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Increasing Egg Viability for Food Security through Rural Household Family Laying Hens Business Models

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Abstract

THIS study was carried out in El-Fayoum and Al-Sharkia provinces, Egypt, and aimed to analyze the business models of Egyptian rural family laying hens and determine their value chain mapping. Two hundred distinct small-scale laying-hen households were randomly chosen from each of the two provinces through a method of stratified random sampling. Each province had 100 households, which were then split up into five districts, each of which had 20 households, and two villages, each of which had 10 households. Direct observation at the farm level and monthly direct interviews utilizing a pretested structured questionnaire were used to gather data. The results indicated that there were three different business models for Egyptian rural families to raise laying hens. These include traditional backyard, micro-franchising, and microfinancing models. The microfinancing and micro-franchising model had higher flock size, laying egg, average egg weight, and female weight at the onset compared to the traditional backyard model. During the study period from January to December 2022, the traditional backyard model (70 eggs/local laying-hen) made a net supplemental income from selling eggs 624-1080 LE/hen/period (20.8 and 36 USD) because of improved productivity of 150-260 eggs/improved and exotic laying-hen in micro-franchising and microfinancing model, respectively. Therefore, for sustainable increasing viability of eggs to meet families' needs and enhanced source of income, traditional backyard laying hen production system must be scaled up to improved business models.

Keywords: Backyard, Micro-Franchising, Microfinancing, Business Models, Laying.

Introduction

Rural poultry production plays a significant role in Egypt's economy. It provides a crucial source of income and food security for many rural families. Rural poultry farming helps supplement the income of households. It's a source of livelihood for many families, especially in rural areas. It is contributing to food security by providing a steady supply of eggs and meat. This is particularly important in rural areas where access to other protein sources might be limited. The poultry sector creates jobs, both directly and indirectly, in rural areas. This includes jobs in feed production, processing, and distribution. While the exact percentage contribution to Egyptian Gross Domestic Product (GDP) is not always clear, the poultry sector is a substantial portion of agricultural activities, in Egypt, which is a key component of the country's economy. In Egypt, around 29% of total eggs are produced in the rural sector [1,2,3]. Significant progress has been made worldwide to raise living standards, combat poverty, and reduce maternal and child mortality, but malnutrition, and lack of food security still exist and many nations are lagging in reaching the sustainable development goals [4,5]. About 30% of people worldwide experienced moderate to severe food insecurity in 2022, up 13.5% from 2019 [6]. This increased trend in food insecurity may be partly attributed to the several challenges the globe faced in 2022, such as the post-pandemic economy, the crisis in Ukraine, the rising costs of food, agricultural inputs, and energy.

Furthermore, in 2022, a noteworthy 22.3% of children under five years old had stunting, compared to 32.4% in Sub-Saharan Africa and 31.8% in South Asia. Other studies reveal that incorporating items derived from animals into a child's diet can significantly reduce stunting in low- and middle-

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income nations. Accordingly, it has been demonstrated that frequent egg consumption greatly improves a child's growth and cognitive development, as well as their nutritional variety, and guarantees that they receive adequate nutrients to fulfill their requirements [5,7]. Eggs are well known for being very cheap and particularly nutrient-dense, with a significant number of essential components in every meal. They contain all of the essential amino acids and are a great source of micro-nutrients and protein.

Despite their evident advantages eggs are still expensive, rare, and infrequently eaten by children in Asia and Africa [8]. In contrast to North America, which has 322 eggs annually, some regions in Asia and Africa have respectively 40 and 87 eggs per capita annually [9]. Moreover, according to data from the U.S. Bureau of Labor Statistics [10], from 2021 until January 2022, in the United States of America, the average cost of a dozen eggs was 4.25-4.82$. According to data from the UNICEF [11] global databases, 22% of children aged 6 to 23 months worldwide eat eggs, nearly 17% of those in the poorest homes, and 30% of those in the richest households. Furthermore, raising poultry is crucial to the livelihoods of rural communities in developing nations [12], but the majority of the poultry farming systems currently in use in these areas are large backyard setups, which are inefficient, unsustainable, and even potentially harmful to human health [13,14].

The availability and consumption of eggs in low- and middle-income nations will not be improved by maintaining chicken production as is, given the aforementioned difficulties. There is a necessity to develop safer, more sustainable, and more efficient methods of producing and obtaining eggs in countries with poor and moderate incomes. In four countries with poor and moderate incomes Kenya, Ethiopia, Malawi, and India Beesabathuni *et al.* [13] and Wong *et al.* [15], examined barriers to egg production and carried out a value chain analysis. Following a thorough examination of the literature and consultation with donors, impact investors, and poultry industry professionals, these nations were chosen. High input prices and restricted access to chicks, feed, vaccinations, extension services, markets, and loans are among the difficulties faced by household poultry families, according to Beesabathuni *et al.* [13] in Kenya, Ethiopia, Malawi, also Banerjee and Ghosh [16] in India and Gharib *et al.* [3] in Egypt.

Five business models were examined by the authors: enterprise development, co-operative farming, microfinance, micro-franchising, and the out-grower model all of which were promoted by various actors, including nongovernmental organizations, private companies, and microfinance institutions, according to Beesabathuni *et al.* [13] and Wong *et al.* [15], who evaluated the egg value chain in three East African and Indian countries. Four criteria were used to analyze these business models: scalability, sustainability, impact, and relevance. Although all five models involved household households increasing egg production through access to soft loans, better inputs, and extension services to varying degrees, four of these models also invested in the grouping of household aggregation to become more economically astute trading partners and take advantage of economies of scale. In the micro-franchising model, hen production rose from an average of 40 eggs per hen in the backyard to at least 100 eggs per hen, and in the company expansion and out-grower model, it reached 290 eggs per hen [13]. Thus, the current study aimed to analyze the business models of Egyptian rural family laying hens and determine their value chain mapping.

Material and Methods

Studied areas and collected data

The two Egyptian provinces of Al-Sharkia and El-Fayoum were chosen as the study areas. Al-Sharkia Province, which is located in northern Egypt between latitudes 30.70 °N and 31.63 °E, is the country's first producer of laying-hen and its third-largest population. El-Fayoum Province, which is situated in the center of Egypt between latitudes 30.84 °N and 29.31 °E, was the second site. Also, it's the oldest province in Egypt to produce poultry [1,2]. The study was performed during 2022 through January and December. The provinces of Al-Sharkia and El-Fayoum were chosen since they had the largest density of small-scale rural laying and the best access to financial markets, based on the majority of household-producing laying hens under Egypt's rural small-scale system. Two hundred distinct small-scale laying-hen households were randomly chosen from each of the two provinces through a method of stratified random sampling. Each province had 100 households, which were then split up into five districts, each of which had 20 households, and two villages, each of which had 10 households. The 200 households reared an average of 10500 laying hens divided into 40 households in the microfinance model reared 6000 laying hens, 60 households in the micro-franchising model reared 3000 laying hens, and 100 households in the traditional backyard model reared 1500 laying hens in two provinces. Direct observation at the farm level and monthly direct interviews utilizing a pretested structured questionnaire were used to gather data about socioeconomics, institutional support, input supply, production performance of small-scale laying-hen chicken farms, and egg marketing from local, improved, and exotic laying-hen.

Statistical Analysis

A pre-test statistical analysis was done and significant differences were observed between the

business models. However, no significant differences were detected among provinces which indicates the similarity among them as far as laying-hen production is concerned, so one-way analysis was used to clarify the objective of the study. The enumeration data from the field survey were tested using the chi-square technique [17]. The general linear model (GLM) of SAS software was used to examine economic and productive data using the least squares method [18]. Duncan's New Multiple Range Test was used to separate the means [19]. $Y_{ij} = \mu + B_i + \varepsilon_{ij}$ was the fixed effects model that was applied in the analysis. Where Y_{ij} is the value of the corresponding variable, μ is the overall mean of the corresponding variable, and B_i is the effect caused by the i^{th} business models where i = 1, 2, and 3 (1 = traditional backyard, 2 = micro-franchising, and 3 = microfinance), and ε_{ij} is a random error related to the ij^{th} observation and is presumed to be independently and normally distributed. The significance difference ($P<0.05$).

Results and Discussion

Egyptian rural family laying hens' business models and their value chains mapping

Findings in Table 1, indicated that there were three different business models for Egyptian rural families to raise laying hens. These include traditional backyard, micro-franchising, and microfinancing models, as mentioned by Beesabathuni et al. [13] in Kenya, Ethiopia, Malawi, also Banerjee and Ghosh [16] in India.

For many rural households, these models are a common and necessary source of food and sustainable income. Rural family laying hen business models in Egypt typically involve small-scale operations with a modest number of laying hens. This allows families to manage the business alongside other agricultural activities or household responsibilities. The primary focus of rural family laying hens' business models in Egypt is to produce eggs for household consumption and sale in local markets. Eggs are a valuable source of protein and essential nutrients for families, contributing to food security.

Model 1: Traditional backyard

In the traditional backyard business model (Table 1 and Figure 1), household women breed and rear-hatched chicks from their owned flocks under traditional conditions. The egg product is used for hatching to get new chicks for a sustainable production cycle. Moreover, for household consumption, and the last part for household income by selling it to neighbors' households. Setting up a traditional backyard laying-hen enterprise in rural Egypt often requires low initial investment costs. Basic infrastructure such as simple housing, scavenging or/with kitchen waste, and water sources with low productivity, low adopted input services, low biosecurity, no vaccinations, and no access to the extension are relatively affordable and accessible to rural families. Moreover, the traditional backyard rural family laying hens' business model in Egypt may involve the use of local laying strains raised in household backyards that are well-adapted to local conditions. These breeds are often hardy and require minimal input. This model of laying hens' businesses in rural Egypt is often integrated with other farming activities, such as crop cultivation or livestock rearing. This integration allows for synergies in resource utilization and diversification of income streams.

In traditional backyard rural families in Egypt often engage in knowledge sharing and mutual support within their communities. This collaborative approach helps in overcoming challenges, sharing best practices, and accessing markets for their egg products. Also, can empower women by providing them with opportunities for income generation and decision-making within the household. Women often play a key role in managing and operating these business models. This finding is in agreement with poultry production, the most primitive (traditional backyard poultry production system), and the most modern manufacturing systems, which are fully automated and integrated, and operate side by side [20]. While the former is a low-input, low-output system, the latter is capital-intensive and employs the newest advances and technology. In nations with low and intermediate incomes, the majority of poultry is produced in backyard systems, mostly using hens [15,21,22]. Despite its low productivity, the traditional backyard poultry production technique is nonetheless crucial to rural communities' food and nutritional security in fragile environments with limited resources [15,23,24].

Model 2: Micro-franchising

This business model is a first step toward an improved traditional backyard (Table 1 and Figure 2). Moderated investment capita as a part of household members' salary for improved laying hen strains are raised. The poultry hatchery sells day-old chicks, together with mixture rations to micro-franchising village agents. To ensure that the chicks are resilient when they are given to backyard raising, village agents breed them until they are 15 to 21 days old. Then sell chicks to the household of women household, sometimes chicks with a mixture of rations. The results are similar to those reported by Beesabathuni *et al.* [13] and Gilbert *et al.* [21] in low- and middle-income nations such as Kenya, Ethiopia, Malawi, and India a hatchery that uses a micro-franchising business model supplies day-old chicks with vaccines and feed to agent. To ensure that the chicks are resilient when exposed to prolonged or backyard growing up, agents breed them until they are 4 to 6 weeks old. Then,

sometimes with feed, they sell these chicks to backyard houses.

As a step toward more income by improving productivity a micro-franchising rural family laying hens' business model group tends to improve their flocks by buying chicks from hatcheries that sell improved laying day-old chicks' strains. This group fed their flocks' mixture rations with improved housing. They had access to extension, but still don't use vaccinations and low biosecurity. As the same result in this model, women play a key role in managing and operating these business models. Households sell production eggs in the village market contrary to the traditional business model which sells to their neighbors to improve household income, but they are similar in consumed at the home level to meet their families' need for food security.

Model 3: Microfinancing

As shown in Table 1 and Figure 3, microfinancing rural family laying hens' business model group, the households had access to loans from women's societies organizations or business associations. Women's economic empowerment projects, which are soft loans that are given to the recipient with no repayment obligations and administrative costs of 5% of the total amount disbursed and paid back throughout one to two years, to cash financing for women's work initiatives in small projects or productive assets to train rural women, develop the role of women in food production, teach them basic life skills, or train them in population and development. It is considered a second step after the adapted micro-franchising model, households tend to raise exotic breeds they buying 100 days of pullets from laying breed companies' agents with high quality balanced commercial ration, and vaccinations. This group adapted input services like Training, veterinary, extension services, improved housing, and access to markets. Households sell eggs in local markets or to middlemen to improve household income sources, they consume a part of the egg at the home level to meet their families' need for food security. The microfinance model is similar in Ethiopia and India, but it is implemented differently. A microfinancing institution (MFI) purchases inputs from a supplier and provides them to micro-entrepreneurs along with loans, extension services, and training on raising backyard chickens. While repaying the loan, women raise chickens and sell their eggs to institutions and the community [13,16,21,22].

Production performance of Egyptian rural family laying hens' business models

As shown in Table 2, the flock size mean, no. of egg/bird/year, average egg weight (gm), female weight at onset (gm), production period length (day), and mortality rate (%) of Egyptian rural family laying hens' business models/hen/period (LE). There were highly significant ($p<0.001$), between laying hens' business models in all measured production performance parameters.

To increase egg viability for food security through a household family laying hens business models, several strategies can be implemented such as micro-franchising and microfinancing business models. The microfinancing model (150, 260, 45.50, 1150.45, 450, and 20) was the highest followed by micro-franchising model (50, 150, 40.45, 1090.50, 540, and 27) in flock size, laying egg, average egg weight, and female weight at the onset but, were the lowest in production period and mortality rate respectively, compared with the traditional backyard model (15, 70, 32.25, 950.75, 720, and 33, respectively). This finding may be due to the microfinancing model of households rearing exotic breeds with balanced diets with improved housing and using vaccination which led to more egg production and income. So, adaptation-enhanced business models improve egg production from 70 eggs per local hen in the traditional backyard model to 260 eggs per exotic hen in microfinancing models. This finding is in agreement with Beesabathuni *et al.* [13] and IDInsight [25], who discovered that the models were increasing the production of hens from an average of 40 eggs per hen in the backyard to at least 100 eggs per hen in the micro-franchising model and the enterprise growth and out-grower model, up to 290 eggs per hen.

Economics efficiency of Egyptian rural family laying hens' business models

As shown in Table 3, the variable cost, benefit, and economic efficiency of Egyptian rural family laying hens' business models/hen/period (LE). There were highly significant between laying hens' business models in all calculated variable cost, benefit, and economic efficiency. The microfinancing model was the highest in total variable cost (1026.81 LE), total revenues (1410 LE), gross margin (383.19 LE), and BCR (1.37 LE), followed by micro-franchising model had total variable cost (840.22 LE), total revenues (964 LE), gross margin (123.78 LE), and BCR (1.14 LE). The lowest value observed in the traditional backyard model, is the total variable cost (586.67 LE), total revenues (631.60 LE), gross margin (44.93 LE), and BCR (1.07 LE).

These results are similar to El-Menawey and Hamouda [26], in Egyptian rural areas, they reported that the total egg revenue, per hen per period was higher in the household groups who adapted to new technology than in the traditional backyard group. It reached about 135.00 and 54.00 LE, respectively. The measures of economic efficiency showed that groups who adopted new technology were more efficient since the gross margin was equal to 130.26 LE as compared to 66.70 LE for the traditional

backyard group. However, the BCR ratio was found to be 3.85% in the adapted new technology group which was higher than the traditional backyard group of 3.53%.

During the study period from January to December 2022, the traditional backyard model (70 eggs/local laying-hen) made a net supplemental income from selling eggs 624-1080 LE/hen/period (20.8 and 36 USD) because of improved productivity of 150-260 eggs/improved and exotic laying-hen in micro-franchising and microfinancing model, respectively. Furthermore, the total variable cost of production per hen/period (LE) in the micro-franchising and microfinancing model are 840.22 and 1026.81 LE for producing 150 and 260 eggs, respectively which means the cost for one egg equal 5.60 and 3.94 LE led to dozen cost is 168 and 118.2 LE, respectively (5.6 and 3.94 USD). The Benefit Cost Ratio (BCR) was higher in the microfinancing model (1.37 LE), Followed by the micro-franchising model (1.14 LE) compared to the traditional backyard model (1.07 LE) was the lowest.

The Return on Investment **(**ROI) reflects the relative return on investment and helps you evaluate the performance of your investment. If the rate of return is positive, it indicates a profit, and if it is negative, it indicates a loss. Results showed that the ROI was higher in the microfinancing model (65.32%), Followed by the micro-franchising model (21.10%) compared to the traditional backyard model (7.66%) was the lowest. Since the soft loans had only 5% administrative costs so upscaling the traditional backyard model to improve business models was more economically profitable.

The results are similar to that reported according to data from the U.S. Bureau of Labor Statistics [10], from 2021 until January 2022, in the United States of America, the average cost of a dozen eggs was 4.25-4.82$. But, in disagreement with those mentioned by Beesabathuni, *et al.* [13] in East Africa and India, because of the increased output of 100 eggs per bird (as opposed to 40) and decreased mortality, backyard households generate a net supplemental income of between USD 72 and USD 144 annually.

Conclusion

This study indicated that there were three different business models in Egyptian rural to raising laying hens. These include traditional backyard, micro-franchising, and microfinancing models. It's important to note that traditional backyard chicken farming has played a big role in rural households for a long time. Local breeds and production methods vary depending on the culture and agroecological system. The microfinancing and micro-franchising models had higher productivity and positive ROI ratios. So, to achieve sustainable improvements to household food security, strategic and systemic training, motivational support, soft loans, and cooperatives are required for rural households to scale up the traditional backyard to new laying hens' business models given that this is a vital sustainable agricultural strategy for promoting food production, food security, and the empowerment of women in Egypt's rural areas.

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Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical of approval

This was a survey study conducted under laying hens in small-scale households' production systems in Egyptian rural areas.

TABLE 1. The main features of rural family laying hens' business models

Model Characteristics	Model 1: Traditional backyard	Model 2: Micro-franchising	Model 3: Microfinancing
Description	Local laying hen strains are grown in backyards, where they scavenge with kitchen waste and farm waste. In systems of low input, low output.	The hatchery sells improved laying day-old chicks to micro-franchisees agents, who are raised to 15-21 days old then sell them to smallholder households.	Laying companies sell day-old chicks to micro-franchise agents, who raise them to 100 days old then sell pullets back to smallholder households.
Household head	Woman	Woman	Woman
Breeds or strains	Owned local	Improved	Exotic
Type of ration	Scavenge & kitchen waste	Mixture & kitchen waste	Commercial ration
Quality of ration	Low	Medium	High
Productivity	Low	Medium	High
Adopted input services	Low	Housing and improved feed	Training, veterinary, extension services, and access to markets

Frequency of use of inputs	Never	Sometimes	Sometimes
Vaccinations	Never	Never	Yes
Access to extension	Never	Sometimes	Sometimes
Extend to biosecurity	Low	Low	Low
Access to market	Village marketplaces and household consumption	Households' consumption and village markets	Village markets
Capita needed	Low	Low	High

TABLE 2. Production performance of Egyptian rural family laying hens' business model/hen/period (LE)

Production performance	Model 1: Traditional backyard	Model 2: Micro-franchising	Model 3: Microfinancing	SEM	P-Value
Flock size mean	15^{c}	50^{b}	150^{a}	3.75	***
No. of egg/bird/year	70^{c}	150^{b}	260^{a}	2.46	***
Average egg weight (gm)	32.25^{c}	40.45^{b}	45.50^{a}	1.54	***
Female weight at onset (gm)	950.75^{c}	1090.50^{b}	1150.45^{a}	10.12	***
Production period length (day)	720^{a}	540^{b}	450^{c}	11.43	***
Mortality rate (%)	33^{a}	27^{b}	20^{c}	1.24	***

[a-b] Each row's means which include different superscripts are significantly different (*** = p<0.001)

TABLE 3. Economics efficiency of Egyptian rural family laying hens' business model/hen/period (LE)

Economics efficiency	Model 1: Traditional backyard	Model 2: Micro-franchising	Model 3: Microfinancing	SEM	P-Value
Variable cost					
Chicks or Pullets price	15^{c}	25^{b}	175^{a}	4.22	***
Rearing feed cost	65^{a}	60^{b}	37.80^{c}	2.45	***
Production feed cost	501.50^{c}	748^{b}	798^{a}	5.11	***
Total feed cost	566.50^{c}	808^{b}	835.80^{a}	3.98	***
Litter cost	0.17^{c}	0.22^{b}	1.01^{a}	0.04	***
Veterinary cost	3^{c}	5^{b}	12^{a}	1.12	***
Water and electric cost	2^{b}	2^{b}	3^{a}	0.05	***
Total variable cost	586.67^{c}	840.22^{b}	1026.81^{a}	5.88	***
Benefit					
Egg revenues	291.60^{c}	624^{b}	1080^{a}	6.58	***
Meat revenues	340^{a}	340^{a}	330^{b}	2.94	**
Total revenues	631.60^{c}	964^{b}	1410^{a}	1.23	***
Economic efficiency					
Gross margin[1]	44.93^{c}	123.78^{b}	383.19^{a}	2.91	***
BCR[2]	1.07^{c}	1.14^{b}	1.37^{a}	0.02	**
ROI[3]	7.66^{c}	21.10^{b}	65.32^{a}	0.01	***

[a-b] Each row's means which include different superscripts are significantly different (**=p<0.01, and *** = p<0.001).
[1]Gross margin= (Total revenues - Total variable cost), [2]Benefit Cost Ratio (BCR)= (Total revenues/Total variable cost), [3]Return on Investment (ROI)= ((Total revenues - Total variable cost)/Total variable cost) ×100.

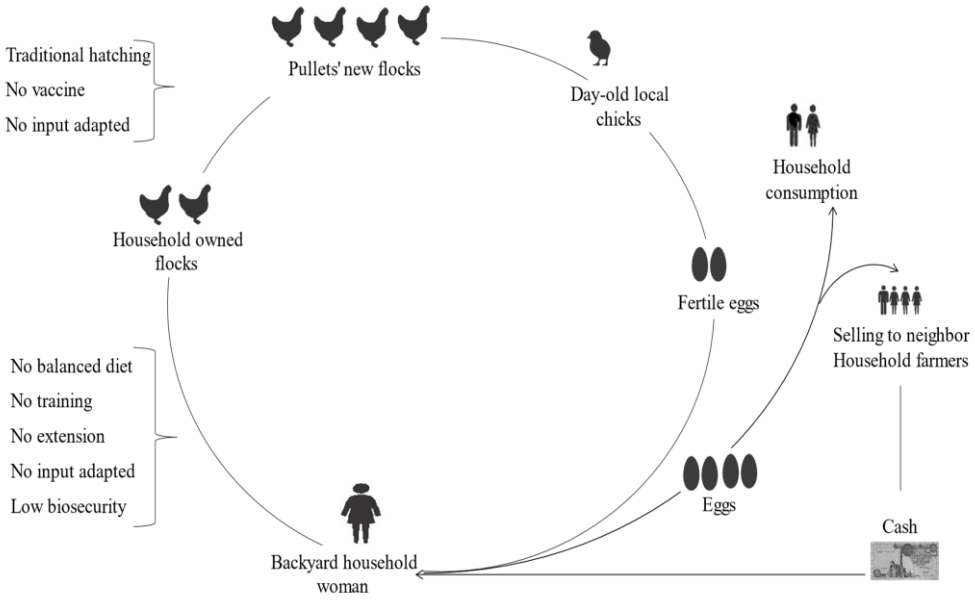

Fig. 1. Traditional backyard Egyptian rural family laying hens' business model value chains mapping.

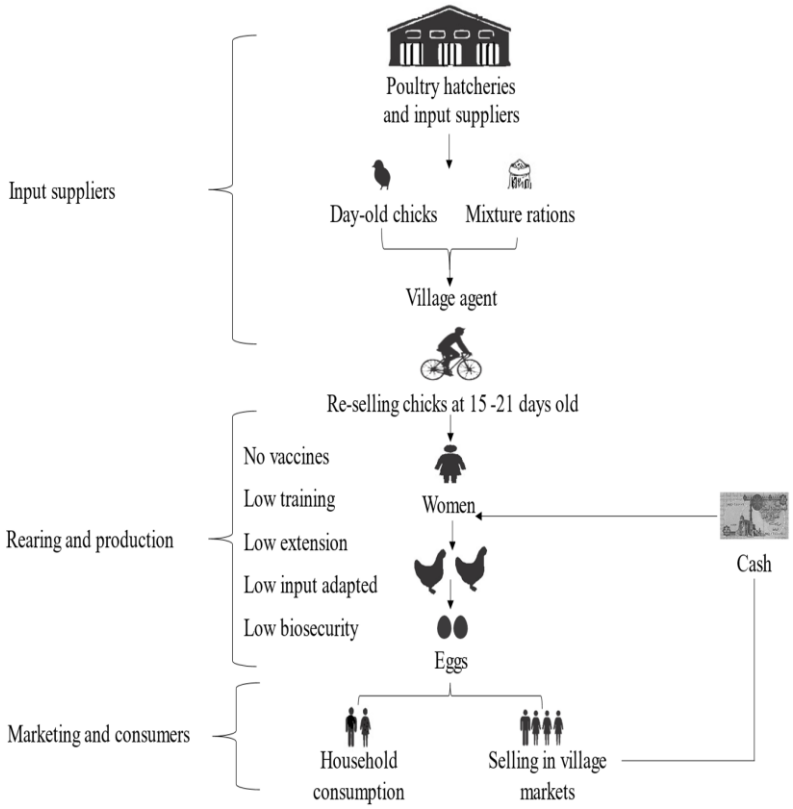

Fig. 2. Micro-franchising Egyptian rural family laying hens' business model value chains mapping.

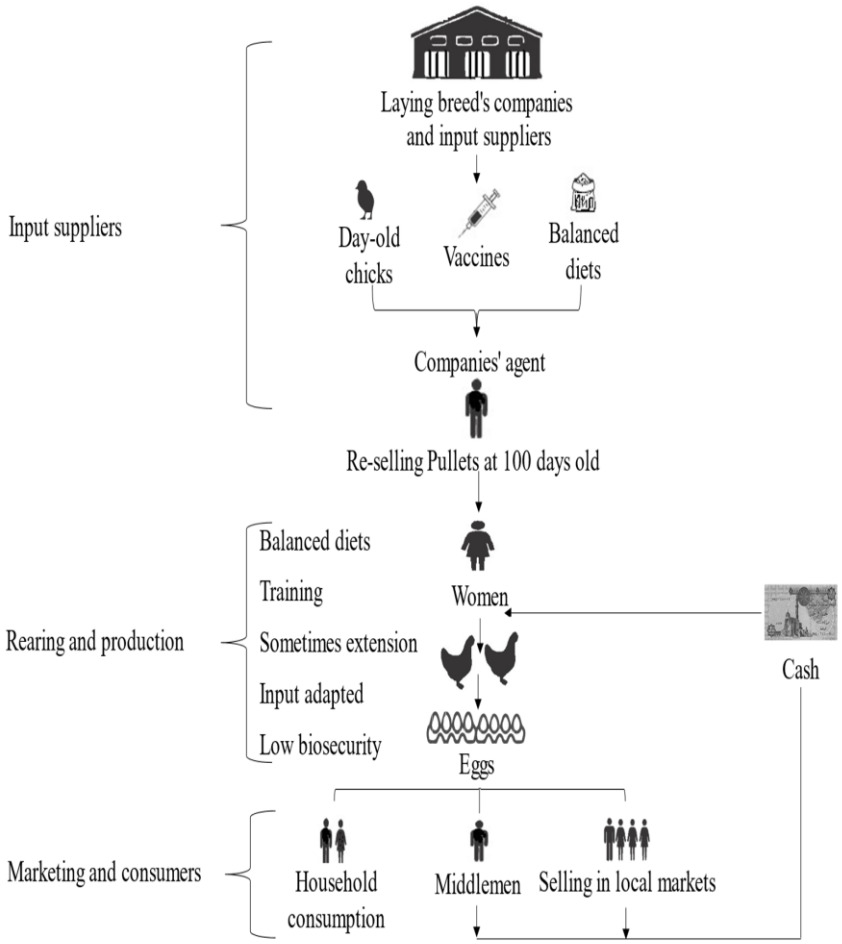

Fig. 3. Microfinancing Egyptian rural family laying hens' business model value chains mapping.

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زيادة المتاح من البيض من أجل الأمن الغذائي من خلال النماذج التجارية الأسرة الريفية للدجاج البياض

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الملخص

أجريت هذه الدراسة في محافظتي الفيوم والشرقية في مصر ، وهدفت إلى تحليل النماذج التجارية الدجاج البياض في الريف المصري وتحديد سلاسل القيمة الخاصة بهم. تم تطبيق تقنية أخذ العينات العشوائية الطبقية لجمع البيانات من 200 أسرة فردية صغيرة الحجم تم اختيارها عشوائيا في المحافظتين، 100 من كل محافظة. تم جمع البيانات من خلال مقابلات شبه منتظمة مع الاستبيانات والملاحظة المباشرة على مستوى الأسرة. أشارت النتائج إلى وجود ثلاثة نماذج أعمال مختلفة للأسر الريفية المصرية لتربية الدجاج البياض. وتشمل هذه نماذج الفناء الخلفي التقليدية ، والامتياز الصغير ، والتمويل الأصغر. كان التمويل الأصغر هو الأعلى يليه نموذج الامتياز الصغير في حجم القطيع ، والبيض البياض ، ومتوسط وزن البيض ، ووزن الأنثى عند عمر بداية وضع البيض ، واقل طول في فترة الإنتاج ومعدل الوفيات على التوالي ، مقارنة بنموذج الفناء الخلفي التقليدي. خلال فترة الدراسة من يناير الي ديسمبر 2022 حقق نموذج الفناء الخلفي التقليدي (70 بيضة / دجاجة) دخلا إضافيا صافيا من بيع البيض 624-1080 جنيها للدجاجة / الفترة (20.8 و 36 دولارا أمريكيا) بسبب تحسين إنتاجية 150-260 بيضة / دجاجة في نموذج الامتياز الأصغر والتمويل الأصغر ، على التوالي. لذلك ، من أجل زيادة مستدامة في جدوى البيض لتلبية احتياجات الأسر وتعزيز مصدر الدخل ، يجب توسيع نطاق نظام إنتاج الدجاج البياض التقليدي في الفناء الخلفي إلى نماذج أعمال محسنة.

الكلمات الدالة: الفناء الخلفي ، الامتياز الصغير ، التمويل الأصغر ، النماذج التجارية ، البياض.