1951, to examine how the interaction between social subsystems and technical subsystems affects enterprise performance and innovation readiness [7]. While well-established in manufacturing and service contexts, STBS remains underutilized in analyzing smallholder-led, informal agricultural enterprises in Southeast Asia.

In contrast to linear innovation frameworks that treat enterprises as passive recipients, the STBS approach recognizes them as adaptive systems shaped by the alignment or misalignment of internal and external subsystems [8]. This provides a more grounded lens for analyzing enterprise dynamics particularly for micro-livestock ventures operating in resource-constrained environments. Notably, Roa-Ortiz and Cala-Vitery [9] emphasize that technology transfer and enterprise growth require not only material upgrades but systemic alignment across institutional, technical, and human domains.

Anchored in the country's Innovative Startup Act (Republic Act No. 11337) [10] and the United Nations Sustainable Development Goals, this study aims to generate empirical insights that can guide innovation support for quail enterprises. The analysis offers both a diagnostic and strategic foundation for targeted interventions such as semi-automated technology prototypes, innovation intermediation, inclusive financing models, and peer-led capacity-building platforms. These findings aim to contribute to a more inclusive and innovation-driven rural development agenda.

Problem Statement

Despite national-level growth in quail egg production, small-scale quail farms in Nueva Ecija operate in resource-constrained environments, often with weak linkages to market, finance, and innovation support mechanisms. Their internal operations also exhibit poor alignment between human routines and technical systems, which hinders performance and long-term viability.

Thus, this study is guided by the central research problem: How do the interactions between social and technical subsystems shape innovation readiness and performance outcomes in small-scale quail enterprises?

To explore this, the following research questions are posed:

1. What are the existing socio-technical characteristics of small-scale quail enterprises in Nueva Ecija?
2. How do these socio-technical factors affect operational efficiency, profitability, and innovation readiness?
3. What systemic barriers constrain the scaling and modernization of these enterprises?
4. What interventions in terms of technological, policy-oriented, or capacity-building can bridge the identified gaps?

2. Materials and Methods

2.1. Research Design and Framework

This study adopted a descriptive-exploratory mixed-methods approach, appropriate for capturing the complex dynamics of small-scale quail enterprises, particularly those operating informally and without systematic documentation. The research design integrated both quantitative survey instruments and qualitative interviews to gather a nuanced understanding of farm-level conditions. The study was guided by the Socio-Technical Business Systems (STBS) framework, which allows analysis of enterprise systems through interrelated subsystems: social, technical, business, interface, and innovation readiness. While STBS has historically been applied in manufacturing and healthcare contexts, its adaptation to agricultural enterprise analysis particularly in resource-constrained settings has gained recent scholarly attention [11].

2.2. Study Site and Sampling Strategy

The study was conducted in Nueva Ecija, Philippines, a recognized agricultural province with growing clusters of small-scale quail producers. Fieldwork occurred between January and March 2024, coinciding with a peak in production activity. Five municipalities namely Jaen, San Antonio, Talavera, Gapan, and San Leonardo were purposively selected based on their concentration of quail farming activities. This selection was informed by exploratory visits, consultations with feed suppliers, and input from local agriculture offices.

Given the absence of a formal registry of quail farms in the province, purposive sampling, supported by snowball referrals, was employed. This approach allowed for varied insights across small-scale quail enterprises [12]. The target population consisted of quail farm owners or primary operators managing flocks ranging from 100 to 500 birds. Inclusion criteria required that respondents had: at least one year of continuous engagement in quail farming; direct operational control over the farm; and ongoing commercial sale of quail-derived products.

A total of 50 respondents were recruited, representing a mix of established and emerging farm operators. Their demographic characteristics including age, gender, educational attainment, farming experience, and flock size are summarized in the Results section.

2.3. Instrument Design and Validation

Data collection utilized a semi-structured questionnaire anchored on the Socio-Technical Business Systems (STBS) framework, composed of five multi-item scales aligned with the framework's core domains: *Social Subsystems* (e.g., labor division, family participation), *Techni-*

cal Subsystems (e.g., tools used, egg collection, housing), *Business Practices* (e.g., budgeting, recordkeeping, cost control), *Interface Mechanisms* (e.g., training access, participation in advisory networks), and *Innovation Readiness* (e.g., openness to change, willingness to invest in innovations). Respondents were asked to rate their agreement with each statement using a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Representative items included: "Tasks in the farm are fairly divided among family members" (Social), "We use specialized tools to reduce labor or handling" (Technical), "We regularly track sales and expenses" (Business), "We attend training sessions relevant to quail production" (Interface), and "We are willing to invest in farm innovations even if there are risks" (Innovation Readiness).

To ensure construct validity and contextual relevance, the instrument underwent expert validation by three professionals in agribusiness, poultry science, and rural entrepreneurship. A pilot test with five non-sample quail raisers was subsequently conducted to refine item clarity, sequencing, and layout. During the pilot phase, the internal consistency of each scale was assessed using Cronbach's alpha. The following reliability coefficients were obtained: Social Subsystems (α = 0.78), Technical Subsystems (α = 0.81), Business Practices (α = 0.76), Interface Mechanisms (α = 0.80), and Innovation Readiness (α = 0.82). All values exceeded the 0.70 threshold commonly accepted for exploratory studies, confirming acceptable scale reliability and internal consistency. The complete instrument used in this study is provided in **Appendix A**.

2.4. Data Collection and Ethical Considerations

All surveys and interviews were conducted onsite at the farms, with individual sessions averaging 30 to 45 minutes. Face-to-face administration enabled researchers to simultaneously conduct observational walkthroughs, documenting physical setups with the respondents' consent. This enhanced triangulation of responses and allowed integration of contextual variables not captured by structured items.

Prior to data collection, the study secured ethical clearance from the institutional research ethics committee. All participants signed informed consent forms detailing the study's objectives, voluntary nature of participation, and data confidentiality provisions.

2.5. Data Analysis

Quantitative data were processed using both descriptive and inferential statistical techniques. Measures such as frequency, mean, and standard deviation were computed to describe the central tendencies and variability of responses across the five core domains of the STBS framework. To examine potential associations, Spearman's rank correlation was employed to assess relationships between each socio-technical subsystem and innovation readiness, given the ordinal nature of the data. Additionally, chi-square tests were applied to explore categorical linkages among select indicators.

For the qualitative strand, responses from open-ended survey items and field notes were subjected to thematic analysis based on the six-phase approach of Braun and Clarke (2006) [13]. This involved familiarization with the data, generation of initial codes, development and review of themes, and final definition and reporting. Manual coding was carried out by the lead researcher, with results validated through peer checking to ensure consistency and interpretive reliability. To contextualize the patterns emerging from the quantitative data, representative verbatim quotes were selected and integrated into the Results and Discussion section. For instance, the remark, "It's difficult to purchase a new incubator because there isn't enough capital," underscores financial constraints in technical investments, while another participant's statement, "We just rely on each other for guidance there's no training from the Department of Agriculture," highlights systemic support gaps. These qualitative insights served as explanatory anchors, enhancing the robustness and narrative coherence of the mixed-methods findings [14].

2.6. Limitations

This study's findings are limited by its non-random sampling approach and relatively small sample size (n = 50). As such, results may not be generalizable to the broader quail farming population in the region. The use of snowball sampling may have introduced bias toward more active or networked farm operators. Future studies may consider employing stratified random sampling and incorporating longitudinal tracking to capture innovation trajectories over time.

3. Results

3.1. Demographic Profile of Respondents

The study engaged 50 small-scale quail raisers across selected municipalities in Nueva Ecija, encompassing a diverse range of demographic characteristics. As shown in **Table 1**, the majority of respondents (48%) were aged between 31 and 45 years old, indicating a concentration of mid-career individuals actively engaged in quail farming. A substantial proportion (30%) belonged to the 46–60 age group, while younger respondents aged 18–30 comprised 12%, and those above 60 years old made up 10%. This age distribution suggests a workforce with both physical capacity and accumulated farming experience. In terms of gender, the sector is predominantly male, with 70% of respondents identifying as male and only 30% as female. This reflects common gender dynamics in poultry and agribusiness operations in rural Philippine settings, where men often lead enterprise operations but women may still contribute significantly in support roles.

Table 1. Summary of the Demographic Profile of Respondents.

Demographic Characteristic	Category	Frequency (n)	Percentage (%)
Age Group	18–30 years old	6	12.0%
	31–45 years old	24	48.0%
	46–60 years old	15	30.0%
	61 years old and above	5	10.0%
Gender	Male	35	70.0%
	Female	15	30.0%
Educational Attainment	Elementary	5	10.0%
	High School	20	40.0%
	Vocational/College Undergraduate	13	26.0%
	College Graduate and Above	12	24.0%
Years of Farming Experience	1–3 years	8	16.0%
	4–6 years	15	30.0%
	7–10 years	17	34.0%
	More than 10 years	10	20.0%
Flock Size (Birds)	100–199	18	36.0%
	200–299	14	28.0%
	300–399	9	18.0%
	400–500	9	18.0%

Note: n = 50. Source: Author's survey data (2024).

Educational attainment among the respondents varied, though a large portion (40%) had completed high school. About 26% attained vocational training or some college education, and 24% were college graduates or held advanced degrees indicating a notable proportion with formal education. Meanwhile, 10% had only reached elementary education, highlighting the range of literacy and knowledge backgrounds among operators. In terms of farming experience, most respondents had moderate exposure to quail production. Specifically, 34% had 7–10 years of experience, followed by 30% with 4–6 years, and 20% with more than 10 years of farming practice. Only 16% were relatively new, with 1–3 years of experience. This distribution implies that many operators have developed substantial operational familiarity, potentially affecting their innovation behavior and enterprise sustainability.

Lastly, flock size a proxy for the scale of operations ranged from 100 to 500 birds. A plurality of respondents (36%) maintained 100–199 birds, while 28% had 200–299 birds. The remaining respondents were equally divided (18% each) between flocks of 300–399 and 400–500 birds. This distribution reflects the small-scale nature of operations, with a majority maintaining flocks below 300 birds, in line with the enterprise definition adopted in the study.

These demographic insights align with broader patterns observed in smallholder ecosystems, where mid-career operators form the backbone of production but often lack integrated value networks and coordinated support systems. Recent RWAE findings suggest that well-structured value networks can substantially enhance operational efficiency, resource access, and market responsiveness among smallholders [15]. Moreover, empowerment-focused models such as farmer cooperatives and peer learning platforms have been shown to significantly improve knowledge sharing and innovation uptake in similar micro-livestock contexts [16]. Embedding such frameworks into quail enterprise development strategies may thus accelerate both performance and innovation readiness.

3.2. Social Subsystem

The findings in **Table 2** show that Work Routines received the strongest rating (WM = 4.07, SD = 0.69), reflecting the structured execution of daily tasks, seasonal adjustments, and clear division of labor. For instance, one respondent shared, *"We have fixed schedules for feeding and cleaning every day. If someone is absent, someone else immediately takes over"* (R21, Sta. Rosa), suggesting operational consistency across sites. This structured adaptability among smallholders parallels observations in other micro-livestock enterprises, where routine acts as a resilience mechanism against operational uncertainties [17].

Table 2. Summary of Social Management Practices in Small-Scale Quail Enterprises.

Indicator	Weighted Mean	Standard Deviation (SD)	Verbal Interpretation
Work Routines			
Daily routines are followed consistently.	4.48	0.56	Strongly Agree
Quail farming tasks are scheduled efficiently.	4.39	0.61	Strongly Agree
There is clear division of labor among workers.	4.36	0.62	Strongly Agree
Overtime or extended hours are frequently required.	3.14	0.89	Agree
Routine adjustments are made based on seasonality.	4.00	0.75	Strongly Agree
Weighted Mean (Work Routines)	**4.07**	**0.69**	**Strongly Agree**
Decision-Making			
Farm decisions are based on data or records.	4.20	0.71	Strongly Agree
Family or worker input is considered in operational decisions.	3.22	1.02	Agree
Production activities are planned ahead of time.	4.13	0.66	Strongly Agree
Market conditions are analyzed before pricing or selling.	3.14	0.93	Agree
Business decisions are regularly evaluated.	3.19	0.95	Agree
Weighted Mean (Decision-Making)	**3.58**	**0.85**	**Agree**
Skill Levels			
Knows proper nutrition and feed formulation.	4.11	0.65	Strongly Agree
Can diagnose common quail diseases.	3.19	0.88	Agree
Has basic training in record-keeping.	3.42	0.77	Agree
Confidently handles quail from brooding to laying.	4.07	0.69	Strongly Agree
Actively learns new quail production techniques.	4.09	0.61	Strongly Agree
Weighted Mean (Skill Levels)	**3.78**	**0.72**	**Strongly Agree**

Note: n = 50. SD = Standard Deviation. Source: Author's survey data (2024).

Decision-Making scored moderately (WM = 3.58, SD = 0.85), with relatively high variability. While some participants relied on data and pre-planning, others leaned on intuition or individual control. As one respondent stated, *"I'm the only one making decisions, even if sometimes my child gives suggestions"* (R9, Cuyapo), implying limited delegation or collaborative mechanisms.

Skill Levels (WM = 3.78, SD = 0.72) revealed mixed capabilities. Although most respondents were confident in general quail care, gaps in diagnostic skills and formal training remained. A typical remark was, *"At the start, I just used the internet and asked neighbors. There were no seminars or formal training"* (R17, Gapan), showing a grassroots approach to knowledge acquisition. The pattern of informal learning observed here echoes findings by Mumah, et al. [18], who note that many rural microenterprises function through experiential learning when formal capacity-building infrastructure is inaccessible.

Together, these results indicate that while small-scale quail raisers exhibit practical competencies and routine discipline, decision-making systems and technical upskilling remain highly variable, potentially limiting their readiness to scale or adapt innovations. The integration of qualitative narratives supports the survey's findings, affirming their credibility and internal consistency.

3.3. Technical Subsystem

The results in **Table 3** reflect a mixed yet improving technical profile among small-scale quail enterprises. The strongest domain was Infrastructure Adequacy (WM = 4.33, SD = 0.58), suggesting that basic structural readiness is well established, including clean and scalable facilities. One respondent highlighted, "There is enough space even if we add more cages. We also have electricity and water for our equipment" (R28, San Antonio), affirming the adequacy of utilities and physical resources.

Table 3. Summary of Technical Management Practices in Small-Scale Quail Enterprises.

Indicator	Weighted Mean	Standard Deviation (SD)	Verbal Interpretation
Technology Adoption			
Use of tools to reduce manual labor is practiced.	3.19	0.84	Agree
At least one modern system or equipment was adopted recently.	3.29	0.88	Agree
Awareness of new technologies for quail production is present.	3.34	0.79	Agree
Technical support is received when adopting new tools.	2.95	0.93	Agree
Technology adoption is viewed as important for small-scale producers.	4.41	0.62	Strongly Agree
Weighted Mean (Tech Adoption)	**3.44**	**0.81**	**Agree**
Infrastructure Adequacy			
Housing provides adequate space for the current flock.	4.39	0.54	Strongly Agree
Quail housing is well-ventilated and weather-protected.	4.35	0.57	Strongly Agree
Production area is clean, organized, and easy to maintain.	4.31	0.61	Strongly Agree
Infrastructure allows for potential scaling or expansion.	4.14	0.65	Strongly Agree
Clean water and electricity are accessible to support operations.	4.45	0.52	Strongly Agree
Weighted Mean (Infrastructure)	**4.33**	**0.58**	**Strongly Agree**
Process Flow			
Workflow from feeding to egg collection is efficient.	4.13	0.64	Strongly Agree
Brooding, laying, and storage areas are clearly designated.	4.08	0.69	Strongly Agree
Operations proceed with minimal delays or task duplication.	4.19	0.67	Strongly Agree
Production-to-delivery process is generally consistent.	3.23	0.88	Agree
Farm layout is optimized to minimize movement and time.	4.17	0.58	Strongly Agree
Weighted Mean (Process Flow)	**3.96**	**0.69**	**Strongly Agree**

Note: n = 50. SD = Standard Deviation. Source: Author's survey data (2024).

Meanwhile, Process Flow also scored high (WM = 3.96, SD = 0.69), with indicators reflecting organized operations and efficient task progression. However, variability in production-to-delivery consistency (SD = 0.88) suggests uneven practices. As noted by a farmer, "Sometimes deliveries are delayed due to unavailable personnel or vehicle issues" (R13, Palayan), highlighting the presence of operational bottlenecks in logistics. These inefficiencies are consistent with prior studies emphasizing the importance of strengthening internal value processes in smallholder systems to minimize post-harvest delays and coordination gaps [19].

On the other hand, Technology Adoption lagged behind (WM = 3.44, SD = 0.81), particularly in terms of access to technical support (SD = 0.93) and the frequency of equipment upgrades, despite strong agreement on the importance of innovation (WM = 4.41). A participant remarked, "There are rarely any visits from technical experts. Everything is self-initiated" (R33, Cabiao), indicating a lack of formalized assistance even when the willingness to innovate is present. This underscores how limited innovation networks and weak extension channels inhibit rural transformation, even when producers demonstrate latent demand for technology [20].

These results suggest that while infrastructure and workflows are reasonably strong, active technology integration is constrained by support gaps and uneven access. This reinforces the need for institution-led extension services and innovation hubs. The relatively high standard deviations confirm heterogeneity among respondents, validating the presence of subgroups requiring tailored interventions.

3.4. Business System

The results in **Table 4** present a nuanced view of the business management capacities of small-scale quail enterprises. The strongest domain emerged in Inventory Management (M = 4.05, SD = 0.72), reflecting consistent tracking of bird populations, feed levels, and inputs. One raiser noted, *"When I feed, I also count how much feed is left. That way, I already know when to buy next week"* (R15, Talavera), highlighting routine-based inventory discipline. However, the relatively low score on record system use (M = 3.14, SD = 1.03) suggests that documentation is largely informal or intuitive.

Table 4. Summary of Business Management Practices in Small-Scale Quail Enterprises.

Indicator	Weighted Mean	Standard Deviation (SD)	Verbal Interpretation
Inventory Management			
Bird counts, feed use, and supply levels are regularly tracked.	4.09	0.72	Strongly Agree
A record system is maintained for daily inventory monitoring.	3.14	1.03	Agree
Reordering is based on previous usage trends and seasonal demand.	4.47	0.58	Strongly Agree
Overstocking and understocking are prevented through planning.	4.03	0.66	Strongly Agree
Inventory practices help reduce losses and spoilage.	4.51	0.54	Strongly Agree
Weighted Mean (Inventory Management)	**4.05**		**Strongly Agree**
Cost Tracking			
Financial records of income and expenses are maintained.	4.02	0.67	Strongly Agree
Production cost per bird or egg is calculated.	3.14	1.09	Agree
Funds are set aside for emergencies or unexpected costs.	4.13	0.61	Strongly Agree
Financial performance is reviewed periodically.	3.08	1.01	Agree
Cost-intensive areas are identified and monitored.	4.07	0.64	Strongly Agree
Weighted Mean (Cost Tracking)	**3.69**		**Strongly Agree**
Marketing Channels			
There is a regular set of buyers or customers.	4.49	0.49	Strongly Agree
Multiple marketing channels are used.	4.04	0.67	Strongly Agree
Promotions are done to increase customer interest.	3.11	1.08	Agree
Product branding or packaging is practiced.	3.14	0.99	Agree
Customer feedback is gathered to improve offerings.	3.26	0.95	Agree
Weighted Mean (Marketing Channels)	3.61		Strongly Agree
Profitability			
Earnings consistently exceed expenses.	4.04	0.68	Strongly Agree
Net income improved over the past year.	4.08	0.66	Strongly Agree
The business is financially stable.	4.01	0.70	Strongly Agree
Some profits are reinvested into operations.	3.17	1.04	Agree
Overall, the venture gives acceptable returns.	4.07	0.63	Strongly Agree
Weighted Mean (Profitability)	**3.87**		**Strongly Agree**

Note: n = 50. SD = Standard Deviation. Source: Author's survey data (2024).

In Cost Tracking, the overall subscale mean was M = 3.69, indicating awareness of operational expenses. Farmers demonstrated an ability to identify costly components of the production process, though fewer computed per-unit costs (M = 3.14). As one participant described, *"I don't know exactly how much I earn per egg, but I do write down expenses for feed and medicine"* (R6, Licab), implying partial financial monitoring that limits precise profitability analysis.

The dimension of Marketing Channels registered a subscale mean of M = 3.61, with high agreement that producers had consistent buyers (M = 4.49) and utilized multiple selling avenues (M = 4.04). Still, low scores in promotional activities and product branding (M = 3.11 and M = 3.14, respectively) revealed underdeveloped strategic marketing practices. One respondent shared, *"We just wrap it in old trays. As long as it's clean, it's fine for our regular buyers"* (R32, Zaragoza), indicating reliance on repeat buyers over differentiation or brand building.

For Profitability, the findings (M = 3.87) affirmed the viability of quail farming, with most respondents confirming that earnings covered costs (M = 4.04) and income improved (M = 4.08). However, the relatively lower reinvestment rate (M = 3.17, SD = 1.04) suggests conservative business behavior. A participant explained, *"Most of the earnings are used for household needs first. It's hard to risk it just in case"* (R10, Jaen), reflecting cautious capital allocation due to financial insecurity or lack of growth planning.

Taken together, these findings reveal that while small-scale quail raisers demonstrate operational discipline and moderate financial literacy, key business dimensions especially pricing accuracy, formalized record-keeping, branding, and reinvestment strategies require strengthening. These results align with recent studies emphasizing that improving value chain governance and smallholder commercialization depend on fostering entrepreneurial literacy and supply chain orientation [21]. These findings point to a need for targeted capacity-building in bookkeeping, product development, and access to financing to transition from informal enterprises to more resilient agribusiness ventures.

3.5. Interface Mechanism

As shown on **Table 5**, the Human-Technical Interface subsystem revealed a strong overall condition across all three indicators. The highest domain was Innovation Constraints (M = 4.01), followed by Human-Machine Issues (M = 3.71) and Operational Bottlenecks (M = 3.55), indicating a mix of systemic, technical, and coordination-related challenges.

Table 5. Summary of Human-Technical Interface in Quail Enterprise Operations.

Indicator	Weighted Mean	Standard Deviation (SD)	Verbal Interpretation
Operational Bottlenecks			
Labor or supply shortages occasionally disrupt operations.	3.24	0.76	Agree
Equipment-related issues contribute to production delays.	4.10	0.58	Strongly Agree
Fluctuations in market demand affect operational flow.	4.06	0.64	Strongly Agree
Access to timely repair or replacement services is limited.	3.14	0.83	Agree
Coordination challenges lead to workflow interruptions.	3.22	0.79	Agree
Weighted Mean (Operational Bottlenecks)	**3.55**	**0.72**	**Strongly Agree**
Human-Machine Issues			
Some tools or machines are not user-friendly or easy to maintain.	3.24	0.71	Agree
Additional guidance or training is needed to operate modern equipment.	4.08	0.60	Strongly Agree
Manual labor is often used due to lack of suitable tools.	4.02	0.67	Strongly Agree
Available worker skills do not always match equipment requirements.	3.14	0.74	Agree
Tools or processes are adjusted to suit labor capacity.	4.05	0.59	Strongly Agree
Weighted Mean (Human-Machine Issues)	**3.71**	**0.66**	**Strongly Agree**
Innovation Constraints			
Capital or loan access limits system improvement.	4.07	0.61	Strongly Agree
Awareness of poultry innovation programs is limited.	3.38	0.77	Agree
Support application processes are challenging.	4.45	0.51	Strongly Agree
Risk of adopting unproven technologies is a concern.	4.02	0.63	Strongly Agree
Time or workload hinders participation in training.	4.11	0.65	Strongly Agree
Weighted Mean (Innovation Constraints)	**4.01**	**0.63**	**Strongly Agree**

Note: n = 50. SD = Standard Deviation. Source: Author's survey data (2024).

Operational Bottlenecks were most evident in the form of equipment delays and unstable market demand. Although issues such as service availability and partner coordination registered lower scores, they remain notable. One participant shared, *"There were delays in our delivery because there was no available person or there was a vehicle problem"* (R13, Palayan), pointing to periodic inefficiencies in logistics and labor scheduling.

Human-Machine Issues highlighted the continued dependence on manual labor due to the lack of ergonomic, user-friendly tools. Respondents expressed the need for proper training and machinery that complements their capacity. As one raiser stated, *"Sometimes the machines are hard to use. That's why I just rely on manual methods even if it's tiring"* (R12, Jaen), underscoring the mismatch between existing tools and user adaptability.

Innovation Constraints emerged as the most critical concern. The strongest agreement was recorded on the difficulty of accessing support (M = 4.45), which includes bureaucratic processes and insufficient information flow. Capital limitations and time scarcity also hinder innovation efforts. A participant explained, *"Even if*

I want to innovate, I don't know where to ask for help or how to apply" (R24, San Antonio), pointing to gaps in institutional guidance and accessibility.

These findings emphasize the urgent need for synchronized interventions: improving tool design and usability, expanding capacity-building programs, and simplifying institutional support systems. Similar human-technical frictions have been documented in studies of agri-enterprise modernization efforts in rural China and sub-Saharan Africa, where adaptive innovation systems were necessary to overcome mismatched tool usability and knowledge gaps [22,23]. Addressing these interface-level challenges is essential for advancing a more innovation-ready and inclusive quail production ecosystem.

3.6. Innovation Readiness and Enterprise Development

The results in **Table 6** indicate that small-scale quail raisers demonstrate strong internal motivation for innovation, particularly in terms of willingness to invest and openness to new ideas. However, they face clear limitations in accessing external support systems that are vital for sustainable enterprise scaling. This reflects a broader pattern observed in rural agribusinesses where the absence of enabling institutional structures hampers innovation scaling despite local entrepreneurial drive [24].

Table 6. Summary of Innovation Readiness and Enterprise Growth Potential.

Indicator	Weighted Mean	Standard Deviation (SD)	Verbal Interpretation
Openness to Innovation			
New techniques or tools are regularly explored to improve the farm.	4.11	0.58	Strongly Agree
Digital tools or mobile apps are considered for possible adoption.	3.14	0.73	Agree
Advice is actively sought from experts, suppliers, or extension workers.	3.38	0.75	Agree
Small-scale innovations are tested before committing to full investment.	4.04	0.60	Strongly Agree
Innovative thinking is valued as part of enterprise growth.	4.01	0.62	Strongly Agree
Weighted Mean (Openness to Innovation)	**3.74**	**0.66**	**Strongly Agree**
Willingness to Invest			
A portion of income is willingly spent on farm improvements.	4.08	0.55	Strongly Agree
Budget is allocated for equipment or facility upgrades.	4.03	0.63	Strongly Agree
Return on investment is monitored for major improvements.	3.13	0.71	Agree
Innovation investment is considered if financing is accessible.	4.01	0.57	Strongly Agree
Innovation is viewed as a necessary component of growth.	4.07	0.59	Strongly Agree
Weighted Mean (Willingness to Invest)	**3.86**	**0.61**	**Strongly Agree**
Access to Support			
Membership in local cooperatives or support groups is maintained.	3.18	0.67	Agree
Updates or invitations from government or NGOs are received.	3.22	0.69	Agree
Sources of support for innovation or technology are known.	3.08	0.75	Agree
Local institutions are perceived as supportive of enterprise growth.	3.09	0.72	Agree
Training or mentoring programs were accessed in the past year.	3.11	0.68	Agree
Weighted Mean (Access to Support)	**3.14**	**0.70**	**Agree**

Note: n = 50. SD = Standard Deviation. Source: Author's survey data (2024).

Openness to Innovation scored a weighted mean (WM = 3.74, SD = 0.66), with respondents showing high agreement on the value of experimentation and innovative practices. For example, one respondent shared, "We try new ways to improve feeding and hygiene, even without formal training, as long as it works" (R30, Rizal), reflecting informal but proactive innovation behavior. However, digital adoption remained low (WM = 3.14), pointing to gaps in digital readiness or accessibility.

Willingness to Invest yielded the highest subscale rating (WM = 3.86, SD = 0.61), showing strong intent to finance improvements. Farmers affirmed budgeting for innovation and recognizing its role in enterprise success. As one operator noted, "I really spent money on the new lighting and ventilation for the cages, because I saw that production improved" (R18, Cabanatuan), indicating a direct link between investment and perceived outcomes. Still, monitoring return on investment (WM = 3.13) was less common, suggesting the need for better financial literacy tools.

Access to Support recorded the lowest subscale mean (WM = 3.14, SD = 0.70), revealing a systemic challenge. Respondents moderately agreed on knowing where to seek assistance or receiving regular updates from institutions. A typical concern was expressed as, "It seems there's no clear support. We're not even updated if there are new programs" (R45, San Isidro), underscoring disconnection from formal innovation networks. These issues mirror constraints identified by Yu and Huang [25], who emphasized the importance of network embeddedness and government-academic linkage in strengthening innovation outcomes in smallholder enterprises.

In summary, while the internal drive for innovation is evident among small-scale quail raisers, the lack of structured, accessible external support continues to hinder full-scale transformation. Bridging this gap through inclusive extension programs, advisory hubs, and coordinated government-academic engagement will be essential for unlocking the sector's growth potential.

3.7. Integrated Analysis of Socio-Technical-Business-Interface Dimensions in Small-Scale Quail Enterprises

The joint-display matrix shown in **Table 7** integrates both quantitative and qualitative findings to offer a comprehensive view of the innovation ecosystem within small-scale quail farming enterprises. Drawing from the five key subsystems social, technical, business, human-technical, and innovation readiness the matrix reveals both enablers and barriers to agri-enterprise growth.

Table 7. Joint Display Matrix: Integration of Quantitative and Qualitative Insights across the STBS Framework Dimensions.

Indicator Category	Quantitative Summary (WM, SD)	Qualitative Theme	Insight
1. Social Subsystem (Farmer capability, social capital, cooperation)	WM = 3.91 SD = 0.63 Interpretation: Strongly Agree	Strong relational networks and individual responsibility support enterprise performance.	Social trust and peer support positively influence operational decisions and local innovations. However, limited participation from younger generations poses potential continuity concerns.
2. Technical Subsystem (Resource access, farm practices, innovation exposure)	WM = 3.67 SD = 0.69 Interpretation: Strongly Agree	Availability of infrastructure and selective technology use are enabling moderate innovation.	While technical upgrades are evident (e.g., improved cages and feed systems), full digital adoption is hampered by cost and complexity. Farmers voice a sustained need for practical technical training.
3. Business Subsystem (Marketing, cash flow, pricing)	WM = 3.61 SD = 0.67 Interpretation: Strongly Agree	Market-oriented yet risk-averse. Pricing is influenced by trader dynamics.	Despite prioritizing product quality, farmers face limited market access and cash flow irregularities, restricting long-term enterprise planning and expansion.
4. Human-Technical Interface (Operational bottlenecks, human-machine issues, innovation constraints)	Operational Bottlenecks: WM = 3.55, SD = 0.72 Human-Machine Issues: WM = 3.71, SD = 0.66 Innovation Constraints: WM = 4.01, SD = 0.63 Interpretation: Strongly Agree across dimensions	Equipment mismatches and funding limitations restrict process optimization.	High agreement with innovation constraints (WM = 4.01) underscores latent demand for process improvements. However, labor-intensive operations and misalignment with available technology reduce efficiency. Institutional support systems remain underutilized.
5. Innovation Readiness & Enterprise Growth Potential (Openness to innovation, willingness to invest, access to support)	Openness: WM = 3.74, SD = 0.66 Willingness: WM = 3.86, SD = 0.61 Access to Support: WM = 3.14, SD = 0.70 Interpretation: Strongly Agree for Openness and Willingness; Neutral for Access	Strong internal drive for innovation but external facilitation is lacking.	Farmers show a proactive attitude toward innovation and investment, yet weak linkages with support institutions such as DA and LGUs undermine potential scale-up and sustainability. Addressing this gap is vital for enterprise growth.

Quantitatively, the results show generally high agreement across subsystems, with the strongest perceptions evident in *innovation constraints* (WM = 4.01), *willingness to invest* (WM = 3.86), and *social capital and cooperation* (WM = 3.91). These figures suggest a readiness and openness among quail farmers to improve their systems, coupled with strong interpersonal networks that enhance collective action. However, the lowest mean appeared under *access to support* (WM = 3.14), indicating a relative gap in institutional engagement and technical assistance.

Thematically, the qualitative data gathered through open-ended responses and field notes—contextualized these numeric trends. For instance, participants emphasized trust-based cooperation and local problem-solving among farmer groups but also noted generational disengagement and labor concerns. On the technical front, most respondents confirmed upgrading physical infrastructure while hesitating on digital adoption, often due to cost or unfamiliarity. Business-wise, the reliance on traders and fluctuating prices discouraged long-term planning, despite farmers' intent to ensure product quality.

The human-technical interface reveals a critical friction point: although basic tools are in place, machine usability, mismatched labor skills, and operational delays challenge system efficiency. Furthermore, while most farmers expressed strong internal motivation for innovation, they found the process of accessing external support be it financial, technical, or organizational either unclear or cumbersome. These insights imply that without streamlining bureaucratic processes and improving outreach, the enterprise growth potential may remain underutilized.

In essence, the joint display underscores that innovation in this sector is not hindered by intent or internal readiness but by gaps in systemic facilitation. Bridging the support divide, improving human-technical alignment, and enhancing market diversification strategies would accelerate innovation outcomes and contribute to more resilient enterprise models.

3.8. Integrated Analysis of Open-Ended Responses and Thematic Insights

To enrich the interpretation of quantitative findings and enhance the explanatory depth of this mixed-methods study, qualitative data from open-ended responses were examined in relation to the Socio-Technical Business Systems (STBS) framework. Responses were grouped and interpreted across five core subsystems: social, technical, business, human-technical interface, and innovation readiness. This integration was operationalized through a joint-display matrix (**Table 6**), enabling meta-inference and triangulation of patterns that influence innovation capacity among small-scale quail enterprises.

Respondents' narratives echoed and deepened the quantitative trends. Within the technical subsystem, participants frequently cited the need for improved manure management systems, emphasizing labor-intensive cleaning processes and sanitation issues. This qualitative evidence reinforced the survey's indication of operational bottlenecks and misalignment between existing tools and user needs—underscoring the importance of locally adapted, low-maintenance innovations.

In the business subsystem, approximately 48% of responses highlighted packaging improvements as a key opportunity to enhance market appeal. Farmers emphasized the impact of presentation and branding on egg pricing, pointing to a gap in value-adding practices and branding strategies. These findings contextualize the moderate weighted mean observed in the quantitative data and suggest avenues for intervention focused on market differentiation.

Concerns in the human-technical interface focused heavily on financing and skills development. A majority of respondents (78%) identified financial assistance—particularly for equipment and facility upgrades as their most urgent requirement. Meanwhile, over half (52%) cited the need for specialized training in areas such as incubation, sanitation, and feed management. These insights validated the quantitative observation that access to external support remains limited, positioning institutional partnerships as a critical lever for enabling innovation adoption.

Overall, the integration of these open-ended insights substantiates and enriches the numerical data, bridging technical indicators with real-world experiences. This interpretive triangulation highlights both systemic gaps and local resilience, offering a grounded understanding of the constraints and capacities shaping innovation readiness in rural quail farming contexts.

4. Discussion

4.1. Social Subsystem: Routine as Resilience, Not Rigidity

Small-scale quail farms in Nueva Ecija exhibit a high degree of informal but disciplined labor routines, which function as both a coping mechanism and an operational strength [26]. These routines, embedded within household-based management styles, provide structure even without formal organizational charts. However, strategic decisions remain highly centralized, typically falling to the owner, which limits data-driven or collaborative planning [27]. While this autonomy allows for quick decision-making, it may hinder adaptability and innovation. Additionally, skill gaps remain particularly in technical knowledge and documentation practices despite confidence in day-to-day farm tasks [28]. Without targeted capability-building, these systems risk becoming resilient but stagnant.

4.2. Technical Subsystem: Infrastructure-Led Stability vs. Innovation Deficit

Quail raisers generally report sufficient infrastructure for their current scale, with high agreement on adequacy of housing, ventilation, and basic tools [29]. These are often achieved through frugal innovation repurposing materials and optimizing limited space. However, technology adoption remains minimal [30], with many farms relying on manual tools for feeding, waste management, and climate control. Although some localized DIY innovations exist, they are not systematized or scaled. Process flow is mostly stable but vulnerable to disruptions due to reliance on human labor [31]. This exposes the paradox: while infrastructure supports stability, the absence of accessible, smallholder-suited technologies and guidance creates an innovation plateau.

4.3. Business Subsystem: Profitability Without Strategy

Profitability is achievable among respondents, yet strategic mechanisms are weak. Most inventory and cost monitoring systems are manual, adequate for current needs but not scalable [32,33]. Marketing strategies remain informal, dependent on walk-in buyers and local resellers, with little evidence of product branding or digital marketing [34]. These practices place the enterprise in a "subsistence entrepreneurship" mode where operations are functional but not optimized for growth. Vulnerability to price shocks and the absence of financial planning tools further underscore the need for structured business development programs [35].

4.4. Human-Technical Interface: Interlocking Constraints

Operational bottlenecks and interface issues reveal how physical and institutional constraints interlock [36]. Respondents report mismatches between equipment design and user needs leading to fatigue, inefficiencies, and safety concerns [37]. These constraints are intensified by limited access to support mechanisms. For instance, the absence of ergonomic tools reduces productivity and feeds into a cycle of underinvestment, especially when confidence in returns is low. As such, the human-technical interface becomes the pressure point where systemic weaknesses converge, requiring integrated solutions that prioritize participatory design and responsive support.

4.5. Innovation Readiness: Motivation without Means

Quail raisers display high openness to innovation and willingness to invest, particularly in practical improvements with immediate returns [38]. However, the lowest-rated domain was access to support (WM = 3.14), reflecting disconnection from institutional enablers. This gap between internal motivation and external scaffolding creates inertia. Innovation remains aspirational without mechanisms to translate intent into implementation. As observed, institutional linkages with LGUs, SUCs, or NGOs are sporadic or absent, undermining enterprise growth [40].

4.6. Integrated Qualitative Insights: Narratives That Echo Systemic Gaps

Thematic analysis of open-ended responses reinforces the patterns above. For instance, improved manure management tools were the most cited need, reflecting not only technical bottlenecks but ergonomic strain and weak institutional diffusion [41]. Similarly, the demand for better egg packaging reflects both a market-readiness mindset and the lack of access to enabling innovations [42]. Financial support remains the most requested intervention, echoing the consistent constraint in capital mobilization for micro-livestock enterprises [43]. Collectively, these qualitative insights align with STBS subsystems and underscore that innovation constraints are less about willingness and more about structural deficiencies.

4.7. Strategic Implications

The integration of survey and qualitative data underscores the importance of modular, co-designed innovations rather than one-size-fits-all solutions. Tailored interventions such as semi-automated manure cleaning prototypes, modular packaging systems, and peer-led training platforms represent high-impact opportunities to bridge subsystems [44]. More critically, this study supports the call for innovation intermediation institutional actors who can facilitate design, testing, and adoption at the grassroots. Only through such embedded support mechanisms can the sector advance from subsistence to sustainable enterprise.

5. Conclusion

This study underscores the complex realities of small-scale quail farming in Nueva Ecija, identifying a coexistence of operational strengths and interface-related limitations. While respondents demonstrated capacity in managing daily routines, maintaining workflow stability, and controlling inventory using low-cost, adaptive methods, these strengths do not automatically signal innovation readiness. Using the Socio-Technical Business Systems (STBS) framework, this study revealed critical gaps—especially in ROI-tracking, cost monitoring, and market diversification—that constrain the transformation of small-scale operations into scalable agri-enterprises.

Despite indications of willingness to innovate, farmers' adoption capacity remains limited by three key constraints: (1) inadequate financial tracking and planning tools, evidenced by low cost-tracking scores (M = 3.69); (2) difficulty accessing innovation support, reflected in the lowest mean score in the study (Access to Support, M = 3.14); and (3) interface inefficiencies, particularly the mismatch between tools and human capacity (Human-Machine Interface, M = 3.71). The feasibility of introducing high-tech systems remains low due to limited institutional capacity and the informal nature of these enterprises. Therefore, the study recommends low-cost, user-centered interventions as more viable alternatives.

Three policy-relevant recommendations emerge from this analysis:

1. **Prototype Co-Design Based on Interface Bottlenecks**
   Respondents identified operational pain points—such as labor-intensive manure handling and fragile egg packaging. These suggest the immediate feasibility of co-designed, semi-automated prototypes targeting ergonomic mismatches (e.g., foot-pedaled manure removers or modular egg trays). These tools should be developed through farmer consultation and tested under field conditions to ensure cultural and economic fit. As Vitug [45] emphasizes, participatory prototyping promotes both usability and ownership.
2. **Local Government and SUC-Led Innovation Support Hubs**
   Given the respondents' limited engagement with formal training or funding programs, LGUs and State Universities and Colleges (SUCs) can serve as accessible conduits for innovation readiness. Feasible initiatives include bundled programs that combine basic digital cost-tracking training (e.g., mobile ledger apps) with microfinancing schemes, particularly those requiring no collateral. This addresses ROI-tracking and financial monitoring

gaps without requiring major institutional overhaul.

3. **Development of Innovation Readiness Assessment Tools (IRATs)**

   The study supports the design of a practical IRAT tailored to small-scale livestock enterprises. This tool can diagnose readiness levels per subsystem (social, technical, business, interface), prioritize interventions, and align them with available support mechanisms. Its feasibility lies in building on existing LGU surveys and integrating them into extension services. Similar tools have improved uptake of innovation in smallholder systems across Southeast Asia [46].

These contextualized strategies not only align with RA 11337 (Innovative Startup Act) and the country's inclusive innovation agenda but also respond directly to observable enterprise gaps. By addressing socio-technical constraints at both the farm and system levels, small-scale quail raisers can be better positioned to scale their operations sustainably, reduce risk exposure, and contribute to broader rural development goals including SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure).

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Institutional Review Board Statement

Ethical review and approval were waived as the study involved minimal risk and no sensitive personal data. Participation was voluntary, with informed consent implied through questionnaire completion. The study followed the principles of the Declaration of Helsinki.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study prior to the conduct of interviews and questionnaire administration.

Data Availability

Data supporting the findings of this study are not publicly available.

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Conflict of Interest

The author declares no conflict of interest.

Appendix A. Survey Questionnaire

Final Survey Questionnaire Used in the Study

This appendix presents the structured questionnaire used for data collection in the study entitled "A Socio-Technical Systems Analysis of Small-Scale Quail Farming: Innovation Barriers and Readiness for Agri-Enterprise Growth." The instrument includes Likert-scale items across five domains, aligned with the Socio-Technical Business Systems (STBS) framework. No modifications were made to item wording after piloting, aside from minor simplifications in the Results tables (e.g., shortened phrasing for clarity).

Survey Questionnaire

Title: A Socio-Technical Systems Analysis of Small-Scale Quail Farming: Innovation Barriers and Readiness for Agri-Enterprise Growth

Instructions: Please answer the following questions honestly. Your responses will be kept confidential and used solely for research purposes. Mark your answers clearly.

PART I: RESPONDENT PROFILE

Please answer the following items by selecting the most appropriate response:

1. **What is your age group?**
   - ☐ 18–30 years old
   - ☐ 31–45 years old
   - ☐ 46–60 years old
   - ☐ 61 years old and above
2. **What is your gender?**
   - ☐ Male
   - ☐ Female
3. **What is your highest educational attainment?**
   - ☐ Elementary graduate
   - ☐ High school graduate
   - ☐ Vocational/College undergraduate
   - ☐ College graduate and above
4. **How many years have you been engaged in quail farming?**
   - ☐ 1–3 years
   - ☐ 4–6 years
   - ☐ 7–10 years
   - ☐ More than 10 years
5. **What is the current size of your quail flock?**
   - ☐ 100–199 birds
   - ☐ 200–299 birds
   - ☐ 300–399 birds
   - ☐ 400–500 birds

PART II: SOCIO-TECHNICAL SYSTEMS ANALYSIS

Likert Scale:

Use this scale to rate most statements:

1 – Strongly Disagree | 2 – Disagree | 3 – Neutral | 4 – Agree | 5 – Strongly Agree

2.1. SECTION A: SOCIAL SUBSYSTEM

a. **Work Routines**

- I follow a consistent schedule in managing my daily farm activities. [1] [2] [3] [4] [5]
- I have designated times for feeding, cleaning, and collecting eggs. [1] [2] [3] [4] [5]
- My farm activities are organized and follow a regular workflow. [1] [2] [3] [4] [5]

- I use a checklist or guide to ensure daily tasks are accomplished. [1] [2] [3] [4] [5]
- Unplanned disruptions rarely affect my daily farming routine. [1] [2] [3] [4] [5]

b. **Decision-Making Practices**

- I make decisions in my quail business based on farm data or records. [1] [2] [3] [4] [5]
- I consult family members or workers when making operational decisions. [1] [2] [3] [4] [5]
- I often plan production activities ahead of time. [1] [2] [3] [4] [5]
- I analyze market conditions before making pricing or selling decisions. [1] [2] [3] [4] [5]
- I regularly evaluate the results of my business decisions. [1] [2] [3] [4] [5]

c. **Skill Levels of Owners/Operators**

- I have knowledge of proper quail nutrition and feed formulation. [1] [2] [3] [4] [5]
- I know how to diagnose common diseases in quails. [1] [2] [3] [4] [5]
- I am trained in basic record-keeping or inventory. [1] [2] [3] [4] [5]
- I am confident in handling quail from brooding to laying stages. [1] [2] [3] [4] [5]
- I continuously seek to learn new techniques in quail production. [1] [2] [3] [4] [5]

2.2. SECTION B: TECHNICAL SUBSYSTEM

a. **Technology Adoption**

- I use tools or machines that reduce manual labor in my farm. [1] [2] [3] [4] [5]
- I have adopted at least one modern system or equipment in the past year. [1] [2] [3] [4] [5]
- I am aware of new technologies for quail production. [1] [2] [3] [4] [5]
- I receive technical support when I adopt new tools. [1] [2] [3] [4] [5]
- I believe technology adoption is important for small-scale producers. [1] [2] [3] [4] [5]

b. **Infrastructure Adequacy**

1. My housing system provides enough space for my current flock. [1] [2] [3] [4] [5]
2. My quail housing is well-ventilated and protects against harsh weather. [1] [2] [3] [4] [5]
3. My production area is clean, organized, and easy to maintain. [1] [2] [3] [4] [5]
4. My infrastructure allows me to scale or expand my farm. [1] [2] [3] [4] [5]
5. I have access to clean water and electricity to support my operations. [1] [2] [3] [4] [5]

c. **Process Flow**

1. My workflow from feeding to egg collection is efficient. [1] [2] [3] [4] [5]
2. I have designated areas for brooding, laying, and storage. [1] [2] [3] [4] [5]
3. I encounter minimal delays or duplication of effort during operations. [1] [2] [3] [4] [5]
4. My process from production to delivery is smooth and consistent. [1] [2] [3] [4] [5]
5. I have adjusted my layout to reduce unnecessary movement or time. [1] [2] [3] [4] [5]

2.3. SECTION C: BUSINESS SYSTEM

a. **Inventory Management**

1. I record the number of birds, feeds, and other supplies regularly. [1] [2] [3] [4] [5]
2. I use a logbook or inventory sheet for daily tracking. [1] [2] [3] [4] [5]
3. I am aware of when to reorder feeds or inputs based on usage. [1] [2] [3] [4] [5]
4. I avoid over- or under-stocking of key materials. [1] [2] [3] [4] [5]

5. My inventory practices help me reduce losses and spoilage. [1] [2] [3] [4] [5]

b. **Cost Tracking**

1. I maintain records of all expenses and revenues. [1] [2] [3] [4] [5]
2. I calculate cost per bird or per egg to determine pricing. [1] [2] [3] [4] [5]
3. I set aside budget for emergency expenses (e.g., repairs, mortality). [1] [2] [3] [4] [5]
4. I review and analyze my financial records regularly. [1] [2] [3] [4] [5]
5. I monitor which parts of my operation incur the most cost. [1] [2] [3] [4] [5]

c. **Marketing Channels**

1. I sell my products to a regular buyer or group of customers. [1] [2] [3] [4] [5]
2. I sell through multiple channels (e.g., direct, resellers, online). [1] [2] [3] [4] [5]
3. I use strategies (bundling, promos, social media) to market my products. [1] [2] [3] [4] [5]
4. I brand or package my products to attract customers. [1] [2] [3] [4] [5]
5. I get feedback from my customers regularly. [1] [2] [3] [4] [5]

d. **Profitability**

1. My income from quail farming consistently exceeds my expenses. [1] [2] [3] [4] [5]
2. I have increased my net income from quail farming in the past year. [1] [2] [3] [4] [5]
3. I consider my quail business financially stable. [1] [2] [3] [4] [5]
4. I am able to reinvest earnings into improving the enterprise. [1] [2] [3] [4] [5]
5. My enterprise provides adequate return on time and effort invested. [1] [2] [3] [4] [5]

2.4. SECTION D: INTERFACE MECHANISM

a. **Operational Bottlenecks**

1. My operations are often delayed due to labor or supply shortages. [1] [2] [3] [4] [5]
2. Equipment problems cause production delays. [1] [2] [3] [4] [5]
3. Sudden demand changes affect my production flow. [1] [2] [3] [4] [5]
4. I lack access to timely repairs or replacements for tools. [1] [2] [3] [4] [5]
5. My workflow is frequently interrupted due to coordination problems. [1] [2] [3] [4] [5]

b. **Human-Machine Interface Issues**

1. I find some equipment difficult to use or maintain. [1] [2] [3] [4] [5]
2. I need additional help or instruction to use modern equipment. [1] [2] [3] [4] [5]
3. I rely heavily on manual labor because tools are insufficient. [1] [2] [3] [4] [5]
4. There is a mismatch between available labor skills and equipment used. [1] [2] [3] [4] [5]
5. I modify tools or routines to match my labor availability. [1] [2] [3] [4] [5]

c. **Innovation Constraints**

1. I want to improve my system but lack access to capital or loans. [1] [2] [3] [4] [5]
2. I am not aware of existing innovation programs related to poultry. [1] [2] [3] [4] [5]
3. I face challenges in applying for government or NGO support. [1] [2] [3] [4] [5]
4. I fear the risk of investing in new technology without results. [1] [2] [3] [4] [5]
5. I experience difficulty attending training or seminars due to time/workload. [1] [2] [3] [4] [5]

2.5. SECTION E: INNOVATION READINESS AND ENTERPRISE DEVELOPMENT

a. **Openness to Innovation**

1. I regularly explore new techniques or tools to improve my farm. [1] [2] [3] [4] [5]
2. I am open to adopting digital tools or mobile apps for my enterprise. [1] [2] [3] [4] [5]
3. I actively seek advice from experts, suppliers, or extension workers. [1] [2] [3] [4] [5]
4. I am willing to test small-scale innovations before full investment. [1] [2] [3] [4] [5]
5. I value innovative thinking as part of my enterprise growth. [1] [2] [3] [4] [5]

b. **Willingness to Invest**

1. I am willing to spend part of my income on farm improvements. [1] [2] [3] [4] [5]
2. I allocate budget for upgrading equipment or facilities. [1] [2] [3] [4] [5]
3. I track return on investment for any major improvements. [1] [2] [3] [4] [5]
4. I would invest in innovation if financing options were accessible. [1] [2] [3] [4] [5]
5. I see investment in innovation as a necessity, not a luxury. [1] [2] [3] [4] [5]

c. **Access to Support**

1. I have joined local cooperatives or support groups. [1] [2] [3] [4] [5]
2. I receive updates or invitations from government or NGOs. [1] [2] [3] [4] [5]
3. I know where to access support for innovation or technology adoption. [1] [2] [3] [4] [5]
4. I feel supported by local institutions in growing my enterprise. [1] [2] [3] [4] [5]
5. I have availed of training or mentoring programs in the past year. [1] [2] [3] [4] [5]

PART III. OPEN-ENDED QUESTIONS ON ENTERPRISE NEEDS

Open-Ended Questions

1. What improvements or innovations do you believe would most help your quail business?

2. What support (e.g., training, financing, equipment) would you like to receive to grow your enterprise?

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